Mediators, selection, Roy models: review focused on issues relevant to Parey et al

September 23, 2016

DR thoughts:

Suppose we observe treatment T (e.g., allowed to enter first-choice institution and course), intermediate outcome M (e.g., completion of degree in first-choice course and institution), and final outcome Y (e.g., lifetime income.)

Treatment T directly affects final outcome Y

$$T \rightarrow Y$$

T also affects intermediate outcome M.

$$T \rightarrow M$$

Intermediate outcome also affects final outcome Y.

$$M \rightarrow Y$$

With exogenous variation in T and M (or identified instruments for each of these), we should be able to estimate each of these three relationships as functions.

With homogeneous (and in a simplest case linear) effects and separate we can use the functions estimated above to compute the total (direct plus indirect) effect of T on Y. We could also compute the share of this effect that occurs *via* the intermediate effect, i.e., $T \rightarrow M \rightarrow Y$. This should be merely the composition of these two functions, or, in the le=inear case, the product of the slope coefficients.

However, there are two major challenges to this estimation.

1. We (may) have a valid instrument for (exogenous variation in) T only, and M may arise through a process involving selection on unobserved variables.

2. Each of the three above relationships (as well as the selection equation) may involve heterogeneous functions; i.e., differential treatment effects.

1 Econometric Mediation Analyses (Heckman and Pinto); or papers citing this?

Relevance to Parey et al

We have an instrument for admission to one's first-choice institution (and course). Our result show an impact of this admission on future income, for at least some groups. However, this effect could come through any of a number of channels. We observe some of these 'intermediate outcomes', including course enrollment, course completion, medical specialization, and location of residence, but we do not have specific instruments for each of these.

2 'Selection Bias in a Controlled Experiment: The case of Moving to Opportunity' (Pinto, 2015)

Summary

- ... 4000+ families targeted, incentive to relocate from projects to better neighbourhoods.
- Easy to identify impact of vouchers
- Challenge (here) is to assess impact of *neighborhoods* on outcomes.
- Method here to decompose the TEOT into unambiguously interpreted effects. Method applicable to 'unordered choice models with categorical instrumental variables and multiple treatments'
- Finds significant causal effect on labour market outcomes

Relevance to Parey et al

1. We also have an instrument (DUO lottery numbers) cleanly identifying the effect of the 'opportunity to do something' (in our case, to enter the course at your preferred institution). However, we also waant to measure the impact of a choices 'encouraged' by the instrument, such as (i) attending the first choice course and institution and (ii) completing this course. We also deal with unordered choices (i. enter course and institution, enter course at other institution, enter other course at institution, enter neither) (ii. choice of medical specialisation)
2. The geographic outcome is relevant to our second paper (impact on 'lives close to home')

Introduction

The causal link between neighborhood characteristics and resident's outcomes has seldom been assessed.

Treatments:

- Control (no voucher)
- Experimental: could use voucher to lease in low-poverty neighborhood
- Section 8: Could use voucher in any () neighborhood

Many papers evaluate the ITT or TOT effects of MTO.

- ITT: effect of being *offered* voucher
  - estimated as difference in average outcome of experimental vs control families
- TOT: effect for 'voucher compliers' (assuming no effect of simply being *offered* voucher on those who don't use it)
  - estimated as ITT/compliance rate

  [ITT and TOT] are the most useful parameters to investigate the effects of *offering* [EA] rent subsidising vouchers to families.

Identification strategy brief

- Vouchers as IVs for choice among 3 neighborhood alternatives (no relocation, relocate bad, relocate good) *[Cf: enter course and fp-institution, enter course at other institution, do not enter course]*
- Neighborhood causal effects as difference in counterfactual outcomes among 3 categories
- Challenge: "MTO vouchers are insufficient to identify the expected outcomes for all possible counterfactual relocation decisions"
  - ... "compliance with the terms of the program was highly selective [Clampet-Lundquist and M, 08]"
- Solution: Uses theory and 'tools of causal inference. Invokes SARP to identify 'set of counterfactual relocation choices that are economically justifiable'
- Identifying assumption: "the overall quality of the neighborhood is not directly caused by the unobserved family variables even though neighborhood quality correlates with these unobserved family variables due to network sorting"

- 'Partition sample ... into unobserved subsets associated with economically justified counterfactual relocation choices and estimate the causal effect of neighborhood relocation conditioned on these partition sets.' [*what does this mean?]*

Results in brief

"Relocating from housing projects to low poverty neighborhoods generates statistically significant results on labor market outcomes ... 65% higher than the TOT effect for adult earnings."

Framework: first for binary/binary (simplification)

First, for binary outcomes (simplified)

Z_ω: whether family ω receives a voucher *(cf institution-winning lottery number)*

T_ω: whether family ω relocates (*cf enters first choice institution and course)*

Counterfactuals

- $T_\omega(z)$: relocation decision ω would choose if it had been assigned voucher $z \in 0, 1$': vector of potential relocation decisions (*cf education choices)* for each voucher assignment (*cf lottery number)*
  - Can partition into never-takers, compliers, always takers, and defiers
- $(Y_\omega(0); Y_\omega(1))$: (Potential counterfactual) outcomes (*cf income, residence, etc*) when relocation decision is fixed at 0 and 1, respectively

Key (standard) identification assumption: instrument independent of counterfactual variables

$$(Y_\omega(0), Y_\omega(1), T_\omega(0), T_\omega(1)) \perp Z_\omega$$

Standard result 1: ITT

$$ITT = E(Y_\omega|Z_\omega = 1) - (Y_\omega|Z_\omega = 0)$$
$$= E(Y_\omega(1) - Y_\omega(0)|S_\omega = [0,1]')P(S_\omega = [0,1]) + E(Y_\omega(1) - Y_\omega(0)|S_\omega = [1,0]')P(S_\omega = [0,1])$$

i.e., ITT computation yields the sum of the 'causal effect for compliers' and the 'causal effect for defiers, weighted by the probability of each.

Standard result 2: LATE

$$LATE = \frac{ITT}{P(T_\omega = 1|Z_\omega = 1) - P(T_\omega = 1|Z_\omega = 0)} = \quad E(Y_\omega(1) - Y_\omega(0)|S_\omega = [0,1]') \\ if\ P(S_\omega = [0,1]) = 0$$

i.e., the LATE, computed as the ITT divided by the 'first stage' impact of the instrument, is the causal effect for compliers if there are no defiers.

Framework for MTO – multiple treatment groups, multiple choices

- $Z_\omega \in \{z_1, z_2, z_3\}$ for no voucher, experimental voucher, and section 8 voucher, respectively
- $T_\omega \in \{1, 2, 3\}$ ... no relocation, low poverty neighborhood relocation, high poverty relocation
- $T_\omega(z)$: relocation decision for family ω if assigned voucher z

→Response type for each family ω is that a three-dimensional vector: $S_\omega = [T_\omega(z_1), T_\omega(z_2), T_\omega(z_3)]$.

→ **ITT** computation now measures a weighted sum of effects across a subset of those response types whose responses vary between the assignments being compared.

Cf:

- Considering the 'treatments': '1: enter other course at fp-inst, '2: enter course at fp-inst', '3: enter course at non-fp inst'
  - (I ignore other course at other institution for now)
- Looking among those who won the course lottery (so we have a binary instrument: wininst $Z_\omega \in 0, 1\}$
- Our reduced-form estimates (regressions on the 'lottery number wins institution' dummy) measures the probablility-weighted sum of:
  - impact of institution within course (T_ω =2 versus 3); for those who would 'fully comply' (enter course at institution if $Z_\omega = 1$, enter course at other institution if 0)
  - impact of the course at fp-institution versus second-best course at fp-institution for 'institution-loving' noncompliers; those who would enter the course *only* if they get the fp-institution and otherwise another course at the same institution
  - effects for perverse defiers