Research Design Process and Stages: Questions and Credibility

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The Research Process

An overview of the research process

- Articulate and fine-tune your question (interrogating why you are asking this question and what will happen given different kinds of possible answers.)
- Develop your research design.
- Plan your analysis and state and justify specific hypotheses and register this plan with a credible impersonal date stamp.
- Implement your intervention and collect data.
- Analyze your data and write up your results.

EGAP Research Design Form

EGAP Research Design Form

- We developed a research design form that helps provide structure for a good research design
  - https://egap.github.io/learningdays-resources/Exercises/design-form.Rmd
- It may help when you are
  - writing a research proposal when you apply for funding, or
  - when developing a pre-registration plan

Sections of the EGAP Research Design Form

- Research question
- Sample
- Treatment
- Outcome
- Randomization strategy
- Implementation
- Power
- Analysis and interpretation

Research question and motivation

- What is the substantive motivation for this research? What problem are you trying to address? What decision are you trying to make?
- Whose mind are you trying to change, and what do they currently believe?
- What general theoretical questions can this research help address?
- State your research question in one sentence.
- What is your main hypothesis?

Sample

- Where and when will your study take place?
- Who/what units are in your study?
- How is this sample selected?
- Do some units need to be left out of the study, because they must receive treatment or must be left out of treatment for logistical or other reasons?
- Do you expect treatment to work differently for certain subgroups?

Treatment

- What is your treatment? Will you have multiple treatments?
- What will your control condition be? Pure control or placebo?
- Are there any ethical concerns with the treatment?
- At what level will you randomize treatment?

Outcome

- What is your primary outcome?
- How will you measure it?
- What data do you need? At what level is the measure available?
- What are your priors about the outcome? This may come from previous studies or educated guesses.
- How many rounds of data will you collect?
- How will you minimize attrition?
- How will you minimize mismeasurement and untruthful reporting?

Randomization strategy

- What type of randomization strategy will you use? Examples: simple, complete, block, cluster, factorial, two-tier, step-wedge, etc.
- Make sure this strategy is consistent with the level of randomization (possible clusters) and expected heterogeneity of treatment effects (possible blocks).
- Specify your blocks and clusters (if any). How many will you have? How large will they be?
- Is interference a possible concern? If so, how will your sample selection and randomization strategy minimize interference?

Implementation I

- How will you do the actual randomization? In public, drawing from a bowl? On a computer?
- Who will implement the treatment?
- If there is a partner who will implement the treatment, what arrangements do you have?
- What are the logistical challenges? Any special challenges for control units?

Implementation II

- How will you track the quality of implementation?
- How will you track compliance with the treatment?
- How will you minimize non-compliance with the treatment (if applicable)?
- How will you check the quality of your data?
- How will data be anonymized and stored securely (if applicable)?

Power

- What is your expected effect size?
  - This might be from a previous study or a target size below which one would not be interested in future interventions.
- Power calculation.
  - If you have clusters, there are additional concerns with intra-cluster correlation.

Analysis and interpretation

- What is your estimand? (e.g., average treatment effect, complier average causal effect, etc.)
- What is your estimator? (e.g., difference in means, OLS with block weights, any clustering). Note that this should be closely linked to your randomization design.
- If you find that your results are consistent with your hypothesis, what alternative explanations might there be? What data would help you distinguish between your explanation and alternative ones?
- If you find that your results are not consistent with your hypothesis, what data will help you figure out what might have happened?

DeclareDesign

Introduction to DeclareDesign

- Declare Design is a software package in R.
- Helps us be concrete about the stages of research design by allowing us to represent them in code, which then allows us to simulate the stages of research design in order to understand the properties of the statistical estimators and tests that we use.
- For more see (https://declaredesign.org/getting-started)
- See also the module on Estimands and Estimators that uses DeclareDesign to help determine the correct estimators.

Introduction to DeclareDesign

- See https://declaredesign.org/
- Regardless of the method, research designs have four components
- MIDA:
  - M: Model (of how the world works)
  - I: Inquiry
  - D: Data strategy
  - A: Answer strategy
- Critical insight: Simulation of a research design teaches what answers a research design can find.
- Working with simulated data *before data collection* helps prevent errors and oversights.

Model

- A model of how we think the world works, including:
  - Ts and Xs (treatments or focal causal variables like policy interventions and other background variables)
  - Ys (dependent variables)
  - Relations between variables (potential outcomes, functional forms, auxiliary variables and contexts)
  - Probability distribution over Xs if not also over Ys.
- This is the theory!
  - Codified numerically.
- The model is wrong by definition. If it were correct, you wouldn't need to do the study.
- But without a model, we don't have a place to start to assess what can be learned.

Inquiry

- An answerable question.
- What is the effect of a treatment T on an outcome Y ?
- Usually a quantity of interest, some summary of the data:
  - Descriptive: What is the mean of Y in treatment, formally.
  - Causal: What would be the average difference of Y if we switched treatment to control? If we claimed that T cannot cause Y, how much evidence do we have about this claim?
  - Quantity is the estimand or hypothesis.
- Not all questions that we want to ask are answerable.
  - And the range of inquiries we can ask are limited: how much can we learn from some summary quantity such as the average treatment effect (ATE)?

Data

- Realize (generate) data on the set of variables (all Xs, Ts and Ys)
- A function of your model
- Includes both:
  - Sampling — how units arrive in your sample
  - Treatment assignment — what values of endogenous variables are revealed

Answer

- Given a realization of the data, generate an answer – an estimate of the quantity of interest (inquiry)
- This is your estimator or test:
  - Difference-in-means
  - t-test
  - Regression methods
  - etc.
- Answer is an estimate of the quantity of interest or p-value (inquiry/estimand/test)

Pre-Registration of Analysis Plans

Bias in published research against null results

- Anticipating or facing difficulties in getting published, manuscripts with null results are never submitted for review or put away in a "file drawer" after several rejections.
- We all face incentives to change your specifications, measurements, or even hypotheses to get a statistically significant result (p-hacking) to improve chances of publication.
- Even people not facing these incentives make many decisions when they analyze data: handling missing values and duplicate observations, creating scales, etc. And these choices can be consequential.
- Overall result: reduced credibility for individual pieces of research and (rightly) reduced confidence in whether we actually know what we claim to know.

Towards review of design rather than outcomes

- One part of solving this problem is to focus on the design, rather than the outcomes.
- The bias against null results can be overcome by reviewing the design, prior to learning the results.
- A good design executed well will produce credible research, which might be a null result. We want credible and actionable null results.
- Reviews of designs are also an opportunity to improve the research before it is implemented.

Pre-registration of analysis plans and research designs I

- Pre-registration is the filing of your research design and hypotheses with a publicly-accessible repository. EGAP hosts one that you can use for free (currently on OSF.io using the EGAP registration form).
- Pre-registration does not preclude later exploratory analyses that were not stated in advance. You just have to clearly distinguish between the two.

Pre-registration of analysis plans and research designs II

- Even if you will be submitting a paper with results rather than a design to an academic journal or you are primarily interested in a final report with findings for a policy audience, there are important advantages to you and to other researchers from pre-registering your research.
  - You can learn about other research, completed and in progress; others can learn about yours. We can learn about studies that produced null results.
  - It forces you to state your hypotheses and plan of analysis in advance of seeing the results, which limits *p*-hacking.

Summary

The research process: Questions, theory, and credibility

- Research starts with our values and theories about how the world works.
- It continues by articulating questions that can be clearly addressed by observation (in this course, using randomized experimentation).
- Good questions have consequential answers: changing scientific explanations, changing policy decisions.
- Good designs tick all the boxes and give readers reason to believe the results.
- Checklists (like the research design form or pre-registration forms) help avoid careless errors.
- Pre-registration further increases credibility and thus the odds of your results having an impact on science and policy.