Granular Instrumental Variables
Gabaix & Koijen

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Erik Loualiche

Motivation

How to estimate a demand (or supply) curve

$$Y = \beta X + \epsilon$$

- Assume $\epsilon \perp X$
- Or find instrument z such that
    - $z \perp \epsilon$: **exogeneity**
    - but $z \not\perp X$: **relevance**

Simple idea: use variation from idiosyncratic shocks

- By construction idiosyncratic shocks are orthogonal to aggregate conditions: **exogeneity**
- Find idiosyncratic shocks such that they are **relevant**
- Granularity: large market participants have idiosyncratic shocks that are both exogenous **and** relevant

Discussion

Easy criticism: free "lunch" flavor

- We have shocks that are large for one condition
- But happen to be small with respect to another ...

Outline limitations

- Main result is very general: only interesting if it's not a tautology
- Understand exactly where it bites: highlight its limitations and what works

Outline use in Asset Pricing

- Missing exogeneity in estimating demand for assets (Koijen & Yogo!)

Plan

Walrasian Assumption

Simultaneous Demand System

$$y_{it} = \phi_d p_t + \eta_t + u_{it}$$
$$q_t = \phi_s p_t + \varepsilon$$

- Equilibrium condition: $q_t = \sum_i y_{it}$

- Equilibrium price:
$$p_t = \frac{\sum_i S_i u_{it} + \eta_t}{\phi_s - \phi_d} - \frac{\varepsilon_t}{\phi_s - \phi_d}$$

Endogeneity

- How can you estimate supply elasticity: since $p_t \pm \varepsilon_t$

Idiosyncratic Assumption

Idiosyncratic shocks

- Idiosyncratic demand of small player: u_{1t}
  - ▸ Exogeneous: $\mathbf{E}u_{1t}\varepsilon_t = 0$ and $\mathbf{E}u_{1t}\eta_t = 0$
  - ▸ But is it relevant? $\mathbf{E}u_{1t}p_t \neq 0$?

Use a large player, say Walmart

- Then we have **relevance** because large
- But do we have exogeneity then? Yes if truly idiosyncratic and firm is a price taker

Implementation: Granular Residual

- How do get in a *systematic* way these large shocks
- Difference between "value"-weighted and equally-weighted demand:

$$\sum S_i y_{it} - \frac{1}{N}\sum y_{it} = \sum S_i u_{it} - \frac{1}{N}\sum u_{it} = u_{\Gamma,t}$$

Discussion of Exogeneity

Walrasian Assumption

- Each market participant is a price taker: *especially* large actors
- Is this a good assumption?
- When is large too large to stay in a non-strategic world
    - Revival of monopsony power literature

Tension between exogeneity and relevance

- Relevance pushes us towards taking shocks of large firms
- This clashes with the exogeneity

Plan

What are the shares in a demand model

Instrument built based on shares of output

$$z_t = \sum S_i y_{it} - \frac{1}{N} \sum y_{it} = \sum S_i u_{it} - \frac{1}{N} \sum u_{it} = u_{\Gamma,t}$$

- S_i are shares that gauge the importance of i in overall demand (or supply)
- Assumption in building instrument: shares are orthogonal to shocks and demand

Other examples

- Similar assumptions on exogeneity of shift shares instrument: Bartik

What are the shares in a demand model

Simplest model of firm heterogeneity

- Heterogeneous firm with CES demand (Melitz-like)
- Sales of firm with productivity φ, have sales share $S_\varphi \propto \varphi^\sigma$
- Lower bound on productivity, $\underline{\varphi}$: the equilibrium quantity on the production side
- What is the granular residual?

$$\varphi_\Gamma = \int_{\underline{\varphi}}^{+\infty} S_\varphi \varphi dF(\varphi) - (1 - F(\underline{\varphi}))^{-1} \int_{\underline{\varphi}}^{+\infty} \varphi dF(\varphi)$$

- φ_Γ depends on *equilibrium* productivity
- Assume Pareto distribution of productivity shocks, $F(\varphi) = 1 - \varphi^{-\gamma}$

$$\varphi_\Gamma = \underline{\varphi} \cdot \left(\frac{\gamma - \sigma}{\gamma - (\sigma - 1)} - \frac{\gamma}{\gamma + 1} \right)$$

Plan

Finding idiosyncratic shocks

Are idiosyncratic shocks large?

- Foster, Sarte & Watson: strong factor structure in productivity
- Idiosyncratic shocks are small
- How granular are actually economies

Rise of superstar

- Larger entities means better idiosyncratic shocks
- But also structural changes in economy

Plan

Examples

Siriwardane

- Large players in CDS market

Koijen & Yogo

- Estimating demand system

Final Thoughts

Results

- Great paper!
- Super creative ... and of course very complete

Some shortcomings

- A few examples ...
- ... but lacks discussions of true limitations to make it accessible