SOK-3011 Linear Models in Economics

Final submission for case I–Applied production analysis.

Case 1: Applied production analysis

Final exam paper. Total points: 50 points.

Submission due date: November 22.

Instructions:

This question paper has two parts. In part 1, answer using theoretical analysis. In part 2, answer based on an analytical discussion of the dataset.

Submit a comprehensive report that includes your answers to each question, along with all relevant estimations, interpretations, and discussions. Additionally, include the code/scripts used for your estimations.

Part 1: Theoretical analysis (15 points)

Question 1: Estimation and homogeneity tests

Suppose you estimate the log-cost Cobb–Douglas regression on a firm sample:

$$\ln c = \alpha_0 + \sum_i \alpha_i \ln w_i + \alpha_y \ln y + \epsilon,$$

where c is cost, w_i are input prices, y is output, and ϵ denotes the error term.

(a) Show how to test the null hypothesis that the cost function is **homogeneous of degree one** in input prices. Write the null hypothesis in terms of the α_is and describe the F-test (restricted vs unrestricted) you would run.

(b) Suppose the F-test rejects homogeneity (you cannot accept degree-one homogeneity). Give **two plausible reasons** for rejection (one economic, one statistical) and for each suggest **corrective actions**.

(c) If some estimated α_i are (near) zero or statistically insignificant, discuss briefly: i. Implications for economic theory; ii. Implications for estimation/statistical-inference.

Part 2: Data analysis (20+10+5 = 35 points)

You will analyze a dataset containing firm-level production and cost data. Using this data, complete the following exercises, providing clear explanations and justifications for each step. You can work with the dataset that you collected for your midterm submission. However, note that **you cannot use the same data set (appleProdFr86) that has already been discussed and analyzed in Arne Henningsen's note** (you must find and work with a different data set).

It is recommended to work with a firm-level dataset that includes at least the following variables: Output–The quantity of goods produced; Inputs–At least two types of inputs; Costs–Total production cost or variable cost, or the input prices. Data on the output price or revenue will also be useful. Ensure that the dataset contains a sufficient number of observations (no. of firms > 25) for meaningful analysis.

Question 2a: Estimation of Production Functions (20 points)

Consider at least three specifications from the following set of production functions: Linear; Cobb-Douglas; Quadratic; Translog.

i. For each specification, estimate the production function using your data. Interpret the estimated coefficients. Analyze and discuss (i) productivity, (ii) returns to scale, and (iii) input substitution, based on the estimated model. Further, evaluate if the observed input choices align with cost-minimizing or profit-maximizing behavior.

ii. Perform a goodness-of-fit analysis. Apply Ramsey's Regression Equation Specification Error Test (RESET) to check for model specification errors. Explain which estimated functional form performs better, using both statistical criteria and economic reasoning.

Question 2b: Estimation of Cost Function or Profit function (10 points)

Here you may choose to work with either the cost function or the profit function, using a Cobb-Douglas specification.

i. Estimate the chosen cost or profit function using your dataset. Interpret the estimated coefficients and assess whether the model aligns with the theoretical economic properties of the cost or profit function. This includes examining the relationships with input and output prices, and applying Shephard's Lemma for cost functions or Hotelling's Lemma for profit functions, as appropriate.

ii. Examine if the estimates provide evidence of optimal input choices, consistent with cost-minimizing or profit-maximizing behavior. Are these observations consistent with the results obtained from the primal approach in Question 2a, in which you estimated the production functions?

Question 2c: Discussion and recommendations (5 points)

Based on your analysis, write a short essay (approximately 500 words) discussing the implications of your findings for understanding firm behavior in the industry from which the data is drawn. Address any limitations of your analysis, including potential issues with data quality, estimation techniques, or model assumptions. Highlight any recommendation or policy implications based on your analysis (e.g., how firms in the industry could improve efficiency).