



Lecture 14: Structural Models

April 22, 2020



Overview

What is Structural Estimation?

How do you write a structural paper?

Three Examples

CEO Firings

Teacher Licensing

Neighborhood Choice

Evaluation and Thank you



Course Administration

1. Papers due Friday
2. You will have an email with a worksheet with all grades (not the paper) by the end of this week – please write me if you see any problems
3. I may take 2 weeks to grade final papers, and I'll write and email comments
4. Structural estimation
5. Course evaluation – here and online, please!



With liberal use of notes from

- Christopher Taber, University of Wisconsin [\[link\]](#)
- Toni Whited, University of Texas at Austin [\[link\]](#)
- Steven Laufer, Federal Reserve Board of Governors



What is Structural Estimation?

1. overview
2. simple example



Everything Until Now: Reduced Form

- What is the effect of some treatment D_i on an outcome y_i ?

$$y_i = \beta_0 + \beta_1 D_i + \beta_2 X_i + \epsilon_i$$

- We focused on conditions under which we can say that β_1 is causal
- Coefficient β_1 tells us about effect for observed treatment D_i
- in other words
 - focus is on internal validity: is β_1 credible?
 - not on external validity: what's impact of $4D_i$?
 - reduced form estimates have little to say about impact of $4D_i$, or $\frac{1}{4}D_i$



Structural Estimation In Contrast

Basically Just Economists

- is designed to answer questions about as-yet-unimplemented policies
- relies on your ability to describe the world through equations combined with data
- yields predictions based on those assumptions
- is “an attempt to estimate an economic model’s parameters and assess model fit”



What Are These Parameters?

May include

- preference parameters
 - risk aversion coefficient
 - relative preference between two goods
- technology parameters
 - production function curvature
- time-invariant institutional features
 - agents' bargaining power
 - financing frictions

Directly from Whited



When Do You Want To Do This?

When

- You want to get intuition about a policy that is not yet implemented
- You want to understand how one moving part impacts another
- You want not to “present ‘new’ theory, but to present a formal structure through which to view data” (Whited)
- When it’s ok to In Steve’s words: “Get the intuition, be skeptical of the quantitative conclusions”



Very Simple Example

- Suppose we'd like to know about the impact of a large increase in the gasoline tax
- This would be one implication of a carbon tax
- Since the 1990s, we've seen only small increases in the gasoline tax
- → question ripe for a structural approach

Assume the world works like this:

$$\text{supply: } Q_t = \alpha_s P_t + X'_{1t} \beta + u_{1t}$$

$$\text{demand: } Q_t = \alpha_d (1 + \pi) P_t + X'_{2t} \gamma + u_{2t}$$

π is the tax on gas



Explaining How the World Works

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$$Q_t^* = \alpha_s \frac{X'_{2t} + u_{2t}}{\alpha_s - \alpha_d(1 + \pi)} + \alpha_d(1 + \pi) \frac{X'_{1t}\beta + u_{1t}}{\alpha_s - \alpha_d(1 + \pi)}$$

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- To solve
 - assume a distribution for u_{t1} and u_{t2}
 - \rightarrow 2 equations, four unknowns: α_s , α_d , β and γ
 - make an assumption about two of these, solve for the remaining two



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- If the model is true, you can then learn the impact of a change in X_{1t} or X_{2t}



How Do You Write a Structural Paper?



Basic Steps to Write a Structural Paper

1. Identify the policy question
2. Write down a model that can simulate policy
 - economic model
 - not statistical model
3. Think about identification/data
4. Estimate the model
5. Simulate the policy counterfactual

Directly from Taber



Estimation is not OLS

- When you “estimate” the model, you are not using OLS
- You are usually trying to minimize some function
- Try to find parameters that are the best fit given your data
- Yields standard errors
- Usually GMM and MLE, with C++ code
- And you generally don't worry about causality, since you assume model is correct



Three Examples



Three Examples

1. Why are CEOs Rarely Fired?
2. How do teacher licensing requirements impact teacher quality?
3. Housing voucher policy



Why are CEOs Rarely Fired?

Lucian Taylor, *Journal of Finance*, 2010

- About 2% of CEOs are fired per year
- too low?
- too high?
- And if it's too low (or high), how costly is this?
- structural papers are great for the “how costly” part



A Model of Board Behavior

- board that maximizes its own utility, which is in part a function of shareholder value
- over many time periods
- in each period, the board keeps or fires the CEO
- CEOs differ in quality, and some generate more profits than others
- but it's hard for the board to tell whether the CEO is good or lucky (or bad or unlucky)
- searching for a new CEO is costly
- and you might not get a good one



Model Yields Four Reasons for Not Firing

1. cost to shareholders is large
2. other potential CEOs are bad
3. takes a while to learn that a CEO is bad



Model Yields Four Reasons for Not Firing

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3. takes a while to learn that a CEO is bad
4. CEO entrenchment = board keeps a CEO shareholders would prefer to fire. why?
 - boards don't like firing people (personal utility cost to board)
 - boards don't care much about shareholder value



Why a Structural Model?

Measuring the relative importance of these four reasons for infrequent firings presents a challenge. Boards' turnover decisions are endogenous, which generates endogenous patterns in firm performance. There are no obvious instruments. Several model elements are unobservable, including a CEO's actual and perceived ability, the CEO talent pool, the board's additional signals of CEO ability, and the board's distaste for firing CEOs. Although we can measure the reasons' directional effects using reduced-form empirical techniques, evaluating their magnitudes requires estimating or calibrating a model. p. 2025



Use Data to Estimate Model

Data

- CEO turnovers, 1971 to 2006: forced or unforced
- firm data from Compustat database
- 981 CEOs, 7,325 firm-year observations

Estimation

- author can't fully solve model with equations
- so he turns to estimation to get parameter values that match moments in the data
- then uses parameter values to make 100,000 simulated CEOs, rather than the 891 in the data



Model Fit

| Moment | Notation | Empirical Value | Simulated Value | Standard Error | <i>p</i> -Value |
|-------------------------------------|-----------------|-----------------|-----------------|----------------|-----------------|
| Profitability intercept | λ_0 | 0.22 | 0.20 | 0.04 | 0.66 |
| Profitability AR(1) coefficient | λ_1 | 0.87 | 0.88 | 0.01 | 0.38 |
| Δ profitability 2 yrs before | $\Delta^{(-2)}$ | -0.37 | -0.62 | 0.27 | 0.29 |
| Δ profitability 1 yr before | $\Delta^{(-1)}$ | -1.36 | -1.06 | 0.27 | 0.14 |
| Δ profitability 0 yrs before | $\Delta^{(0)}$ | -1.73 | -1.99 | 0.26 | 0.20 |
| Δ profitability 1 yr after | $\Delta^{(1)}$ | -1.15 | -0.02 | 0.27 | 0.00 |
| Δ profitability 2 yrs after | $\Delta^{(2)}$ | 0.60 | 0.42 | 0.27 | 0.38 |
| Var(Profitability residuals) | $Var(\delta)$ | 11.99 | 11.92 | 0.20 | 0.60 |
| Forced turn. hazard rate, yrs 1-2 | $h^{(1-2)}$ | 2.52 | 1.76 | 0.29 | 0.00 |
| Forced turn. hazard rate, yrs 3-4 | $h^{(3-4)}$ | 2.66 | 3.46 | 0.46 | 0.03 |



Bottom Line

- “model needs a very large total CEO turnover cost to fit the observed forced turnover rate”
- “boards behave as if firing a CEO costs shareholders an estimated 5.9% of firm assets”
- with a few additional assumptions, divides this 5.9% into a 1.3% real cost to shareholders and a 4.6% personal cost to the board
- → “CEO turnover is extremely costly to directors, ... or directors do not care much about shareholder value”

p. 2053



2. Teacher Licensing

“Licensing and Occupational Sorting the Market for Teachers” by Matt Wiswall

- make sure you keep submitting your papers



What is the Impact of Licensing on Teacher Quality?

- important, policy relevant question
- can't really answer with reduced form approach because there are no states without teacher licensing
- welfare consequences of licensing
 - benefits: screening out the worst teachers/doctors/nurses – inasmuch as you can screen
 - costs: limiting supply of labor
- Wiswall argues that the net effect of teacher licensing is actually to lower teacher quality



Sketch of Model

- there is a population of workers with a distribution of underlying ability
- future workers choose a field to enter
- “the costs of meeting licensing requirements varies across workers who are assumed to be heterogeneous in their endowments of general skills”
- the more “general skills” a person has, the larger the opportunity cost of getting a teacher license – because teaching programs require a large investment in teaching-specific human capital: education courses

Conclusions: higher quality potential teachers are more likely to be deterred



Some Licensing Info

- about 3 million teachers in US
- licensing is a test of basic skills – with about a 90% pass rate
- and requires a set of education coursework
- and unlike medicine or law, teaching salaries are among the lowest of all fields for college graduates



Estimating the Model

Data

- data on college graduates from Baccalaureate and Beyond survey
- college experience and post-graduation employment
- with long-run follow-up
- and data on wages

Methods

- know some means in the data
- know means in model as function of model parameters
- find parameters that minimize difference between empirical and estimated means

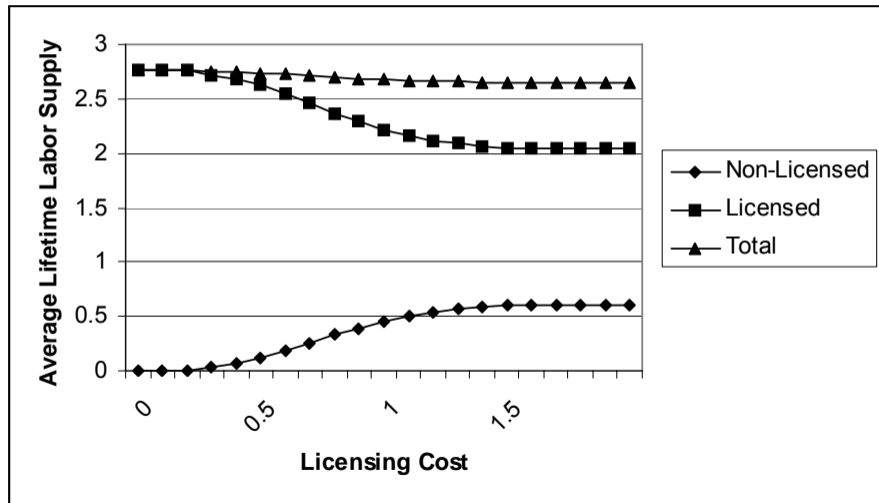


Findings

- “cost to obtaining a teaching license in the first year after college graduation is \$29,030 in 2003 dollars” – about a year of a starting teacher’s salary
- counterfactual policy 1: eliminating licensing
 - increase teacher labor supply by 3.4%
 - raise average quality by 2.2%
 - reduce mean teaching career length by 17%
- counterfactual policy 2: increase costs of licensing
 - reduces entry into teaching profession
 - “increases average length of teaching careers”



Teacher Labor Supply By Licensing Cost Regime



"Licensing cost of 0 is free entry, 1 is current policy, and 1.5 is 50 percent larger licensing costs than

3. Housing Voucher Policy

“Estimating Neighborhood Choice Models: Lessons from a Housing Assistance Experiment” by Alvin Murphy, Sebastian Galiani, and Juan Pantano. *American Economic Review*, vol. 105, no. 11, November 2015.

- fits in a literature that estimates neighborhood choice in a structural framework
- good for looking at policies that are not politically or financially feasible



How Would Restraints on Housing Vouchers Impact Outcomes for Recipients?

MTO

- 1994 experiment that offered public housing residents vouchers for housing elsewhere
- if they moved to lower poverty neighborhoods
- took place in five participating cities
- recipients received vouchers and housing counseling
- many chose not to move, and movers went to neighborhoods similar to initial ones
- two control groups: non-recipients, and recipients w/o restricts or counseling

Limits of MTO

- can't disentangle the voucher from the counseling
- can't put limits on segregation of new neighborhoods



Findings

- requiring voucher recipients to move to even lower poverty neighborhoods decreases take-up substantially: 16% at poverty rate $< 5\%$
- requiring voucher recipients to move to less segregated neighborhoods also decreases take-up



Structural Models, In Sum

- great for thinking about policies beyond what we observe
- great for generating magnitudes
- what drives estimation is very opaque
- model intuition may be explicable to general audience
- estimation intuition would be difficult to explain to a policymaker



The End

- You will have an email with a worksheet with all grades by the end of this week (no paper)
- If you're a PhD student, I'll expect to hear from you with questions – when you email for an appointment
- It's been a pleasure
- Please stay safe and healthy