Randomization & Pseudo-Randomization Part I
Lecture 4 – Part 1

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Exp Class Lectures
Suppose we could find a variable or set of variables that are ignorable in the determination of $P_j$ but have a consequential effect on $T$.  

Another way to think of the variable or set of variables in relationship to $P_j$ is that they are redundant in the determination of the potential choices given information levels. If we could find such a variable, then maybe we could use it as a substitute for information and avoid or sidestep the problem of confounding that occurs when we use information.
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If we could find such a variable, then maybe we could use it as a substitute for information and avoid or sidestep the problem of confounding that occurs when we use information.
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Although in political science these two methods are often considered separately, the theoretical basis underlying the two approaches when based on an RCM model of causality is identical, as a growing body of literature in statistics and econometrics has established.
The goal of sidestepping confounding by finding such a variable is the basis for two principal methods used to establish causality:

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Although in political science these two methods are often considered separately, the theoretical basis underlying the two approaches when based on an RCM model of causality is identical, as a growing body of literature in statistics and econometrics has established.

In the literature on measuring causality through experiments, the assignment to treatment is used in the same way as an instrumental variable is used in observational data without experimental manipulation.
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The Ideal Instrumental Variable

Definition of an Ideal IV

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- It is useful to be clear about the definition of an ideal IV as then we can consider how relaxing that definition affects the ability of a researcher to estimate causal effects.
- So that we can take a general approach that incorporates both experimental research and statistical analysis of observational data, we define an ideal IV independent of estimation procedures.
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- So that we can take a general approach that incorporates both experimental research and statistical analysis of observational data, we define an ideal IV independent of estimation procedures.
- That is, usually explanations of IV approaches begin with particular models of the data generating process and the assumptions about functional forms and correlations between variables that allow for IV estimation given those models.
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That is, usually explanations of IV approaches begin with particular models of the data generating process and the assumptions about functional forms and correlations between variables that allow for IV estimation given those models.

Instead we begin abstractly, independent of a particular functional form of the data generating process or estimation procedure, and focus on the properties of an ideal IV.
The Ideal Instrumental Variable

Definition of an Ideal IV

- We classify $M$ as an ideal IV if the following three conditions are satisfied:

  1. **Condition (Independence):**
     
     $M$ is statistically independent of the potential choices, that is, in the situation where the potential choices are designated as $P_j$, we assume $M \perp (P_0, P_1)$ where $\perp$ denotes statistical independence.

  2. **Condition (Perfect Substitute):**
     
     $M$ is a perfect determinant of who receives treatment, that is, $T$.

  3. **Condition (No Missing Data):**
     
     We can perfectly observe the choices made by those affected by $M$. That is, define $P_{OBS}$ as the choices observed by the researcher and $P_{ACT}$ as the actual choices made by the units of study. When there is no missing data then $P_{OBS} = P_{ACT}$ for all units.
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The Ideal Instrumental Variable
Definition of an Ideal IV

- If these three conditions hold, then:

\[
ATE = E(P_{dj} | M = 1) - E(P_{dj} | M = 0)
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**Perfect Substitute:** $M$ is a perfect determinant of who receives treatment, that is, $T$.

**No Missing Data:** We can perfectly observe the choices made by those affected by $M$. That is, define $P^{OBS}$ as the choices observed by the researcher and $P^{ACT}$ as the actual choices made by the units of study. When there is no missing data then $P^{OBS} = P^{ACT}$, for all units.
The Ideal Instrumental Variable

Definition of an Ideal IV

Figure: The Ideal Instrumental Variable

- $M$ is the potential instrument and is assumed independent of $U$. $M$ only affects $Y$ through $T$. 
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Definition of an Ideal IV

- $M$ is the potential instrument and is assumed independent of $U$. $M$ only affects $Y$ through $T$.
- But since $V$ and $U$ are correlated, we cannot use control functions since ignorability of treatment does not hold.

Figure: The Ideal Instrumental Variable
Random assignment of manipulations in an experiment in which subjects are assigned simultaneously, manipulation assignments are independent of other randomly assignment manipulations of other treatment variables, can enforce perfect compliance with manipulations, & can observe all choices of subjects is an ideal IV.
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Observing all choices ensures there is no missing data.
Can you design an experiment in which all three of these conditions hold?
Is Random Assignment of Manipulations in Experiments an Ideal IV?

- Can you design an experiment in which all three of these conditions hold?
- Can you think of a study with observational data in which all three conditions hold for an Ideal IV?

Implication – Need to think about how we can deal with cases in which random assignment is not an ideal IV & how researchers with observational data can deal with IV's that are not ideal.
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- Implication – Need to think about how we can deal with cases in which random assignment is not an ideal IV & how researchers with observational data can deal with IV’s that are not ideal.
- Consider each condition separately.
- Begin with Independence.
Potential Violations of Independence in Random Assignment

How Random Assignment is Operationalized in the Lab & Timing Issues

- Typically laboratory experimentalists recruit a "subject pool"
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Subjects who participate on Monday morning might be differently affected by manipulations than those who participate on Thursday evening.
Potential Violations of Independence in Random Assignment
How Random Assignment is Operationalized in the Lab & Timing Issues

- Typically laboratory experimentalists recruit a "subject pool"
- In most laboratory experiments subjects are not randomly assigned to manipulations simultaneously but over time & their assignments can then depend on variables related to their choice as to when to participate.
- Subjects who participate on Monday morning might be differently affected by manipulations than those who participate on Thursday evening.
- Subjects who participate in the summer one year might also be differently affected than those who participate several years later in the winter.
Field experiments are also usually conducted over a period of time, sometimes in waves.
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If a field experiment is conducted over a period of time it is important that the manipulations be randomized within given time periods.

Nevertheless, within a given time period some subjects may be manipulated on a Monday morning while others might be manipulated on a Thursday afternoon.
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Maintaining independence of manipulations is also important in field experiments that evaluate more than one treatment effect or a complexity of treatment effects.
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If the assignments are correlated, then independence of the manipulations can be violated.
Potential Violations of Independence in Random Assignment
When Random Assignment Probabilities Vary

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  - One example he provides is an experiment in which the manipulation is a technology that is distributed randomly to children but experimenter is interested in effects of manipulation on their parents.
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  - In this case, parents with more children are more likely to be exposed to technology.
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In this case, parents with more children are more likely to be exposed to technology.

If having more children is related to potential outcomes of interest, then a violation of independence.
Suppose 2 data sources for experiment—consumer list from marketing agency & voter registration list.
Potential Violations of Independence in Random Assignment
When Random Assignment Probabilities Vary: Information & Voting Example

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- Randomize such that half come from each list.
- Assume information only affects voters who have completed college.
- Because not randomized within educational categories, then more likely to select college educated voters – no independence between manipulation & potential outcomes.
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- Randomize such that half come from each list.
- Assume information only affects voters who have completed college.
- Because not randomized within educational categories, then more likely to select college educated voters – no independence between manipulation & potential outcomes.
- Have independence within educational categories, but not across educational categories.
Potential Violations of Independence in Random Assignment
When Random Assignments Are Made at Aggregate Levels

- If assignment of manipulation is made at group level rather than at individual level, a researcher might have problems with independence when attempting to make causal inferences at the individual level.
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- In Lassen manipulation at city district level although Lassen studied effect at individual level.
- If there is a relationship between living in a particular city district & potential outcomes studied, then there is a violation of independence.
Michelson and Nickerson (2009) points out that in some mobilization experiments randomization is done at the precinct level or some other aggregate level in order to avoid other problems in implementing the randomization such as mobilizers contacting subjects who were designated not to be contacted see for example Arceneaux 2005, Imai King and Nall 2009, King et al 2007.
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- If residence in these aggregate groups is related to potential outcomes, then independence is violated.
Potential Violations of Independence in Random Assignment
Mechanisms and Manipulations

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- Suppose manipulation is providing a group of potential voters with campaign material where some voters receive material & others do not.
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- Suppose manipulation is providing a group of potential voters with campaign material where some voters receive material & others do not.
- Material provides factual information about candidates (only way to get information.)
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But voters who receive information are told that campaign material is being mailed by a particular nonprofit, nonpartisan group.
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- Knowledge may affect willingness to vote or how vote.
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- Knowledge may affect willingness to vote or how vote.
- May reinforce view that voting is a norm.
- If had become informed via a different mechanism, then voting choices may be differently affected.
- Thus potential choices are affected by $M$ (assuming information is not available to subjects independent of mailing).
Potential Violations of Independence in Random Assignment

Effects from Knowledge of Manipulations

- If random assignment takes place publicly & subjects know that others are affected, random assignment can affect the behavior of both those treated & not differently from if the treatment had occurred without random assignment

AIR and Heckman (1997) discuss problems with using draft lottery numbers as an IV for enlisting in military. Men with low lottery numbers, who expect to be drafted may get more education as a way of avoiding service through deferment & men with high numbers might have received more on-the-job training by employers who were more confident that they would not be leaving their jobs.
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- Field experiments involving candidate or party behavior in elections may be more problematic.
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- In Wantchekon candidates were experimentally induced to vary their messages to voters across election districts.
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- Field experiments involving candidate or party behavior in elections may be more problematic.
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- Since variation could be observed by other candidates & parties as well as other elites–behavior with respect to the voters may have been affected.
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Did happen in some of districts where some candidates used experimental strategies & others did not–Wantchekon excludes from analysis.
Using Experimental Design to Solve Independence Problems

Solving Problems in Timing Through Design: In the Laboratory

- Should try to run manipulations on same day or approximate time.
Using Experimental Design to Solve Independence Problems

Solving Problems in Timing Through Design: In the Laboratory

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- Advantageous to have a subject pool from which to draw from that is likely homogeneous in possibly confounding unobservables and observables over time.
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- Advantageous to have a subject pool from which to draw from that is likely homogeneous in possibly confounding unobservables and observables over time.
- Principal methodological advantage of using undergraduate students as subjects in experiments; it increases ability to compare effects of different manipulations carried out over time.
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Advantageous to have a subject pool from which to draw from that is likely homogeneous in possibly confounding unobservables and observables over time.

Principal methodological advantage of using undergraduate students as subjects in experiments; it increases ability to compare effects of different manipulations carried out over time.

Also possible to build a nonstudent subject pool, as did Mutz, that is arguably homogenous on observables over time.
Attempt to draw a samples of subjects across time periods that are likely to be homogenous on observables & unobservables as is done in laboratory experiments which use a standard homogenous subject pool.
Using Experimental Design to Solve Independence Problems

Solving Problems in Timing Through Design: In the Field

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- Can be more difficult
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Solving Problems in Timing Through Design: In the Field

- Attempt to draw a samples of subjects across time periods that are likely to be homogenous on observables & unobservables as is done in laboratory experiments which use a standard homogenous subject pool.

- Can be more difficult

- If there is sufficient variation within each time period, confounding unobservables that vary over time can be controlled for *ex post* by using regression control methods.
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In example might condition randomization within educational category by distribution of such categories within target population of experiment.
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When Randomization Varies Within Observables

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- In example might condition randomization within educational category by distribution of such categories within target population of experiment.
- Then randomization independent of potential outcomes for target population (assuming sample of subjects drawn is randomly drawn from target population).
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GKB randomized within some observables—intention to vote, receives a paper (non-Post/non-Times), mentioned ever reading a paper, received a magazine, or asked whether wished read newspapers more.
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- Then randomization independent of potential outcomes for target population (assuming sample of subjects drawn is randomly drawn from target population).
- GKB randomized within some observables—intention to vote, receives a paper (non-Post/non-Times), mentioned ever reading a paper, received a magazine, or asked whether wished read newspapers more.
- If interested in individual effects, avoid randomizing at group levels if possible.
In example where mailing sent by nonprofit group – one way to solve problem is to vary mechanisms by which manipulation occurs.
Using Experimental Design to Solve Independence Problems

When Mechanism Leads to Independence Violations

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- Send mailings that are reported to come from a partisan source (although there may be difficulties in the ethics of doing so because of potential harms to the political parties).
- Can use design to determine whether source of mailing interferes with independence of random assignment of information on potential choices.
Minimizing knowledge of random assignments might be desirable.
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But of course can lead to ethical concerns, however, as discussed later.
When an IV or Assignment is not a Perfect Substitute for Treatment

Potential Problems of Substitutability in Random Assignment: What is Noncompliance?

Definition (Pre-Treated Subject)
Subject who has experienced the desired manipulation prior to his or her random assignment.

Definition (Always-Taker)
Subject who chooses an assigned manipulation independent of his or her random assignment.

Definition (Never-Taker)
Subject who chooses against an assigned manipulation independent of his or her random assignment.

Definition (Defier)
Subject who chooses the opposite of the manipulation assigned to him or her.
Problems with Substitutability

Noncompliance in the Laboratory

- Some laboratory experiments use naturally occurring candidates as in Spezia, et. al,
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- If subjects had already been exposed to candidates, then would be pre-treated.
- Problems of always-taking, never-taking, or defying—may occur in lab if subjects fail to pay attention during instructions in the sense that they fail to read something they are told to read, or fail to listen when told to listen.
Problems with Substitutability
Noncompliance in the Laboratory: Repetition & Information Control

- In some game theoretic experiments form of noncompliance occurs when subjects interact repeatedly & subjects can make inferences based on previous behavior which can influence their behavior in later periods.
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But if not true, data gathered from later periods may be suspect.
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But if not, then need to be concerned about the possible effects of communication on information levels.
Problems with Substitutability
Noncompliance in the Laboratory: Drop-Off in Sequential Experiments

Definition (Sequential Experiment)
In which subjects participate in manipulations conducted either over time or at separate time intervals.

- Druckman & Nelson (2003) contact subjects 10 days after an experiment in a survey to determine whether framing effects observed in the original experiment diminish over time & Chong & Druckman (2009) have subjects participate in 2 sessions 3 weeks apart.
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- In both cases some subjects failed to come to the second round.
Problems with Substitutability

Noncompliance in the Field: Delinquent Subjects ...

- Pre-treatment, always-taking, never-taking, & defying more likely manifested in field experiments. Consider GKB:

  A subject is not complying with manipulation if already subscribes to newspaper (has been pre-treated).
  A subject who chose to start subscription to newspaper during experiment or purchased newspaper daily at a newsstand regardless of assignment would be an always-taker. A subject who refused to accept newspaper when offered (either by not bringing it in or throwing it away once it arrived) & never purchased newspaper when not offered, would be a Never-taker. A subject who only chose to subscribe to newspaper or purchase it daily when it was not assigned but chose to refuse to accept newspaper when assigned would be a defyer.
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Michelson & Nickerson (2009) highlight a number of situations that can occur—such as mobilizers enthusiastically contacting voters who were designated not to be contacted because of their desire to increase voter participation, having difficulty identifying subjects by names from lists, failing to locate subjects’ addresses, etc.
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Using Experimental Design to Solve Substitutability Problems
Dealing with Pre-Treated Subjects in the Laboratory

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In either case, recommendation is for researchers to attempt to measure when subjects have been pre-treated & to consider data from these subjects separately than those who have not been pre-treated.
Dealing with Other Types of Noncompliance

In the Laboratory: Using Randomization to Reduce Cross-Effects When Subjects Engage in Repeated Games

- Often randomly assign subjects to roles in each period & take pains to make periods equivalent in terms of payoffs to a one-shot game.

Used by Dal Bo in studying the effects of manipulations on the extent of cooperation in prisoner dilemma games.

Important subjects fully understand how randomization occurs so that the cross-effects are indeed minimized.

One solution is to only conduct one-shot games, however, there may be good reasons to allow subjects to play the games more than once to facilitate possible learning as explained later.
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- May have to pay more on average to all subjects.
Dealing with Other Types of Noncompliance

In the Laboratory: Controlling Communication Between Subjects

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Important issue is to carefully consider how allowing less controlled communication may interfere with other manipulations investigating when designing experiment.
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- Discuss motivating subjects further later.
Dealing with Other Types of Noncompliance

In the Laboratory: Using Financial Incentives & Other Motivation Techniques & Sequential Experiments

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Dealing with Other Types of Noncompliance
In the Laboratory: Using Financial Incentives & Other Motivation Techniques & Sequential Experiments

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- Ignoring these implications & overbidding by bidding one’s signal has
  been labeled the “winner’s curse” result.