Methodology: Design, Procedure and Data Analysis

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3/27/2008

Goals of This Lecture

- Overview of a Typical Experiment
- Answer Three Questions:
- How good is my design?
- How should an experiment be carried out?
- How should I analyze my data?

3 Stages of Experimental Research

- Experimental Design
  - Before: What experiment should I run?
- Testing and Running an Experiment
  - During: How is the experiment carried out?
- Data Analysis
  - After: What does the data say?

Outline

- Experimental Design:
  - Goals; Control
- Testing the Experiment:
  - Programming the Experiment
  - Pre-testing: Pilot Studies and Simulation
- Running the Experiment:
  - Giving Instructions and Comprehension Tests
  - Post-Experimental Surveys
  - Handing out Payments
  - What if Something Unexpected Happens?

Outline

- Data Analysis:
  - Graphs
  - Summary Statistics
  - Regressions and other Basic Econometrics
  - Maximum Likelihood Estimations: QRE, Cognitive Hierarchy, level-k, EWA…
  - Out-of-Sample Prediction
  - Special Handling for Eyetracking and fMRI, etc.

Goals of Experiment Design

- Test theory
  - Falsify or choose between competing theories
- Key: What is the simplest example of this theory?
- Replicate the field
  - Can serve as future policy test-beds
- Key: What is the key feature of the field situation?
- Other goals:
  - Exploratory: just to see what happens
  - Teaching: give students hands-on experience

Goals of Experiment Design

- What is the goal of LUPI's lab experiment?
  - Replicate the field situation
  - Test the Poisson Nash Equilibrium prediction
- What design choices did they make?
  - Scale down exactly by 2000 (but 99999→99)
  - Explicitly randomize for participation
  - Simulate a Poisson distribution
  - Show only winning number
- Which choice was for which goal?

Controls in Experimental Design

- Neutral Language and Anonymity
  - Benchmark focusing on incentive structure
- Monetary Payment
  - People like to earn money and don't mind more
- Written Instructions
  - Public Knowledge (~Common Knowledge)
- Experimental Screen Display
  - Does top-down or left-right affect the results?

Controls in Experimental Design

- Recruiting Protocol: Any selection bias?
  - Don't want students who were taught to do X
  - Do we get the same people at different times?
  - Does ethnicity or university culture matter?
- Can we measure or assume the parameter?
  - Measure, Control or Assume…
- Key: A good design makes treatment and control groups almost identical except "X"…

Programming the Experiment

- Programming the Experiment:
  - Run by hand or using computer software?
- Common experimental software:
  - z-Tree: "Zurich Toolbox for Readymade Economic Experiments"
  - j-Market: for complicated market experiments
  - j-Auction: for combinatorial auctions
  - PTB3: Matlab's Psychophysics Toolbox
  - Write your own software?

Pre-Testing: Pilot Studies

- Does a design work or not? Run it and see
  - First on fellow classmates (unpaid/paid)
  - Then on real subjects
- Pilots tell you a lot about design flaws
  - Does the program work as planned? Crashed?
  - Ask subjects "what is your strategy?" ex post
- Pilot data are NOT used in formal analysis
  - They are pre-committed "pilots"

Pre-Testing: Simulations

- Simulate Pseudo Data and Analyze Them
  - Similar procedures could be used later to
    - Generate bootstrap standard errors
    - Perform out-of-sample predictions
    - Check robustness of the econometric method
- Will you test fail pseudo data generated by the exact given theory?
- Will your estimation procedure uncover the true data-generating process you used?

Running the Experiment

- Overview of a Typical Session
  - Subjects Sign In
  - Read out Instruction
  - Ask for and Answer Questions
  - Quiz for Comprehension (if applicable)
  - Practice Rounds (not paid)
  - Real Rounds (paid)
  - Post-Experiment Survey
  - Handing Out Payments

Running the Experiment

- Read Written Instructions: Neutral, Public Knowledge
- Quiz: Test if subjects understand structure, etc.
- Post-Experimental Surveys
  - Collect demographics
  - Free Question: "What is your strategy?"
- Handing out Payments
  - Private Payments
  - Record Sheets and Administrative Records
- What if Something Unexpected Happens?

Running the Experiment

- What does the instructions of LUPI look like?
  - Are they "neutral"? Why or why not?
- What did experimenters ask after LUPI?
  - What demographics did they collect?
  - What were subjects' strategies?
- How were these data used in the analysis?

Data Analysis: Reduced Forms

- Graphs: How can you visualize the data?
- Summary Statistics
  - Averages, Median, STD, etc.
  - t-test, χ^2 test, etc.
  - Signed rank-sum test (non-parametric t-test)
- Regressions and other Basic Econometrics
  - OLS, Random Effects
  - Logit Regressions

Data Analysis: Structural Estimation

- Maximum Likelihood Estimations
  - For each parameter
  - Calculate Likelihood of seeing data
  - Find the parameter that maximizes this likelihood
- Logit-QRE: best λ (better response precision)
- Cognitive Hierarchy: best τ (aver. cog. level)
- Level-k: best "spike-logit" λ & ε (exact hits)
- EWA: best set of learning parameters

Data Analysis: Structural Estimation

- Out-of-Sample Predictions
  - Use 2/3 of the data to estimate data (MLE, etc.)
  - Obtain (MLE) parameters of the model
  - Use the estimated model to predict hold-out data
  - Prediction power: avoid overfitting
- Special Handling:
  - Eyetracking: DataViewer, Time Series, and Markov Switching
  - fMRI: E-prime, Matlab's SPM2

Data Analysis: LUPI

- What graphs did LUPI use?
- What summary statistics did LUPI use?
- Any regressions?
- How did they run MLE for QRE and Cognitive Hierarchy?
- Any out-of-sample prediction or simulation?
- Can you think of any other way they could have analyzed the data?

Conclusion

- Overview of an Experiment
  - Design, Procedure, and Data Analysis
- How good is your design?
  - What are your goals? Are they fulfilled?
- How should an experiment be carried out?
  - SOP
- How should I analyze my data?
  - Employ all state-of-the-art econometrics!
  - Create new “Experimetrics”!