Advanced Applied Econometrics Static Discrete Choice

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Plan for today

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

What is structural econometrics?

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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)

Structural Econometrics

Descriptive vs structural analyses

- Descriptive analysis: establish facts about observable quantities
- RCT

Structural Econometrics

- Policy evaluation
- Economic model

Program Evaluation

Haile (2022):

Structural Econometrics

- 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):

Structural Econometrics

"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 Fritiers (2013) vs Rust (2013).

An Introductory Example

How much revenue raised by **introducing income taxes**?

Simple answers?



Effects of tax change I

How much additional revenue (AR)

- AR=new tax rate * wage * number of hours worked
- 2 AR=new tax rate * wage * hours worked post tax

How many hours worked post tax?



Effects of tax change II

How many hours worked post tax?

- estimate observed corr between wages and hours
- \blacksquare interpret as L^S -elasticity?

Effects of tax change III

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

- **11 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
 - (eq. 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.



van Soest (1995): Structural Models of Family Labor Supply: A discrete choice approach

Main contributions of paper?

Main contributions of paper

- Model labour supply as discrete choice problem
- 2 Taking account of couples' joint decision problem
- Include (more) realistic description of tax system
- Implement unobservables into decision problem

Model Structure

Assumptions, Alternatives? Atheoretic answers?

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 (1): Household u-max

Alternatives to household utility maximization

- multiple decision-makers: collective model (can be cooperative)
- incorporate household formation
- usual caveats re. utility-maximizing behaviour

Structure of model

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What assumptions on preferences (2)?

Structure (2): Preferences

Couples' utility depends on income (y) and leisure (I_f, I_m) . How?

Structure (2): Preferences II

Couple utility depends on income (y) and leisure ($I_t \& I_m$).

(1)
$$U(v) = v'A v + b'v$$

Ensuring global maximum => FOC and SOC on u-function ((3),(4)), e.g.

(4) 2
$$(\alpha_{11} \log y + \alpha_{21} \log l_m + \alpha_{31} \log l_f) + \beta_1 > 0$$

Alternative preferences?

Structure of model

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What assumptions on discrete choice (3)?

Structure (3): Discrete choice framework

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

(5)
$$U_j = U(y_j, Im_j, If_j) + \varepsilon_j$$

where ε_i is EV(1) (**Logit**) such that

(6)
$$Pr[U_j > U_{k \neq j}] = \frac{exp(U(y_j, Im_j, If_j))}{\sum_{k=1}^{m} exp(U(y_k, Im_k, If_k))}$$

What are errors ε_i ?

Structure of model

Assumptions, Alternatives? Atheoretic answers?

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What assumptions on static nature (4)?

Structure (4): Static framework

Only contemporaneous variables affect choices - alternatives?

Structure (4): Static framework II

How might future and past influence labour supply?

- Unemployment insurance payments are not static
- The future is uncertain

How might these affect choices?

Structure (4): Static framework III

Unemployment insuranace payments are not static

- short spells of unemp attractive for high-earners
- dynamic effect interacts with wage
- can this be addressed by FC of working?

$$Pr[U(w, l) > U(b + b(t), l)]$$
 \Leftrightarrow
 $Pr[U(w - FC, l) > U(b, l)]$

Structure (4): Static framework IV

The future is **uncertain**

- risk averse individuals save to smooth utility
- income can be saved, leisure not

Structure of model

Assumptions, Alternatives? Atheoretic answers?

- 1 hh utility maximization
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What assumptions on labour market (5)?

Structure (5): Labour supply focus

Only labour supply modelled here - alternatives?

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

impute wages based on observables (exploit 1st moment)

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

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

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

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

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



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

- **11 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

- wage discrimination
- 2 search cost
- (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).
- 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)
- ⇔ 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 ⇒ Model with hours restrictions...

- 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_i a sampling error?

- **a** sample is choice (**modelled as** $U_i U_k$)
- iid ⇒ 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)
$$\beta_{lf} = \sum_{k} \beta_{lm \ k} x_{k}$$

$$\alpha_{lm} = \sum_{k} \alpha_{lm \ k} x_{k}$$

- \blacksquare examples of x_k ?
- identification?

Preference heterogeneity: unobserved characteristics

Step 2 - include unobserved preference heterogeneity

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

- \blacksquare contrast to ε_i & interactions of β with x_k .
- additive separable
- random (≡ uncorrelated with observables restriction ?)
- identification?

Preference heterogeneity: unobserved chars II

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

identification of variance of ζ

- ⇒ 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?

■ identification of variance of ζ purely functional form

$$Pr(i,j) = F_j(Wbm_i, Wbf_i, X_i)$$

$$= \frac{exp(v'_{i,j}A \ v_{i,j} + (b + \zeta_i)'v_{i,j})}{\sum_{k \neq j}^{m} exp(v'_{i,k}A \ v_{i,k} + (b + \zeta_i)'v_{i,k})}$$

Estimation of van Soest ('95)

What estimation strategy?

Estimation of van Soest ('95)

First estimation strategy using ML

- 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.

- 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?



Presenting results of van Soest ('95)

Standard errors of elasticities - see table 4 (p.80)

- elasticities: non-linear function of parameters
- draw parameters (β) from asymptotic distrib
- calculate elasticities for diff draws.

Coding

Principles

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

Simulate to estimate

Good practice: Simulate before estimating. Why?

In practice: Simulation and Estimation

- 11 Simulate economic behaviour in model with your favourite parameters.
- 2 Generate simulated data.
- 3 Save the data. Forget the parameters.
- Write the likelihood function as a function of data and parameters.
- 5 Maximize likelihood of observing your simulated data w.r.t. parameters.
- 6 Rediscover your favourite parameters.

