

EMPIRICAL INDUSTRIAL ORGANIZATION (ECO 310)

Fall 2022 – Victor Aguirregabiria

PROBLEM SET 1

Due on Sunday, October 2, before 11:59pm via Quercus

INSTRUCTIONS. Please, follow these instructions for the submission of your completed problem set.

1. Write your answers electronically in a word processor.
2. For the answers that involve coding in STATA, include in the document the code in STATA that you have used to obtain your empirical results.
3. Convert the document to PDF format.
4. Submit your problem set in PDF online via Quercus.
5. You should submit your completed problem set before **Thursday, September 29, at 11:59pm.**
6. You can discuss about the problem set with you classmates, but your answers and code should be written individually.

The total number of marks is 200.

PROBLEM 1. [70 points]. Consider an industry for an homogeneous product. Firms use capital and labor to produce output according to a Cobb-Douglas technology with parameters α_L and α_K and Total Factor Productivity (TFP) A . Suppose that firms are price takers in the input markets for labor and capital. Let W_L and W_K be the price of labor and capital, respectively.

QUESTION 1.1. (20 points). Derive the expression for the cost function of a firm $C(Y)$ as a function of output Y , the technological parameters α_L and α_K , TFP, and input prices. Explain in detail the different steps in your derivation.

QUESTION 1.2. (20 points). For this question 1.2, suppose that $\alpha_L = 0.5$ and $\alpha_K = 0.4$. Obtain the values of the following elasticities. Explain your answer.

- a. Elasticity of cost with respect to output.
- b. Elasticity of cost with respect to TFP.

- c. Elasticity of cost with respect to the price of labor.
- d. Elasticity of cost with respect to the price of capital.
- e. Elasticity of output with respect to labor.
- f. Elasticity of output with respect to TFP.

Suppose that the output market in this industry is competitive: firms are price takers. The demand function is linear with the following form: $P = 1000 - 10 Q$, where P is the market price of output, and Q is the aggregate output from all the firms in the market. Suppose that $\alpha_L = 0.25$ and $\alpha_K = 0.25$, and input prices are $W_L = 1$ and $W_K = 1$. Suppose also that each firm has a fixed cost (the cost of fixed land) that is exogenous and equal to 10.

NOTE. In this question, there is a third input that is land. We can consider that the production function is: $Y = A L^{\alpha_L} K^{\alpha_K} (Land)^{\alpha_{Land}}$. Since the Land input is the same for all the firms, we can consider, without loss of generality, that firms employ one unit of land. That is $Land = 1$ such that $Y = A L^{\alpha_L} K^{\alpha_K} (1)^{\alpha_{Land}} = A L^{\alpha_L} K^{\alpha_K}$. Since Land is fixed, it is not chosen optimally to minimize costs. Therefore, the fixed cost of land is $W_{Land} * Land = W_{Land}2$, that we assume is equal to 10. This fixed cost can be added to the cost function from labor and capital we have obtained above in Question 1.1.

QUESTION 1.3. (10 points). Taking into account the values of the parameters as established above, write the expression for the profit function of a firm (revenue minus cost) as a function of the market price of output, P , a firm's output, Y_i , and its TFP, A_i .

QUESTION 1.4. (10 points). Using the condition "price equal to marginal cost", obtain the optimal amount of output of a firm as a function of the market price, P , and the firm's TFP, A_i . Explain your derivation.

QUESTION 1.5. (10 points). A firm is active in the market (i.e., it offers a positive amount of output) only if its profit is greater or equal than zero. Using this condition show that a firm is active in this industry only if its TFP satisfies is greater than a threshold value that depends on market price P . Obtain the expression for this threshold value as a function of price. Explain your derivation. Interpret the result.

PROBLEM 2. [130 points]. The datafile *spanish_dairy_farms.dta* contains annual information from 247 dairy farmers in the region of Asturias (Spain) between 1993 and 1998. The dataset includes information on the production of milk in physical units, the number of cows, the amount of feed, labor, and land. Consider a Cobb-Douglas function for the production of milk in terms of the following inputs: cows, feed, labor, and land.

$$MILK = A * COWS^{\alpha_C} FEED^{\alpha_F} LABOR^{\alpha_L} LAND^{\alpha_D}$$

Use this dataset to implement the following estimators and hypothesis tests. Provide the code in STATA and the table of estimation results.

QUESTION 2.1. (20 points).

- Write the production function in logarithms. Interpret it as a linear regression model.
- OLS estimator in model with time dummies. Comment the results.
- Test the null hypothesis $\alpha_C + \alpha_F + \alpha_L + \alpha_D = 1$. Comment the results.

QUESTION 2.2. (20 points).

- Fixed Effects estimator with time dummies. Comment the results.
- Test the null hypothesis $\alpha_C + \alpha_F + \alpha_L + \alpha_D = 1$. Comment the results.
- Test the null hypothesis of no time-invariant unobserved heterogeneity: $\eta_i = 0$ for every firm i . Comment the results.

QUESTION 2.3. (30 points).

- Fixed Effects - Cochrane-Orcutt estimator with time dummies. Comment the results.
- Test the null hypothesis $\alpha_C + \alpha_F + \alpha_L + \alpha_D = 1$. Comment the results.
- Test the four over-identifying restrictions of the model. Comment the results.

QUESTION 2.4. (20 points).

- Arellano-Bond estimator with time dummies and non-serially correlated transitory shock. Comment the results.
- Test the null hypothesis $\alpha_C + \alpha_F + \alpha_L + \alpha_D = 1$. Comment the results.

QUESTION 2.5. (30 points).

- Arellano-Bond estimator with time dummies and AR(1) transitory shock. Comment the results.

- b. Test the null hypothesis $\alpha_C + \alpha_F + \alpha_L + \alpha_D = 1$. Comment the results.
- c. Test the four over-identifying restrictions of the model. Comment the results.

QUESTION 2.5. (10 points). Based on the previous results, select your preferred estimates of the production function. Explain your choice.
