ECO 272

Practice Mid-Term Examination II

Q.1 We would like to examine whether minimum wages affects unemployment. Consider the following population regression function:

$$Unemp_{cs} = \beta_0 + \beta_1 MinWage_s + \delta \mathbf{X}_{cs} + \epsilon_{cs} \tag{1}$$

The unit of observation is the county c, in state s. *Unemp* is the rate of unemployment in county c; *MinWage* is the state minimum wage. $\mathbf{X}$ reflects other controls.

a) Regression using OLS provides $\hat{\beta}_1 = -0.024$. An omitted variable is the history of labour movements in a state. Assume that states with a strong labour movement have higher minimum wages, or $Cov(Unions_s, MinWage_s) > 0$. Is the estimated β_1 an over-estimate or an under-estimate of the true impact of minimum wage policies on unemployment? Show your steps and clearly state any assumptions you make. [3]

b) We want to test if the effect of minimum wages on unemployment varies by region. We split the U.S. in four mutually exclusive regions: north, south, east and west, denoted by binary variables, and test the following regression specification:

$$\begin{aligned} Unemp_{cs} = \beta_0 &+ \beta_1 MinWage_s + \beta_2 MinWage_s \times East_s + \beta_3 MinWage_s \times South_s \\ &+ \beta_4 MinWage_s \times North_s + \beta_5 East_s + \beta_6 South_s + \beta_7 North_s + \delta \mathbf{X}_{cs} + \epsilon_{cs} \end{aligned} \tag{2}$$

OLS estimation yields the following coefficients:

$\hat{\beta}_1 = -0.037; se(\hat{\beta}_1) = 0.014$
$\hat{\beta}_2 = -0.007; se(\hat{\beta}_1) = 0.002$
$\hat{\beta}_3 = 0.005; se(\hat{\beta}_1) = 0.001$
$\hat{\beta}_4 = 0.02; se(\hat{\beta}_1) = 0.017$

Assuming that unemployment is measured as a fraction ($Unemp \in (0,1)$) and $MinWage$ is measured in USD, interpret the β_1 coefficient in equation (2). [1]

c) Based on the above coefficients, in which counties of the U.S. would you argue unemployment to be the most responsive to changes in minimum wages? Does unemployment in counties in Northern states respond differentially to changes in minimum wage? [3]

d) Set up the equation to test whether the effect of minimum wage on unemployment is statistically equivalent in counties in the eastern states, vis-a-vis counties in the western states. You don't have to solve for the t-statistic, but state the null hypothesis in terms of the coefficients, and write the basic equation for computing the t-statistic. [4]

Q.2) We want to estimate how rapid public transit affects unemployment. We study the rollout of a new metro route in 2017, and workers' employment status. The rapid public transit had stops in select cities (treated), but not others (control). No city had a rapid public transit prior to 2017.

a) The raw summary statistics are the following with μ representing the mean unemployment rate:

μ_{treat}, 2016 $= 0.057$
$\mu_{control}$, 2016 $= 0.069$
μ_{treat}, 2019 $= 0.043$
$\mu_{control}$, 2019 $= 0.051$

Use the summary statistics to compute the unconditional difference-in-difference coefficient, and provide a 1 sentence interpretation of the treatment effect. [1]

b) We formally estimate this using the following linear probability model. The unit of observation is individual i, living in city c, in year t.

$$Pr(Unemp = 1)_{ict} = \beta_0 + \beta_1 Treat_c + \beta_2 Post_t + \beta_3 Treat_c \times Post_t + \delta \mathbf{X}_{ict} + \epsilon_{ict} \tag{3}$$

b) Interpret the β_1 coefficient, assuming $\hat{\beta}_1 = 0.053$ $(se(\hat{\beta}_1) = 0.014)$. [2].

c) Upon estimation using OLS, assume $\hat{\beta}_3 = -0.021$ $(se(\hat{\beta}_1) = 0.007)$. If areas receiving mass transit had lower number of schools per capita in the pre-treatment period, does this make it likely for the treatment effect to be biased upwards or downwards? [3]

d) Consider a set of covariates denoted as $\mathbf{Z}$. $\mathbf{Z}$ includes a number of pre-treatment city covariates, interacted with the post-treatment indicator. Including all the covariates in $\mathbf{Z}$ result in the following treatment effect: $\hat{\beta_3} = -0.019$ ($se(\hat{\beta_1}) = 0.005$). Would you claim the treatment effect to be biased or unbiased? [4]

Note: to receive full credit, you would need to state the assumption which needs to be satisfied for the treatment effect to be unbiased.

Hint: ***Z*** *includes variables such as schools in 2016, roads in 2016, consumption in 2016, crime in 2016, government spending in the city in 2016 and so on, all interacted with the post-treatment indicator.*

Q.3. Consider the following population regression function to study whether enrolling in a 4-year college depends on parental income.

$$Pr(College = 1)_i = \beta_0 + \beta_1 Income_i + \delta \mathbf{X}_i + \epsilon_i \tag{4}$$

The unit of observation is student i, with *Income* denoting parental income for student i, measured in thousands of USD. $\mathbf{X}$ contains other covariates. The outcome of interest is a binary variable $College$, equaling 1 if the high school student enrolled in college.

a) If $\hat{\beta_1} = 0.011$ and $se(\hat{\beta_1}) = 0.0025$, does income have a large or small impact on college enrollment for this sample of students? Assume that the mean of *Income* is 65 (or USD 65,000); the sample mean of $College = 0.38$. [3]

b) The data is from a sample survey with survey weights. The survey weights represent the probability that the student is representative of the population (U.S. high school students) If the survey weights are used to re-estimate the summary statistics, the mean value of *Income* falls to 58 (or USD 58,000). What type of households are over-sampled in the survey [1]

c) We want to test for a differential impact of parental income with parental education on the likelihood of attending college. Consider the following equation:

$$Pr(College = 1)_i = \beta_0 + \beta_1 Income_i + \beta_2 ParentCollege_i + \beta_3 Income_i \times ParentCollege_i + \delta \mathbf{X}_i + \epsilon_i \tag{5}$$

ParentCollege is a binary variable equaling 1 if either parent of student i has gone to college. Assume the following coefficients:

$\hat{\beta}_1 = 0.007$, $se(\hat{\beta}_1) = 0.005$
$\hat{\beta}_2 = 0.19$, $se(\hat{\beta}_2) = 0.047$
$\hat{\beta}_3 = 0.019$, $se(\hat{\beta}_1) = 0.004$

d) Interpret each of the β_1, β_2 and β_3 coefficients. Based on the above coefficients, would you say income by itself affects college enrollemnt? [5]

e) Assume you can reject the null of $\beta_1 + \beta_2 = 0$ at the 5% level. What is the impact of a USD 20,000 increase in parental income on college enrollment, conditional on either parent being educated [2].

f) A possible omitted variable is student IQ. Assume $Corr(IQ, College) > 0$. When would the omission of IQ from equation (4) and (5) not bias the estimated coefficients? [2]

Q.4) We would like to study how property crimes are affected unemployment. The specification of interest is:

$$Crimes_c = \beta_0 + \beta_1 Unemp_c + \delta \mathbf{X}_c + \epsilon_c \tag{6}$$

The unit of observation is county c. *Crimes* is crime per thousand persons; *Unemp* is the county unemployment rate in the past year.

You concerned about omitted variables and decide to include state fixed effects. Upon including state fixed effects $\hat{\beta}_1$ increases from 0.012 to 0.033.

a) Provide a precise 1/2 sentence definition of state fixed effects. State 2 factors which are being controlled for by state fixed effects. [2]

b) Assume that a main omitted variable predicting crimes is the quality of law enforcement ($Enforce_s$) which varies by state. If $Corr(Crime_c, Enforce_s) < 0$, what does this imply about the correlation between unemployment and crime enforcement? [3]

c) You consider including region fixed effects to control for omitted factors, where each region comprises of a collection of states. Upon estimation in OLS, *Stata* omits your region fixed effects and reports only the state fixed effects. The violatio of which classical assumption makes *Stata* omit the region fixed effects. [2]

Hint: the *Pacific* region for instance is made up of California, Washington and Oregon.

d) After including state fixed effects, what type of factors will cause bias in the estimation of β_1 in equation (6)? [2]