CHAPTER VI

DETREMENTS OF RAILWAY EARNINGS AND EXPENDITURE

The previous analysis of Railway earning and its expenditure shows some interesting trends. This lead us to further analyse the inter-relationship between the variables and their components. Particularly, the gross earning and expenditure both are treated as function of factors such as national income per capita, density of traffic, average haul, industrialization etc., which directly effect the two. We have further investigated the position of different components in the gross earning and expenditure. The object of the later being the determination of place of each component in the total and their possible effect on the gross earning and expenditure.

Simple mathematical formulas are used to achieve the desired ends. In all the regression method of least square is followed. As there are more than one dependent variables in all the functions, multiple regressions are run throughout. The validity of the formula in many cases are also tested by simple and necessary testing techniques.
The data used relates to ten years in all cases, i.e. from 1950-51 to 1959-60 (both years inclusive). The necessary data is assimilated from the Railway Board Reports, most of which have already been referred to earlier. The indicators of other factors are formulated from various sources which have been referred to at suitable places. The period of ten years though not quite long for such a study, yet is not inadequate. We could have taken data for thirteen years, i.e. from 1947-48 to 1959-60, but it being full of events and we cannot have the correct picture of the situation for the present purpose and hence from the underlying calculations, first three years have been left out.

Before, we give the results of regression, it is worth while to briefly introduce the factors influencing the gross earnings in general. Passengers earning is assumed to be affected, mainly by:

1. The improvement in the price level.
2. Passengers traffic.
3. Average distance a passenger travelled, i.e. average load.

Secondly, the goods earning is assumed to be effected by:

1. Growth of industrial and agricultural production.
2. Goods traffic.
3. Average haul.
4. Price level.
Thirdly, the Railway expenditure has been assumed to be affected by:

1 - The level of economic development.
2 - Total traffic
3 - The average speed of trains.
4 - The price level of the country.

Therefore, all these factors are apparently related with the dependent variables as well as among each other.

For purposes of quantifications, the three indicators in the first case were represented by income per-capita which is now generally accepted measure for the level of living, the average density of passengers per mile and average distance the passenger travelled calculated from the reports.

For the second case, the total national income is taken to indicate the growth in the over all production. The indicator is assumed to adequate represent the earnings in agricultural and industrial production, which is not so very realistic, because a substantial part in the total income is on account of other activities. The other two indicators are calculated from the reports. Price level is taken to isolate the effect of prices, if any and while sale price indices indicates this.

1. The total traffic is calculated on the basis of:

\[
P = \frac{\text{Passenger density} \times \text{passengers earning} + \text{goods density} \times \text{goods earning}}{\text{Total earning}}
\]

2. The average speed is calculated on the basis of: Total engine hours
For expenditure, the influence of economic development is indicated by the total national income. The total national income as an indicator of economic development is certainly better than when it is used for agricultural and industrial production as in the second case. The other factors were represented by density of traffic per mile, average speed calculated from the reports and the wholesale price indices, respectively.

In all these three functions, the impact of the Railways rates and fares is likely to be considerable. But because it is more significantly effected by political and economic factors, which are somewhat elaborate, and it is not easy to quantify the changes in it, it has not been taken into consideration in any of the above functions. It is hoped, that the substantial amount of unexplained variables in the dependent variables would be on account of the rates and fare policy.

The general form of the mathematical formula used in the present analysis is:

\[ y = f \left( x_1, x_2, x_3, x_4 \ldots \ldots \right) \]

In all cases logarithmic fractions are taken, which beside from having many other advantages, directly give the elasticity of the dependent variables with respect to the independent one. In other words, the exponent of the independent variables are the elasticities. In logarithmic form, the general functions can be written as:
\[
\log y = \alpha_1 \log x_1 + \beta_2 \log x_2 + \beta_3 \log x_3 + \beta_4 \log x_4 \ldots
\]

which is the same as:

\[
y = A x_1^{\beta_1} x_2^{\beta_2} x_3^{\beta_3} x_4^{\beta_4} \ldots
\]

while \( y \) is the dependent variable (gross earning or gross expenditure in our case) and \( x \) are the independent variables (i.e., the influencing factors described above or the components of gross earnings and expenditure). \( A \) is a constant and \( \beta \) are the exponents or elasticities.

RESULTS OF REGRESSIONS

The following four functions analysed are:

1 - relating passenger earnings with the influencing factors.
2 - relating goods earning with the influencing factors
3 - relating expenditure with the influencing factors
4 - relating expenditure with its components for 10 years.

The results for each are given below:

1. Passengers earnings and the influencing factors:

The factors, i.e. income per capita \((x_1)\), density of passengers per mile \((x_2)\) and average lead per passenger \((x_3)\), explain among themselves 76 per cent of the total variance in
passengers earnings. The values of $\beta_1$ and $\beta_5$ are significant at 5 per cent level of significance, as shown below:

<table>
<thead>
<tr>
<th>Table No. 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results of regression on passenger earning</td>
</tr>
<tr>
<td>$a$</td>
</tr>
<tr>
<td>Calculated ratio</td>
</tr>
<tr>
<td>Standard error</td>
</tr>
<tr>
<td>t - ratios</td>
</tr>
</tbody>
</table>

The major influence on passenger earnings appears to be of the level of living, followed by average distance travelled. The negative influence of density per mile is perhaps explained by the high rate of fare at short distances and vice-versa. The value of $\beta_2$ is however not significant and hence not different from zero. The over-all relationship seems to be in line with the apriori expectations.

2. Goods earning and the influencing factors:

In this case the four functions, namely, total national output ($x_1$), price level ($x_2$), density of goods per mile ($x_5$) and
average haul \( (x_4) \) accounts for 95 per cent of the total variance. But total national output and average haul only are significant. The impact of other two factors are insignificant as shows below:

<table>
<thead>
<tr>
<th>Table No. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results of regression on goods earning</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>( \alpha )</th>
<th>( \beta_1 )</th>
<th>( \beta_2 )</th>
<th>( \beta_3 )</th>
<th>( \beta_4 )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated ratio</td>
<td>0.4648</td>
<td>2.0158</td>
<td>0.0476</td>
<td>0.1080</td>
<td>-1.4166</td>
</tr>
<tr>
<td>Standard error</td>
<td>-</td>
<td>0.0769</td>
<td>0.0176</td>
<td>0.0211</td>
<td>0.9889</td>
</tr>
<tr>
<td>t - ratio</td>
<td>-</td>
<td>26.2135</td>
<td>2.6592</td>
<td>5.0237</td>
<td>-0.1594</td>
</tr>
</tbody>
</table>

The negative influence of average haul is again perhaps due to the negative relationship between the freight rate and distance. Effect of price level and density of goods traffic is also positive.

5. Total expenditure and the influencing factors

The impact of the four independent factors are considerable. These are, national income \( (x_1) \), price level \( (x_2) \), total traffic\( (x_3) \)
and average speed ($x_4$). In other words, 91 per cent of the total variance in the total expenditure is explained by the four factors. The most important effect is of quantity of traffic $\beta_2$ followed by the level of economic development $\beta_4$. The calculated and tabulated values of $\beta$ are given in the following table.

**Table No. 5**

Results of the regression on expenditure

<table>
<thead>
<tr>
<th></th>
<th>$\alpha$</th>
<th>$\beta_1$</th>
<th>$\beta_2$</th>
<th>$\beta_3$</th>
<th>$\beta_4$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated ratio</td>
<td>0.8040</td>
<td>0.6711</td>
<td>-0.5983</td>
<td>0.7617</td>
<td>-0.4167</td>
<td>0.9061</td>
</tr>
<tr>
<td>Standard error</td>
<td>-</td>
<td>0.0476</td>
<td>0.1009</td>
<td>0.0348</td>
<td>0.2444</td>
<td>-</td>
</tr>
<tr>
<td>t - ratio</td>
<td>-</td>
<td>14.0987</td>
<td>5.9526</td>
<td>21.8879</td>
<td>-1.7050</td>
<td>-</td>
</tr>
</tbody>
</table>

Speed and the price level have negative influence. Speed too has negative influence is quite understandable because greater is the speed lesser is the expenditure and vice-versa. But the negative influence of price level is quite unexplained. Fortunately, the influence of these two factors are not significantly different from zero and hence may even be negative.
4. **Expenditure and its components:**

The total expenditure is broadly divided into:

a - expenditure on general administration, as $x_1$

b - expenditure on repair and maintenance, as $x_2$

c - expenditure on operation, as $x_3$

d - contribution to depreciation reserve fund as $x_4$.

The data for the ten years (except for the depreciation reserve fund)\(^1\) has shown considerable consistency and has enabled us to mathematically work out the relative position of each in the total expenditure. The result of regressions on total expenditure on general administration, repair and maintenance, operating expenses (contribution to depreciation reserve fund is not considered because it is not directly related with the total expenditure), as given below:

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1. The same is also evident from the unchanged figures for number of years. Refer to Railway Board Reports, Vol. II Statement No.30 (a).
Table No. 4

Regression on total expenditure and components

<table>
<thead>
<tr>
<th></th>
<th>$\beta_1$</th>
<th>$\beta_2$</th>
<th>$\beta_3$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated ratio</td>
<td>0.8572</td>
<td>-0.0741</td>
<td>0.6048</td>
<td>0.9023</td>
</tr>
<tr>
<td>Standard error</td>
<td>0.4215</td>
<td>0.1611</td>
<td>0.1978</td>
<td>-</td>
</tr>
<tr>
<td>t - ratio</td>
<td>2.0546</td>
<td>-0.4600</td>
<td>3.0576</td>
<td>-</td>
</tr>
</tbody>
</table>

More than 90 per cent of the variance in total expenditure is explained by these three broad components. Among these, all are significantly different from zero. The most important item of expenditure being general administration, followed by operating expenses. The $\beta_3$ co-efficients also broadly indicate the elasticity of the total expenditure with respect to the change in the components. It would be possible, for instance, to work out the total expenditure for the given changes in any two of the three components. Similarly, it would be possible to work out broadly the distribution of a given total expenditure (including the provision for depreciation reserve fund), into three broad components, namely, on general administration, repair and maintenance and operating expenses.

It may be argued that a given provision for depreciation reserve fund leads to a certain increase in the total expenditure
and hence, is related to the total expenditure. We, therefore, tried another regression where all of the four broad categories of expenditure, namely, general administration \( (x_1) \), repair and maintenance \( (x_2) \), operating expenses \( (x_3) \) and depreciation reserve fund \( (x_4) \) were included. The results of the regression are given in the following table:

**Table No. 5**

<table>
<thead>
<tr>
<th>( X )</th>
<th>( \beta_1 )</th>
<th>( \beta_2 )</th>
<th>( \beta_3 )</th>
<th>( \beta_4 )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated ratio</td>
<td>0.9870</td>
<td>0.2059</td>
<td>-0.4796</td>
<td>0.5796</td>
<td>0.2297</td>
</tr>
<tr>
<td>Standard error</td>
<td>-</td>
<td>0.1204</td>
<td>0.0460</td>
<td>0.0566</td>
<td>0.0327</td>
</tr>
<tr>
<td>( t )-ratio</td>
<td>-</td>
<td>1.7101</td>
<td>10.4261</td>
<td>10.2403</td>
<td>7.0245</td>
</tr>
</tbody>
</table>

The explained variance is improved a little as compared to the earlier regression. Operating expenses remained the most important component. Second in importance becomes depreciation reserve fund. Further, expenditure on general administration becomes least important. Moreover, the co-efficient is not significant from zero as apparent from the comparison of the \( t \)-ratio.
In this way, the results of the regression analysis appears to be encouraging, especially because the values of the co-efficient are significant and not unexpected and also the unexplained variance in each case is very substantial. However, a little more refinement in the technique may be required for making these results useful for forecasting, for which such analysis is primarily done.