

# Quasi-experiments in epidemiology

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# Quasi-Experiments in Epidemiology: Workshop Materials

All materials: <https://github.com/leekshaffer/Epi-QEs/>



# How Will I Know?



# About Me

- Assistant Professor at Yale School of Public Health
- Teach statistical modeling and study design
- Research focus on infectious disease study design and cluster-randomized trials



# Rise of Quasi-Experiments



## Natural experiments help answer important questions

*This year's Laureates – David Card, Joshua Angrist and Guido Imbens – have shown that natural*

## A revolution in empirical research

The Laureates' contributions from the early 1990s demonstrate that it is possible to answer important questions about cause and effect using natural experiments. Their contributions complement and

# QEs in Economics and Political Science

## Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania

By DAVID CARD AND ALAN B. KRUEGER\*

*On April 1, 1992, New Jersey's minimum wage rose from \$4.25 to \$5.05 per hour. To evaluate the impact of the law we surveyed 410 fast-food restaurants in New Jersey and eastern Pennsylvania before and after the rise. Comparisons of employment growth at stores in New Jersey and Pennsylvania (where the minimum wage was constant) provide simple estimates of the effect of the higher minimum wage. We also compare employment changes at stores in New Jersey that were initially paying high wages (above \$5) to the changes at lower-wage stores. We find no indication that the rise in the minimum wage reduced employment. (JEL J30, J23)*

## The Economic Costs of Conflict: A Case Study of the Basque Country

By ALBERTO ABADIE AND JAVIER GARDEAZABAL\*

*This article investigates the economic effects of conflict, using the terrorist conflict in the Basque Country as a case study. We find that, after the outbreak of terrorism in the late 1960's, per capita GDP in the Basque Country declined about 10 percentage points relative to a synthetic control region without terrorism. In addition, we use the 1998–1999 truce as a natural experiment. We find that stocks of firms with a significant part of their business in the Basque Country showed a positive relative performance when truce became credible, and a negative relative performance at the end of the cease-fire. (JEL D74, G14, P16)*

## Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program

Alberto ABADIE, Alexis DIAMOND, and Jens HAINMUELLER June 2010, Vol. 105, No. 490, Applications and Case Studies DOI: 10.1198/jasa.2009.ap08746

# QEs in Epidemiology and Public Health

Natural Experiments:  
An Overview of Methods,  
Approaches, and Contributions  
to Public Health Intervention  
Research

Peter Craig, Srinivasa Vittal Katikireddi,  
Alastair Leyland, and Frank Popham

*Annual Review of Public Health*  
Designing Difference in  
Difference Studies: Best  
Practices for Public Health  
Policy Research

Coady Wing,<sup>1</sup> Kosali Simon,<sup>2</sup>  
and Ricardo A. Bello-Gomez<sup>1</sup>

# QEs in Epidemiology and Public Health

ELSEVIER

Journal of Clinical Epidemiology 89 (2017) 43–52

Epidemiology

## Quasi-experimental study designs series—paper 6: risk of bias assessment

Hugh Waddington<sup>a,\*</sup>, Ariel M. Aloe<sup>b</sup>, Betsy Jane Becker<sup>c</sup>, Eric W. Djimeu<sup>a</sup>, Jorge Garcia Hombrados<sup>d</sup>, Peter Tugwell<sup>e</sup>, George Wells<sup>e</sup>, Barney Reeves<sup>f</sup>

Current Epidemiology Reports (2022) 9:22–37

<https://doi.org/10.1007/s40471-022-00288-7>

EPIDEMIOLOGIC METHODS (PP HOWARDS, SECTION EDITORS)



## Causal Inference Challenges and New Directions for Epidemiologic Research on the Health Effects of Social Policies

Ellicott C. Matthay<sup>1</sup> · M. Maria Glymour<sup>2</sup>

# Considering the Role of Evidence

**A comparison of quasi-experimental methods with data before and after an intervention: an introduction for epidemiologists and a simulation study**

Roch A Nianogo  <sup>1,2\*</sup>, Tarik Benmarhnia<sup>3</sup> and Stephen O'Neill<sup>4</sup>

Article

Alternative causal inference methods in population health research:  
Evaluating tradeoffs and triangulating evidence

Ellicott C. Matthay <sup>a,b,\*</sup>, Erin Hagan <sup>a</sup>, Laura M. Gottlieb <sup>a</sup>, May Lynn Tan <sup>a</sup>, David Vlahov <sup>c</sup>,  
Nancy E. Adler <sup>a</sup>, M. Maria Glymour <sup>a,b</sup>



- Allows use of routinely-collected data
- Evaluates interventions in-context
- Provides “real world evidence”/population impact
- Answers questions randomized trials and observational studies cannot
- But ... has threats to internal and external validity

# Threats and Considerations

- Exchangeability conditions phrased differently
- Requires other assumptions, which are sometimes “hidden” or opaque
- Trade-offs between bias, variance, and generalizability
- Need to carefully consider desired estimand (ATT vs. others)
- Rarely includes sample size/power justification

# Workshop Details

# Workshop Plan: Part I

8:30–9:00 Introduction and core DID issues

9:00–9:45 Advanced DID and staggered adoption

9:45–10:30 Analysis 1: Advanced DID of COVID-19 vaccine mandates

# Workshop Plan: Part II

**10:40–11:15** Introduction to synthetic control

**11:15–11:45** Analysis 3: SC of Ohio's COVID-19 vaccine lottery

**11:45–12:15** Advanced SC methods overview

**12:15–12:30** Analysis 4: Advanced SC of multiple states' COVID-19 vaccine lotteries

# Workshop Goals

- Understand, interpret, and critique the use of DID and SC in epidemiology
- Gain familiarity with state-of-the-art methods related to DID and SC and identify resources for further exploration
- Contextualize the assumptions needed for causal inference from quasi-experiments
- Implement staggered adoption DID and SC analyses and diagnostics/inference in R

# A Note on the Examples

I will focus here on infectious disease examples from published literature with available data. Some issues are specific to ID, while others are not, but they illustrate the points of how to approach these questions.

## The Use of Quasi-experimental Designs for Vaccine Evaluation

James A. Lopez Bernal,<sup>1,2,3</sup> Nick Andrews,<sup>3</sup> and Gayatri Amirthalingam<sup>1</sup>

<sup>1</sup>Immunisation, Hepatitis and Blood Safety Department, Public Health England, <sup>2</sup>Department of Health Services Research and Policy, London School of Hygiene and Tropical Medicine, and  
<sup>3</sup>Statistics, Modelling and Economics Department, Public Health England, London, United Kingdom

**Quasi-experimental methods for pharmacoepidemiology: difference-in-differences and synthetic control methods with case studies for vaccine evaluation**

Lee Kennedy-Shaffer 

## Using Difference-in-Differences to Identify Causal Effects of COVID-19 Policies

Andrew Goodman-Bacon  
Vanderbilt University, and  
NBER

Jan Marcus  
University of Hamburg, and  
DIW Berlin

**Parallel Trends in an Unparalleled Pandemic Difference-in-differences for infectious disease policy evaluation**

 Shuo Feng, Alyssa Bilinski  
doi: <https://doi.org/10.1101/2024.04.08.24305335>

# Let's Get To It!

All materials: <https://github.com/leekshaffer/Epi-QEs/>



# Epidemiologic Considerations for DID

# Key Assumptions

- Parallel trends (in expectation of potential outcomes)
- No spillover
- No anticipation/clear time point for treatment

# Methods to Improve Assumptions

- Re-scale the outcome
- Incorporate covariates
- Include more or fewer units and/or time periods

# ATT Estimand

## ! Estimand Interpretation

DID estimates the **Average Treatment Effect on the Treated (ATT)**.

This may not be generalizable to other units, including the untreated units in the study.

# Internal vs. External Validity

- Internal validity may be high if the assumptions are justified.
- External validity may be low because of limited transportability of the ATT and limited information on effect heterogeneity.

# Bias vs. Variance

- Incorporating additional units/periods can reduce variance, but may also risk violating the assumptions
- Generally conducted with limited, carefully-selected units: low bias but high variance

## Examples

- More distant vs. closer untreated units
- Incorporating more untreated units
- Incorporating more recent time periods

# Summary: DID for Epidemiology

## Advantages:

- Simple to implement
- Uses summary data
- No need to model time trends or collect covariates
- Straightforward interpretation

## Disadvantages/Limitations:

- Targets ATT not ATE
- Need to justify key assumptions
- Requires careful selection of controls
- Limited inference with few units/periods

# Questions?