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Causal Inference

Introduction: Causality and the Fundamental Problem of Causal Inference

Ken Stiller

Part 1

April 2025

## Causal Inference

"Felix, qui potuit rerum cognoscere causas"

- Virgil, 29BC.

Why Causal Inference?

▶ Our world is full of causal claims!

▶ This is inevitable!

▶ Can you think of anything that relates to knowledge that does not rely on a chain of cause and effect?

▶ Can we answer questions about the (social) world, without making assumptions about whether X and Y are causally related?

▶ It will make you a better voter, informed citizen, allow you to make better decisions, and differentiate fake news.

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Do Masks Protect You Against Covid?
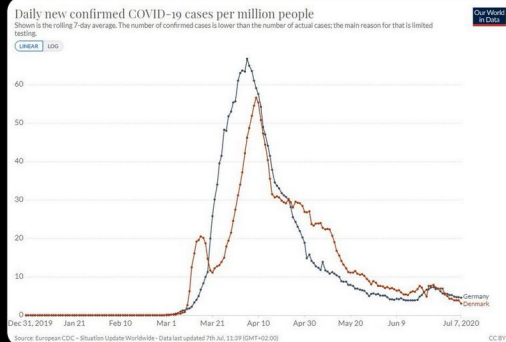
One (among too many!) weird, weird thoughts on Twitter.

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Do Masks Protect You Against Covid? II

Backed up by a real doctor - seems legit.

Do Masks Protect You Against Covid? III

So they do help? Probably, but how can we know?

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Do Masks Protect You Against Covid? IV

We're confident at this point - but it is pretty hard to actually know something!

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Let's Look at a Hard Case

Why did Russia decide to invade Ukraine (in early 2022)?

Ukraine - Territorial Gains?

Opinion: What we can expect after Putin's conquest of Ukraine

By <u>Robert Kagan</u>
Contributing columnist

February 21, 2022 at 5:39 p.m. EST

🎧 **Listen to article** 6 min

Ukraine - Domestic Reasons?

Opinion **Russian politics**

Putin's threats disguise a weakening position

A regional sphere of influence made up of corrupt autocracies is vulnerable to uprisings and instability

GIDEON RACHMAN   + Add to myFT

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Ukraine - Identity?

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Ukraine -Security Concerns?

Why the Ukraine Crisis Is the West's Fault

The Liberal Delusions That Provoked Putin

John J. Mearsheimer

Ukraine - Ukraine's Agency?

NATO recognises Ukraine as Enhanced Opportunities Partner

12 Jun. 2020 - | Last updated: 12 Jun. 2020 15:47

English | French | Russian | Ukrainian

On Friday (12 June 2020), the North Atlantic Council recognised Ukraine as an Enhanced Opportunities Partner. This status is part of NATO's Partnership Interoperability Initiative, which aims to maintain and deepen cooperation between Allies and partners that have made significant contributions to NATO-led operations and missions.

Why did Russia decide to invade Ukraine (in Feb 22)?

For all these reasons?

▶ Possibly to some extent

▶ But this is not really a satisfactory or helpful answer

▶ *We seek to make accurate, precise and 'helpful' claims*

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Why Do We Do Science?

- To *explain* things?
  - Why did something happen?
  - $? \rightarrow Y$

- To *predict* things?
  - What will happen?
  - $X \rightarrow ?$

- Are these two mutually exclusive?
  - It's always about the relationship between two events (i.e. causation).
  - $X \rightarrow Y$

- Is it much better to know a small part about everything than everything about a small part?
  - This - again - is a false dichotomy!
  - Looking at causality might (help) overcome it

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Why Causal Inference

- ▶ The focus of Causal Inference is applied econometrics, developing tools to answer questions of the form "what is the effect of X on Y"
  - ▶ What is the effect of reading the Daily Mail on voting intentions in the UK?
  - ▶ What is the effect of parents' education on children's income?
  - ▶ What is the effect of the minimum wage on unemployment?
  - ▶ What happens to a country if it withdraws from a trade agreement?
  - ▶ What is the effect of getting a high grade in Causal Inference on your likelihood of getting into a PhD?

- ▶ Answering such questions is difficult. Our world is full of data and observations, but often careless interpretations.

- ▶ Being reasonably confident about a causal effect is usually not that easy

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Welcome to Causal Inference

Setup of the course:
- ▶ 2 weekends
- ▶ 25-27 April
- ▶ 23-25 May

Mostly at the first weekend:
- ▶ Motivation
- ▶ Theory
- ▶ Examples

In-between and at the second weekend:
- ▶ Apply what you learn
- ▶ Deepen your knowledge with readings You'll be able to apply all methods by the end of the seminar
- ▶ Using R, R Markdown

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Ken Stiller

I'm a lectureer at the University of Bayreuth. I'm also affiliated with the European University Institute. I received a PhD in International Relations from the Department of Politics of International Relations at the University of Oxford, and I hold an MPhil in IR from Oxford.

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Road map: Causal Inference

1. Introduction, Causality, FPCI
2. Potential Outcomes Framework and Selection Bias
3. Randomised Control Experiments
4. Selection on Observables, Multiple Regression and Matching
5. Panel Data and Fixed Effects Models
6. Differences-In-Differences
7. Instrumental Variables and 2SLS Estimation
8. Regression Discontinuity Designs
9. Revisiting Instrumental Variables and Fuzzy Regression Discontinuity Design

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Assessments

- ▶ Participation in class (15%)
- ▶ Presentations at second weekend (35%)
  - ▶ You will select a paper to critically discuss (send to me by 9 May) and give a presentation of about 15mins:
  - ▶ (i) presenting the paper and theoretic context
  - ▶ (ii) explain and assess the causal question the paper seeks to answer
  - ▶ (iii) critically discuss the papers approach and limitations
  - ▶ (iv) suggest remedies and tentatively design an improved identification strategy
- ▶ Take Home Exam: Distributed by the end of this course, deadline 30 June 2025 at noon (50%)

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Where to find our course materials

▶ You'll find all resources (slides, lab code, assignments) on our
   course page:
   https://bayreuth-politics.github.io/CI25/

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Extra Assignment

▶ The world is full of incorrect causal claims (unfortunately).

▶ Look out for them!

▶ If you find a really bad one, send them to me by email.

▶ Best one (i.e. most ridiculous incorrect claim) gets an honorary mention at the end of the last lecture for this term!
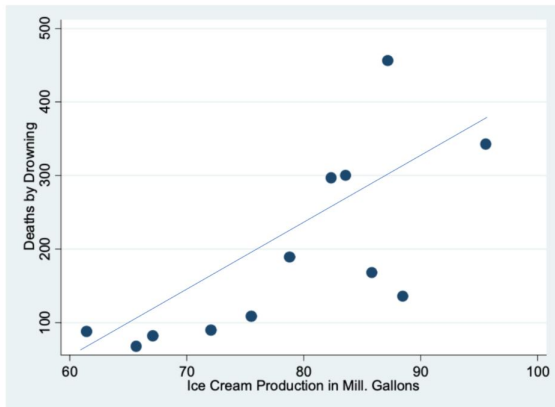
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What is the Effect of Ice Cream Production on Drowning?

Monthly data for the USA in 2004 – a strong relationship between ice cream sales and drownings

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What Causes Drownings?

1. Ice cream

2. Lots of swimming in High temperatures

3. Irresponsible parents

4. Something else

5. I don't know

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Drowning, Ice Cream, and the Heat
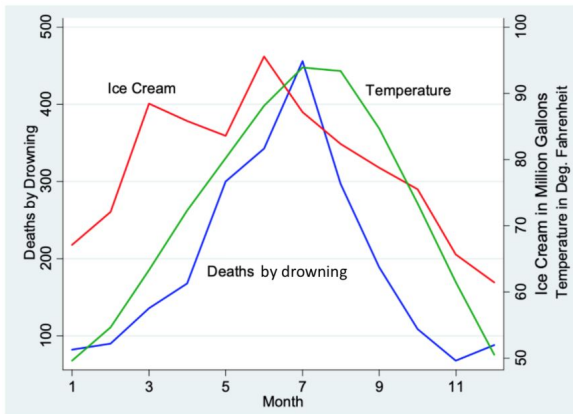
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Correlation is Not Causation: A Third Variable can Cause Both

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Correlation is Not Causation: A Third Variable can Cause Both

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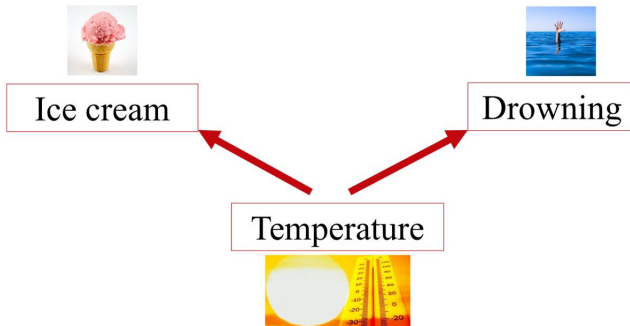
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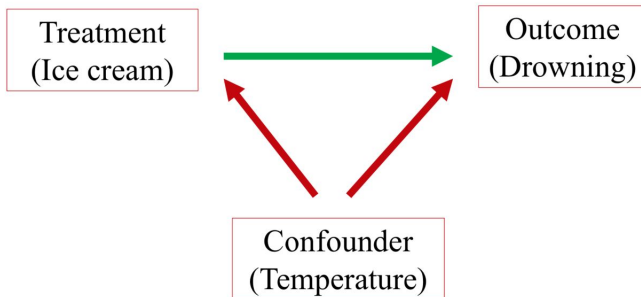
Definitions

Causality

Refers to the relationship between events where one set of events (the effects) is a direct consequence of another set of events (the causes). (Hidalgo & Sekhon 2012)

Causal Inference

The process by which one can use data to make claims about causal relationships. (Hidalgo & Sekhon 2012)

Inferring causal relationships is a central task of science.

Examples

► What is the effect of peace-keeping missions on peace?

► What is the effect of church attendance on social capital?

► What is the effect of minimum wage on employment?

A Counterfactual Logic

Counterfactual Logic

If X had/had not been the case, Y would/would not have happened

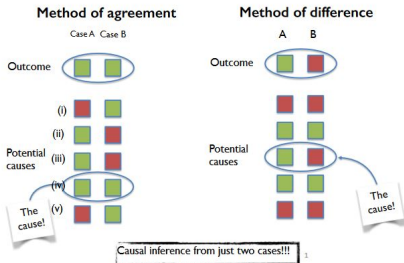**Example**:*Does college education increase earnings?*

- ▶ If high school grads had instead obtained a college degree, how much would their income change?
- ▶ If college grads had only obtained a high school diploma, how much would their income change?

John Stuart Mill: A System of Logic (1843)

A series of "canons" for inductive inference. Two well-known methods of comparison:

- ▶ Method of Difference: Units similar in all respects but one manipulable treatment. Units differ in their outcomes.
- ▶ (Method of Indifference: Units dissimilar in all respects but one. Outcome same in both units.)

Suppose all of the potential causes can be enumerated and accurately measured. Then these two methods will *under certain conditions* tell us the cause of an outcome:

Causal inference from just two cases!!!

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Mill & the Counterfactual Logic of Causality

Causal Inference as a counterfactual Problem

Rather than defining causality purely in reference to observable events, counterfactual models define causation in terms of a comparison of observable and unobservable events.

▶ We need to construct counterfactuals of the observed world as comparison units (Method of Difference).