Instrumental Variables: Practice

Econ 140 Spring 2025, Section 8

Jonathan Old

Syllabus/OH bCourses Website Feedback form (**Always open**) RStudio

Roadmap

1. Time for your questions
2. (Group) data projects
3. Introduction to Instrumental Variables
4. IV Summary
5. Time for your questions
6. Rainfall IV
7. Group work
8. Time for your questions

Your questions

Any questions?

...Remember – this is a safe space! Every question is useful!

(Group) data projects

Your time for questions

I prepared a document that can help you find data if you are lost. See it on bCourses.

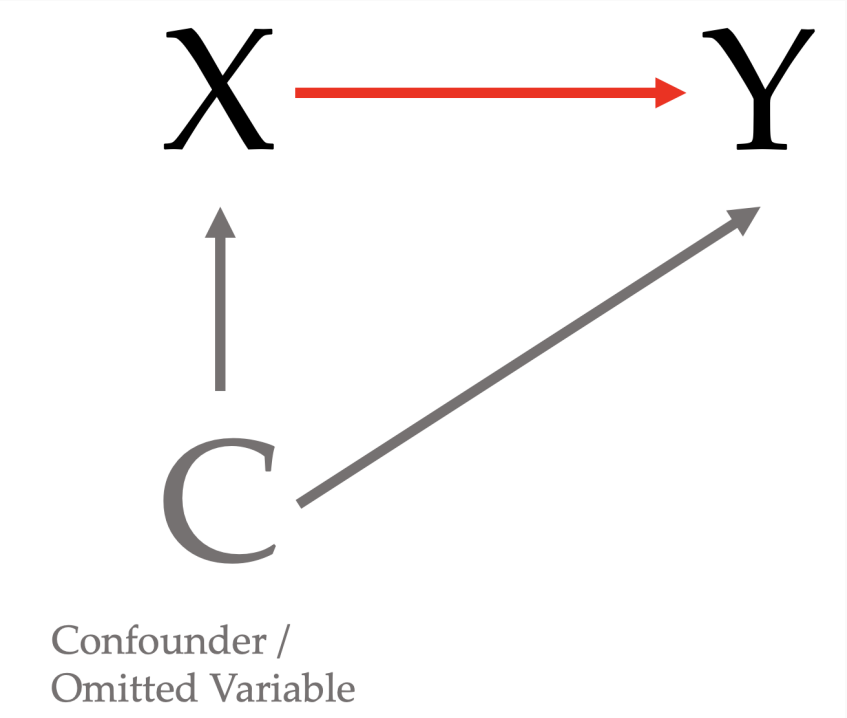
The first deadline is on April 5 (day after tomorrow).

Group work encouraged!

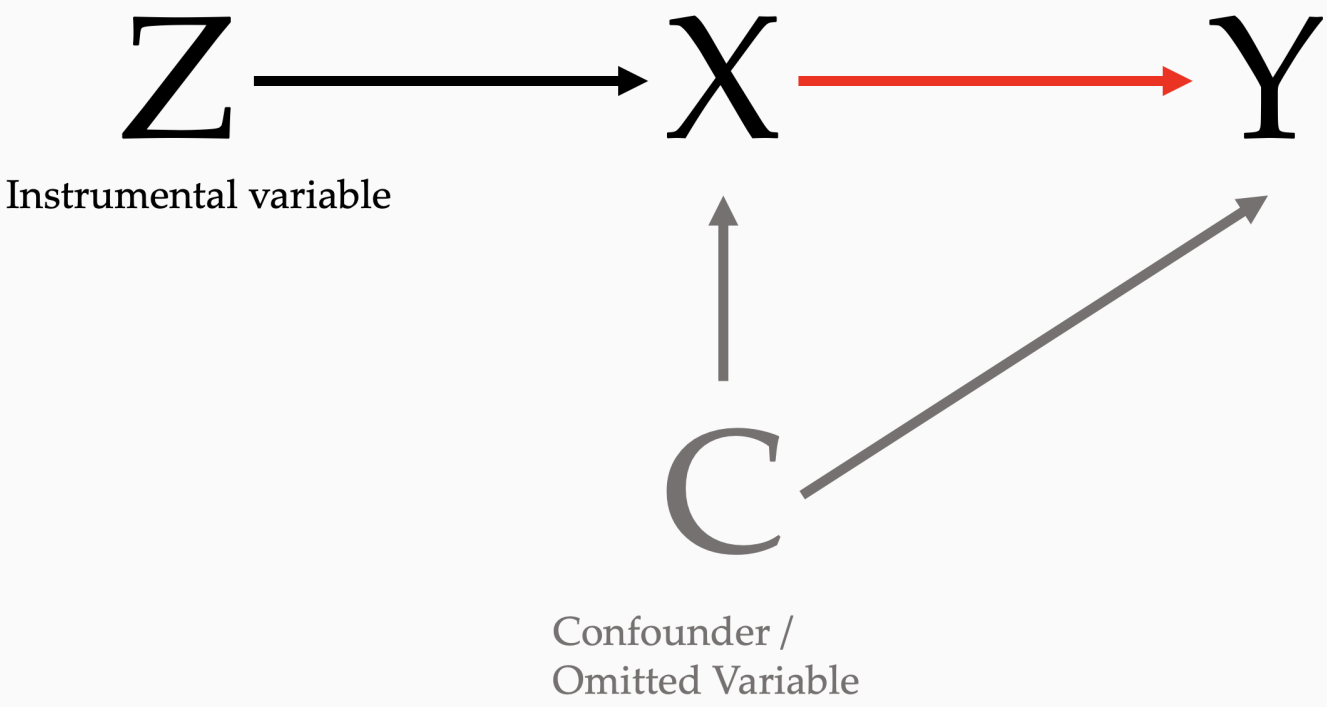
Most important tip: All good questions in this course are of the form: What is the effect of X on Y?

Introduction to Instrumental Variables

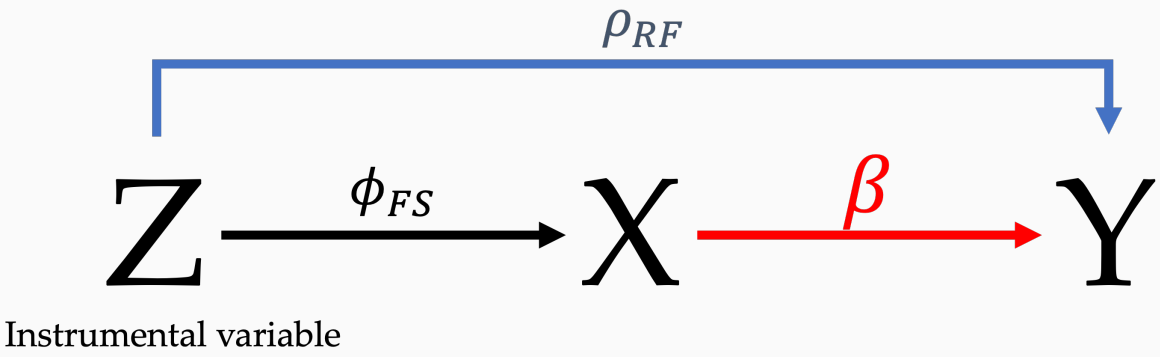
Recap: Omitted Variable Bias



Instrumental variables: The setup



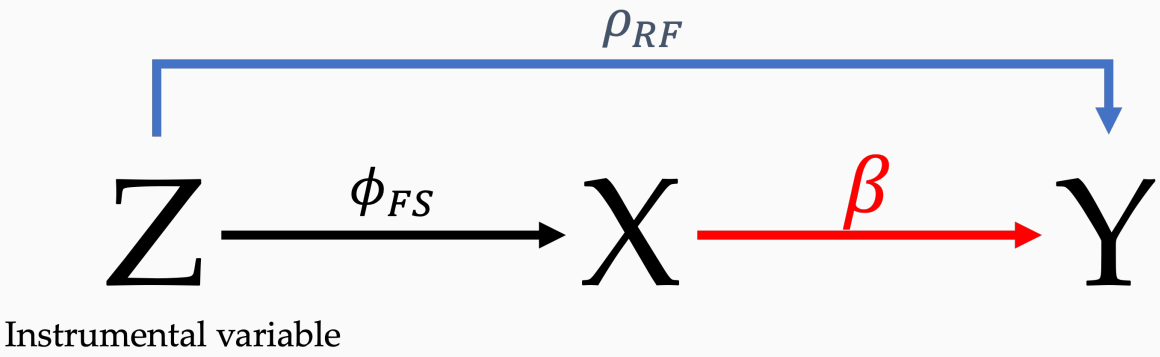
Recap: IV ”rescales” the effect



A simple example:

- We want to know the effect of chocolate (X) on happiness (Y), using a randomized voucher as instrument (Z).
- We find: people with voucher were 3 points more happy ($\rho = 3$), and ate 0.5 more chocolates ($\phi = 0.5$).
- Then, the effect of eating one more chocolate is:

Recap: IV "rescales" the effect



A simple example:

- We want to know the effect of chocolate (X) on happiness (Y), using a randomized voucher as instrument (Z).
- We find: people with voucher were 3 points more happy ($\rho = 3$), and ate 0.5 more chocolates ($\phi = 0.5$).
- Then, the effect of eating one more chocolate is: $\beta = \rho/\phi = 3/0.5 = 6$.

IV in R

Let's see how IV and 2SLS works on `Datahub`

Calculating the IV coefficient

What is the effect of **eating chocolate** (D) on happiness (Y).

- Why not estimate: $Y_i = \alpha + \beta D_i + \varepsilon_i$?

Randomly give voucher to buy chocolate at 90% discount (Z).

- Why not estimate: $Y_i = \alpha + \beta Z_i + \varepsilon_i$?

Let us set up some regressions:

$$\text{Regression of interest: } Y_i = \alpha + \beta D_i + e_i$$

$$\text{First stage: } D_i = \alpha_1 + \gamma Z_i + u_i$$

$$\text{Reduced Form: } Y_i = \alpha_2 + \delta Z_i + v_i$$

$$\text{Plug in regression of interest: } Y_i = \alpha + \beta(\alpha_1 + \gamma \cdot Z_i + u_i) + e_i$$

$$\text{Get back reduced form: } = \underbrace{(\alpha + \beta\alpha_1)}_{\alpha_2} + \underbrace{(\beta\gamma)}_{\delta} Z_i + \underbrace{(\beta u_i + e_i)}_{v_i}$$

$$\text{So we see that } \quad \delta = \beta\gamma \Leftrightarrow \beta = \delta/\gamma$$

IV gives us the treatment effect for the compliers

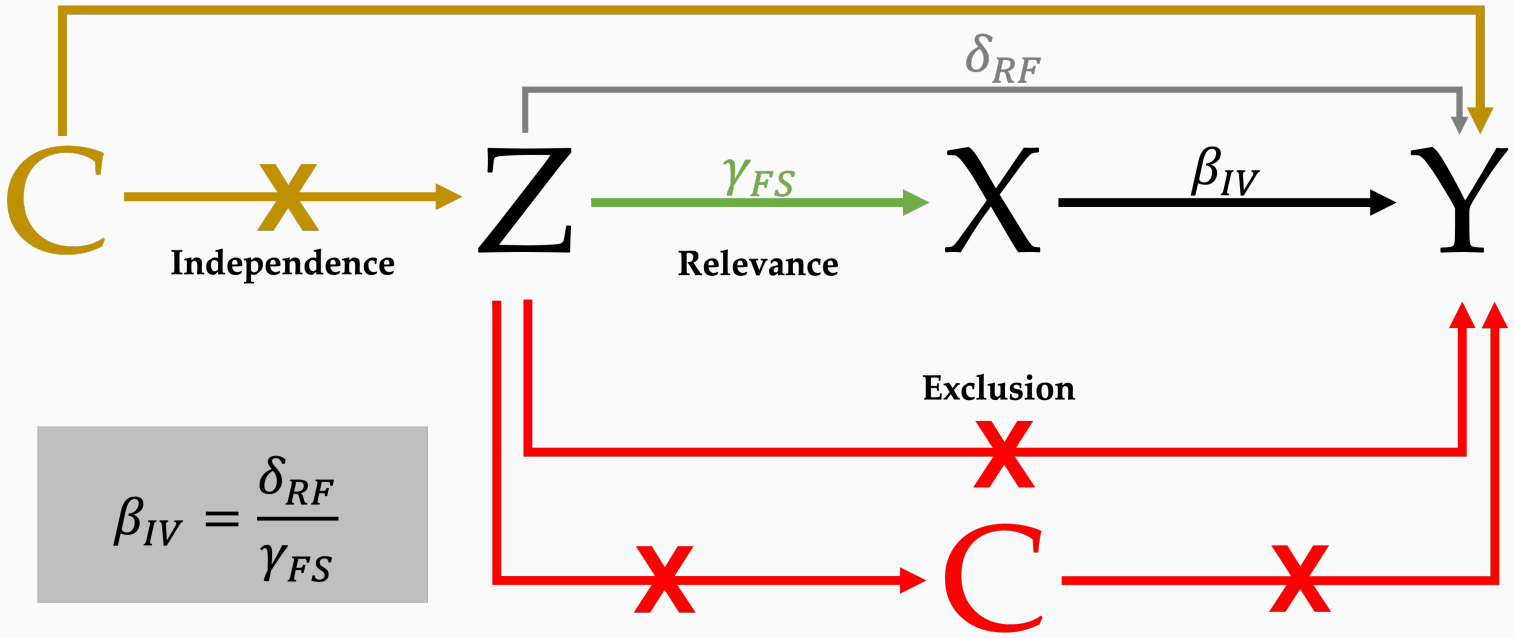
Potential outcomes! (unobserved)		***Does not get voucher (Z=0)***	
Gets voucher (Z=1)		*Eats chocolate (D=1)*	*Does not eat chocolate (D=0)*
	Eats chocolate (D=1)	Always-takers: E(D|Z=1)=E(D|Z=0)=1 ➔ E(Y|Z=1)=E(Y|Z=0)	Compliers
	Does not eat chocolate (D=0)	Defiers	Never-takers: E(D|Z=1)=E(D|Z=0)=0 ➔ E(Y|Z=1)=E(Y|Z=0)

IV Summary

IV summary

We need the following three assumptions for IV to work:

1. **Relevance**: *Z* must truly affect *X*
2. **Independence/Exogeneity**: *Z* is as good as randomly assigned
3. **Exclusion Restriction**: The **only** way that *Z* affects *Y* is via *X*.



$$\beta_{IV} = \frac{\delta_{RF}}{\gamma_{FS}}$$

Your questions

Any questions?

...Remember – this is a safe space! Every question is useful!

Rainfall IV

Intro

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Economic Shocks and Civil Conflict: An Instrumental Variables Approach

Edward Miguel, Shanker Satyanath, and Ernest Sergenti

University of California, Berkeley and National Bureau of Economic ResearchNew York University

PDF | PDF PLUS | Abstract | Full Text

Abstract

Estimating the impact of economic conditions on the likelihood of civil conflict is difficult because of endogeneity and omitted variable bias. We use rainfall variation as an instrumental variable for economic growth in 41 African countries during 1981–99. Growth is strongly negatively related to civil conflict: a negative growth shock of five percentage points increases the likelihood of conflict by one-half the following year. We attempt to rule out other channels through which rainfall may affect conflict. Surprisingly, the impact of growth shocks on conflict is *not* significantly different in richer, more democratic, or more ethnically diverse countries.

I. Introduction



Journal of Political Economy
Volume 112, Number 4
August 2004

Article DOI

https://doi-org.libproxy.berkeley.edu/10.1086/421174

Why IV?

There is a growing body of research that highlights the association between economic conditions and civil conflict (see Sambanis [2001] for a review). However, the existing literature does not adequately address the endogeneity of economic variables to civil war and thus does not convincingly establish a causal relationship. In addition to endogeneity, omitted variables—for example, government institutional quality—may drive both economic outcomes and conflict, producing misleading cross-country estimates.

Relevance

In this paper we use exogenous variation in rainfall as an instrumental variable for income growth in order to estimate the impact of economic growth on civil conflict.[1] Weather shocks are plausible instruments for growth in gross domestic product in economies that largely rely on rain-fed agriculture, that is, neither have extensive irrigation systems nor are heavily industrialized. The instrumental variable method makes it credible to assert that the association between economic conditions and civil war is a causal relationship rather than simply a correlation. As such,

Sub-Saharan Africa is the ideal region for this identification strategy: the World Development Indicator database indicates that only 1 percent of cropland is irrigated in the median African country, and the agricultural sector remains large. We find that weather shocks are in fact closely related to income growth in sub-Saharan Africa (in the first-stage regression). However, our identification strategy is inappropriate for other regions of the world, since weather is not sufficiently closely linked to income growth.[2] Although the analysis is not global, it is likely to be of exceptional interest from both the research and policy perspectives, since the incidence of civil wars in Africa is high and has increased in the past two decades.

Exclusion

following year. We attempt to rule out other channels through which rainfall may affect conflict. Surprisingly, the impact of growth shocks on conflict is *not* significantly different in richer, more democratic, or more ethnically diverse countries.

Exclusion

While it is intuitively plausible that the rainfall instruments are exogenous, they must also satisfy the exclusion restriction: weather shocks should affect civil conflict only through economic growth. In the Introduction above, we acknowledge the possibility that economic channels other than per capita economic growth per se (i.e., income inequality or rural poverty rates) may be key underlying causes of civil conflict in the aftermath of adverse rainfall shocks; unfortunately we do not have reliable cross-country data on these other intermediate channels. There are, however, central government budget figures for ap-

Exclusion

A more serious violation of the exclusion restriction is the possibility that high levels of rainfall might directly affect civil conflict independently of economic conditions. For instance, floods may destroy the road network and thus make it more costly for government troops to contain rebel groups. Note that this first possibility is not a serious threat to our estimation strategy, since higher levels of rainfall are empirically associated with significantly *less* conflict in the reduced-form regressions.

Exclusion

because of more difficult transportation conditions. To explore this possibility, we estimated the impact of rainfall shocks on the extent of the usable road network using World Bank data, and we did not find a statistically significant relationship. In fact, the point estimates on current and lagged rainfall are both positive (e.g., the coefficient on current rainfall growth is 192, standard error 1,025; regression not shown), which argues against the theory above. Another potential violation of

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EPISODE 50

Edward Miguel on Collecting Economic Data by Canoe and Correlating Conflict with Rainfall

Nov 5, 2021
By Steven D. Levitt
Produced by Morgan Levey

Comments

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He's a pioneer of using randomized control experiments in economics — studying the long-term benefits of a $1 health intervention in Africa. Steve asks Edward, a Berkeley professor, about Africa's long-term economic prospects, and how a parking-ticket-scandal in New York City led to a major finding on corruption around the world.

00:00 10 54:26

Group work

Past exam question

We will tackle the difficult Fall 2023 exam question together:
Link

Group work

Group 1: We are interested in the effect of being in the army on crime. We instrument being in the army with a lottery (paper)

Group 2: We are interested in the effect of protestant religion on economic growth. We instrument protestantism in a region with the distance to Wittenberg (paper)

Group 3: We are interested in the effect of air pollution on mortality. We instrument local air pollution with wind direction (paper)

1. Relevance: Z must truly affect X
2. Independence/Exogeneity: Z is as good as randomly assigned
3. Exclusion restriction: The **only** way that Z affects Y is via X

Your job: Discuss whether these assumptions hold!

Your questions

Any questions?

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