

# Theoretical questions

## Derivations

- 1. Given the following conditions:

$$E(u) = 0$$

$$Cov(x, u) = E(xu) = 0$$

$$\hat{\beta}_0 = \bar{y} - \hat{\beta}_1 \bar{x}$$

Derive OLS estimator ( $\hat{\beta}_1$ ) in a simple linear regression using Method of Moments?

- 2. Derive OLS intercept  $\hat{\beta}_0$  for a simple linear regression?
- 3. Given  $\hat{\beta}_1 = \frac{\sum_{i=1}^n y_i(x_i - \bar{x})}{SST_x}$ , derive the variance of OLS estimator (simple bivariate case)?
- 4. Given  $\hat{\beta}_1 = \frac{\sum_{i=1}^n y_i(x_i - \bar{x})}{SST_x}$ , show that OLS estimator is unbiased when SLR1 to SLR4. hold.
- 5. Under asymptotic properties, we say the estimator is **consistent**, when MLR1 to MLR4 are fulfilled. Show the theorem that estimator is consistent (Theorem 5.1)?
- 6. Show that omitted variable bias can lead to inconsistent estimator (**asymptotic case**).
- 7. Assume  $u \sim N(0, \sigma^2)$ . How can we derive a **log-likelihood** estimator for regression, given:

$$L(\beta_0, \beta_1, \sigma^2) = \left( \frac{1}{\sqrt{2\pi\sigma^2}} \right)^n \prod_{i=1}^n e^{-\left\{ \frac{1}{2} \frac{(y_i - \beta_0 - \beta_1 x_i)^2}{\sigma^2} \right\}}$$

- 8. Assume a regression equation:

$$y = \beta_0 + \beta_1 x_1 + u$$

Derive an IV estimator using an instrument  $z$ .

## Formulae and other theory

- 9. What is the formula of the total sum of square (SST) of a variable  $y$ ? What is the formula of the estimated sum of square (SSE) of a variable  $y$ ? What is the formula of the residual sum of squares (SSR)?
- 10. What is the difference between adjusted  $R^2$  and  $R^2$ ?
- 11. Can you describe the Gauss-Markov assumptions? Which assumptions are required to show that OLS is unbiased/consistent? Which assumptions are required to show OLS is BLUE?
- 12. How does OLS estimate the estimators OR what is the objective function solved by OLS?
- 13. What are the consequences of including irrelevant variables in a regression?
- 14. What are the consequences of omitting a relevant variable in a regression?
- 15. The variance of the error term is represented by  $\sigma^2$ , what is the formula of computing  $\sigma^2$ ?
- 16. What is the formula of t statistics or t ratio?
- 17. What is right tailed, left tailed, and two-sided test?
- 18. What are the (desirable) properties of error term in OLS?
- 19. What are the conditions that instrumental IV should satisfy?
- 20. What is a reduced form equation in the context of IV regressions?
- 21. What is the difference between 'just identified' and 'over identified model' in the context of IV regression?
- 22. What is the difference between the equations of OLS and IV estimators (write the two equations)?
- 23. What are logit and probit regressions? What are average partial effects (APE) and partial effects at average (PEA)?

**NOTE:** You might be asked other relevant questions not included in this list