

# Intro to Practical Econometrics

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Applied Statistics and Econometrics 2  
ECON GA-1102.031 / ECON GA-1102.032

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# This Class

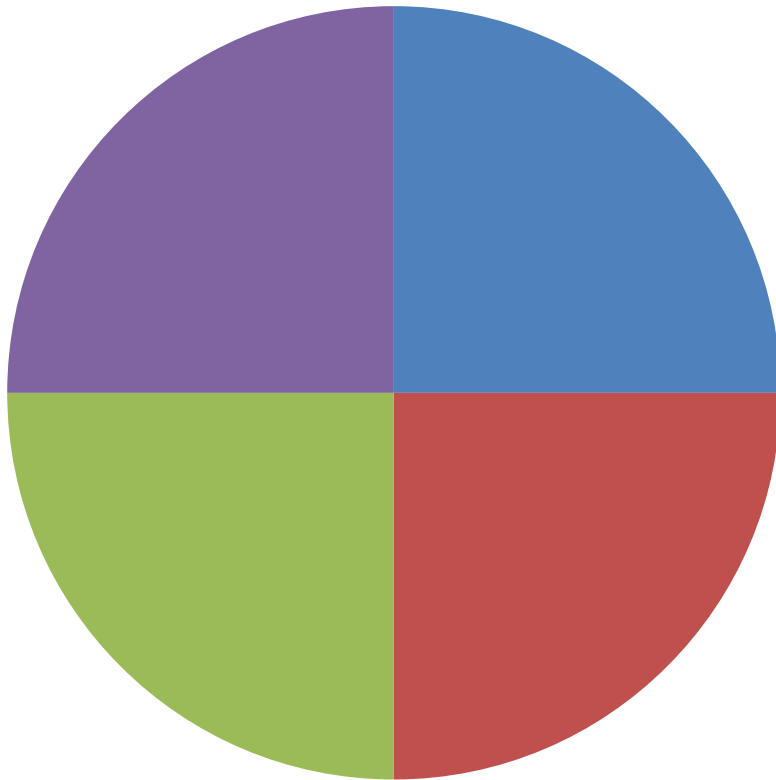
# Lab = Enhanced Recitation

- Recitation
  - Review theory
  - Solve exercises to complement theory, homework
- Empirical work in R
  - Complement lecture
  - Research project
- Answer your questions – resuscitation

# Office hours

- No formal office hours but available by email
- Last half hour of class for 1 on 1 discussion or research group meetings
  - by appointment or “walk in”

# Class structure



- 1. Recitation (exercises)
- 2. Empirical work in R
- 3. Your questions
- 4. Individual meetings

# Research Project

# Intro: Motivation

One of the priorities of this course is to guide you into producing your own research by the end of the semester

- Great opportunity to explore a topic of interest
- Apply the econometric methods you learned
- Excellent topic of discussion for job interviews

# Intro: Logistics

- Groups of 3 to 5 students (preferably from same lab section)
- Important dates:

Project Requirement	Date Due
Group Signup	Feb 6
Problem Statement	Feb 27
Model Description	Mar 27
Presentation	May 1
<b>Final Report</b>	<b>May 14</b>

- Details in the *Instructions for Term Project* handout



# Research Project: Broad Guidelines

# Three ingredients of a successful research project

1. **Academic rigor**
  - a) Understand and encompass the existing literature
  - b) Innovative, yet appropriate, use of data
  - c) Appropriate causal inference
2. **Policy relevance**
  - a) Tied to new facts or trends
  - b) Framed in terms of policy levers
  - c) Timely
3. **Broadly communicated**
  - a) Accessible to a wide range of audiences
  - b) High potential for media coverage
  - c) Partnered with policy makers



# Model should be anchored in established economic theory

Avoid data mining! Put the Econ in the Econometrics

Some (broad) theoretical frameworks:

- Supply / demand
- Consumption smoothing
- Monopolistic competition

Keep eyes open for empirical examples in your textbooks (Chiang book, Greene book)

# Research Project: Data

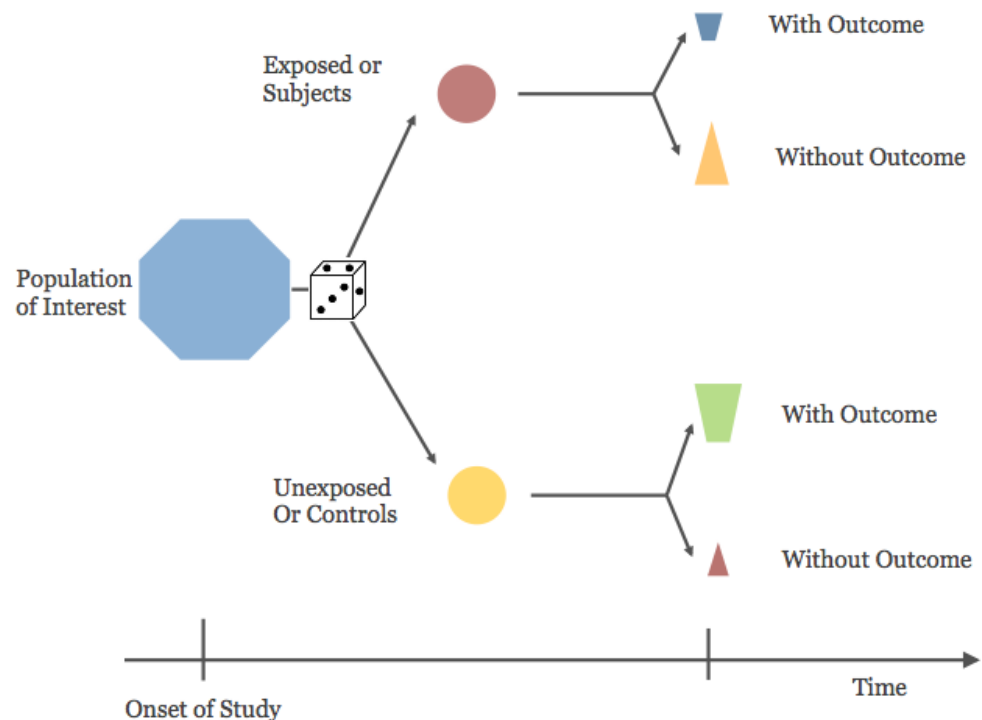
# Experimental vs. observational data

- Experimental data come from experiments designed to evaluate a treatment or policy or to investigate a causal effect
- Observational (nonexperimental) data are collected using surveys and administrative records

# Experimental data: RCTs

## Randomized Control Trials:

- All participants are randomly assigned into two groups.
- The control group receives no treatment (or placebo)
- The experimental group receives the treatment.
- After a follow-up period, compare the two groups



# RCTs: advantages

The gold standard for causal inference

- Randomization minimizes selection bias
- Ensures that the only systematic difference between the control treatment group is the treatment itself, with the effects from other confounding factors eliminated



# RCTs: disadvantages

- **Cost:** Called “the gold standard” because expensive (in money and time)
- **Ethics:** Especially in social science, we cannot impose some treatment due to ethic concerns

# Observational data: advantage

## Readily available:

### Public databases

- Federal Reserve Economic Data <https://fred.stlouisfed.org/>
- US Census <https://www.census.gov/en.html>
- US Bureau of Labor Statistics <https://www.bls.gov/>
- US Economic Accounts <https://www.bea.gov/data>
- Penn World Tables <https://cid.econ.ucdavis.edu/pwt.html>
- IMF <https://www.imf.org/en/Data> OECD: <https://data.oecd.org/>

### Replication data sets

- openICPSR <https://www.openicpsr.org/openicpsr/repository/>
- Harvard Dataverse <https://dataverse.harvard.edu/>

### Author personal website

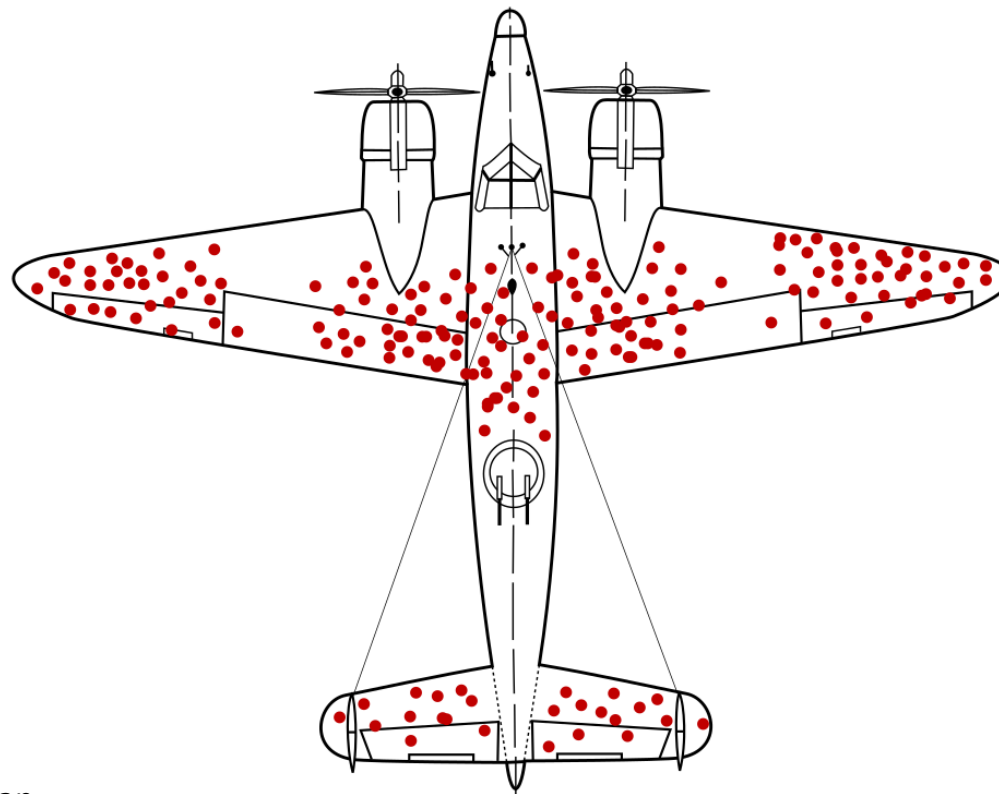
**Paid** Haver Analytics, Bloomberg, FactSet, Markit, CapitalIQ

### Curated datasets

- R datasets <https://vincentarelbundock.github.io/Rdatasets/articles/data.html>
- Data and Story Library <https://dasl.datadescription.com/datafiles/>

# Observational data: disadvantage 1

Choices already baked in: Know your data collection methodology!  
(see Abraham Wald, survivorship bias, selection bias, truncation, censoring)



Source: Martin Grandjean

# Observational data: disadvantage 2

“Treatment” is not randomly assigned so difficult to estimate causal effects

**Much of econometrics dedicated to dealing with causality using observational data**

# Causal Inference

# Regression

$$Y = \beta_0 + \beta_1 X + \varepsilon$$

$Y$  = dependent variable

$X$  = independent variable

$\varepsilon$  = other factors (aka "error term")

$$\text{Lifespan} = \beta_0 + \beta_1 \text{RedWineConsumption} + \varepsilon$$

Wealth as possible confounder (wealthy people likely to drink wine but also likely to get better health care)

$$\text{LungCancer} = \beta_0 + \beta_1 \text{SmokingTobacco} + \varepsilon$$

Ronald Fisher (a smoker himself) argued on the side of tobacco companies about possible confounders (genetics etc)

- Regression can be useful but be careful not to interpret causally
- The most we can say is that “X is associated with Y”
- Or “a one unit increase in X is associated with a  $\beta_1$  increase/decrease in Y”

# Causal effect

- Causal effect - the effect on an outcome of a given action or treatment as measured in an ideal RCT
- The concept of the **ideal randomized controlled experiment** does provide a theoretical benchmark to define causal effects in research design
- Sometimes nature helps - natural experiments (quasi-experiments) provide randomization

# Methods

- Difference in Differences – Greene Ch. 6
- Instrumental Variables – Greene Ch. 8



# Difference in Differences

**Jon Snow**

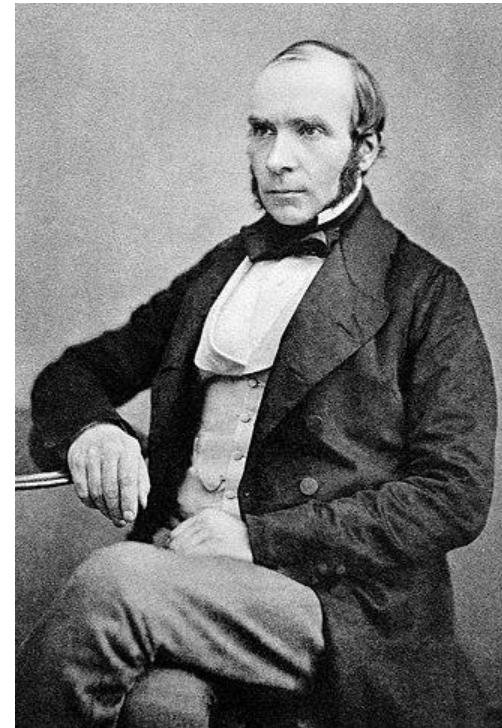
(“Game of Thrones” character)



**VS**

**John Snow**

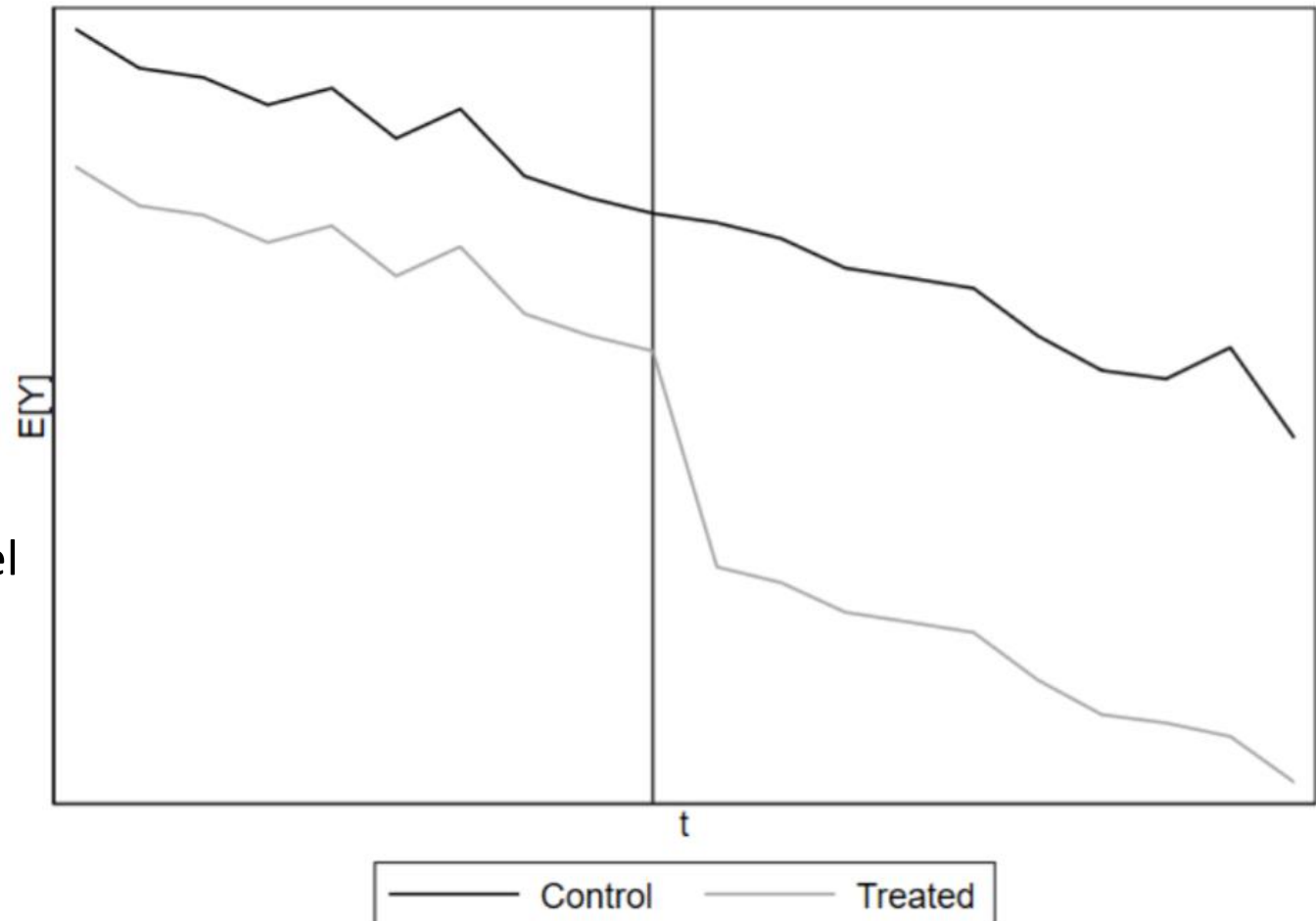
(Father of epidemiology)



Source: Wikipedia

# Difference in Differences

- John Snow 1850s – cholera incidence vs. water provider
- Card and Krueger (1994) – NJ, PA unemployment level vs. min wage



# Difference in Differences



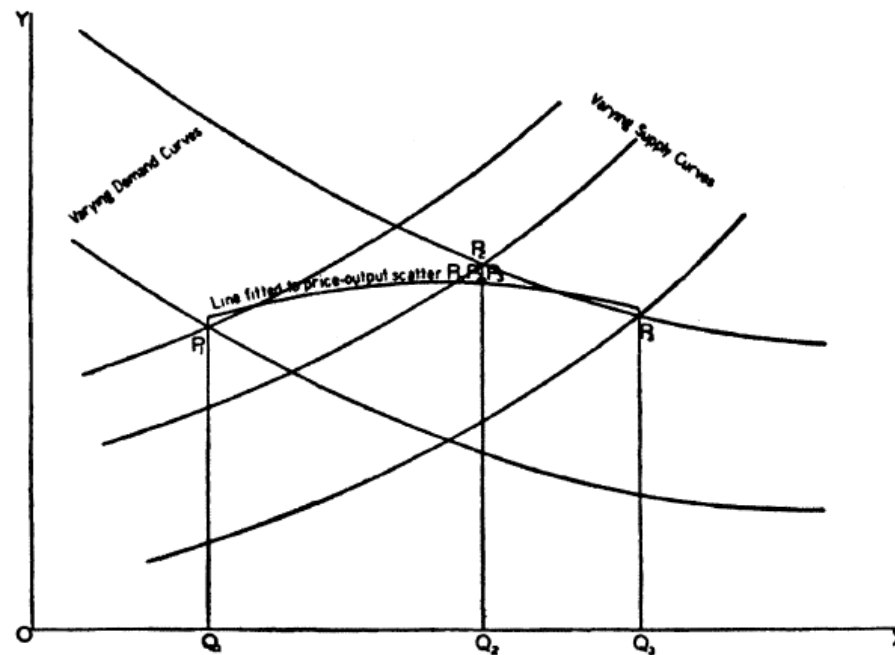
- Sources of randomization:
  - Local governments change policy (marijuana, pay-day loans, min. wage)
  - Jurisdictions hand down legal rulings (abortion)
  - Natural disasters (wildfires in California, hurricanes in Louisiana)
  - Firms lay off workers

Image source: Scott Cunningham, Causal Inference: The Mixtape(2020)

# Instrumental Variables

## Phillip G Wright's original illustration of the identification problem

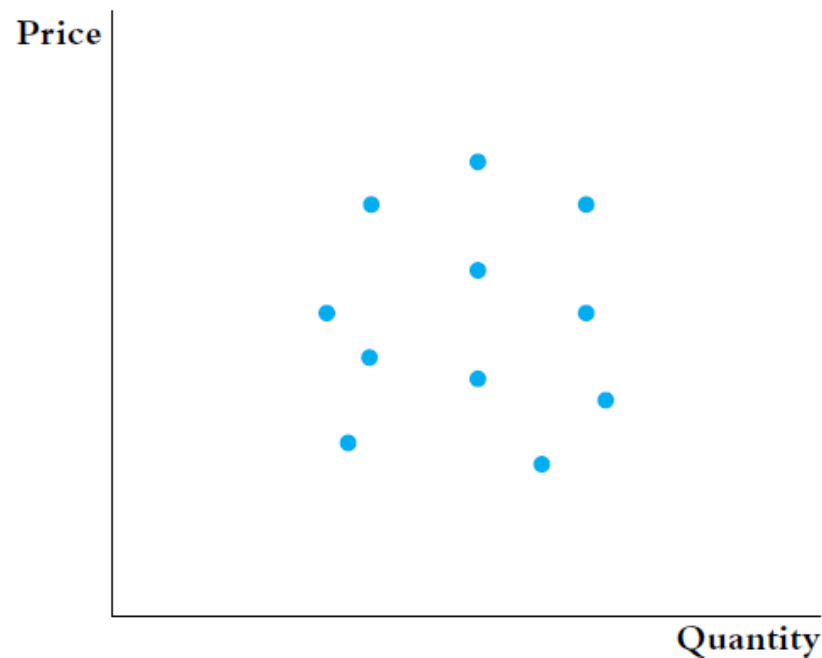
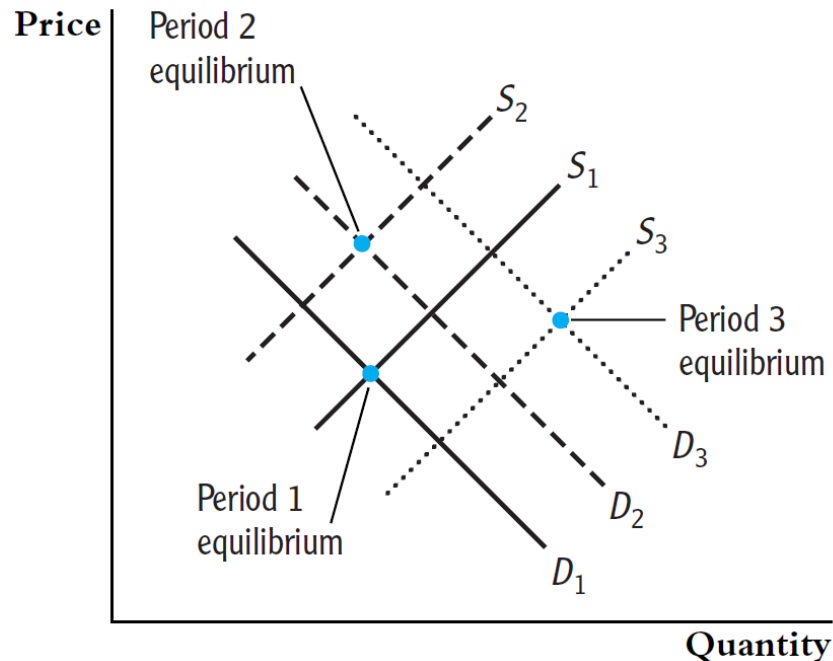
FIGURE 4. PRICE-OUTPUT DATA FAIL TO REVEAL EITHER SUPPLY OR DEMAND CURVE.



Source: PG Wright, The Tariff on Animal and Vegetable Oils (1928)

# Instrumental Variables

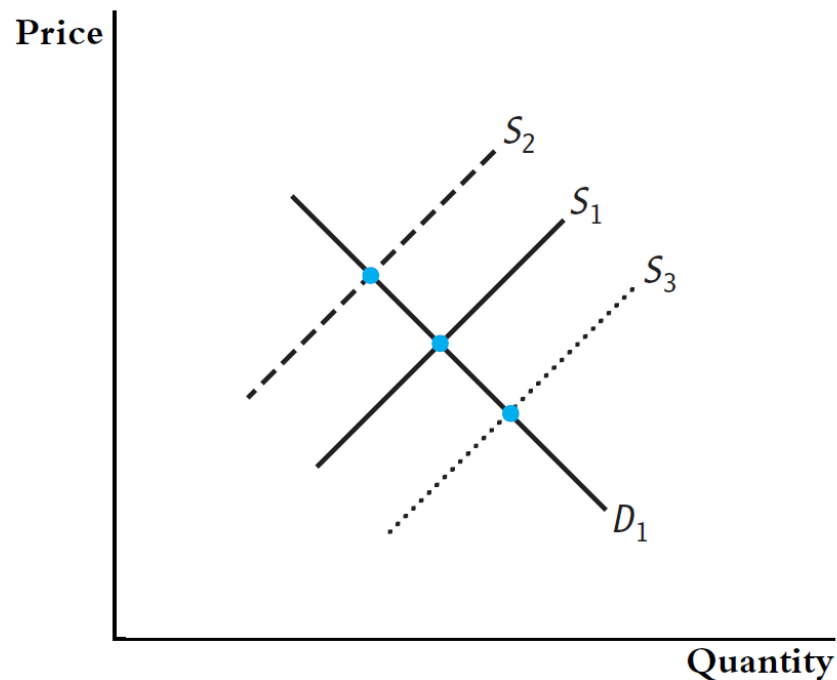
$$\ln(Q_i^{butter}) = \beta_0 + \beta_1 \ln(P_i^{butter}) + u_i$$



Source: Stock and Watson

# Instrumental Variables

## Using Rainfall as Instrumental Variable for Butter Supply



Source: Stock and Watson

# Statistical Data Types

# 1. Cross-sectional data

- Data on different entities for a single time period are called cross-sectional data
- The sequence of each observation number is arbitrarily assigned
- Cross-sectional data can be experimental data or observational data

person	year	income	age	sex
1	2018	50	27	M
2	2018	80	38	F



## 2. Time series data

- Data for a single entity collected at multiple time periods
- The sequence of each record is based on the time period it happened

person	year	income	age	sex
1	2018	50	27	M
1	2019	55	28	M
1	2020	60	29	M

- Be careful with time series data:
  - Serial correlation, nonstationarity
  - Spurious correlation <http://tylervigen.com/spurious-correlations>
- Proper analysis may require knowledge of advanced methods: Vector Autoregressive models (VAR), GARCH etc.

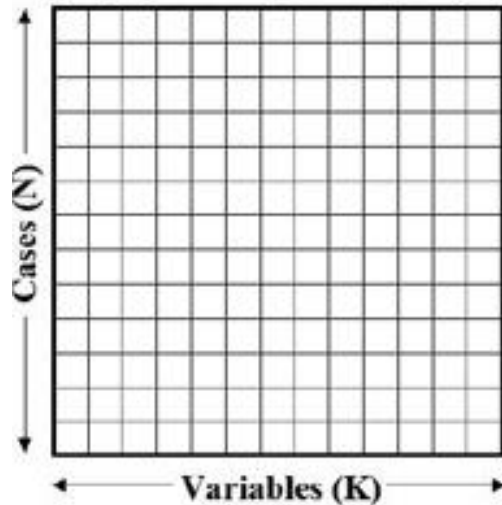
# 3. Panel data

- Also called longitudinal data - data for multiple entities in which each entity is observed at two or more time periods.
- Panel data are **very useful for estimating causal effects**

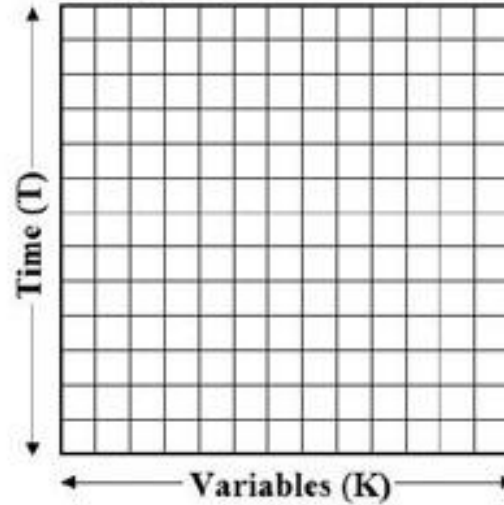
person	year	income	age	sex
1	2018	50	27	M
1	2019	55	28	M
1	2020	60	29	M
2	2018	80	38	F
2	2019	85	39	F
2	2020	90	40	F

# Statistical data types visualization

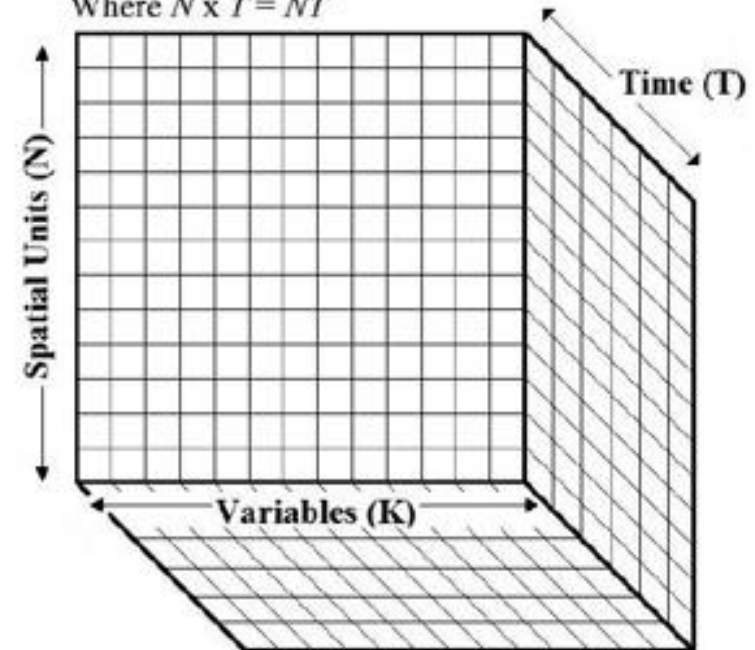
a) Cross-Sectional Analysis  
(Single, or average time point)



b) Time-Series Analysis  
(Single unit)



c) Time-Series Cross-Sectional Analysis  
Where  $N \times T = NT$



# Summary - Research Project

- Great topic for future job interviews
- Writeup is like the empirical section of the final exam (i.e. show you've learned the material) but packaging matters (policy relevance)
- A topical research question has legs
- Econometric model should be anchored in economic theory (careful with data mining)
- Panel data better for estimating causal effects

## TLDR

- **Find a good reference paper**
- **Start now!**

# Next Steps

# Next Steps

- Start thinking about your project - group sign-up due Feb 6
- Next week: Panel data analysis with R (may help with HW)
  - Install RStudio <https://www.datacamp.com/community/tutorials/installing-R-windows-mac-ubuntu>
  - Bring laptops (fully charged, few outlets in classroom)