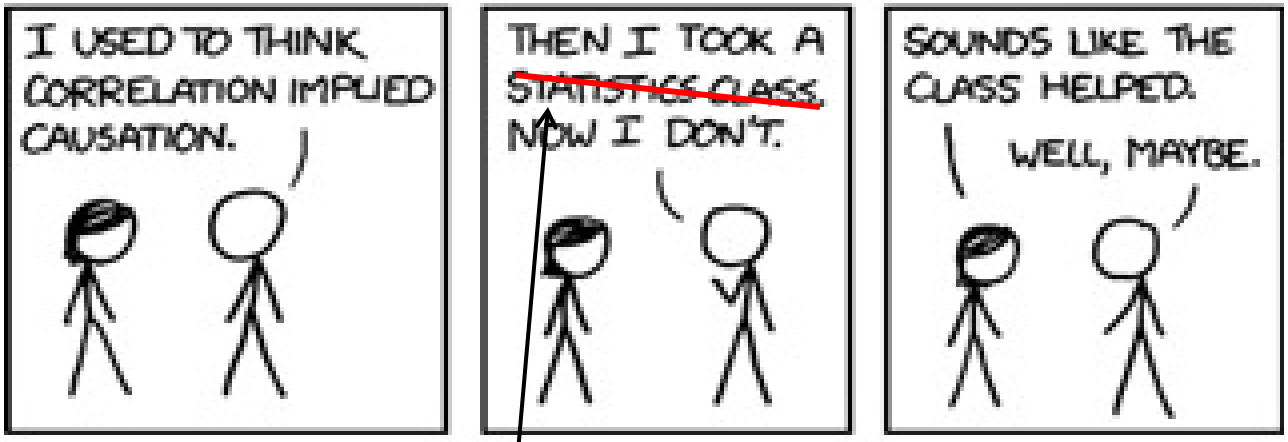
# ESM 296: Lecture 1



# Motivation: Policy Decisions

- 1. Credible empirical studies are key inputs to making sound policy decisions

- Examples:

- What is the impact of secure property rights on natural resource outcomes (i.e., effect of ITQ on fish stocks, harvest decisions, and their economic value)?

- What will be the impact of climate change on human health?

- Are environmental regulations that improve ambient air quality cost-effective?

# Aside: Terminology

- The field of analysis of empirical policy evaluation methods goes by many labels:
- "Program evaluation"
- "Policy evaluation"
- "Impact evaluation"
- "Causal inference" (of course the inference could be about a question without a direct a policy application)

# Motivation (ctd)

- 2. Designing and implementing a credible empirical study is often difficult … The context matters a lot

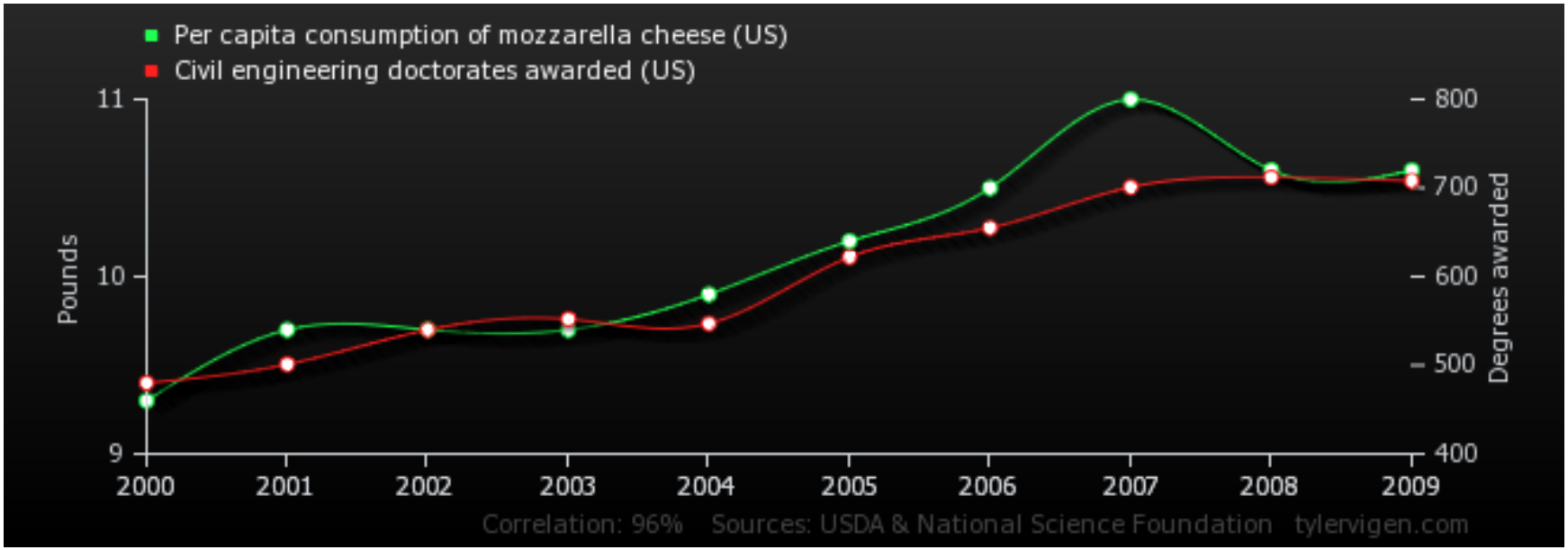
- In an purely ecological setting, simple correlation between outcome and "treatment" (predictor of interest) may reveal a causal relationship
  - Example: Measuring the effect of ambient temperature on mockingbird song frequency and dB level

- When humans 'interfere' with natural systems, the analysis is typically not as simple
  - Example: ITQ regimes are not randomly implemented across fisheries and may be negatively selected on biological/economic outcomes
  - Humans exposed to high levels of ambient pollution may be negatively selected on SES (e.g., Env Justice literature)

# Motivation:

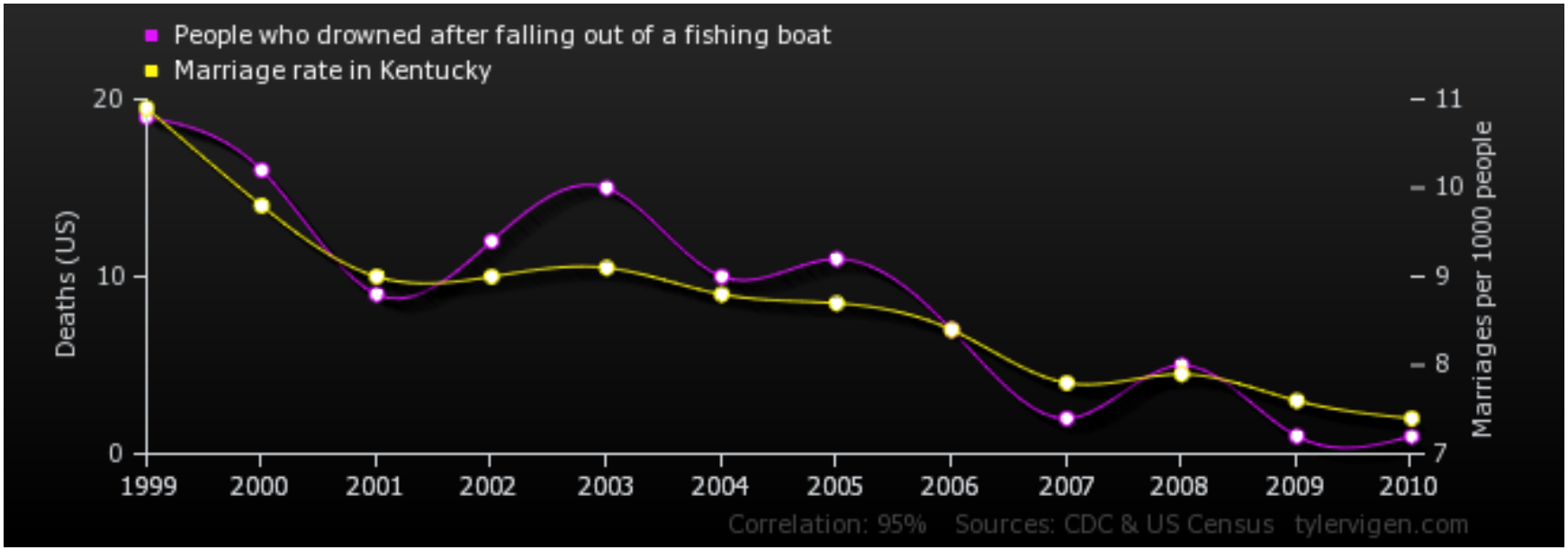
- 3. Key challenge is that most study designs in social sciences (and natural sciences) are non-experimental:
  - "Treatment" status not randomly assigned to subjects
  - Subjects often select their treatment status
  - Opens up the possibility of biases due confounding, omitted variables, selection, simultaneity causality
- $\Rightarrow$ Correlation $\neq$ causation
  - i.e. observing a correlation between two variables does not imply there is a causal relationship between the variables

# Correlation ≠ Causation: Some Examples




Note: correlation = 0.96

Source:
http://www.tylervigen.com/




Note: correlation = 0.95

Source:
http://www.tylervigen.com/

# What is Causality?

- Causality is complex concept, even if it appears simple and intuitive (ask a philosopher...)
- We will use the counterfactual or potential outcome framework to define causal relationships
- Other definitions or frameworks exist, but most policy evaluation techniques have been developed with the potential outcomes framework, so I use it here

# Objectives of this class:

- 1. Provide a better understanding of issues that lead to the correlation ≠ causation problem
  - Of course this also highlights when simple correlations (or naïve regression coefficients) derived from observational data can have a “causal” interpretation

- 2. Present assumptions and statistical methods that <u>can help</u> identifying causal relationships with non-experimental data
  - Note the underlined above: these methods are never silver bullets that guarantee identification of causal relationships
  - Validity of any particular application is always dependent on context and subject to maintained assumptions
  - **How believable are the assumptions?**

# More Terminology: Study design

- Outcome: dependent variable of interest in the study
  - In the ITQ and fisheries example, the outcomes could be: fish stocks, fish harvests, economic value of harvest
  - In the air pollution example, the outcome could be: measures of health, housing values, etc

- Treatment: independent variable of interest in the study
  - ITQ status ={0,1}
  - Ambient air pollution concentrations

- Treatment assignment (mechanism): Process by which subject become exposed (or not) to the treatment
  - In RCT: random process (i.e. coin flip)
  - ITQ: Not sure…
  - Air Pollution: Sorting process in which individuals tradeoff housing values and ambient air pollution level

# Identifying Causal Relationships with Non-Experimental Data

- As we will see, the key will be to understand the mechanism by which treatment status was assigned to the subjects we are studying
  - Randomly
  - Quasi-randomly / exogenously ?
  - Selected based on observed characteristics?
  - Selected based on unobserved characteristics?

- There are assumptions & methods to identify causal relationships for all types of treatment assignment mechanisms
  - Again, the context, and the credibility of the maintained assumptions will distinguish between good and not so good empirical papers

# Class Administrative Details

- Class meets twice a week (Mon/Wed, 12:30-1:45)
- Office hours: Fridays 1:30-3:00, or by appointment (email), North Hall 2050
- Class website: (lecture notes, assignments, data, answer keys, readings, etc)
  http://www.econ.ucsb.edu/~olivier/esm296/esm296.html

# Class Evaluation

- 1. Class participation: 10%

- 2. Assignments (4) 30% (10% each, will count best 3).
  Can work individually or in teams of 2

- 3. Final examination (take-home during exam week): 60%

# Teaching Assistant

- Dan Ovando
- dovando@bren.ucsb.edu

# Textbooks / Readings

- No required textbook

- Recommended #1: "Mostly Harmless Econometrics" by J. Angrist & S. Pischke [A&P]
  - Modern presentation (and not too technical) of most of the material from this class
  - About $25 in paperback

- Most of the material in A&P is also covered in the online lecture notes by G. Imbens and J. Wooldridge [I&W] "What's New In Econometrics." More technical than A&P (http://www.nber.org/minicourse3.html )

# Textbooks / Readings (ctd)

- Recommended #2: Undergraduate textbook "Introduction to Econometrics" by J. Stock & M. Watson [S&W]
  - I will put on copy in reserve at the Library
  - There are 3 editions available, all are fine, and you may find a used version for about $50

- Other readings will be posted on the class website

# Outline of class

- 1. Basics of regression analysis
  - Bivariate regression
  - Multivariate regression
  - Nonlinear specifications, dummy variables, interactions
  - Hypothesis tests
- 2. Internal / External validity of empirical studies
- 3. Definition and framework of causal relationships
- 4. Regression and Matching
- 5. Propensity Score Methods

# Outline of class (ctd)

- 6. Instrumental Variables Methods
- 7. Regression Discontinuity Methods (if time permits)
- 8. Fixed Effects and Difference-in-Difference Methods
- 9. Introduction to ‘Big Data’ methods (if time permits)

# Disclosure: (1)

- I was training as a labor economist but am now a researchers environmental economics (mostly)

- Most of the “go to” examples and applications I know are from these fields (including the textbooks and readings)
  - This is especially true of the homeworks

- I will try my best to find good applications in other fields of interests for Bren students (ecology, hydrology, etc)

- Feel free to pass along some suggestions to this end!

# Disclosure: (2)

- Like most economists, I use the commercial statistical software Stata


- My class demonstrations and homework solutions will use Stata

- It is available in the Bren “GIS” lab and other some labs on campus (including new library)

- Students can use the software of their choice for this class. “R” seems like the best suited one besides Stata

# Before next class:

- Review slides from S&W on class website
- Begin reading S&W Chapters 4-7
- Begin reading A&P Chapter 3