ECO 612 Lecture 0:
Some Initial Thoughts and Course Logistics

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What This Course Is About

- Models, and how we solve them
- Consumer and firm heterogeneity
- Workhorse frameworks (and how to extend them)
- Student presentations closer to the research frontier

Why Do We Need Structural Models?

- In macroeconomics, designed experiments are typically infeasible
- Natural experiments are rare and often narrow
- Reduced-form work can be unstable under policy changes (Lucas critique)
- What we do: build structural models that replicate relevant patterns in the data
- Use the model as a laboratory for counterfactual experiments

Structural versus Reduced Form I: The Objects

- **Structural model:** primitives + equilibrium mapping.

  primitives (θ, shocks, constraints, info) $\Rightarrow$ policy rules g $\Rightarrow$ DGP under a regime

- **Reduced form:** an empirical relationship among endogenous outcomes in a given regime.

$$y = \beta x + \varepsilon$$

  or $\mathbb{E}[y \mid x]$, VAR/LP IRFs, etc.

- **Key distinction:** θ is intended to be portable across regimes; β generally is not.

Structural versus Reduced Form II: What Reduced Form Identifies

- Reduced form identifies an effect of a **particular variation** *in the current environment*:

$$\beta \approx \frac{\partial \mathbb{E}[y \mid x, \text{regime}]}{\partial x}$$

- It need not identify primitives separately:

$$\beta = B(\theta, \text{policy rule}, \text{expectations}, \text{shock variances})$$

- Structural estimation/calibration is the inversion step:

$$m(\theta) \approx \widehat{m} \quad \Rightarrow \quad \widehat{\theta} \text{ that can be used for counterfactual regimes.}$$

Rule of thumb

β is credible for *nearby* counterfactuals; θ for *policy changes that move behavior/equilibrium.*

Structural versus Reduced Form III: Lucas Critique Example

Structural System

$$\text{Demand } q_t = \alpha - \beta p_t + u_t \quad \text{and supply} \quad q_t = \gamma + \delta p_t + v_t \quad \text{with} \quad \beta, \delta > 0.$$

- Solving gives the reduced-form equilibrium price:

$$p_t = \frac{\alpha - \gamma}{\beta + \delta} + \frac{u_t - v_t}{\beta + \delta}.$$

- If a policy changes γ, δ, or the variance of v_t, then the joint law of (p_t, q_t) changes

Structural vs Reduced Form IV: Exogenous Demand Shifter Z_t

- Now we have $q_t = \alpha - \beta p_t + cZ_t + u_t$ and $q_t = \gamma + \delta p_t + v_t$
- Z_t is **exogenous** (set outside the system); (p_t, q_t) are **endogenous**.
- Solving the two equations for (p_t, q_t) gives the **reduced form**:

Reduced form

$$\text{Reduced form prices} \quad p_t = \pi_{20} + \pi_{21} Z_t + e_t^p \quad \text{and quantities} \quad q_t = \pi_{10} + \pi_{11} Z_t + e_t^q$$

$$\text{with coefficient} \quad \pi_{20} = \frac{\alpha - \gamma}{\beta + \delta}, \quad \pi_{21} = \frac{c}{\beta + \delta}, \quad \pi_{10} = \frac{\beta\gamma + \delta\alpha}{\beta + \delta}, \quad \text{and} \quad \pi_{11} = \frac{\delta c}{\beta + \delta},$$

$$\text{and shocks} \quad e_t^p = \frac{u_t - v_t}{\beta + \delta}, \quad e_t^q = \frac{\delta u_t + \beta v_t}{\beta + \delta}.$$

Overarching Themes

- Model design: start from the question, then add ingredients
- Separating ingredients: primitives, functional forms/parameters, behavior, equilibrium
- Endogenous vs exogenous objects (and why it matters for identification)
- Typical workflow:

  Question $\rightarrow$ reference model $\rightarrow$ minimal additions $\rightarrow$ data $\rightarrow$ tractability $\rightarrow$ counterfactuals

- Iteration is normal: modeling and identification usually require multiple passes
- Motivation discipline: What do we learn *only* from this model?

Types of Papers to Write

Controlling for execution, in decreasing order of reward:

- Opening a new field
- New mechanism/facts plus quantification
- Incremental but consequential improvements of a workhorse model
- Quantification (within an established framework)

We will focus on the latter three.

Common Mistakes

- No clear question (or the question is not economic)
- Starting from a story instead of a disciplined object
- Writing a model for its own sake
- Starting from the state of the art when a simpler benchmark would do
- Tenuous connection to the data or weak identification story
- Weak motivation: unclear what changes relative to the benchmark
- Unnecessary mathematical complexity
- Unnecessarily complicated language

What You Should Get Out of This Course

- Minimum: a library of working code for workhorse models that you can extend
- Ideally: the skill to map a question into a tractable, data-disciplined model
- Ideally: the skill to solve that model and run credible counterfactuals

Roadmap

- Computational foundations: root finding, optimization, integration, approximation
- Review: Aiyagari
- Calibration: matching, GMM, SMM, indirect inference
- First assignment: your own twist on Aiyagari
- Aggregate uncertainty: Krusell-Smith
- Firm dynamics: Hopenhayn and Melitz
- Endogenous markups: Atkeson–Burstein and Kimball
- Demand: CES, nonhomotheticity, Epstein–Zin, GHH
- Second assignment: paper presentations