APPENDIX - 5 B

Testing of returns to Scale :

Production Function - without restriction.

$$Y = \beta_o - X_1^{\beta_1} \cdot X_2^{\beta_2} \cdot X_3^{\beta_3} \cdot e$$

Where X_1, X_2, X_3 are, capital, labour and raw material respectiv y.

β_1, β_2, β_3 are regression coefficients.

Another production function is fitted with a restriction

$$Y = \beta_o X_1^{\beta_1} \cdot X_2^{\beta_2} \cdot X_3^{\beta_3} \cdot e$$

and $\beta_1 + \beta_2 + \beta_3 = 1$

$\therefore$ $\text{Log } Y = \text{Log } \beta_o + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 + \log e$

.which can be written as

$$y = B + \beta_1 X_1 + \beta_2 X_2 + B_3 X_3 + E$$

For estamating the regression coefficient the following procedure is followed.

Four equations are fitted as follows.

$$\beta 1 \Sigma ai^2 + \beta 2 \Sigma ai\ bi + \beta 3 \Sigma ai\ ci + \beta o = \Sigma aidi$$

$$\beta_1 \Sigma a_i b_i + \beta_2 \Sigma b_i^2 + \beta_3 \Sigma c_i b_i + \beta_o = \Sigma b_i d_i$$

$$\beta_1 \Sigma a_i c_i + \beta_2 \Sigma b_i c_i + \beta_3 \Sigma c_i^2 + B_o = \Sigma b_i d_i$$

$$\beta_1 + \beta_2 + \beta_3 = 1$$

Where $a_i = (X_{1i} - \bar{X}_1)$

$b_i = (X_{2i} - \bar{X}_2)$

$c_i = (X_{3i} - \bar{X}_3)$

$d = (Y_i - \bar{Y})$

In the above four equations, there are four unknowns β_1, β_2, β_3, and β_0. Hence these can be solved.

If the estimates arrived at between these two equations are significantly different from one another then, we reject the null hypothesis that $\beta_1 + \beta_2 + \beta_3 = 1$. Therefore the industry doesnot face constant returns to scale. For this F-ratio estimated and tested for significance.

$$F - ratio = \frac{e_2^2 - e_1^2}{e_1^2} \cdot (N - K)$$

Where e_1^2 = Sum of squres of the deviation from the regression equation fitted by the method of least square without restriction.

e_2^2 = Sum of squres of the devitions from the other regression equation fitted with restrition. (i.e. $\beta_1 + \beta_2 + \beta_3 = 1$)

N − K = Degrees of fredom.

If the estimated F − ratio is greater than table value at 5% significance level, then we regect in null hypothesis that

$\beta_1 + \beta_2 + \beta_3 = 1$ and accept the alternative hypothesis

$\beta_1 + \beta_2 + \beta_3 \neq 1$.