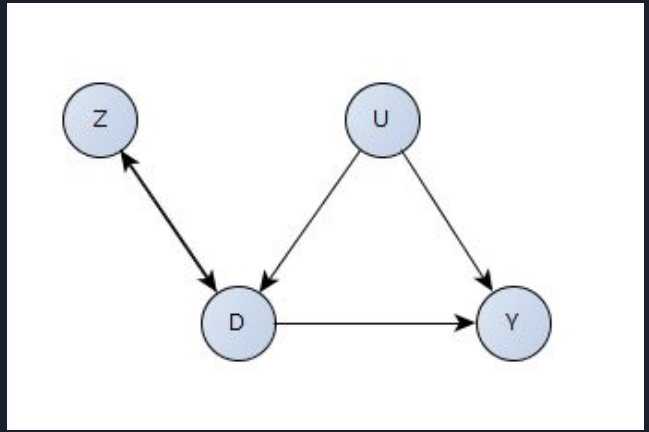
Final Exam Review

Instrumental Variables

- Assumptions and Tests
  - **The instrument is "strong enough"** -- check its correlation with the causal state. It should be dependent with D.
  - **Exclusion Restriction** -- The instrument is only associated with the outcome through the causal state
  - If there's heterogeneity in the treatment effect, monotonicity.
- Estimators
  - Wald estimator
  - TSLS -- can control when you don't have clean instruments!
- Caveats
  - Actually estimate LATEs! The ATE on the population induced into the treatment by the instrument
  - We have to make the additional assumption of monotonicity



Instrumental Variables

Examples

- Draft lottery
  - Randomly chosen birthdays cause military service
  - Study the effect of military service on life outcomes (e.g. lifetime earnings)
- Experiments with non-compliance
  - Assignment to treatment causes treatment
  - Not all those assigned comply!
- Advertising
  - Impressions cause clicks on ads, which can cause product purchases
  - Exclusion restriction can be tricky: do impressions causes purchases?

For a review of more applications:
Angrist, J.; Krueger, A. (2001). "Instrumental Variables and the Search for Identification: From Supply and Demand to Natural Experiments". Journal of Economic Perspectives. 15 (4): 69–85. doi:10.1257/jep.15.4.69

Front-Door Criterion

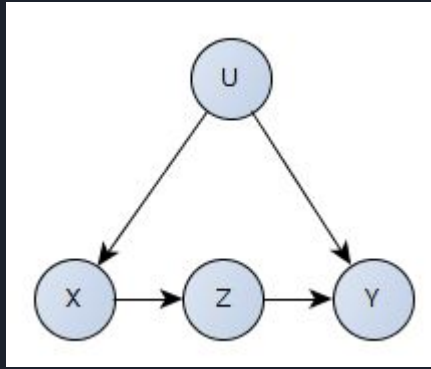
- Assumptions:

Definition 3.3.3 (Front-Door)
A set of variables Z is said to satisfy the front-door *criterion relative to an ordered pair of variables (X, Y) if:*

(i) *Z intercepts all directed paths from X to Y;*

(ii) *there is no back-door path from X to Z; and*

(iii) *all back-door paths from Z to Y are blocked by X.*



- Estimators:

Theorem 3.3.4 (Front-Door Adjustment)
If Z satisfies the front-door criterion relative to (X, Y) and if $P(x, z) > 0$, then the causal effect of X on Y is identifiable and is given by the formula

$$P(y|\hat{x}) = \sum_z P(z|x) \sum_{x'} P(y|x', z)P(x'). \quad (3.31)$$

Front-Door Criterion

Examples

- Smoking
  - Tar is the mechanism for the effect of smoking on lung cancer
- Military Service
  - Civilian workforce participation vs. military training are mechanisms for the effect of military service on lifetime earnings

Time-Series Estimation

- Treatment over all units:
  - Usually assume unconfoundedness
  - The Y_0 counterfactual continues on its trend, can be extrapolated with a model
  - The Y_1 counterfactual is as observed
- Treatment over some units
  - Might assume unconfoundedness
    - Can compare D=1 and D=0 groups to get the effect
  - Can use matching approaches
    - The propensity score matching example from homework
- What is change-score good for?
  - Controlling for constant confounders

Improvements (from M&W)

- The an effect on other variables that should be effected
- Show no effect on variables that shouldn't be effected
- Consider meaningful subgroups (e.g. those who don't receive treatment, or those with large expected effects)
- Include additional adjustment variables -- we can still control for things!
- Compare time trend with untreated units
- If treatment is unapplied, does the effect shift back?
- How frequent are shifts in the outcome? How likely is the effect just noise?