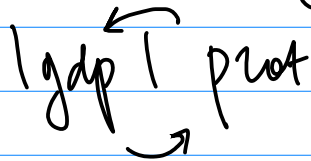


SEM

- 1) omitted variable
- 2) measurement error
- 3) simultaneity



1) relevance $\text{cov}(z_i, x_i) \neq 0$

2) exogeneity $\text{cov}(z_i, \epsilon_i) = 0$

$$\hat{\beta} \xrightarrow{r} \beta + \frac{\text{cov}(x_i, \epsilon_i)}{\text{var}(x_i)} \uparrow \frac{1}{\sigma^2(z_i)} \text{ bias}$$

$$E(\hat{\beta}_2) = \beta_2$$

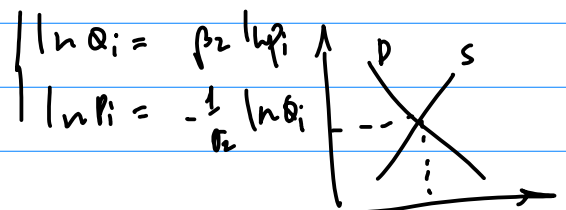
(p2.)

$$D: \ln Q_i = \beta_1 + \beta_2 \ln P_i + \epsilon_i, \beta_2 < 0 \quad \lim_{n \rightarrow \infty} \hat{\beta}_2 = \beta_2$$

$$S: \ln Q_i = \gamma_1 + \gamma_2 \ln P_i + \gamma_3 \ln T_i + u_i, \gamma_2 > 0 \leftarrow$$

$$\text{cov}(\ln T_i, \ln P_i) \neq 0$$

↑ structural form



$$\text{cov}(\ln T_i, \epsilon_i) = 0$$

reduced form

$$\begin{cases} \ln Q_i = \theta_1 T_i + \theta_2 \epsilon_i + \theta_3 u_i \\ \ln P_i = - \end{cases}$$

$$\text{cov}(\ln P_i, \epsilon_i) = \text{cov} \left(\frac{\beta_1 + \epsilon_i - \gamma_1 - \gamma_3 \ln T_i - u_i}{\gamma_2 - \beta_2}; \epsilon_i \right) =$$

$$\left. \begin{array}{l} \{ \text{cov}(T_i, \varepsilon_i) = 0 \\ \text{cov}(u_i, \varepsilon_i) = 0 \} \end{array} \right\} = \frac{\sigma_\varepsilon^2}{\sigma_2 - \beta_2} \neq 0$$

$$\sigma_2 > 0 \Rightarrow > 0$$

$$\beta_2 < 0$$

$$\begin{cases} W_i = \alpha_0 + \alpha_1 \cdot p_i + \cancel{\alpha_2} \cdot u_i + \cancel{\alpha_3} z_i + \varepsilon_i \\ p_i = \beta_0 + \beta_1 W_i + \beta_2 u_i + \cancel{\beta_3} z_i + v_i \end{cases}$$

(a) $\alpha_2 = \alpha_3 = 0$

$$\begin{cases} W_i = \alpha_0 + \alpha_1 p_i + \varepsilon_i & \text{over} \\ p_i = \beta_0 + \beta_2 W_i + \beta_3 u_i + \beta_4 z_i + v_i & \text{under} \end{cases}$$

(b) $\alpha_2 = \beta_3 = 0$

W_i - exact \Rightarrow exactly identified
 p_i - exact

(c) $\alpha_2 = \alpha_3 = \beta_3 = 0$