19.01.2021 Econometrics - I : Lecture 3.

Concept of ceteris paribus (all else held constant).

⇒ KEY TO ESTABLISHING CAUSALITY

Aside: Doodle Poll.

Tue : 1:30p – 2:30p ✓ } Maj vote

Fri. ~~Tue~~ : 12:30p – 1:30p ✓

Fri : 1:30p – 2:3p. } significant votes

*Always available by email & appointment (GA)

Ceteris paribus (all else held constant)

$X \longrightarrow Y$

→ In order to establish a $\boxed{\text{causal relation}}$ of X on Y, we implement/simulate an experiment wherein X is shocked or changed by a unit and observe the resulting change in $\underline{Y}$, while

→ keeping all remaining covariates constant

* (including those that were unobserved but potentially correlated with X)

$$\Rightarrow \underline{wage_i} = \beta_0 + \beta_1 \underline{educ_i} + \beta_2 \underline{exper_i} + \beta_3 \underline{training_i} + \underline{u_i}$$

(Yes/No)

$$i = 1, 2, --, N = 1000$$

Parameter of interest → β_3

No training → $train_i = 0$

(Yes) training → $train_i = 1$

$$\beta_3 = \left. \frac{\partial wage}{\partial train} \right|_{\substack{d(educ)=0 \\ d(train)=0}}$$

$$wage_i = \beta_0 + \beta_1 \, edu_i + \beta_2 \, exp_i + \beta_3 \, train_i + u_i$$
$$+ \beta_4 \, female_i$$

$i = 1, 2, \ldots, N$

$$\frac{\partial wage_i}{\partial train_i} = \underline{\beta_3} \leftarrow \text{parameter of interest.}$$

But

$\hookrightarrow$ β_3 value (estimated from data)

Causation or simply $\underbrace{\text{an association}}_{\text{correlation}}$?

[everything to do with ceteris paribus]

[nothing to do with ceteris paribus]

To further the discussion on causality we must focus on the unobserved error or u

u_i →
- ability
- age
- prev. contributions / status
- referrals
- $\boxed{\text{Gender}}$ $fem_i = \begin{cases} 1 & \text{if } i \text{ is female} \\ 0 & \text{otherwise.} \end{cases}$

$$wage_i = \beta_0 \cdot 1 + \beta_1 \, educ_i + u_i \quad i = 1, 2, \ldots, N$$

i	$wage_i$	$educ_i$
1	2000/hr	10
2	1500/hr	11
3	500/hr	15
⋮	⋮	
100	1200/hr	10

Among the unobservables we could have "innate ability"

What is the causal impact of an addinal year of education on wages?

educ. level = 10 years → collect individuals → $\bar{w}_{10}$ (avg. wage)
educ. level = 11 years → collect individual → $\bar{w}_{11}$ (avg. wage)

$$\beta_1 = \bar{w}_{11} - \bar{w}_{10} > 0$$ → is this an association? (Yes)
or a causal relation? (Not necessarily)

It is feasible that individuals of higher innate ability would generally choose to spend more years in education?

Hence, I wasn't able to simulate the ceteris paribus experiment.

(on)

$$wage_i = \beta_0 + \beta_1 educ_i + \beta_2 abil_i + u_i$$

$$\beta_2 (m_1 + m_2 educ)$$

$$\left.\frac{\partial wage}{\partial educ}\right|_{d(abil.)=0} = \beta_1$$

Aside

$\text{Corr}(wage, educ)$ $\quad \text{Corr}(educ_i, abil_i) \neq 0$

$\text{corr}(educ, abil)$ $\quad = 1$

$\text{corr}(wage, abil.)$ $\quad abil_i = m_1 + m_2 educ_i$

Aside

Association / correlation → intechangeably

$Z_1, Z_2 \rightarrow \text{Corr}(Z_1, Z_2) = 0.8$

Causation → simulate ceteris paribus experiment

Aside

Example 2.

20 kg/ac — 24 kg/ac

(1) $\text{Yield}_i = \beta_0 + \beta_1 \text{fertilizer}_i + u_i$

(kg/ac)   (kg/ac)

$i = 1, 2, \ldots, 10{,}000$

Is there a causal relation between an additional unit of fertilizer on crop productivity?

$$\beta_1 = \frac{\partial \text{ yield}}{\partial \text{ fert.}}$$

Did I simulate a ceteris paribus experiment?

$u_i <$ Rain (weather), soil quality

exogenous

(2) $\text{yield}_{it} = \beta_0 + \beta_1 \text{fertilizer}_{it} + \beta_3 \text{age}_{it} + u_i$

$+ \beta_4 \text{rain}_t + \beta_5 \text{soil}_i$