5th set assignments Introductory Econometrics

Task 1

Practical example: Nerlove(1963): Returns to Scale in Electricity Supply

A complete discussion of the example can be found in Hayashi(2000), pp.60. To summarize the problem: We want to estimate a microeconomic cost function for the electricity supply sector. Therefore, consider the output of firm i to be determined by a Cobb-Douglas production function:

$$Q_i = A_i x_{i1}^{\alpha_1} x_{i2}^{\alpha_2} x_{i3}^{\alpha_3}$$

where Q_i is firm i's output, x_{i1} is labor input for firm i, x_{i2} is capital input and x_{i3} is fuel. A_i captures unobservable differences in production efficiency (or firm heterogeneity). The α_j are the output elasticities with respect to factor j. The sum $\alpha_1 + \alpha_2 + \alpha_3 \equiv r$ is the degree of returns to scale (note, that $r = 1$ would imply constant returns to scale). The cost function associated with such a production function is:

$$TC_i = r \cdot (A_i x_{i1}^{\alpha_1} x_{i2}^{\alpha_2} x_{i3}^{\alpha_3})^{-1/r} Q_i^{1/r} p_{i1}^{\alpha_1/r} p_{i2}^{\alpha_2/r} p_{i3}^{\alpha_3/r}$$

where TC_i are the total costs for firm i. Linearizing by taking logs yields:

$$\log(TC_i) = \mu_i + \frac{1}{r}\log(Q_i) + \frac{\alpha_1}{r}\log(p_{i1}) + \frac{\alpha_2}{r}\log(p_{i2}) + \frac{\alpha_3}{r}\log(p_{i3})$$

where $\mu_i = \log[r \cdot (A_i x_{i1}^{\alpha_1} x_{i2}^{\alpha_2} x_{i3}^{\alpha_3})^{-1/r}]$. Now, let $\mu = E(\mu_i)$ and define $\varepsilon_i \equiv \mu_i - \mu$ so that $E(\varepsilon_i) = 0$. This ε_i represents the industry's average efficiency relative to the firm's efficiency. We can write for the total cost equation:

$$\log(TC_i) = \beta_1 + \beta_2 \log(Q_i) + \beta_3 \log(p_{i1}) + \beta_4 \log(p_{i2}) + \beta_5 \log(p_{i3}) + \varepsilon_i$$

where

$$\beta_1 = \mu,\ \beta_2 = \frac{1}{r},\ \beta_3 = \frac{\alpha_1}{r}\ \beta_4 = \frac{\alpha_2}{r}\ \beta_5 = \frac{\alpha_3}{r}$$

- Download the Excel spreadsheet `nerlove.xls` and import the data in EViews.
- Create the necessary variables to estimate the cost equation with OLS.
- Estimate the cost equation and interpret the parameters.
- Discuss, whether the assumptions of the classic linear regression model are satisfied.
- Which restriction is implied by the notion that the degree of returns to scale is constant ($\alpha_1 + \alpha_2 + \alpha_3 \equiv r$)?
- Test with two alternative procedures if the above restriction can be rejected.
  Hint: The restricted model reads as:

$$\log\left(\frac{TC_i}{p_{i3}}\right) = \beta_1 + \beta_2 \log(Q_i) + \beta_3 \log\left(\frac{p_{i1}}{p_{i3}}\right) + \beta_4 \log\left(\frac{p_{i2}}{p_{i3}}\right) + \varepsilon_i$$

- Reformulate the model to get the log of the average costs as the independent variable. Then, create the new independent variable and estimate this model. What happens to parameter β_2 in this new setting? Discuss the difference in the two values for R^2 obtained in the total cost and the average cost equation.
- Test the hypothesis that there exist constant returns to scale ($H_0 : r = 1$)
- Eventually, make a residual series from your restricted model estimated previously. Plot the residuals against $\log(Q_i)$. Are you disturbed after looking at the plot?

Data set description:

- `TC` $\hat{=}$ total costs
- `Q` $\hat{=}$ output
- `PL` $\hat{=}$ wage rate (factor price for labor)
- `PF` $\hat{=}$ factor price for fuel
- `PF` $\hat{=}$ rental price for capital