Problem Set 5

Name:________________________

For this problem set, you need to use the Stata datafile “production function.dta.” This datafile contains a panel data set of 575 manufacturing firms in Spain during 9 years: 1982 - 1990. It includes the following variables:

Name	Description	Notation
year	Year	t
id	Firm identification number	i
y	Logarithm of real annual output	$\log(Y)$
lt	Logarithm of annual total employment	$\log\left(L^P + L^T\right)$
lp	Logarithm of annual "permanent" employment	$\log\left(L^P\right)$
k	Logarithm of real capital stock at the beginning of year	$\log(K)$
ik	Investment rate (annual investment / capital beginning year)	I/K
rt	Ratio of temporary employment over permanent employment	$\mathbf{L}^T/\mathbf{L}^P$
wage	Ratio of annual wage bill over total employment	W

We consider an extension of the standard Cobb-Douglas production function. This extended version takes into account that: (1) temporary and permanent workers can have different productivity; and (2) that new investments during the year can have different productivity that the capital stock at the beginning of the year. That is:

$$Y_{it} = A_{it}(L_{it}^P + \lambda_L L_{it}^T)^{\alpha_L}(K_{it} + \lambda_K I_{it})^{\alpha_K}$$

where L^P and L^T represent permanent and temporary workers, respectively; $\lambda_L > 0$ is a parameter that measures the productivity of temporary workers relative to permanent workers; K is capital at the beginning of the year; I represents investment during the year; $\lambda_K > 0$ is a parameter that measures the productivity of new investments relative to old capital; and A, α_L and α_K have the usual interpretation. We can take the logarithm transformation of this production function and - using standard approximations - obtain the following linear regression model:

$$\log(Y_{it}) = \alpha_L \log(L_{it}^P) + \alpha_L\lambda_L \log\left(\frac{L_{it}^T}{L_{it}^P}\right) + \alpha_K \log(K_{it}) + \alpha_K\lambda_K\left(\frac{I_{it}}{K_{it}}\right) + a_{it}$$

Q1. For the following questions, provide the code in Stata /Python and the table of estimation results.

(a) Estimate the parameters of this production function using OLS with time dummies. Present also the estimates of the parameters λ_L and λ_K. Explain the results.

(b) Test the null hypothesis $\lambda_L = 1$. Is temporary labor significantly less productive than permanent labor? Explain.

(c) Test the null hypothesis $\lambda_K = 1$. Is new capital significantly less productive than old capital? Explain.

(d) Test the null hypothesis $\alpha_L + \alpha_k = 1$. Is there significant evidence of decreasing returns to scale? Explain.

Q2. For the following questions, provide the code in Stata/Python and the table of estimation results.

(a) Estimate the parameters of this production function using Fixed Effects estimator with time dummies. Present also the estimates of the parameters λ_L and λ_K. Explain the results.

(b) Implement the same tests as in Questions 1(b), 1(c), and 1(d), and answer the same questions. Explain the results.

Q3. For the following questions, provide the code in Stata/Python and the table of estimation results.

(a) Using the quasi-first difference transformation ($y_{it} - \rho y_{i,t-1}$) obtain the equation of the linear regression model that we estimate to implement the Fixed Effects + Cochrane-Orcutt estimator. The model has 9 parameters, but it imposes 4 restrictions on these parameters. Write the equations for these 4 restrictions on the parameters.

(b) Estimate the parameters of this production function using **Fixed Effects - Cochrane Orcutt** estimator with time dummies. Present also the estimates of the parameters λ_L and λ_K. Explain the results.

(c) Test the 4 restrictions on the parameters implied by the Cochrane- Orcutt model. Test each restriction separately, and also the 4 joint restrictions (5 different tests).

Q4. For the following questions, provide the code in Stata/Python and the table of estimation results.

(a) Estimate the parameters of this production function using Arellano-Bond estimator with time dummies and non-serially correlated transitory shock. Present also the estimates of the parameters λ_L and λ_K. Explain the results.

(b) Test for the null hypothesis of no serial correlation in the transitory shocks. Explain the results.

(c) Test for the over-identification restrictions of this IV estimator. Explain the results.

Q5. For the following questions, provide the code in Stata/Python and the table of estimation results.

(a) Estimate the parameters of this production function using Arellano-Bond estimator with time dummies and with an AR(1) transitory shock. Present also the estimates of the parameters λ_L and λ_K.

(b) Test for the null hypothesis of no serial correlation in the transitory shocks. Explain the results.

(c) Test the 4 restrictions on the parameters implied by the Cochrane-Orcutt model. Test each restriction separately, and also the 4 joint restrictions (5 different tests).

(d) Test for the over-identification restrictions of this IV estimator. Explain the results.