Experimental Economics

Introduction II

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Outline for today

- Types of Economic Experiments
  - lab experiments
  - natural experiments
  - …
- Measurement models: Experimental Economics vs Econometrics

Sources of Data

- **Economics** has long been considered **deductive science,** before combining theoretical considerations with observations from the real world
- Only more recently (1980's), **experiments** were introduced to Economics

	Naturally occurring	***Experimental***
Field	•GDP •Inflation •Unemployment rate (field data from economic outcomes)	• Policy experiments • Experiments as part of representative surveys • Experiments conducted outside the lab
Lab	Discovery of Penicillin	**Laboratory experiment in a controlled environment**

The empirical method

The importance of control

Naturally occurring field data, that is, direct observations of the real world may suffer from **endogenous** problems:

- Selection effects
- Unobservable variables
- …

Data is not collected in a controlled environment

The empirical method

The importance of control

- To establish whether an independent/ exogeneous variable (*treatment*) influences the dependent variable (*outcome*)…
- one needs a control condition (*counterfactual*)

Counterfactual

An example

Suppose that after half of the lab experiments, I decide to give you one day more time to hand in the lab reports.

And, suppose, the grades of the lab reports improved.

What can you say?

Is there a positive effect of having one more day?

Counterfactual

An example

Better grades could have resulted from:

- Easier topics in the second half
- Students may have studied more after midterms
- More experience with the course
- Better mood because of nicer weather
- …

Counterfactual

An example

In an **ideal** world:

Have the same group of students with and without an additional day to hand in

- a lab report about the exact same experiment
- that they did for the first time
- under the same weather conditions
- … and everything else constant, too

→ **That's impossible!!!** (Difference between social and natural sciences)

Measurement models

It's intuitive to think of the **empirical problem** in a *dichotomous* way

- $y_1 =$ outcome with treatment
- $y_0 =$ outcome with no treatment

The treatment effect τ for unit i can be measured as: $\tau_i = y_{i1} - y_{i0}$

Problem: due to missing counterfactual → $\boldsymbol{\tau_i}$ **is unknown**

Measurement models

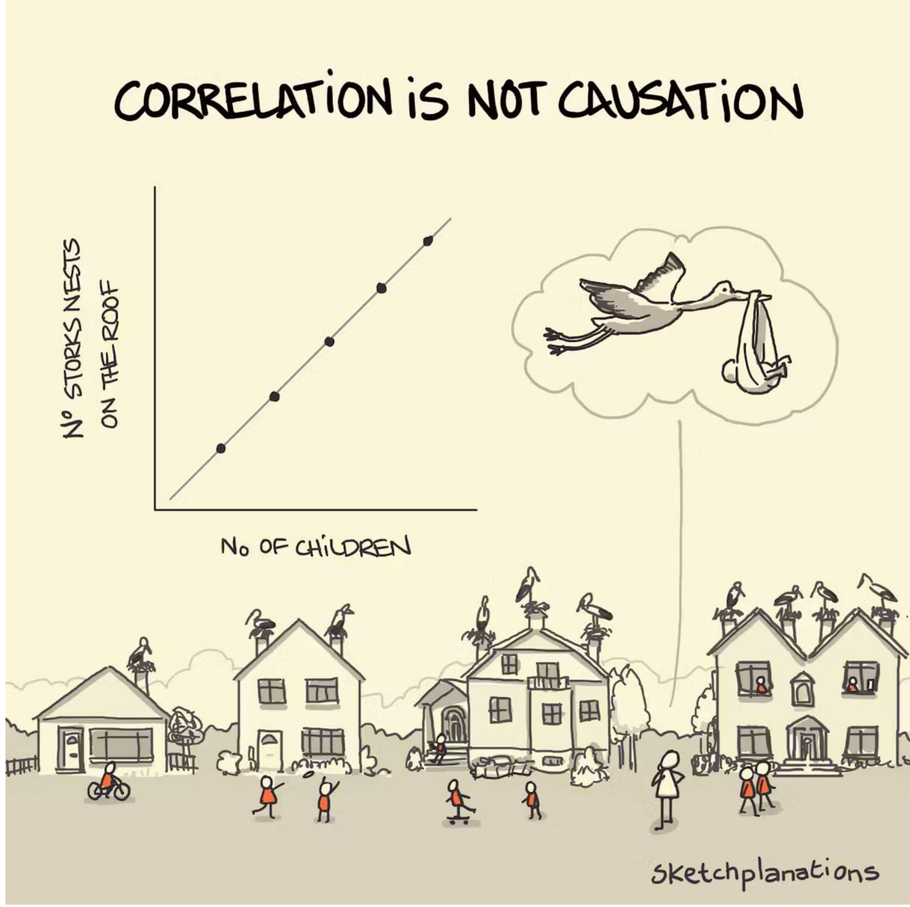
Econometrics

Economists have spent years developing approaches to the analysis of economic data and still do - **investigate causal relationships among variables** - , with the purpose of giving empirical content to economic theories and verifying or refuting them.

Correlation vs. causality

Storks bring babies

- Do more storks cause more babies?
- Post-war Germany
  - stork population grew and more babies were born
  - causal relationship?
- One explanation
  - after bombing ended → stork population recovered
  - men returned from war → couples were able to make babies
- Confounding variable: end of war → spurious correlation



Generate the missing counterfactual

- Naturally occurring data → **Econometrics** (advanced statistical methods applied to economics, e.g., regression, IV) **to establish counterfactuals for causality**

- Controlled experiments → **Generate data with control condition (counterfactual)**
  - No problem with **causality** since causal relationship between independent variable and dependent variable is guaranteed by design.

Controlled experiments

Considering causality, controlled experiments are the **most convincing** method of creating the counterfactual since they directly construct a control group via ***randomization***.

In this case, the population average treatment effect is given by:

$$\tau = y_1^* - y_0^*$$

y_1^* : average outcome after the treatment of treated population
y_0^* : average outcome after the treatment of non-treated population

Natural experiments

- Example from Germany: number of high school years were reduced from 9 → 8 in some states.

- Research question: Does this affect scholastic performances?

- Identify treatment effects in cases where
  - randomization is not possible
  - selection is not an issue

- Considers the treatment itself as an experiment and finds a comparison group to *mimic* the control.

Difference-in-Differences (DiD)

An econometrical method

τ is measured by **comparing the difference in outcomes before and after for the treated** with the **before and after outcomes for the non-treated**
→ treatment effect on the treated

$$\tau = [y^*_{1a} - y^*_{1b}] - [y^*_{0a} - y^*_{0b}]$$

where

y^*_{1a} is the mean outcome for the treated group **a**fter the treatment
y^*_{1b} is the mean outcome for the treated group **b**efore the treatment
y^*_{0a} is the mean outcome for the untreated group **a**fter the treatment
y^*_{0b} is the mean outcome for the untreated group **b**efore the treatment

Natural experiments

More examples

Smoking ban in Helena, Montana from June 2002 until December 2002

- Heart attacks rate dropped by 40% while the smoking ban was in effect
- Confounding effect: the heart attack rates were already in decline (endogenous)

Nuclear weapons testing

- Partial nuclear testing ban treaty (1963) → atmospheric nuclear test forbidden
- Compare people born before 1963 and after 1963, for instance to check the rate of replacement for cells in different human tissues.
- DiD: compare areas with greater exposure to those with lower exposure

Measurement methods

If controlled experiments can produce **the most convincing evidence of randomization**

and the **statistics needed for the analysis are simple** because randomization does the work itself…

why not use controlled experiments more often?

→ **External validity**: Many questions are difficult to answer in this setting

- Does the GDP growth in the U.S. influences vaccination in Africa?
- Do environmental regulations alter trade and capital flows?

Laboratory Experiments

A lab experiment constructs a **small-scale environment** where an **experimenter's control should be assured** to properly measure the treatment effects.

Control and **Replication** are the essence of Lab Experiments

Control a variable

In practical terms, ***to control*** a variable means

- **Fixing** and **maintaining** it at some **constant level**
- Set it at different levels across different interventions

Control in Laboratory Experiments

"In laboratory experiment, a microeconomic system is created, which reflects a complete and self-contained economy" (Vernon Smith, Nobel Prize winner in 2002)

Two key elements:

1. **Institution (rules of the game)**
   - Possible actions
   - Sequence of actions
   - Information condition (message space)
   - Incentives
   - Framing (language, story)
   - Outcomes
2. **Environment**
   - Initial endowment
   - Agents' preferences
   - Measure confounding variables (e.g., agents' beliefs)

Control over preferences

The subjects are likely to have **prior characteristics and preferences** which are difficult to observe.

→ **control over preferences is the most significant element of lab experiments.**

How can we gain control over subjects' preferences?

Use incentives!

Types of Experiments

- Natural experiments
- Laboratory experiments
- Online experiments
- Field experiments
- Experimental surveys

Controlled experiments
→ randomization is possible

Experimental labs around the globe

Vernon Smith Experimental Econ Lab, Purdue University

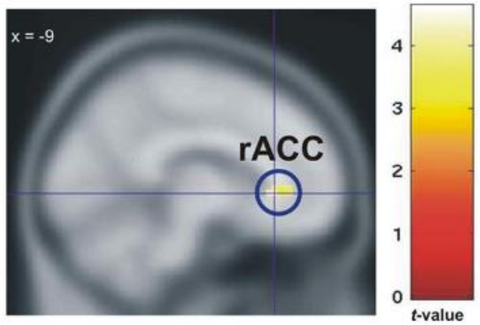
CREED Lab, University of Amsterdam

XLAB at ISEG

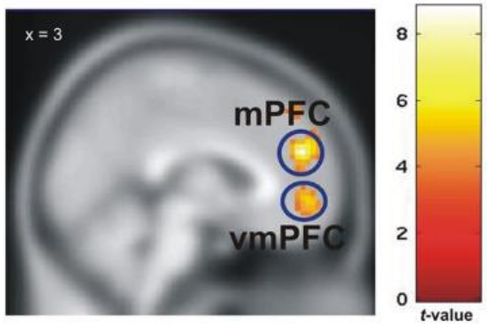
Magnetic resonance imaging (MRI)

E.g., **k-level thinking** in the guessing game **correlates** with **neural activity** (Coricelli and Nagel, 2009)

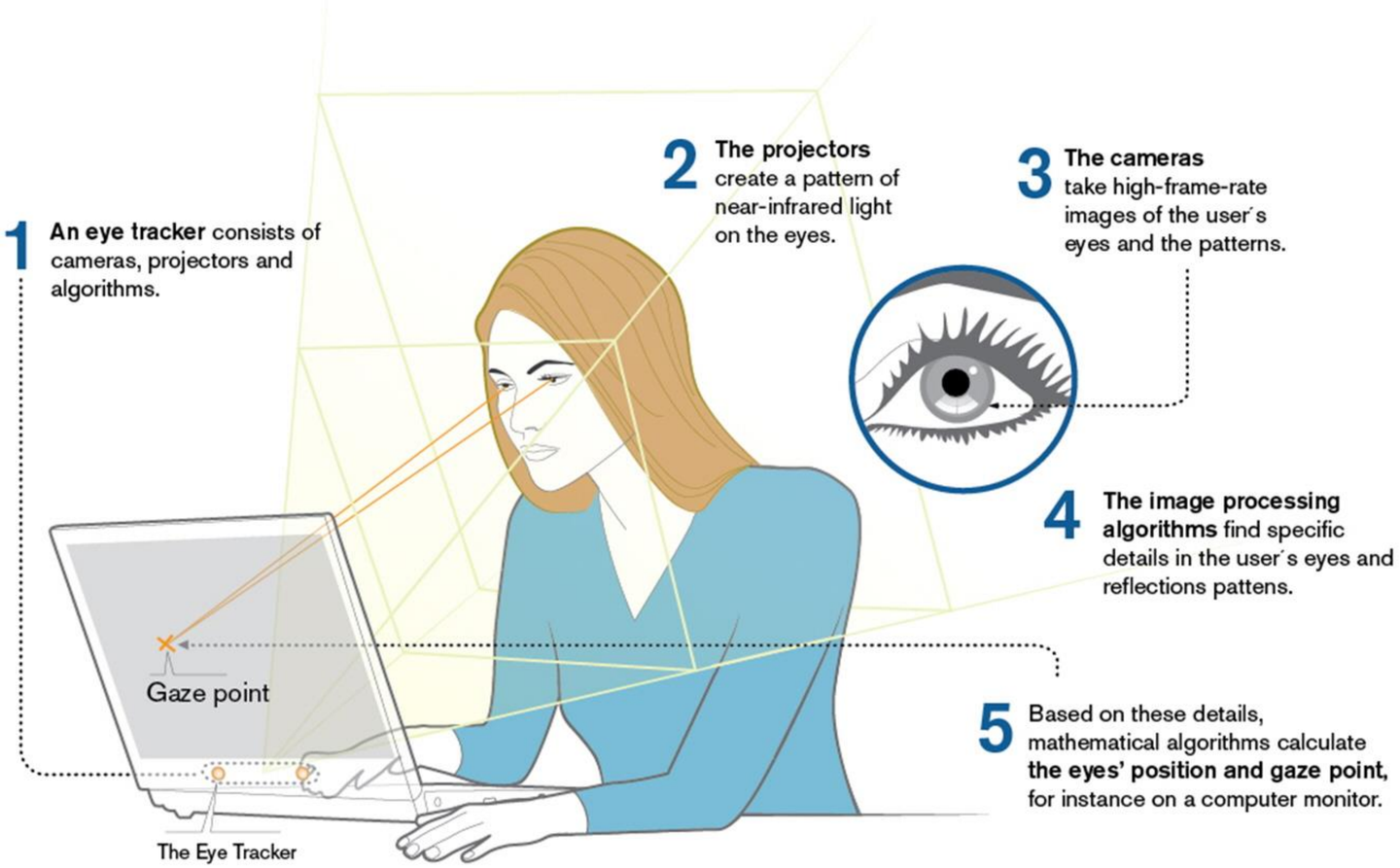
Low level of reasoning



High level of reasoning



Eye-tracking



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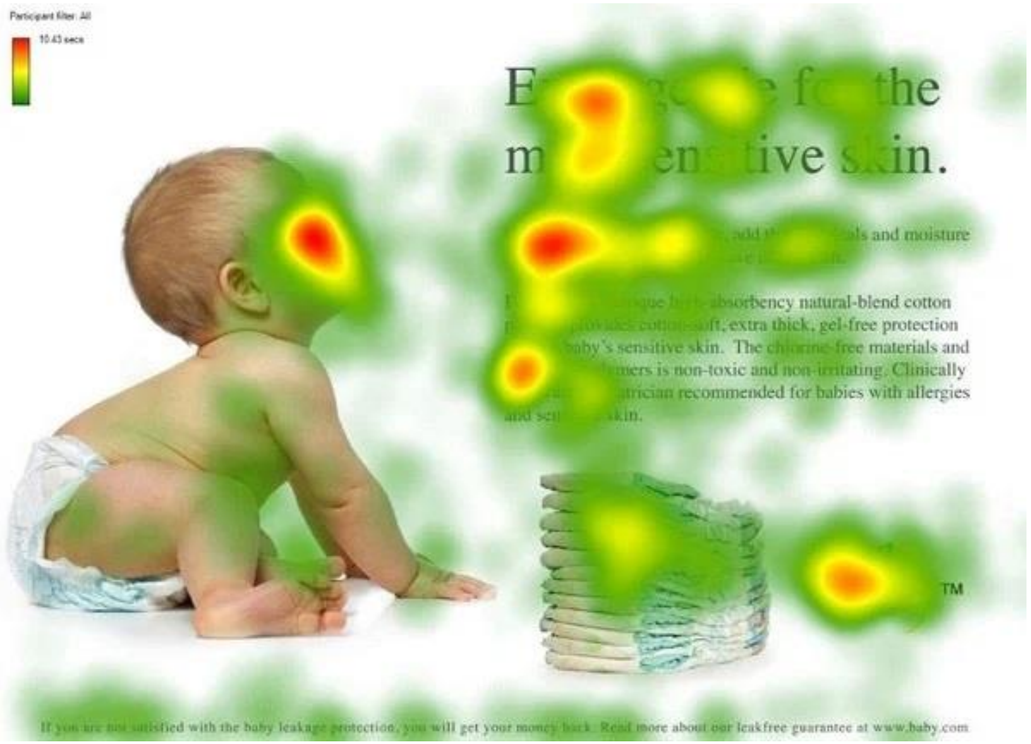
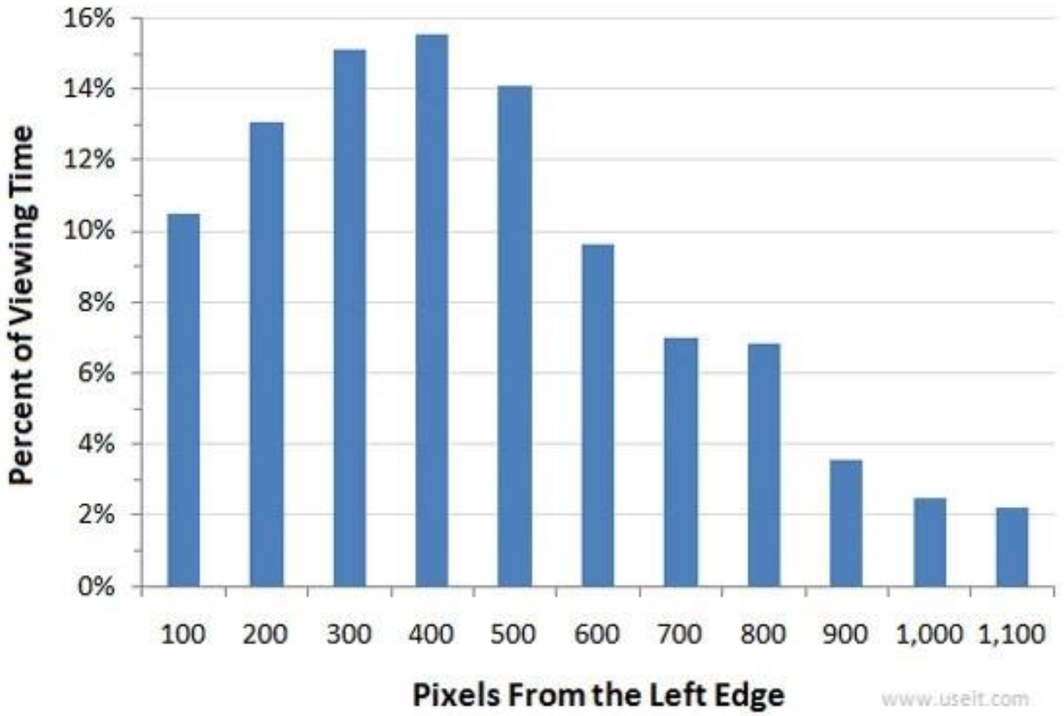


websites can be optimized by including images that serve as visual cues for where visitors should look next (neilpatel.com)

Eye-tracking



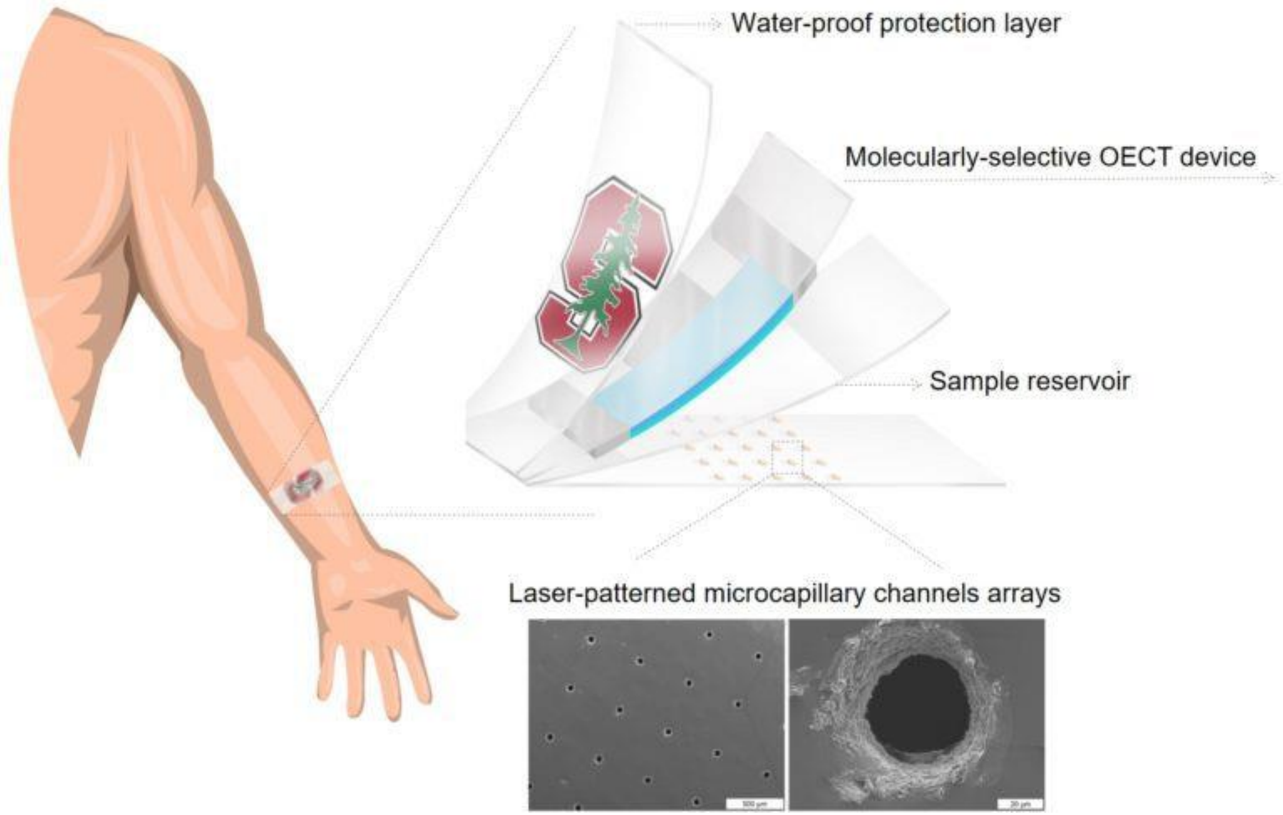
Websites tend to be browsed in an **F-pattern**

Heart rate monitor

E.g., applied in research on cheating behavior

Measure sweat

A proxy for stress levels



Wearable device from Stanford measures cortisol in sweat

Field experiments

Are Emily and Greg More Employable Than Lakisha and Jamal?
A Field Experiment on Labor Market Discrimination (AER, 2004)

Online experiments

- *Microsoft, Amazon, eBay, Booking.com, Facebook, Google* conduct countless online experiments daily (e.g., AB testing) → Big Data
- Specialized firms that program economic experiments (e.g., *Expilab*)
- Online participant recruitment platforms (e.g., *CloudResearch, prolific*)
- Online labor markets (e.g., *Amazon Mechanical Turk*)

Experimental surveys

The Asian disease example – framing effects

Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs, A and B, to combat the disease have been proposed. Which one do you prefer?

Lives saved frame

- **Program A:**
  1/3 probability that 600 people are saved, otherwise 0 people are saved
- **Program B**
  200 people are saved for sure

Lives lost frame

- **Program A':**
  1/3 probability that 0 people will die, otherwise 600 people will die
- **Program B'**
  400 people will die for sure

Usually, humans behave risk averse for gains and risk seeking for losses.