Section 8: Instrumental Variables

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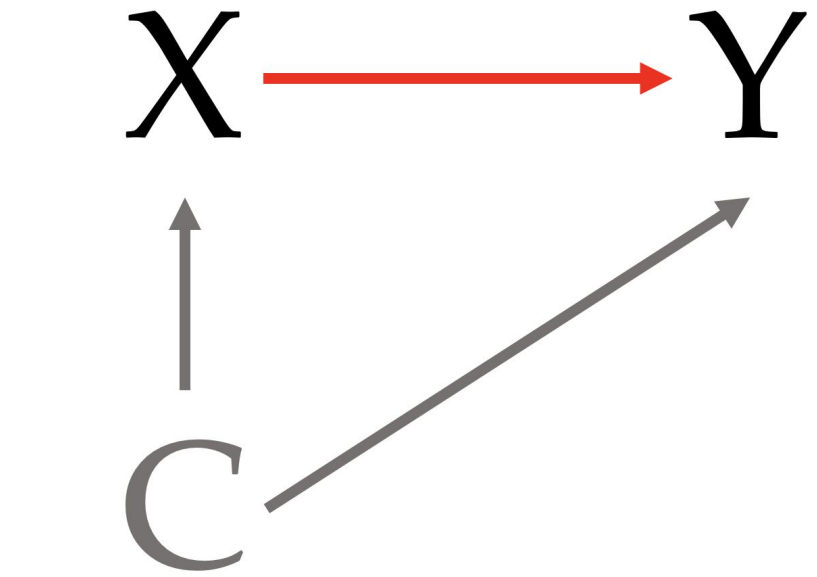
Roadmap for today

- Instrumental Variables
  - Setup (Causal Diagram)
  - Application: Rainfall, Growth, and Conflict
  - IV, LATE and Wald
- Short-term project

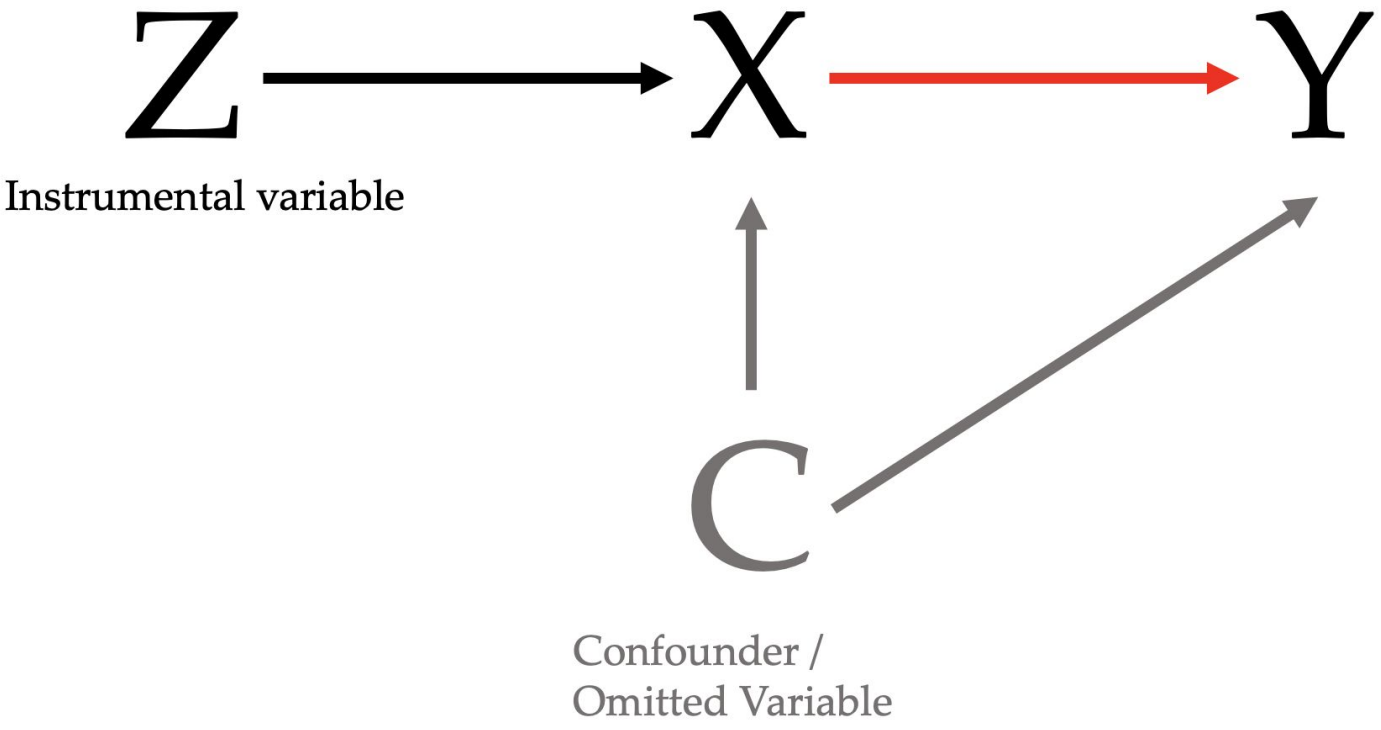
Instrumental Variables

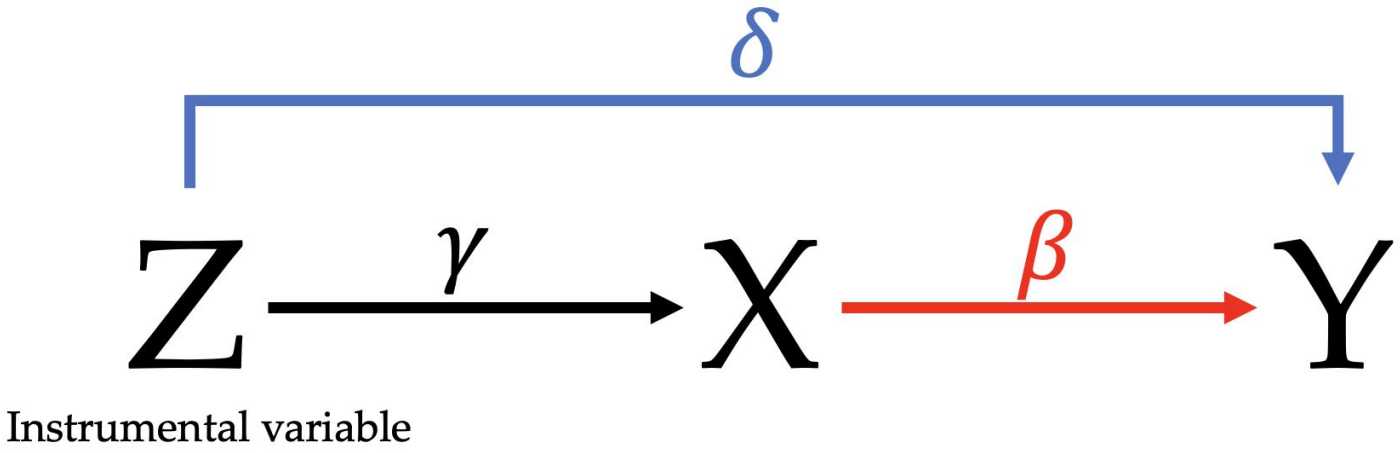
The setup



Confounder /
Omitted Variable

The setup





How do we calculate β ?

- Assuming Z is a “good” instrument: γ and δ are true causal effects!
- Hence, we can use simple algebra: $\delta=\gamma^*\beta$, so $\beta = \delta/\gamma$
- We can do this more formally on the blackboard

Interpretation of IV: Better LATE than never!

We are interested in the effect of eating chocolate in a given week (D) on happiness (Y).

- Why not estimate: lm(Y ~ D)?

We randomly give some students in the room a voucher to get a chocolate at a 90% discount (Z).

- Why not estimate: lm(Y ~ Z)?

Let us set up the three regressions:

First stage: $D = a + \phi * Z$

Reduced Form: $Y = b + \varrho * Z$

IV: $\lambda = \varrho / \phi$ (Sometimes: Second stage)

IV just “rescales” the effect of the instrument

- How do we interpret ϕ? : The average difference in chocolate consumption between those who got a voucher and those who didn’t
- How do we interpret ϱ? The average difference in happiness between those who got a voucher and those who didn’t

$$\lambda = \frac{\rho}{\phi} = \frac{E\left[Y_i \mid Z_i = 1\right] - E\left[Y_i \mid Z_i = 0\right]}{E\left[D_i \mid Z_i = 1\right] - E\left[D_i \mid Z_i = 0\right]}$$

Better LATE than never!

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

Does this always work?

- No! It only works if we have a valid instrument!
- For this, we need three conditions:

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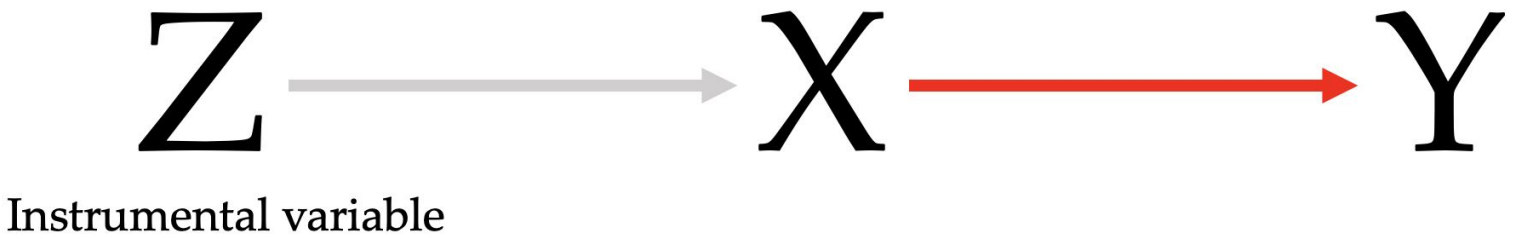
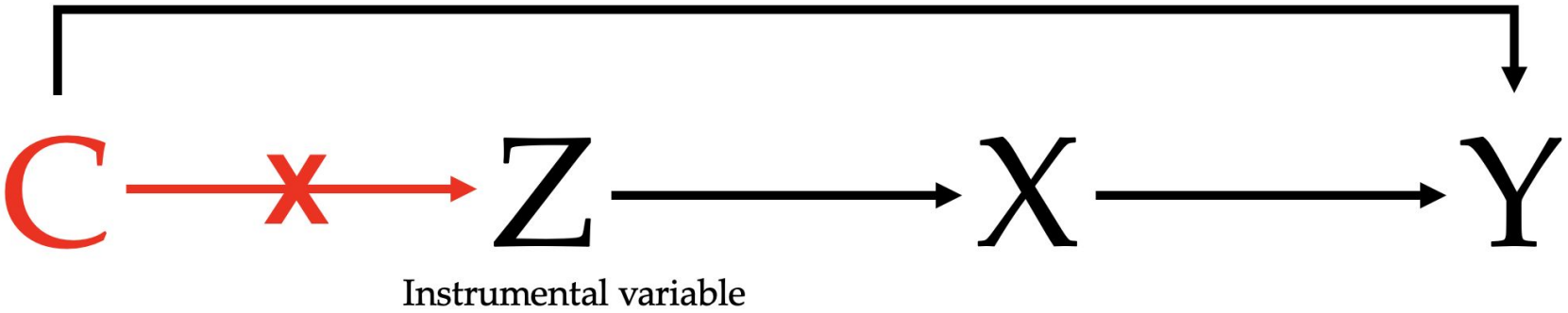
    1. Relevance: Z must truly affect X



Does this always work?

- No! It only works if we have a valid instrument!
- For this, we need three conditions:

2. Independence: Z is as good as randomly assigned



Does this always work?

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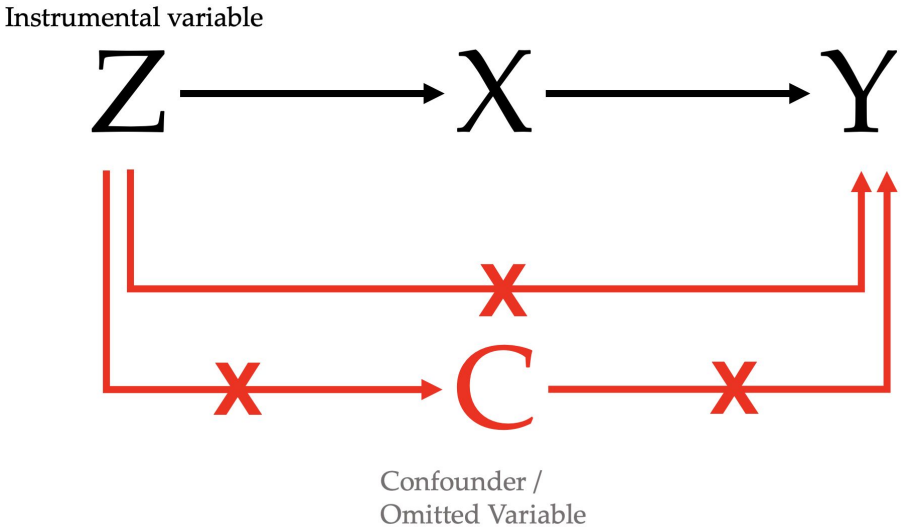
3. Exclusion: The **ONLY** way that Z affects Y is via X!



IV Conditions summarized

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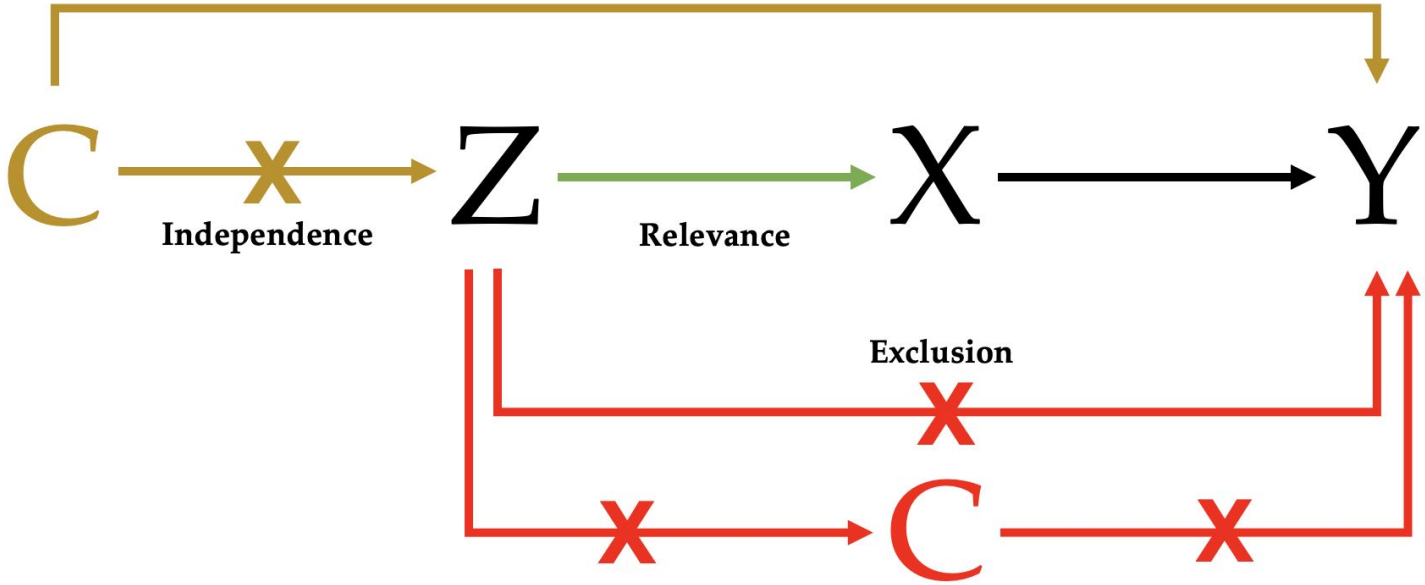

IV: Application

Economic Shocks and Civil Conflict: An Instrumental Variables Approach

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SECTIONS

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

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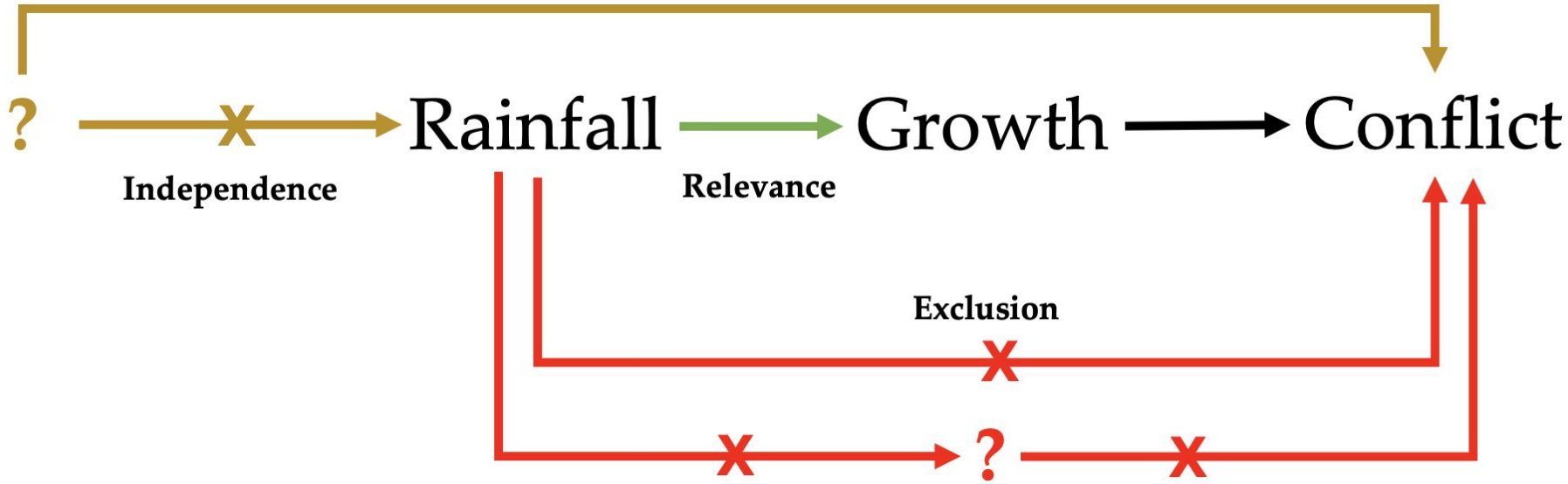
Estimating the Effect of Economic Growth on Conflict



Your job:

A) Find at least one plausible story why this condition **may be violated**.

B) Explain how you would **test** whether this is actually true.

Your turn

We need at least one group for each of the three conditions.

1. Relevance: Z must truly affect X
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Your job:

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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.

Relevance

TABLE 2
RAINFALL AND ECONOMIC GROWTH (First-Stage)
Dependent Variable: Economic Growth Rate, t

EXPLANATORY VARIABLE	ORDINARY LEAST SQUARES				
	(1)	(2)	(3)	(4)	(5)
Growth in rainfall, t	.055***	.053***	.049***	.049***	.053***
	(.016)	(.017)	(.017)	(.018)	(.018)
Growth in rainfall, $t-1$	.034**	.032**	.028**	.028*	.037**
	(.013)	(.014)	(.014)	(.014)	(.015)
Growth in rainfall, $t+1$				.001	
				(.019)	
Growth in terms of trade, t					−.002
					(.023)
Log(GDP per capita), 1979		−.011			
		(.007)			

Exclusion restriction

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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.

Exclusion restriction I

A. Potential Violations of the Exclusion Restriction

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 approximately half of our sample period from the World Bank, and we find that rainfall growth is not significantly associated with tax revenues (neither total revenues nor revenue as a proportion of national income; results not shown), indicating that changes in governments' fiscal positions are unlikely to be driving our findings.

Exclusion restriction II

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 restriction III

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 the exclusion restriction could occur if low rainfall is associated with heat waves that raise tempers and spontaneously provoke conflict. How-

Results

The main empirical findings are as follows. Using the comprehensive new database of conflicts developed by the International Peace Research Institute of Oslo, Norway, and the University of Uppsala, Sweden, we find that GDP growth is significantly negatively related to the incidence of civil conflict in sub-Saharan Africa during the period 1981–99 across a range of regression specifications, including some with country fixed effects. The relationship between GDP growth and the incidence of civil wars is extremely strong: a five-percentage-point drop in annual economic growth increases the likelihood of a civil conflict (at least 25 deaths per year) in the following year by over 12 percentage points—which amounts to an increase of more than one-half in the likelihood of civil war. Other variables that have gained prominence in the recent

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Other instruments

- We are interested in the effect of being in the army on crime. We instrument being in the army with a lottery (paper)
- We are interested in the effect of protestant religion on economic growth. We instrument protestantism in a region with the distance to Wittenberg (paper)
- 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: Z is as good as randomly assigned
3. Exclusion: The **ONLY** way that Z affects Y is via X.

Your job: Discuss the plausibility of the three assumptions

Short term project:
Your questions and ideas