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Set Identified Dynamic Economies and Robustness to Misspecification

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Motivation

- Frictions are an integral part of dynamic equilibrium models
- Nevertheless, the selection and specification of the relevant mechanisms involves arbitrary assumptions. Should we care?
  - Different mechanisms M_i imply a different mapping from policy to outcomes:

$$\mathrm{M_i} : (\mathcal{X}, \text{Policy}) \to \mathcal{Y}$$

- Hard to distinguish across M_i's with standard macroeconomic data and methods

Highlights of our Approach

- We propose a methodology that is robust to misspecification and utilizes survey information
- **Robustness**: Economy with frictions as a family of perturbations to the frictionless economy that are not uniquely pinned down
- For any of those perturbations, unique moment inequalities are satisfied
  - **Set identification**
- We further constrain the admissible models by using qualitative surveys: **Distributional** information, important for heterogeneous agent economies
- We illustrate how one can use the set of identified economies to do inference about a complete model

Partial Equilibrium Example: Liquidity Constraints

- Consumption - Savings decision of household i:

$$\max_{\{c_{i,t}\}_1^\infty} \mathbb{E}_0 \sum_{t=1}^{\infty} \beta^t \frac{c_{i,t}^{1-\omega} - 1}{1-\omega}$$
$$s.t. \quad y_{i,t} = s_{i,t} + c_{i,t}$$
$$w_{i,t+1} = Rw_{i,t} + s_{i,t} \geq 0$$

- Euler equation

$$\Delta c_{i,t+1} = ((\beta(1+r))^{\frac{1}{\omega}} - 1)c_{i,t} + \epsilon_{i,t+1} + \lambda_{i,t+1}$$

where

$$\mathbb{E}_t \lambda_{i,t+1} \geq 0$$

- Implied bound on risk aversion

$$\omega < \frac{\| \log(\beta(1+r)) \|}{\log \mathbb{E} y_{i,t} c_{i,t} - \log \left(\mathbb{E} y_{i,t} c_{i,t} - \| \mathbb{E} y_{i,t} \Delta c_{i,t+1} \| \right)}$$

- Consistent with many mechanisms $b(.)$ such that $w_{i,t+1} \geq -b(w_{i,t}, y_{i,t})$
- **Intuition**: High $\mathbb{E} y_{i,t} \Delta c_{i,t+1} \leftrightarrow$ Low $\bar{\omega} \leftrightarrow$ Agent not insured enough...
- $\mathbb{E} \lambda_{i,t+1}$ measures average distortions in consumption growth
  - Non trivial function of parameters and potentially wide
- Can we do better?

Why Qualitative Survey Data is Useful

- Suppose that we also ask whether the household has (or expects to have) any financial constraints.
- This determines whether $\lambda_{i,t} > 0$ and is model free!
- It can be shown that the following quantile restriction holds, for $\tilde{\mu} := (\beta(1+r))^{\frac{1}{\omega}} - 1$:

$$\mathbb{P}_t(\Delta c_{i,t+1} < u) \geq \Phi_{0,\sigma_\epsilon^2}(u - \tilde{\mu} c_{i,t}) \mathbb{P}_t(\lambda_{i,t+1} = 0)$$
$$+ \Phi_{0,\sigma_{\epsilon,ols}^2}(u - \tilde{\mu}_{ols} c_{i,t}) \mathbb{P}_t(\lambda_{i,t+1} > 0)$$

- As long as $\mathbb{P}_t(\lambda_{i,t+1} > 0) \in (0,1)$, then the set of admissible models shrinks
  - **Intuition**: Constraints are only occasionally binding...
- Mechanisms that could not be rejected using consumption data can now be discarded

Extension to General Equilibrium

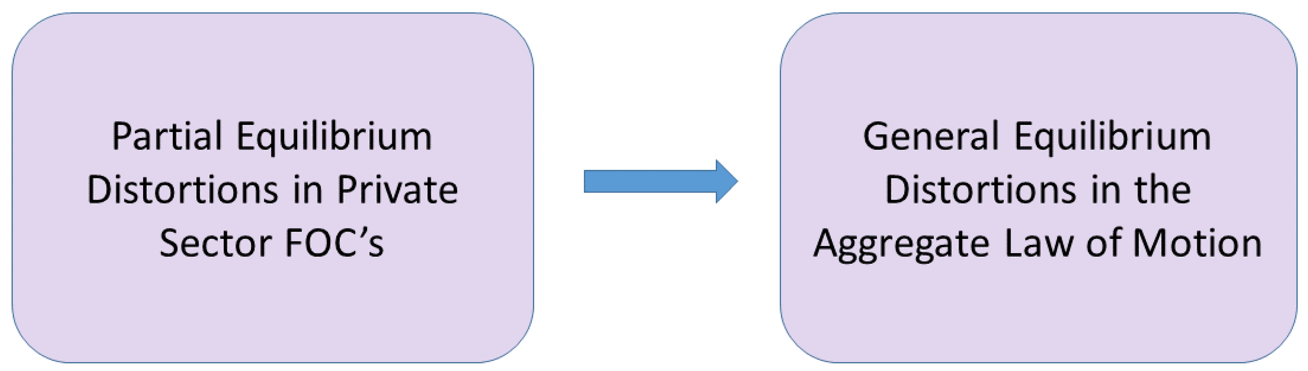
- For $\lambda_t := \int \lambda_{i,t} d\Lambda_t(i)$,

$$\mathbb{E}_t \lambda_{t+1} \geq 0$$

where $\Lambda_t(i)$ is the distribution of the agents

Internal Consistency

- We provide a representation result that translates partial to general equilibrium distortions



- We can therefore directly work with existing solution methods!

Aggregated Survey Data

- Survey based restriction changes:
  - We observe **proportions** ($\hat{B}_t$) of agents that face frictions
- Condition for informativeness: $\hat{B}_t \in (0,1)$
- Do these types of surveys exist?
  - Yes! For example, Business and Consumer Survey by the European Commission

Testing Parametric Models of Frictions

- A complete model identifies particular distortions, $\mathbb{E}\lambda_t^{CM}(\Theta)$, which should lie within the robust set estimate, $\mathbb{E}\lambda_t^{IM}(\Theta)$
- Equilibrium models which impose strong cross equation restrictions may predict distortions which are not in accordance with $\mathbb{E}\lambda_t^{IM}(\Theta)$
- We propose a statistic that tests the distance of $\mathbb{E}\lambda_t^{CM}(\Theta)$ to $\mathbb{E}\lambda_t^{IM}(\Theta)$:

$$\mathcal{W}_t = \left(\sqrt{t} \inf_{\lambda_{IM} \in \lambda(\hat{\Theta}_{IM})} ||\mathcal{V}^{-\frac{1}{2}}(\lambda_{IM} - \lambda_{CM})|| \right)^2$$

- We prove its consistency and power and that Bootstrap works

Application to Firm Financial Frictions in Spain

- We investigate the adequacy of the S.O.E version of the Smets and Wouters (2007) model augmented with the financial accelerator of Bernanke, Gertler and Gilchrist (1999)
- Idiosyncratic shock to return on capital for each firm and costly state verification: (Aggregate) External Finance premium:

$$\mathbb{E}_t R_{t+1}^k = -\chi_{rp}(N_t - Q_t - k_t) + r_t - \mathbb{E}_t \pi_{t+1}$$

- Endogenous and Exogenous collateral constraints imply an aggregate capital adjustment constraint $\psi\left(\frac{I_t}{K_t}\right)$ (Wang and Wen (2012))
  - We show that this implies negative distortions to investment and output
- We thus use $\mathbb{E}_t(X_{t+1} - X_{t+1}^f) \leq 0$ where $X := \{Y, I, C, H\}$ and X_{t+1}^f the frictionless model prediction
- These restrictions also accommodate consumer liquidity constraints as in the example

Empirical Results

CM: SW-BGG model and IM: Robust (Incomplete) Model