

- Structural econometrics
- Examples of a structural model
- Practical session,
- Python and example with Max Blesch

What is structural econometrics?

What is structural econometrics?

Structural econometric models...

- “...combine explicit **economic theories with statistical models**” (Reiss and Wolak, 2007)
- “...[infer] underlying parameters that represent **tastes, technology, and other primitives** from observations of individual households and firms...” (Adda and Cooper, 2003)
- ... estimate **features of a data generating process** (i.e., a model) that are (assumed to be) invariant to the policy changes or other counterfactuals of interest (Haile, 2022)

Descriptive vs structural analyses

- Descriptive analysis: establish facts about observable quantities
- RCT
- Policy evaluation
- Economic model

Program Evaluation

Haile (2022):

- Program evaluation (indeed, any type of so-called "causal inference") is always a form of structural estimation. It requires a set of maintained hypotheses about the world (i.e., a model) allowing one to define and identify a counterfactual quantity of interest.
- TT, ATE, LATE, QTE, etc. are all precisely defined only under a well specified model of how the data are being generated. Any suggestion that these objects are **"model free" is nonsense**.
- Causality is always defined by a counterfactual.

Reduced form vs structural

Haile (2022):

- "Reduced form" is sometimes used to mean "equation I won't derive, justify, or take questions on, but which I will nonetheless treat as causal when I talk about conclusions. **This is just bad science.**"

Other views and definitions by Rust (2010), thoughtful (and spiteful) comments on Keane (2013) in Fritjers (2013) vs Rust (2013).

Effects of tax change I

How much **additional revenue (AR)**

- 1 $AR = \text{new tax rate} * \text{wage} * \text{number of hours worked}$
- 2 $AR = \text{new tax rate} * \text{wage} * \text{hours worked post tax}$

How many hours worked post tax?

Effects of tax change III

using theory... why might **number of hours worked** change?

- 1 hours margin:** change in hours for (pre- & post-) workers
- 2 participation margin:** change in participation pre vs. post-tax:

Effects of tax change IV

- 3 **life-cycle** margin:
changing taxes may influence optimal allocation of work over life
(eg. if progressivity is increased...)
- 4 **wage** margin: **equilibrium (gross) wage may change**

Conclude: Predicting reform effect (AR) requires structural model. But: Model choice depends on **margin** and **identification**.

Structure of model

Assumptions, Alternatives? Atheoretic answers?

- 1 hh **utility maximization**
- 2 specific structure of preferences
- 3 **discrete** choice framework
- 4 **static** model structure
- 5 labour **supply** focus

What alternatives to (1)?

Structure of model

Assumptions, Alternatives? Atheoretic answers?

- 1 hh **utility maximization**
- 2 specific structure of preferences
- 3 **discrete** choice framework
- 4 **static** model structure
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What assumptions on preferences (2)?

Structure of model

Assumptions, Alternatives? Atheoretic answers?

- 1 hh **utility maximization**
- 2 specific structure of preferences
- 3 **discrete** choice framework
- 4 **static** model structure
- 5 labour **supply** focus

What assumptions on discrete choice (3)?

Structure (3): Discrete choice framework

Couples **max** U among $j \in \{1, \dots, NH\}$ alternatives

$$(5) \quad U_i = U(y_i, lm_i, lf_i) + \varepsilon_i$$

where ε_j is $EV(1)$ (**Logit**) such that

$$(6) \quad Pr[U_j > U_{k \neq j}] = \frac{\exp(U(y_j, lm_j, lf_j))}{\sum_{k=1}^m \exp(U(y_k, lm_k, lf_k))}$$

What are errors ε_j ?

Structure of model

Assumptions, Alternatives? Atheoretic answers?

- 1 hh **utility maximization**
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What assumptions on static nature (4)?

Structure (5): Labour supply focus II

Only labour **supply** modelled here - alternatives?

1 labour demand

Changes in employment and taxes may change equilibrium wage in imperfect competition.

van Soest ('95): Missing Wages

Wages missing for non-workers: So what?

Missing Wages II

Solutions to unobserved wages

- 1 **impute wages** based on observables (exploit 1st moment)

$$(10) \quad L = F_{job}(Wbm^e(Z), Wbf^e(Z), X)$$

where $Wbf^e(Z) = \exp(Z'_f \hat{\pi}_f) \dots$ where does $\hat{\pi}$ come from?

- 2 integrate over wage distribution (**1st & 2nd moments**)
- 3 proposed practical implementation (relate (10) to (11)).

$$(10) \quad L = \int_0^\infty \int_0^\infty F_{job}(Wbm, Wbf, X) p(Wbm, Wbf) dWbm dWbf$$

$$(11) \quad L = \frac{1}{R} \sum F_{job}(Wbm_r, Wbf_r, X)$$

Missing Wages III

Integrating over predicted wage distribution:

What problem does it solve, and **what does it not solve?**

van Soest ('95): Why not more part time?

Standard model does not fit data: PT overpredicted

Why?

Hours restrictions

Standard model does not fit data: PT overpredicted

- 1 **taste for diversity** in utility function (where?)
- 2 full-time work and/or unemp't more attractive than modelled (**UI neglected**)
- 3 labour demand **not continuous in hours** - $w = w(h)$ (“**hours restrictions**”)

How include this **labour demand effect**?

Identification of hours restrictions

Add cost-of-PT-parameter (to be estimated), due to

- 1 **wage discrimination**
- 2 **search cost**
- 3 (other) non-monetary cost

Can we discriminate between these?

Hours restrictions

- 1 Differentiate wage discrimination from search cost:
Observe **different wage rates of PT and FT workers**. Let $w = w(h)$.
- 2 Differentiate search cost from (other) non-monetary cost ?
In panel data, **use duration in unemployment** ($\lambda = \lambda(PT)$).

Any concerns about **ad-hoc “cost of PT”-parameter?**

Cost-of-PT

Is new parameter **structural**, i.e. **policy-invariant**?

Counter example:

- Assume **FC of setting up contract** (specific hours)
- \Leftrightarrow incentive for firms to **design desired contracts**
- search costs **higher for less popular contracts**
- if optimal hours change, **changed incentives for firms to offer contracts**
- cost of PT **parameter changes after tax change**

cf. general critique in Rust (2013)

Hours restrictions: Results

Results \Rightarrow Model with hours restrictions...

- 1 **better fit of model** - how?
- 2 **reduces wage-elasticity** of labour supply - how?

Hours restrictions: Results (II)

Lower estimated elasticity with restrictions:

- people reacting less than desired due to restrictions

Heterogeneity

What is heterogeneity & why does it matter ?

Heterogeneity & sampling errors

Is **alternative-specific error** ε_j a sampling error?

- sample is choice (**modelled as** $U_j - U_k$)
- iid \Rightarrow **independence of “irrelevant” alternatives**
- not sampling, rather **appreciation error**

How to include **heterogeneous preferences over choices**?

Preference heterogeneity: observed characteristics

Step 1 - include **interaction with observed chars**

$$(2) \quad \beta_{lf} = \sum_k \beta_{lm \ k} x_k$$
$$\alpha_{lm} = \sum_k \alpha_{lm \ k} x_k$$

- examples of x_k ?
- identification?

Preference heterogeneity: unobserved characteristics

Step 2 - include unobserved preference heterogeneity

$$(15) \quad \beta_{lm} = \sum_k \beta_{lm\ k} x_k + \eta_{lm}$$

- contrast to ε_j & interactions of β with x_k .
- **additive separable**
- random (\equiv uncorrelated with observables - restriction ?)
- **identification ?**

Preference heterogeneity: unobserved chars II

Relative idiosyncratic preferences of couples for l_m and l_f
unaccounted for by (by construction, orthogonal to) differences
in couples' observable characteristics

identification of variance of ζ

- \Rightarrow allow joint errors of partners not to be iid
- Conditional on observables, *how much more similar are*
obs from same couple than two other observations?

Unobserved preference heterogeneity: identification

- identification of variance of ζ **purely functional form**

$$\begin{aligned} Pr(i, j) &= F_j(Wbm_i, Wbf_j, X_i) \\ &= \frac{\exp(v'_{i,j} A v_{i,j} + (b + \zeta_i)' v_{i,j})}{\sum_{k \neq j}^m \exp(v'_{i,k} A v_{i,k} + (b + \zeta_i)' v_{i,k})} \end{aligned}$$

Estimation of van Soest ('95)

What estimation strategy?

Estimation of van Soest ('95)

First **estimation strategy using ML**

- 1 Wage & participation estimated jointly.
- 2 Hours decision using predicted wage from first step

Why not estimate all together?

Presenting results of van Soest ('95)

Where are **estimated labour supply elasticities**?

Presenting results of van Soest ('95)

Wage-elasticity of labour supply

Change in hours as result of change in wages.

- 1 take hh with **median chars.**
- 2 **vary wage rate** by 1%
- 3 apply **estimated coefficients**
- 4 by how many % do predicted hours change?

Standard errors?

Coding

Principles

- 1 Use a **script** and **document your code**. Always.
- 2 There is **always** a solution. Not one.
- 3 One solution is **fast**,
- 4 another is **easy to read** & understand,
- 5 another is **flexible**.
- 6 You won't find any immediately. No matter. **Try again.**

