

ECONOMIC SHOCKS AND CIVIL CONFLICT: AN INSTRUMENTAL VARIABLES APPROACH

Edward Miguel

University of California, Berkeley and National Bureau of Economic Research

Shanker Satyanath and Ernest Sergenti

New York University

Yifei Jiang
Mar.23rd.2019

Contents

- Introduction
- Literature
- Data and Estimation
- Results
- Conclusion

Introduction

- Civil wars

Civil conflict is the source of immense human suffering: it is estimated that civil wars have resulted in three times as many deaths as wars between states since World War II (Fearon and Laitin 2003).

A major locus for civil wars in recent years has been **sub-Saharan Africa**, where 29 of 43 countries suffered from civil conflict during the 1980s and 1990s.

- Economic conditions and civil conflict

The existing literature does not adequately address the **endogeneity** of economic variables to civil war and thus does not convincingly establish a causal relationship.

Omitted variables—for example, government institutional quality—may drive both economic outcomes and conflict, producing misleading cross-country estimates.

- Rainfall as instrumental variables for income growth

Instrumental Variables

- 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.
- **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.

The analysis is not global

- Weather shocks are in fact closely related to income growth in sub-Saharan Africa (in the first-stage regression).
- It addresses the problem of **measurement error** in African national income figures, which are widely thought to be unreliable.

Main Results

- 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.
- Other variables that have gained prominence in the recent literature—per capita GDP level, democracy, ethnic diversity, and oil exporter status—**do not** display a similarly robust relationship with the incidence of civil wars in sub-Saharan Africa.

Literature

- Collier and Hoeffler (1998, 2001, 2002)

Young men are more likely to take up arms when **income** opportunities are worse for them in agriculture or in the formal **labor market**, relative to their expected income as a fighter.

Slow income growth, low per capita income, are significantly positively associated with the onset of civil conflict.

- Elbadawi and Sambanis (2002)

They confirm most of Collier and Hoeffler's findings.

Ethnic fractionalization has a statistically significant quadratic relationship with the incidence of civil war and that **democracy** reduces the incidence of civil war.

- Fearon and Laitin (2003)

Lower per capita GDP is significantly associated with the onset of a civil war.

The key channels linking poverty and civil war are low repressive capabilities resulting from **weak militaries and poor roads**.

Literature

- Authors are aware of the potential **endogeneity** problems and they attempt to address this by using as explanatory variables **lagged values of per capita GDP growth** or levels.
- This approach implicitly assumes that economic actors do not anticipate the incidence of civil war and adjust economic activity.
- The existing analyses may also be prone to **omitted variable bias**: fast-growing countries may differ from slow-growing countries along many institutional dimensions, some of which are hard to measure,
- It becomes difficult to pinpoint the true underlying causes of conflict.

Data

- Civil conflict

The Armed Conflict Data database, developed by the International Peace Research Institute of Oslo, Norway, and the University of Uppsala, Sweden (referred to as PRIO/Uppsala).

record all conflicts with a threshold of 25 battle deaths per year

All country-year observations with a civil conflict in progress with at least 25 battle deaths per year are coded as **ones**, and other observations are coded as **zeros**.

- Rainfall: instrumental variables

The Global Precipitation Climatology Project (GPCP) database of monthly rainfall estimates.

rely on a combination of actual weather station rainfall gauge measures, as well as satellite information on the density of cold cloud cover

The principal measure of a rainfall shock is the **proportional change** in rainfall from the previous year.

- Other Country Characteristics

Descriptive Statistics

TABLE 1
DESCRIPTIVE STATISTICS

	Mean	Standard Deviation	Observations
A. Civil Conflict Measures (1981–99)			
Civil conflict with ≥ 25 deaths: (PRIO/ Uppsala)	.27	.44	743
Onset	.07	.25	555
Offset	.15	.36	188
Civil conflict with $\geq 1,000$ deaths:			
PRIO/Uppsala	.17	.37	743
Onset	.04	.19	625
Offset	.15	.36	118
Collier and Hoeffler (2002)	.17	.38	743
Doyle and Sambanis (2000)	.22	.41	724
Fearon and Laitin (2003)	.24	.43	743
B. Rainfall Measures (1981–99)			
Annual rainfall (mm), GPCP measure	1,001.6	501.7	743
Annual growth in rainfall, time t	.018	.209	743
Annual growth in rainfall, time $t - 1$	.011	.207	743
C. Economic Growth			
Annual economic growth rate, time t	-.005	.071	743
Annual economic growth rate, time $t - 1$	-.006	.072	743
D. Country Characteristics			
Log(GDP per capita), 1979	1.16	.90	743
Democracy level (Polity IV score, -10 to 10), time $t - 1$	-3.6	5.6	743
Democracy indicator (Polity IV score > 5), time $t - 1$	.15	.36	743
Ethnolinguistic fractionalization (source: <i>Atlas Marodov Mira</i>)	.65	.24	743
Religious fractionalization (source: <i>CIA Factbook</i>)	.49	.19	743
Oil-exporting country (source: WDI)	.12	.32	743
Log(mountainous) (source: Fearon and Laitin 2003)	1.6	1.4	743
Log(national population), time $t - 1$ (source: WDI)	8.7	1.2	743
Growth in terms of trade, time t (source: WDI)	-.01	.16	661

Estimation

- First stage

Weather variation, as captured in **current and lagged rainfall growth**, is used to instrument for per capita economic growth in the first stage, with other country characteristics controlled for.

$$\text{growth}_{it} = a_{1i} + X'_{it}b_1 + c_{1,0}\Delta R_{it} + c_{1,1}\Delta R_{i,t-1} + d_{1i}\text{year}_t + e_{1it} \quad (1)$$

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*** (.016)	.053*** (.017)	.049*** (.017)	.049*** (.018)	.053*** (.018)
Growth in rainfall, $t - 1$	.034** (.013)	.032** (.014)	.028** (.014)	.028* (.014)	.037** (.015)
Growth in rainfall, $t + 1$				.001 (.019)	
Growth in terms of trade, t					-.002 (.023)
Log(GDP per capita), 1979		-.011 (.007)			
Democracy (Polity IV), $t - 1$		.0000 (.0007)			
Ethnolinguistic fractionalization		.006 (.044)			
Religious fractionalization		.045 (.044)			
Oil-exporting country		.007 (.019)			
Log(mountainous)		.001 (.005)			
Log(national population), $t - 1$		-.009 (.009)			
Country fixed effects	no	no	yes	yes	yes
Country-specific time trends	no	yes	yes	yes	yes
R^2	.02	.08	.13	.13	.16
Root mean square error	.07	.07	.07	.07	.06
Observations	743	743	743	743	661

- The first-stage relationship between rainfall and income growth is strongly **positive**.
- This relationship is robust to the inclusion of country controls (regression 2) and fixed effects (regression 3).
- Higher order: not statistically significantly related to growth

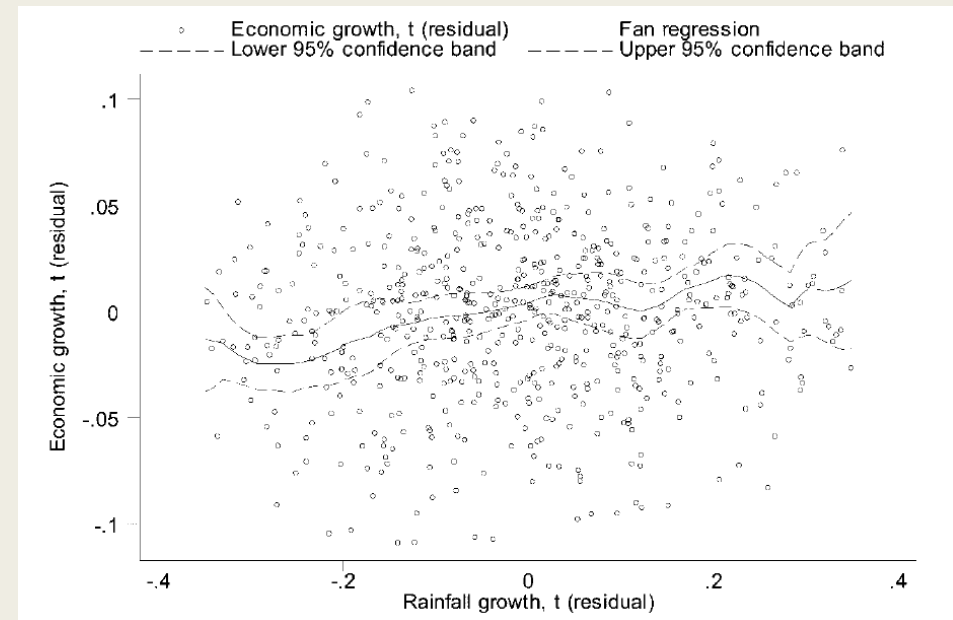
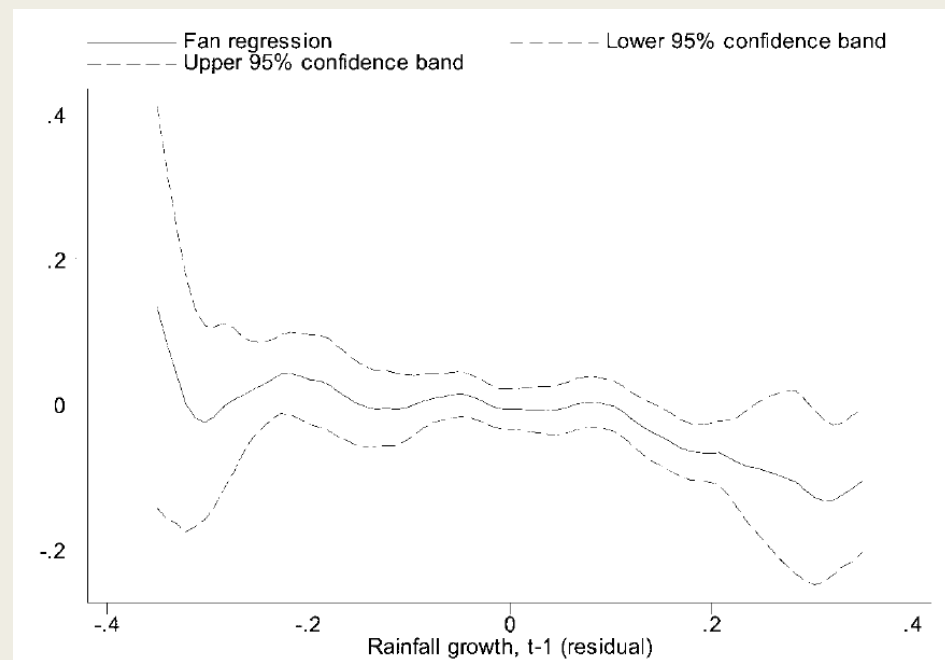


TABLE 3
RAINFALL AND CIVIL CONFLICT (Reduced-Form)

EXPLANATORY VARIABLE	DEPENDENT VARIABLE	
	Civil Conflict ≥ 25 Deaths (OLS) (1)	Civil Conflict $\geq 1,000$ Deaths (OLS) (2)
Growth in rainfall, t	-.024 (.043)	-.062** (.030)
Growth in rainfall, $t-1$	-.122** (.052)	-.069** (.032)
Country fixed effects	yes	yes
Country-specific time trends	yes	yes
R^2	.71	.70
Root mean square error	.25	.22
Observations	743	743

- Higher levels of rain fall are associated with **significantly less conflict** in the reduced-form regression, for all civil conflicts.
- Better rainfall makes civil conflict **less likely** in Africa.



Estimation

- Second stage

The second-stage equation estimates the impact of income growth on the incidence of violence.

$$\text{conflict}_{it} = \alpha_{2i} + X'_{it}\beta_2 + \gamma_{2,0}\text{growth}_{it} + \gamma_{2,1}\text{growth}_{i,t-1} \\ + \delta_{2i}\text{year}_t + \epsilon_{2it}$$

TABLE 4
ECONOMIC GROWTH AND CIVIL CONFLICT

EXPLANATORY VARIABLE	DEPENDENT VARIABLE: Civil Conflict ≥ 25 Deaths						DEPENDENT VARIABLE: Civil Conflict $\geq 1,000$ Deaths
	Probit (1)	OLS (2)	OLS (3)	OLS (4)	IV-2SLS (5)	IV-2SLS (6)	IV-2SLS (7)
Economic growth rate, t	-.37 (.26)	-.33 (.26)	-.21 (.20)	-.21 (.16)	-.41 (1.48)	-1.13 (1.40)	-1.48* (.82)
Economic growth rate, $t-1$	-.14 (.23)	-.08 (.24)	.01 (.20)	.07 (.16)	-2.25** (1.07)	-2.55** (1.10)	-.77 (.70)
Log(GDP per capita), 1979	-.067 (.061)	-.041 (.050)	.085 (.084)		.053 (.098)		
Democracy (Polity IV), $t-1$	.001 (.005)	.001 (.005)	.003 (.006)		.004 (.006)		
Ethnolinguistic fractionalization	.24 (.26)	.23 (.27)	.51 (.40)		.51 (.39)		
Religious fractionalization	-.29 (.26)	-.24 (.24)	.10 (.42)		.22 (.44)		
Oil-exporting country	.02 (.21)	.05 (.21)	-.16 (.20)		-.10 (.22)		
Log(mountainous)	.077** (.041)	.076* (.039)	.057 (.060)		.060 (.058)		
Log(national population), $t-1$	.080 (.051)	.068 (.051)	.182* (.086)		.159* (.093)		
Country fixed effects	no	no	no	yes	no	yes	yes
Country-specific time trends	no	no	yes	yes	yes	yes	yes
R^2	...	.13	.53	.71	...	...	...
Root mean square error	...	.42	.31	.25	.36	.32	.24
Observations	743	743	743	743	743	743	743

- Contemporaneous and lagged economic growth rates are **negatively**, though not statistically significantly, correlated with the incidence of civil conflict.
- Other variables: mountainous and population
- The incidence of civil wars in sub-Saharan Africa is influenced by **economic shocks**.
- A range of other political, social, and geographic variables have, at best, a tenuous impact.

TABLE 4
ECONOMIC GROWTH AND CIVIL CONFLICT

EXPLANATORY VARIABLE	DEPENDENT VARIABLE: Civil Conflict ≥ 25 Deaths						DEPENDENT VARIABLE: Civil Conflict $\geq 1,000$ Deaths
	Probit (1)	OLS (2)	OLS (3)	OLS (4)	IV-2SLS (5)	IV-2SLS (6)	IV-2SLS (7)
Economic growth rate, t	-.37 (.26)	-.33 (.26)	-.21 (.20)	-.21 (.16)	-.41 (1.48)	-1.13 (1.40)	-1.48* (.82)
Economic growth rate, $t-1$	-.14 (.23)	-.08 (.24)	.01 (.20)	.07 (.16)	-2.25** (1.07)	-2.55** (1.10)	-.77 (.70)
Log(GDP per capita), 1979	-.067 (.061)	-.041 (.050)	.085 (.084)		.053 (.098)		
Democracy (Polity IV), $t-1$	.001 (.005)	.001 (.005)	.003 (.006)		.004 (.006)		
Ethnolinguistic fractionalization	.24 (.26)	.23 (.27)	.51 (.40)		.51 (.39)		
Religious fractionalization	-.29 (.26)	-.24 (.24)	.10 (.42)		.22 (.44)		
Oil-exporting country	.02 (.21)	.05 (.21)	-.16 (.20)		-.10 (.22)		
Log(mountainous)	.077** (.041)	.076* (.039)	.057 (.060)		.060 (.058)		
Log(national population), $t-1$	.080 (.051)	.068 (.051)	.182* (.086)		.159* (.093)		
Country fixed effects	no	no	no	yes	no	yes	yes
Country-specific time trends	no	no	yes	yes	yes	yes	yes
R^2	...	.13	.53	.71	...	...	...
Root mean square error	...	.42	.31	.25	.36	.32	.24
Observations	743	743	743	743	743	743	743

- An instrumental variable estimate including country controls on **lagged growth**: significant
- The IV- 2SLS fixed-effects estimate on lagged growth is similarly large, negative, and significant.
- A five-percentage-point decline in lagged growth leads to a greater than 12-percentage-point increase in the incidence of civil war.
- The IV-2SLS estimate is **much more negative** than the OLS estimates:
bias due to measurement error in the per capita income growth measures is likely to be larger in magnitude than the negative endogeneity bias

Robustness check

- Dropping one country at a time: robust
- Negative economic shocks: similar to positive shocks
- Different categories of conflict: similar probit estimation
- Alternative measures of rainfall: large and negative
- Alternative databases: negative, several significant

TABLE C2
RESULTS USING OTHER RAINFALL MEASURES
Dependent Variable: Civil Conflict ≥ 25 Deaths

EXPLANATORY VARIABLE	IV-2SLS		
	IV: GPCP Data (1)	IV: NCEP Data (2)	IV: FAOCLIM Data (3)
Economic growth rate, t	-1.13 (1.40)	.02 (1.82)	.45 (.68)
Economic growth rate, $t - 1$	-2.55** (1.10)	-2.26 (1.36)	-1.35* (.75)
Country fixed effects	yes	yes	yes
Country-specific time trends	yes	yes	yes
R^2	...	...	...
Root mean square error	.32	.31	.27
Observations	743	743	607

TABLE C3
RESULTS USING OTHER CIVIL CONFLICT MEASURES: IV-2SLS

EXPLANATORY VARIABLE	DEPENDENT VARIABLE: Civil Conflict ≥ 25 Deaths (1)	DEPENDENT VARIABLE: Civil Conflict $\geq 1,000$ Deaths			
		(2)	(3)	(4)	(5)
Economic growth rate, t	-1.13 (1.40)	-1.48* (.82)	-.96 (.77)	-1.62 (1.07)	-.84 (.78)
Economic growth rate, $t - 1$	-2.55** (1.10)	-.77 (.70)	-.65 (.56)	-.96 (.68)	-.84*** (.30)
Country fixed effects	yes	yes	yes	yes	yes
Country-specific time trends	yes	yes	yes	yes	yes
Root mean square error	.32	.24	.17	.24	.23
Observations	743	743	743	724	743

TABLE 5
 INTERACTIONS BETWEEN ECONOMIC GROWTH AND COUNTRY CHARACTERISTICS
 Dependent Variable: Civil Conflict ≥ 25 Deaths

EXPLANATORY VARIABLE	IV-2SLS				
	(1)	(2)	(3)	(4)	(5)
Economic growth rate, t	-1.20 (1.43)	.92 (2.62)	-9.9 (22.9)	-.99 (1.26)	-1.85 (1.81)
Economic growth rate, $t - 1$	-2.86* (1.46)	-3.01* (1.70)	-6.4 (6.1)	-2.37** (1.04)	-2.97** (1.39)
Economic growth rate, $t \times$ democracy (Polity IV), $t - 1$	.01 (.21)				
Economic growth rate, $t - 1 \times$ democracy (Polity IV), $t - 1$	-.10 (.16)				
Economic growth rate, $t \times$ log(per capita income, 1979)		-1.98 (2.70)			
Economic growth rate, $t - 1 \times$ log(per capita income, 1979)		.58 (1.09)			
Economic growth rate, $t \times$ ethnolinguistic fractionalization			12.1 (30.1)		
Economic growth rate, $t - 1 \times$ ethnolin- guistic fractionalization			5.1 (8.1)		
Economic growth rate, $t \times$ oil-exporting country				-2.8 (6.9)	
Economic growth rate, $t - 1 \times$ oil-export- ing country				3.2 (3.1)	
Economic growth rate, $t \times$ log(mountainous)					.39 (.83)
Economic growth rate, $t - 1 \times$ log(mountainous)					.23 (.62)
Country fixed effects	yes	yes	yes	yes	yes
Country-specific time trends	yes	yes	yes	yes	yes
Root mean square error	.33	.34	.41	.32	.32
Observations	743	743	743	743	743

- The impact of economic growth shocks on the incidence of major conflicts is remarkably—and perhaps surprisingly—**similar** for African countries with a wide range of **institutional, political, social, and economic** characteristics.
- **Economic factors** trump all others in determining the incidence of civil conflict.
- However, the African countries during the sample period: most were poor, ethnically diverse, and undemocratic, with similar colonial legacies

TABLE 6
ECONOMIC GROWTH AND CONFLICT ONSET

EXPLANATORY VARIABLE	DEPENDENT VARIABLE	
	Onset, Civil Conflict ≥25 Deaths (IV-2SLS) (1)	Onset, Civil Conflict ≥1,000 Deaths (IV-2SLS) (2)
Economic growth rate, t	-3.15* (1.87)	-2.85* (1.45)
Economic growth rate, $t - 1$	-1.84 (1.48)	-.80 (1.25)
Country fixed effects	yes	yes
Country-specific time trends	yes	yes
Root mean square error	.28	.24
Observations	555	625

- Conflicts are significantly less likely to start as economic growth increases.
- The results are robust to the inclusion of country controls.

One thing about instrumental variables: Exclusion Restriction

- **Weather shocks should affect civil conflict only through economic growth.**
- 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.

rainfall growth is not significantly associated with tax revenues: fiscal policies

- High levels of rainfall might **directly affect** civil conflict independently of economic conditions.

To the extent that the hypothesized bias exists, the estimates would be lower bounds on the true impact of economic growth on civil conflict.

- Rainfall may make it difficult for both government and rebel forces to engage each other in combat, because of more difficult transportation conditions.

The impact of rainfall shocks on the extent of the usable road network: not statistically significant

- **unable to definitively rule out the possibility** that rainfall could have some independent impact on the incidence of civil conflict beyond economic growth, though these other effects are likely to be **minor**

Conclusion

- Using rainfall shocks as instrumental variables for economic growth, we find that growth shocks have a **dramatic causal impact** on the likelihood of civil war: a five-percentage-point negative growth shock **increases** the likelihood of a civil war the following year by nearly one-half.
- The impact of economic shocks is also **approximately the same** across countries with a range of different **economic, social, and political institutional** characteristics, suggesting that **economic conditions** are the most critical determinants triggering civil conflict in Africa.