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ECON 52603

**Problem Set 5:**

**Question 1.**

* **(a):** I first noticed that model has a good fit suggest by the high R-squared value.
  + **Estimated Parameters:**
    - **alphaL = 0.6228523**
    - **alphaK = 0.328945**
    - **lambda\_L = -0.9373099**
    - **lambda\_K = -3.805305**
* **(b):** The results indicate that temporary labor is significantly less productive than permanent labor. We can assume that temporary workers are only about 93.7% as productive as permanent workers.
* **(c):** These results indicate that new capital is significantly less productive than old capital. This is an unexpected result for me, but I double checked for potential measurement issues.
* **(d):** The results indicate there is significant evidence of decreasing returns to scale. A proportional increase in all inputs leading to a less than proportional increase in output would be expected.

**Question 2.**

* **(a):** The R-squared shows a good overall fit of the model. From the F-test, we can reject the null hypothesis of no firm-specific effects, making the use of Fixed Effects effective.
  + **Estimated Parameters:**
    - **alphaL = 0.** **0.6869962**
    - **alphaK = 0.2356506**
    - **lambda\_L = -0.6796066**
    - **lambda\_K = -1.266406**
* **(b):** The results indicate that temporary labor and new capital both remain significantly less productive than permanent labor and old capital, respectively. Both the gaps between the levels of productivity from old to new increased from the OLS model. We can still see evidence of decreasing returns to scale, but less confidently than in the OLS model.

**Question 3.**

* **(a):** 
  + The model equation after transformation is:
    - ***yit - ρyi,t-1 = β1(lpit - ρlpi,t-1) + β2(rtit - ρrti,t-1) + β3(kit - ρki,t-1) + β4(ikit - ρiki,t-1) + (εit - ρεi,t-1)***
  + The 4 restrictions from the C-O model are:
    - 1. ***ρ = -β[L.lp]/β[lp]***
    - 2. ***ρ = -β[L.rt]/β[rt]***
    - 3. ***ρ = -β[L.k]/β[k]***
    - 4. ***ρ = -β[L.ik]/β[ik]***
* **(b):** The rho value of this model indicates substantial serial correlation. The F-test for firm specific effects remains significant like all the previous models. The year dummy coefficients show significant and increasing productivity over time. We can assume that temporary workers are around 68% as productive as permanent workers and cannot make as clear of difference in productivity between the new and old capital.
  + **Estimated Parameters:**
    - **lambda\_L = -0.6796066**
    - **lambda\_K = -0.8244414**
* **(c):** There is strong evidence against the C-O restriction for temporary labor (1st restriction), while the evidence is weaker against the C-O restriction for permanent labor (2nd restriction). For capital and the investment ratio, the C-O restriction appears valid (3rd + 4th restrictions). The Joint test of all restrictions shows strong evidence against the joint validity of all C-O restrictions.

**Question 4.**

* **(a):** The chi2 value indicates the model is significant. The year effects still show a trend of increasing productivity over time. We also still see that lower productivity of temporary labor and new capital, this time with less precision than previously.
  + **Estimated Parameters:**
    - **lambda\_L = -rt/lp = -0.889**
    - **lambda\_K = -ik/k = -2.025**
* **(b):** We can reject the null hypothesis of no first-order serial correlation, which is expected. We fail to reject the null hypothesis of no second-order serial correlation, which validates the use of lags greater than or equal to 2 as instruments.
* **(c):** The Sargan and Hansen tests allow us to reject the null hypothesis that instruments are valid. The difference-in-Hansen tests the exogeneity of year dummies as instruments and we fail to reject the null hypothesis that the subset of instruments is exogenous. These test results are evidence there are potential issues with instrument validity.

**Question 5.**

* **(a):** The chi2 value indicates the model fit is good. The better coefficient estimates show improvement over the model without AR(1).
  + **Estimated Parameters:**
    - **lambda\_L = -rt/lp = -0.411**
    - **lambda\_K = -ik/k = -0.276**
* **(b):** The first AR test rejects the null hypothesis of no first-order serial correlation, which is still expected. The second AR test fails to reject the null hypothesis of no second-order serial correlation, like previously, validates the use of lags greater than or equal to 2 as instruments.
* **(c):** All the individual tests fail to reject the null hypothesis, and the Joint test fails to reject the null hypothesis that all restrictions hold jointly. The validation of the C-O restrictions shows a little more improvement over the model without AR(1).
* **(d):** The Hansen test does bring some concern about the instrument validity, but the Difference-in-Hansen test for year dummies suggest that they are valid instruments.