Introduction, sufficient Statistics and Calibration

CUHK Structural Estimation Workshop

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About this workshop

- Just a guideline!
- Practice need perfect!
- Nobody born to know!
- Be critical and kind!

▶ Causal inference and related methodology

▶ One alternative: sufficient statistics

▶ General concept and process of structural estimation

▶ Calibration

Several approach to causal effect

- RCT (experiment)
- Reduced-form and (quasi) experiment
  - Usually based on Rubin's PO (potential outcome) framework
- Structural form: describe based on theory
- Directed Acyclic Graph (DAG) (Usually in computer science)

RCT: clearest causal effect

Doubt on reduced-form and design-based causal inference

- RCT: not knowing mechanism behind data, thus cannot make policy evaluation and welfare analysis
  - Especially sensitive to heterogeneity: which mechanism dominate
  - External validity
- RCT is useless for strategic behavior and causal relationship in general equilibrium
  - Cannot keep all other conditions equal in reality
- High cost of RCT, hard to implement, short valid periods
  - Hard to analyze dynamic effect
- (Quasi) Experiment: Lack of discussion on uncertainty and complexity
- Experiment: Lack of theoretical foundation and usage of a lot of data

Why or why not Structural Model

- Clear explanation power
  - Analysis: theoretical model, clear assumption and variable, information structural
  - Application: Cost-benefit and welfare analysis, counterfactual analysis, simulation, prediction...
  - Establish data generating process, characterizing by parameters
- Rely on reasonable assumption
  - Assume behavior pattern
  - Assume heterogeneity distribution
- Large scale of computation, difficulty in estimation

Combine Structural with reduced form / RCT

Chen Z, Jiang X, Liu Z, et al.　"Tax Policy and Lumpy Investment Behaviour: Evidence from China's VAT Reform"．The Review of Economic Studies, 2023, 90: 634-674.

- Impact of value added tax reform on firm investment
- DID: 2009 VAT reform on whether invest and investment rate
- Dynamic investment model: fixed and quadratic adjustment cost, partial impossibility inverse
  - Extensive and intensive margin decision
- Use the impact of value added reform (From DID!) as moment condition (From structural!)
- Result: Which tax policy can stimulate investment?

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Sufficient statistics

- Usually for policy and taxation
- Combine the pros of structural and reduced form
- No need for complex model
  — Structural model: reduce dimension by functional form
  — Sufficient statistics: reduce dimension by restricting policy content and preference

General process
- Setup a model from theory
- Use Largrangian multiplier to represent marginal welfare effect
- Use marginal utility and Lagrangian multiplier to represent taxation's marginal welfare
- Use equilibrium condition to represent good's marginal utility and taxation and welfare elasticity
- Estimate the impact of taxation on marginal consumption, thus welfare
- Evaluate by checking assumption condition

Chetty (2009): p4; p18-p23

Chetty's note

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- General steps: Taber's note: p8-p19
  — Taber's note
- Private content, p13-p46

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Calibration is for structural, but not "structural estimation"

- Calibrate and estimate are two concepts
  - Taylor, p12
    - Taylor's note
- General practice: Sargent, p11-p33
  - Sargent's note

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Thank you for listening!
Any questions?