**Business 41903**

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## Problem Set 3

**1.** Consider a model for new capital investment in a particular industry (say manufacturing) where the cross section observations are at the county level and there are T years of data for each county:

$$\log(invest_{it}) = \theta_t + \alpha_i + z_{it}'\gamma + \delta_1 tax_{it} + \delta_2 disaster_{it} + u_{it}.$$

The variable $tax_{it}$ is a measure of the marginal tax rate on capital in the county, and $disaster_{it}$ is a dummy indicator equal to one if there was a significant natural disaster in country $i$ at time $t$ (e.g. a major flood, hurricane, etc.). The variables in $z_{it}$ are other factors affecting capital investment, and the $\theta_t$ represent different time intercepts.

a. Why is allowing for aggregate time effects important in this context?
b. What kinds of variables are captured in $\alpha_i$?
c. Interpreting the equation as a causal model, what sign does economic reasoning suggest for $\delta_1$?
d. Explain in detail how you would estimate the coefficients in this model. Be specific about the assumptions justifying your estimation procedure. How would you estimate standard errors? Again be specific about the assumptions justifying your standard error estimates.
e. Discuss whether strict exogeneity is reasonable for the two variables $tax_{it}$ and $disaster_{it}$; assume that neither of these variables has a dynamic effect on capital investment while answering this question.

**2.** Use the data in murder.raw to answer this question. Use only the data for 1990 and 1993. As your model, use

$$mrdrte_{it} = \delta_0 + \delta_1 d93_t + \beta_1 exec_{it} + \beta_2 unem_{it} + a_i + u_{it}$$

a. Estimate the model by pooled OLS and provide the results. Carefully explain and justify how you compute standard errors. Based on these results, does it appear that there is a deterrent effect of capital punishment?

b. Explain why it doesn't matter whether you use FD or FE in this example. For your preferred estimator, how should you compute standard errors?

c. Provide the FD estimates and appropriate standard errors. Which standard errors do you use and why? Does it appear that there is a deterrent effect of capital punishment based on these results?

d. Which results (POLS or FD) do you prefer in this exercise and why?

**3.** [Simulation Exercise] Consider panel data generated by

$$y_{it} = \rho y_{it-1} + \alpha_i + u_{it}$$

where $u_{it} \sim N(0,1)$ iid over $i$ and $t$, $\alpha_i \sim N(0,1)$ iid across $i$, and $y_{i0} \sim N(\alpha_i/(1-\rho), 1/(1-\rho^2))$. For $\rho = 0$, $\rho = .5$, and $\rho = .95$, do the following:

a. Draw observations for individuals $i = 1, ..., n$ and time periods $t = 0, 1, ..., T$ with $n = 100$ and $T = 6$ from the model.

b. Compute the fixed effects estimator of $\rho$, the first-difference IV estimator of $\rho$ using $y_{it-2}$ as instrument, the Hahn-Kuersteiner bias-corrected estimator (described in the course notes), and the panel jackknife bias-corrected estimator. (The panel jackknife bias-corrected estimator is implemented by computing the full sample fixed effects estimator, $\widehat{\rho}_T$, and leave-one-time period out estimators $\widehat{\rho}_{-t}$ for $t = 1, ..., T$. Each $\widehat{\rho}_{-t}$ is obtained as the fixed effects estimator using all observations *except* those from period $t$. The bias-corrected estimator is then $\widetilde{\rho} = T\widehat{\rho}_T - \frac{T-1}{T}\sum_{t=1}^{T}\widehat{\rho}_{-t}$.)

c. Repeat a.-b. 1000 times.

d. Compute the bias and root-mean-squared-error of each estimator. Form a histogram for each estimator. Do the histograms appear to be approximately normal centered over the true parameter value? Comment on what you think you learn that is generalizable from this exercise.

e. Repeat a.-d. with $T = 25$.

**4.** Autor (2003, *Journal of Labor Economics*) "Outsourcing at Will: The Contribution of Unjust Dismissal Doctrine to the Growth of Employment Outsourcing" studies the effects of laws that limit employers' discretion to terminate workers on employment through temporary help services (THS). The file autor_out2.dat contains a subset of data from this paper. (You could use this data to replicate Table 5 Columns 1 and 2.) The data contain employment and labor law data for the period 1979 to 1995. We will not try to replicate the paper but will instead use these data to play with different panel models. In the following, let $i$ denote state and $t$ denote year.

a. Estimate the model

$$lnths_{it} = \alpha_i + \delta_t + \beta_1 mico_{it} + \beta_2 lnemp_{it} + \varepsilon_{it} \tag{0.1}$$

treating $\alpha_i$ and $\delta_t$ as fixed effects and using standard errors clustered by state. Outline assumptions under which the coefficient $\beta_1$ estimates the causal effect of implied contract exceptions to employment at will (captured by the dummy variable *mico*) on THS employment. Under these assumptions what do your estimates imply about the effect of implied contract exceptions on THS employment?

b. In the paper, Autor includes linear (or higher order) state specific time trends in the estimated models. E.g. estimated models are of the form

$$lnths_{it} = \alpha_i + \delta_t + \kappa_i t + \beta_1 mico_{it} + \beta_2 lnemp_{it} + \varepsilon_{it} \tag{0.2}$$

Estimate (0.2) treating $\alpha_i$, $\delta_t$, and $\kappa_i$ as fixed effects and using standard errors clustered by state. Outline assumptions under which the coefficient $\beta_1$ estimates the causal effect of implied contract exceptions to employment at will (captured by the dummy variable *mico*) on THS employment. Under these assumptions what do your estimates imply about the effect of implied contract exceptions on THS employment? Are the results from model (0.1) and (0.2) statistically or qualitatively different? What does this suggest?

c. You are worried that there may be a latent variable that varies over time and across state - call it the state-level state of the labor market - that is related to passage of laws impacting the labor market and employment in THS. Suppose you believe that $lnemp_{it}$ is a sensible, though likely imperfect proxy for this variable. Use the structural assumption that a labor

market law cannot have a direct effect until it is passed to define an IV strategy and estimate model (0.1) using this IV strategy. Outline assumptions under which the coefficient $\beta_1$ from (0.1) using your IV strategy estimates the causal effect of implied contract exceptions to employment at will (captured by the dummy variable *mico*) on THS employment. Under these assumptions what do your estimates imply about the effect of implied contract exceptions on THS employment?

d. You wish to explore dynamics and consider formal specification testing under the assumption that laws that limit employers' discretion to terminate workers cannot have effects before they are actually passed. To do this you decide to estimate model (0.1) and (0.2) augmented by including four leads and four lags of *mico*. Estimate (0.1) and (0.2) including four leads and four lags in addition to the contemporaneous value of the policy variable (i.e. add four leads and lags of *mico*). You may estimate either the distributed lag or event study specification of the model. What do these results suggest about dynamics and the identifying assumptions in [a] and [b]. (You need not revisit [c], though you can also do so if you wish.)