Experimental Economics

Experimental Method

Outline

1. Principles of Economics Experiments
2. Experimental Design
3. Human Subjects
4. Laboratory facilities
5. Conducting an experiment
6. Data Analysis
7. Advantages and limitations of lab experiments

1. Principle of Economic Experiments

Data Sources

	Happenstance	Experimental
Field		
Laboratory		

Happenstance Data: by-product of ongoing uncontrolled processes
Experimental Data: deliberately created for scientific purposes under controlled conditions
Laboratory Data: gathered in an artificial environment designed for scientific purposes
Field Data: gathered in a naturally occurring environment.

	Happenstance	Experimental
Field	Most of empirical work in economics use FH data	Scope of this Course
Laboratory	Discovery of Penicillin	

Advantages of Experimental Data (1)

= Causation can be verified.

⇔Empirical economic analysis using FH data cannot explain the causations.

" X causes Y " can be confirmed in LE data.
It is not clear with FH data. It is possible that "Z is causing X and Y", instead of "X is causing Y".

- For example,

Y: crop yield
X: the field is under trees

X1: bird droppings
X2: shade

=> How do we confirm that X1 is actually causing Y OR X2 is causing Y?

Many socio-economic studies conclude the determinants of Y as X { income, age, gender, education… }.

Is X (= higher education) causing Y (=higher cigarette consumption) ?

Is X (= higher income) causing Y (= higher cigarette consumption)?

Or is there any common factor Z which is characterizing both X (income) and X (education) and resulting Y ???

Experimental data obtained from carefully designed experiments can reveal the causal relationship clearly [X -> Y] by controlling all other variables to be constant.

FH data often suffers from

- the omission of the relevant variables
- measurement error of unknown magnitude
- skewed coverage.

Advantages of Experimental Data (2)

<Cost vs. Validity>

- Costs: FE ≥ FH > LE

- Validity : [Internal vs. External Validity]

Internal Validity: Do the data permit correct causal inferences? (proper experimental controls, design and data analysis)

External Validity: Can we generalize our inferences from laboratory to field?

Purposes of Experiments

- **To generate data that might influence a specific decision** (of policy makers/authorities).

- **To provide data on how best to influence the decisions of consumers, voters and managers**. (voter response to television messages, campaign slogans, consumers response to TV advertisements and new products)

- **To discover empirical regularities in areas for which existing theory has little to say.**
- **To test new institutions in the laboratory before introducing them in the field.**
- **To help map the range of applicability for competing theories offering different predictions.**

- **To demonstrate whether there are any conditions under which the theory can account for the data. To test the theory for robustness.**
- **To find regularities in observed behavior in a broad range of interesting environments and to see which theories can best account for these regularities.**

⇔ Theory {a set of axioms, assumptions, definitions, and the conclusions which logically follow from them}

Realism vs. Models

- Which approach is correct when you are designing an experiment,

A: to mimic reality

B: to mimic a formal model

?

Answer : Neither!

Design your experiment:

- To learn something useful
- To answer the questions that motivate your research

- Mimic reality?

It is impossible to build the details of reality in your lab.

It is **impossible/very difficult to disentangle causes and effects** if you set up your lab environment to re-create reality.

=> Start simple. Select a few variables and examine the exact cause-effect relationship.

- Mimic Theory?

Most formal models leave out details.

Sometimes it's not possible to design the lab as the theory is formulated.

e.g. Rational expectations model:

Traders' orders theoretically are based on observed market-clearing prices.

In the lab, should an experimenter announce market-clearing prices before traders place orders or after?

- Even if you succeed in creating a laboratory economy that closely replicates the assumptions of a formal model, <u>you may not learn much from it.</u>

⇒Consistent observed behavior in your lab with the implications of the formal model

⇒Weak evidence of the models' explanatory power.

(If not consistent, then experimental design will be criticized.)

<= Evidence would be stronger if you had observed the same behavior in a lab that relaxed the more stringent assumptions of the model.

- A laboratory experiment should be judged by its impact on our understanding, not by its fidelity either to reality or to a formal model.

Controlled Economic Environments

Agents: resource endowments, information, technology etc. are defined by experimenters.

Note: Home-grown characteristics exist.

Institution : the agents interact within.

Induced-value theory

- Proper use of **a reward medium** allows an experimenter to **induce pre-specified characteristics in experimental subjects**, and the subjects' innate characteristics become largely irrelevant.

Three conditions to induce agents' characteristics

1. **Monotonicity**

   Subjects must prefer more reward medium to less, not become satiated.

2. **Salience**

   The reward Δm received by the subject <u>depends on her actions</u> as defined by institutional rules that she understands.

3. **Dominance**

   Changes in subjects' utility from the experiment come predominantly from the reward medium and other influences are negligible.

- **Dominance** could be problematic since preference V and "everything else" z may not be observable by the experimenter.

- Decision making may be based on

(1) Reward

(2) Fairness (influence of rewards earned by others)

(3) Demand Effect (subjects' effort to help the experimenter. Provide "ideal/expected" answers/reactions)

(4) Everything else including weather, emotion…

Laboratory Experiment vs. Survey

- Controlled economics experimentation is different from survey asking people to make choice under hypothetical settings.
- Salient rewards are not involved in survey based data collection. Respondents are not making economic choices under conditions within the control of the researcher.

- "What people say they would do in hypothetical situations does not necessarily correspond to what they actually do"
- "A field "market survey" that offers a choice between brand X and brand Y is a controlled economic experiment if respondents know they get to keep the brand they choose."

Q: Can we design a survey which include three conditions for "controlled economic environments"?

Parallelism

- Some economists question the external validity of laboratory data and feel that such data somehow is not representative of the real world.
- How do you answer to such skepticism?

Charles Plott (1982)

- "The art of posing questions rests on an ability to make *the study of simple special cases relevant to an understanding of the complex*. General theories and models by definition apply to all special cases. Therefore, **general theories and models should be expected to work in the special cases of laboratory markets**. As models fail to capture what is observed in the special cases, they can be modified or rejected in light of experience. The relevance of experimental methods is thereby established."

Practical Advices

1. The average payment should exceed subjects' average opportunity cost to promote monotonicity and salience. (e.g. > average hourly wage rate on campus employment opportunities)

2. Find subjects whose opportunity costs are low and whose learning curves are steep. (e.g. undergraduate students)

3. Create the simplest possible economic environment in which you can address your issues. Simplicity promotes salience and reduces ambiguities in interpreting your results. (e.g. dry runs, quizzes for comprehension check)

4. To promote dominance, avoid loaded words in instructions. Use neutral terms for subjects' roles. (e.g. buyer-seller, player A-player B, not opponent)

5. If dominance becomes questionable (and your budget permits), try a proportional increase in rewards.

6. When feasible and appropriate for your research, maintain the privacy of subjects' actions and payoffs, and of your own experimental goals.

7. Do not deceive subjects or lie to them. Salience and dominance are lost if subjects doubt the announced relation between actions and rewards.

Experimental Design

- **Focus Variables**

A few variables of your interests which you would like to observe the effects.

- **Nuisance variables**

The variables you must also keep track with little or no direct interest, but potentially affect your results.

How do we avoid confounding the effects of two or more variables:

<Control and Randomization>

1. Direct experimental control: Constants and treatments

2. Indirect control: Randomization

3. Within-subjects design as an example of blocking and randomization

4. Factorial Design

5. Crossover Design

1. Direct Experimental Control: Constants and Treatment

- By controlling important variables of your interests you produce experimental data, rather than happenstance data.

Options

(a) Keep it constant

(b) Set it at two or more different levels (two different set of cost parameters, elasticities)

=> Treatment vs. Control

For example,

- Fixed (constant) cost parameters

Vs.

- Two levels of cost parameters
  - one inducing highly elastic supply
  -the other inelastic supply

=> **Treatment variable**: variables controlled at two or more levels

- Tradeoff between controlling variables and constant.

constant ↑ => simpler, cheaper, but learn less about the direct effects and the interactions among the variables.

In order to obtain the clear causality,

vary all treatment variables independently.

	Elastic Demand	Inelastic Demand
Posted Offer Auction	Observations (PO-E)	-
Double Auction	-	Observations (DA-I)

	Elastic Demand	Inelastic Demand
Posted Offer Auction	Observations (PO-E)	Observations (PO-I)
Double Auction	Observations (DA-E)	Observations (DA-I)

2. Indirect Control: Randomization

- Some variables are difficult/impossible to control.

e.g. weather in agricultural experiment

Subjects' expectations about the experiments (alertness, interest, emotion etc.)

<= some of them are not observable or controllable.

- Uncontrolled nuisance variables can cause inferential errors if they are confounded with focus variables.

e.g. [old fertilizer vs. new fertilizer] focus variable
+ +
[bad weather good weather] nuisance var.

⇒Cannot decompose the effect of new fertilizer on increased yield.

⇒The problem is that you may attribute an observed effect to a focus variable when the effect actually arises from an uncontrolled nuisance.

Solution against uncontrolled nuisance variable?

⇒**Randomization**

Assign chosen level of the treatment variables in random order.

e.g. consumers' idiosyncrasies/habits could be uncontrolled nuisance variable.

=> assign each treatment randomly upon their arrival at the site.

Completely Randomized. : each treatment is equally likely to be assigned in each trial. (e.g. flipping coins)

3. The within subjects design [Blocking and Randomization]

- Between-subject design
  - Levels of the focus variable vary only across subjects (e.g. A treatment for Subject 1, B treatment for Subject 2)
- Within-subject design
  - Several levels of the focus variables are used for each subject.

e.g. WTP vs. WTA

Testing if new instruction will bring WTP and WTA closer.

Individual variability is an important nuisance which should be considered carefully.

⇒Ask WTP and WTA questions in random order and analyze the difference WTA-WTP across subjects for each gamble.

Will discuss this in ANOVA models.

4. Factorial Design

- Combining randomization and direct control when you have two or more treatment variables.

e.g. Two treatment variables (factors) R and S, with three levels H, M and L for R and two levels H and L for S

⇒3 X 2 factorial design

⇒Total 6 treatments {HH,HL,MH,ML,LH,LL}

⇒3 X 2 X 4 = 24 trials if replicated 4 times.

⇒Randomization: assign 6 treatments randomly to the six trials in each replication.

5. Crossover Design

- Varies the levels (A and B) of a treatment variable across trials for a subject.

⇒When the treatment variable has lasting effects for several trails, consider ABA crossover design.

⇒With AB treatment, the outcome of B treatment may be influenced by treatment A's characteristics. In order to test if AB design confounds time and learning with the treatment variables, try ABA design and compare the outcome from the first A and the last A treatment.

Practical Advice

1. **Experience and learning**: Subjects' behavior changes over time as they come to better understand the laboratory environment.
2. **Noninstitutional interactions:** Subjects' behavior may be affected by interactions outside the laboratory institution. Need to carefully monitor the subjects' interactions during a break.

3. **Fatigue and boredom**: Subjects' behavior may change over time simply as a result of boredom or fatigue. (max. 2 hours, occasional changes in payoffs recommended).

4. **Selection Bias**: The subjects or their behavior may be unrepresentative because their selection as "samples" are biased. (self-selection, experimenter selection)

5. **Subject or group idiosyncrasies:** A subject's background or temperament may lead to unrepresentative behavior. Necessary to replicate the same experiment with different subjects.

Human Subjects

- Economic theory has largely bypassed questions about how humans
  - Observe
  - Learn
  - Memorize
  - Form expectations
  - Adapt
  - Formulate
  - Choose strategies and decisions

by making convenient assumptions and leaving the actual discovery of answers to other social scientists.

- However, answers to these questions about human behavior are crucial to many core areas of economics.

Who should your subjects be?

1. Students {undergraduate, graduate, Major?}

2. Professionals

Students Subjects

Undergraduate or MBA students

1) Ready access to the subject pool
2) Convenience in recruiting on university campuses
3) Low opportunity cost
4) Relatively steep learning curve
5) Some lack of exposure to confounding external information

Note: Doctoral students may be disastrous subjects.

Experimenter may lose dominance with doctoral students since they often respond more to their understanding of possibly relevant theory than to the direct incentives of your laboratory economy.

Ph.D. students from economics or business schools are more likely to be aware of your objectives. Better to avoid recruiting such subjects.

Note 2: Need to carefully examine the external validity/ generalizability fo experimental research when use university students.

\+ Students are literate in language, mathematics and often statistics. Experiments ask subjects to understand the detailed instructions in short time period. Subjects need to have steep learning curves.

Professional Subjects

- "If the object of the experiment is to measure reactions to the experimental conditions and objectives, it is unproductive to choose as subjects those whose prior experience is contrary to the current design requirements, for they will have difficulty in adjusting to a new frame of reference with consequent suboptimal behavior" (Burns, 1985)

⇒Many studies have reported results from parallel experiments in which students and professionals were given similar incentives.

⇒Consider incorporating professionals in development of model and experimental design, but maybe not in the experiments itself due to the adjustment problem.

Data Analysis

1. Report Summary Statistics
2. Summarize data using Graphs/Figures/Tables
3. Statistical Inferences
   – Testing your hypothesis "Does treatment X affect outcome Y?" "Is outcome Y better predicted by model M1 or by model M2?"
   – ANOVA
   – Hypothesis tests: Wilcoxon statistic, Mann-Whitney U statistic, Binomial or signs test

Planning Experiments

1. Define the objectives of the experiment.
2. Identify all sources of variation.
   a) Treatment factors & their levels
   Treatment factors ≥ 2 => factorial experiment.
   b) Nuisance factors
   = Either setting it as constant for all treatments [set the temperature of each unit of land constant] OR set it as blocking factors.
   c) Blocking factors
   = a nuisance factor which level is held constant for one group of experimental units, change it to a different fixed value for a second group, change it again for a third..
   [changing temperature for each block of units]
   d) Covariates
   = Some nuisance variation is a property of the subjects and can be measured before the experiment takes place. Can also be a blocking factor.
   [blood pressure of a patient, IQ of students…]

3. Choose a rule by which to assign the subjects to the levels of the treatment factors.
   - ⇒Randomization
4. Run a pilot experiment
5. Specify the model
   - ⇒Fixed effects model (Factor levels are selected by the experimenter. Compare the effects on the response variable of these specific levels)
   - ⇒Random effect models (A factor has an extremely large number of possible levels)
   - ⇒Mixed models (some factors are fixed, and others are random)
6. Outline the analysis
   - ⇒Hypotheses to be tested
   - ⇒Confidence intervals to be calculated.
7. Calculate the number of observations needed.