Economic shocks and civil war

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Introduction

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- Why do civil wars occur at all?
- And equally important: what is the long-run **economic** impact of conflict? (Not necessarily civil conflict).

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- Theoretically, positive income shocks could affect conflict in different ways: a rise in income may increase the opportunity cost of fighting, making conflict less likely.
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Dube and Vargas, Price shocks and civil conflict

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- You may be familiar with this conflict as one that has complex roots in the drug trade as well as in political disputes between the government, right-wing paramilitaries and leftist guerrillas.
- These authors, however, wish to take a more micro-level approach: what affects incentives of individuals to go and fight.
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Context: Colombian conflict

- The period of interest for the analysis is 1988 to 2005, during which the Colombian civil war was a three-way conflict embroiling the government, left-wing guerrillas and right-wing paramilitaries; there is also evidence of collusion between the government and paramilitaries.
- The data includes four measures of violence, including guerrilla attacks, paramilitary attacks, clashes and war-related casualties, in over 950 municipalities between 1988 and 2005.

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Theoretical channels for the impact of income on conflict

- The authors modify a classic framework developed by Becker to analyze crime.
- Any shock that raises the return to appropriation will increase conflict, by increasing labor supplied to the conflict sector ("rapacity effect").
- Any shock that raises wages will reduce conflict by decreasing labor supplied to appropriation activity ("opportunity cost effect").

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Empirical strategy: intuition

- The primary specification will be a difference-in-difference evaluating the differing impact of changing oil and coffee prices over time on municipalities that are more or less likely to produce oil or coffee.
- The prices employed will be world prices (in the case of coffee, the authors instrument for the price with supply from other major producing nations to eliminate endogeneity).
- The location of oil deposits is assumed to be exogenous.
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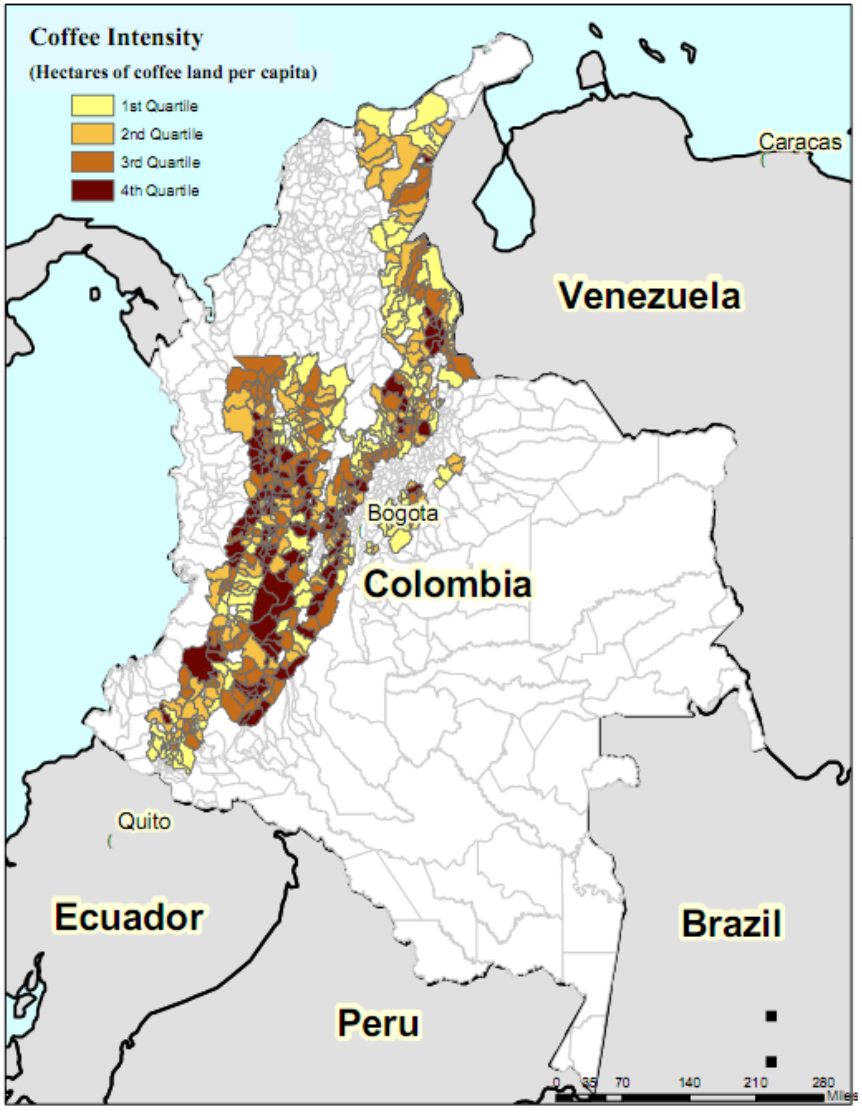
Coffee cultivation

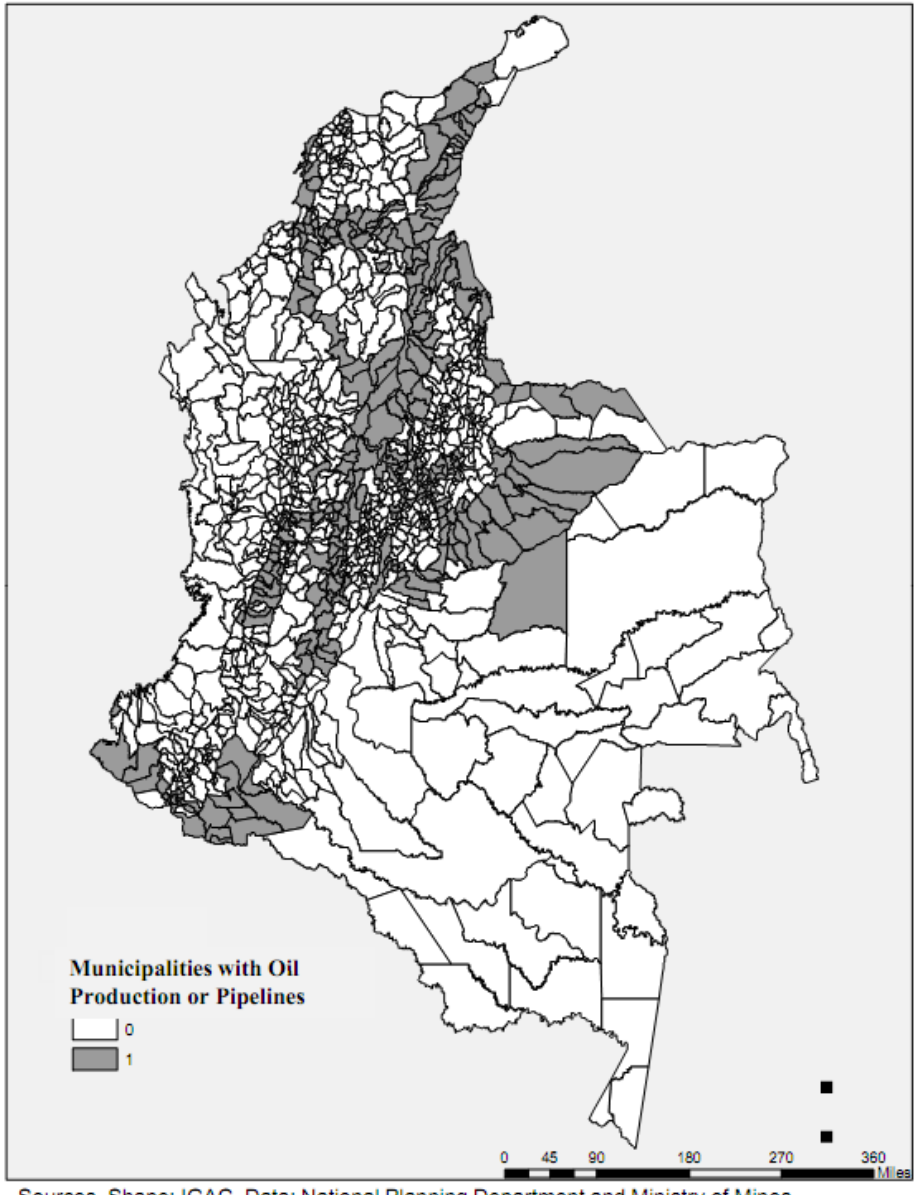
Figure 1. Coffee Intensity of Colombian Municipalities



Source: National Federation of Coffee Growers

Oil production

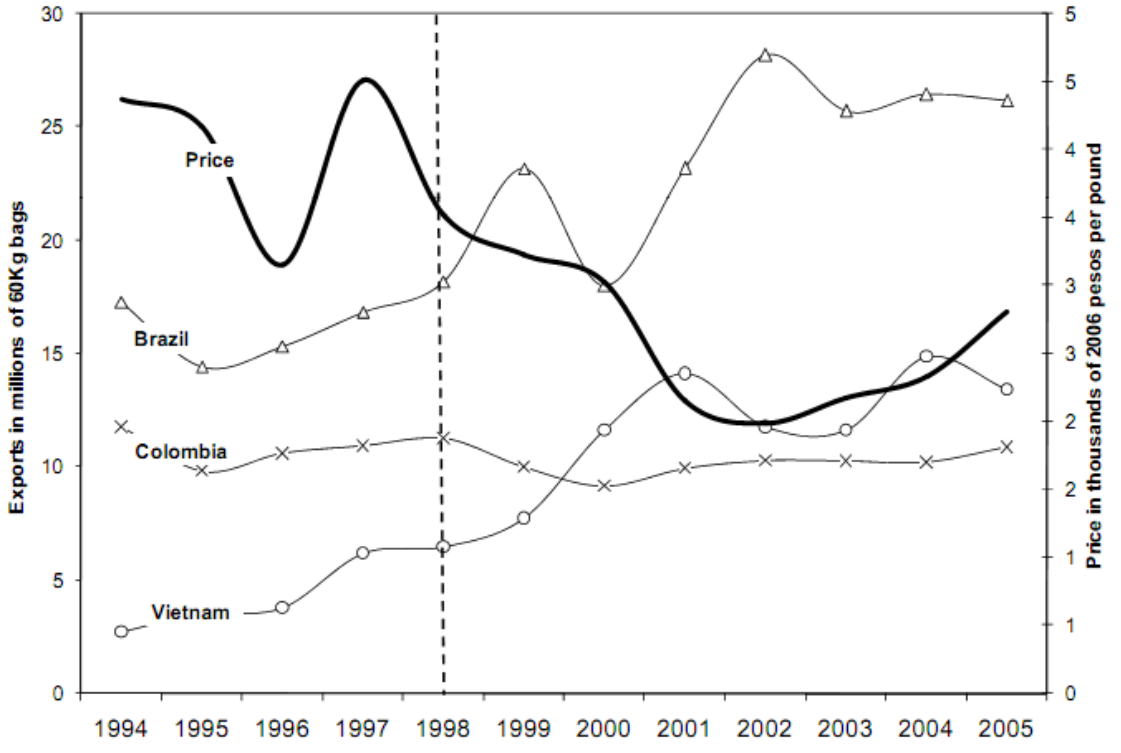
Figure 2. Municipalities with Oil Reserves or Oil Pipelines



Sources. Shape: IGAC, Data: National Planning Department and Ministry of Mines

Coffee prices

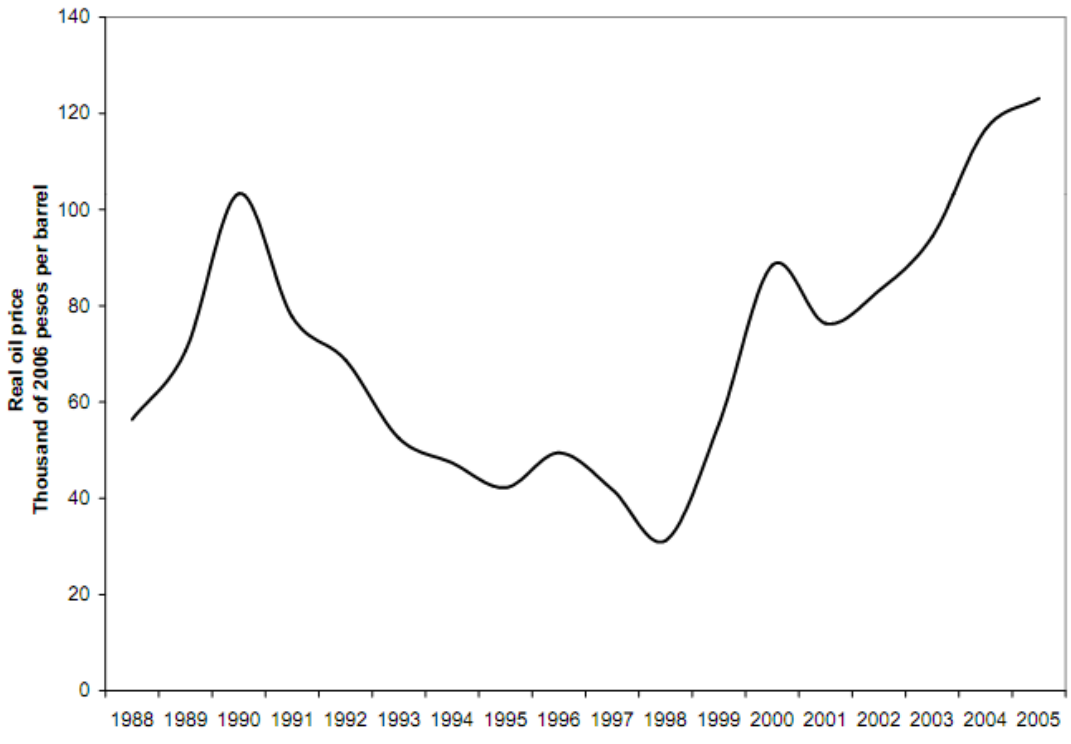
Figure 5. Coffee Exports of Main Producers and Real International Price



Source: International Coffee Organization and National Federation of Coffee Growers

Oil prices

Figure 3. Real Price of Oil



Source: International Financial Statistics

Not the specification

- The specification of interest is complex; analyze it step by step.
- Consider the simple specification:

$$y_{jrt} = \alpha_j + \beta_t + (Oil_{jr} \times OP_t)\lambda + (Cof_{jr} \times CP_t)\rho + \epsilon_{jrt}$$

where y is an outcome in municipality j, region r and time t; Oil_{jr} and Cof_{jr} are the levels of production of oil and coffee in municipality j; and OP_t and CP_t are oil and coffee prices.

- This specification measures the difference-in-difference between municipalities that do and do not produce coffee (oil), comparing across years with and without a high price for coffee (oil).

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Still not the specification

- The authors then add region-specific time trends, a time trend for municipalities that produce coca, and other covariates X.

$$\begin{aligned} y_{jrt} &= \alpha_j + \beta_t + \delta_r t + Coca_{jr} t\gamma + (Oil_{jr} \times OP_t)\lambda + (Cof_{jr} \times CP_t)\rho \\ &+ X_{jrt}\phi + \epsilon_{jrt} \end{aligned}$$

- What is the potential problem with this specification? When prices of coffee increase, municipalities may substitute in and out of coffee production (and maybe oil production, though this is less probable - why?)

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Unpacking the exclusion restriction

- If this substitution is then correlated with other unobservable characteristics, Cof_{jr} would be endogenous and thus a source of bias.
- The authors argue that oil deposits are exogenously given.
- Accordingly, they instrument for $Cof_{jr} \times CP_t$ with rainfall and temperature, climatic conditions that are predictive of patterns of coffee cultivation.

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Final specification

- The final specification of interest is the following.

$$\begin{aligned} y_{jrt} &= \alpha_j + \beta_t + \delta_r t + Coca_{jr} t\gamma + (Oil_{jr} \times OP_t)\lambda + (\widehat{Cof_{jr} \times CP_t})\rho \\ &+ X_{jrt}\phi + \epsilon_{jrt} \end{aligned}$$

- The exclusion restriction requires that there is no correlated shock that differentially affects violence in non-commodity producing areas, in oil-producing areas and in areas climatically suited for coffee production; and price shocks do not affect violence through any channel other than their impact on coffee (oil) production.
- What would constitute a violation of the exclusion restriction? Price shocks lead to changes in the national political leadership that differentially affect municipalities with and without commodity production (for example).

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Primary results

Table IV
The Effect of the Oil and Coffee Shocks on Violence, 1988-2005

Dependent variables:	(1) Guerilla attacks	(2) Paramilitary attacks	(3) Clashes	(4) Casualties
	Panel A: The oil shock			
Oil production x log oil price	0.454	0.805	0.042	0.876
	(1.110)	(0.139)***	(0.656)	(1.761)
Oil pipe length x log oil price	-0.341	0.281	-0.083	0.336
	(0.540)	(0.113)**	(0.338)	(1.653)
Observations	15709	15709	15709	15709
Number of municipalities	876	876	876	876
	Panel B: The coffee shock			
Coffee int x log coffee price	-0.198	-0.057	-0.285	-0.868
	(0.073)***	(0.022)***	(0.086)***	(0.364)**
Observations	15999	15999	15999	15999
Number of municipalities	894	894	894	894

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Panel C: The coffee and oil shocks

Coffee int x log coffee price	-0.192	-0.064	-0.285	-0.881
	(0.071)***	(0.022)***	(0.087)***	(0.359)**
Oil production x log oil price	0.493	0.810	0.107	1.038
	(1.112)	(0.139)***	(0.661)	(1.791)
Oil pipe length x log oil price	-0.295	0.292	-0.003	0.554
	(0.543)	(0.113)***	(0.334)	(1.633)
Observations	15999	15999	15999	15999
Number of municipalities	894	894	894	894

Notes. Variables not shown include municipality and year fixed effects and log of population. Robust standard errors clustered at the department level are shown in parentheses. In Panels A-C, the interaction of coffee intensity and the internal price of coffee is instrumented by the interaction of coffee intensity and the export volume of Brazil Vietnam and Indonesia. *** is significant at the 1% level, ** is significant at the 5% level, * is significant at the 10% level.

Discussion questions

- How do the authors substantiate the proposed channels (i.e., that coffee shocks increase opportunity costs of conflict, while oil price shocks increase the spoils to fight over)?
- What other channels do the authors test? Do you feel there are other plausible potential narratives that they failed to exclude?
- What is the external validity of these results? Do they apply to other types of conflict? What about regions that have no valuable natural resources?

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- The next paper evaluates cross-country variation in the prevalence of civil conflict in the region where it has taken the greatest human toll: sub-Saharan Africa.
- 29 of 43 countries in the region suffered from civil conflict in the 1980s and 1990s; in the median country in the region, hundreds of thousands of people were displaced as a consequence of civil war.
- The paper uses exogenous variation in rainfall as an instrumental variable for income growth to estimate the impact of growth on civil conflict; they find GDP growth is significantly and negatively correlated with the incidence of civil conflict.

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Rainfall as an instrument

- The authors note that sub-Saharan Africa is the ideal region for this identification strategy: agriculture remains extremely important, and only 1% of the agricultural sector is irrigated.
- Thus weather shocks are closely correlated with income growth (the first stage is strong).
- Rainfall is commonly used as an instrument in development economics - it is correlated with income, food availability and thus nutritional status, and many other outcomes.
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- Liberian troops withdrew in 1993, but the rebels were successful in recruiting mainly rural, uneducated young men to continue fighting.
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Data on civil conflict

- Conflict can be challenging to measure, particularly civil conflicts that are often characterized by long duration and relatively low intensity.
- This paper employs a database developed by a collaboration in Norway and Sweden, referred to as PRIO/Uppsala, that records all conflicts with a threshold of 25 battle deaths in a year.
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- According to this definition, there was civil conflict in 27% of county-year observations between 1981 and 1999. Any disagreement with this measurement strategy?

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Summary statistics

TABLE C1
LIST OF COUNTRIES IN THE SAMPLE

Country	Total Years	Years of Civil Conflict ≥25 Deaths (PRIO/Uppsala)	Years of Civil Conflict ≥1,000 Deaths (PRIO/Uppsala)
Angola	19	19	17
Benin	19	0	0
Botswana	19	0	0
Burkina Faso	19	3	1
Burundi	19	8	1
Cameroon	19	1	0
Central African Republic	19	0	0
Chad	19	17	11
Republic of Congo (Brazzaville)	19	3	3
Democratic Republic of Congo (Kinshasa)	18	12	11
Côte d'Ivoire	19	0	0
Djibouti	11	1	0
Ethiopia	19	15	11
Gabon	19	0	0
Gambia	19	1	0
Ghana	19	2	0
Guinea	19	2	1
Guinea-Bissau	19	2	1
Kenya	19	1	0
Lesotho	19	1	0
Liberia	11	3	1
Madagascar	19	0	0
Malawi	19	0	0
Mali	19	2	0
Mauritania	19	0	0
Mozambique	19	12	12
Namibia	9	2	2
Niger	19	6	0
Nigeria	19	0	0
Rwanda	19	9	5
Senegal	19	7	1
Sierra Leone	19	9	2
Somalia	11	11	3
South Africa	19	13	13
Sudan	18	16	14
Swaziland	19	0	0
Tanzania	19	0	0
Togo	19	2	0
Uganda	19	17	12
Zambia	19	0	0
Zimbabwe	19	2	2
Total	743	199	124

NOTE.—The 19 sample years are 1981–99. Eritrea and Equatorial Guinea were dropped from the analysis because of missing data. For Djibouti, Liberia, and Somalia, GDP data are missing since 1992. For Sudan and the Democratic Republic of Congo, GDP data are missing for 1999. Namibia became independent in 1990.

Graphical evidence: OLS

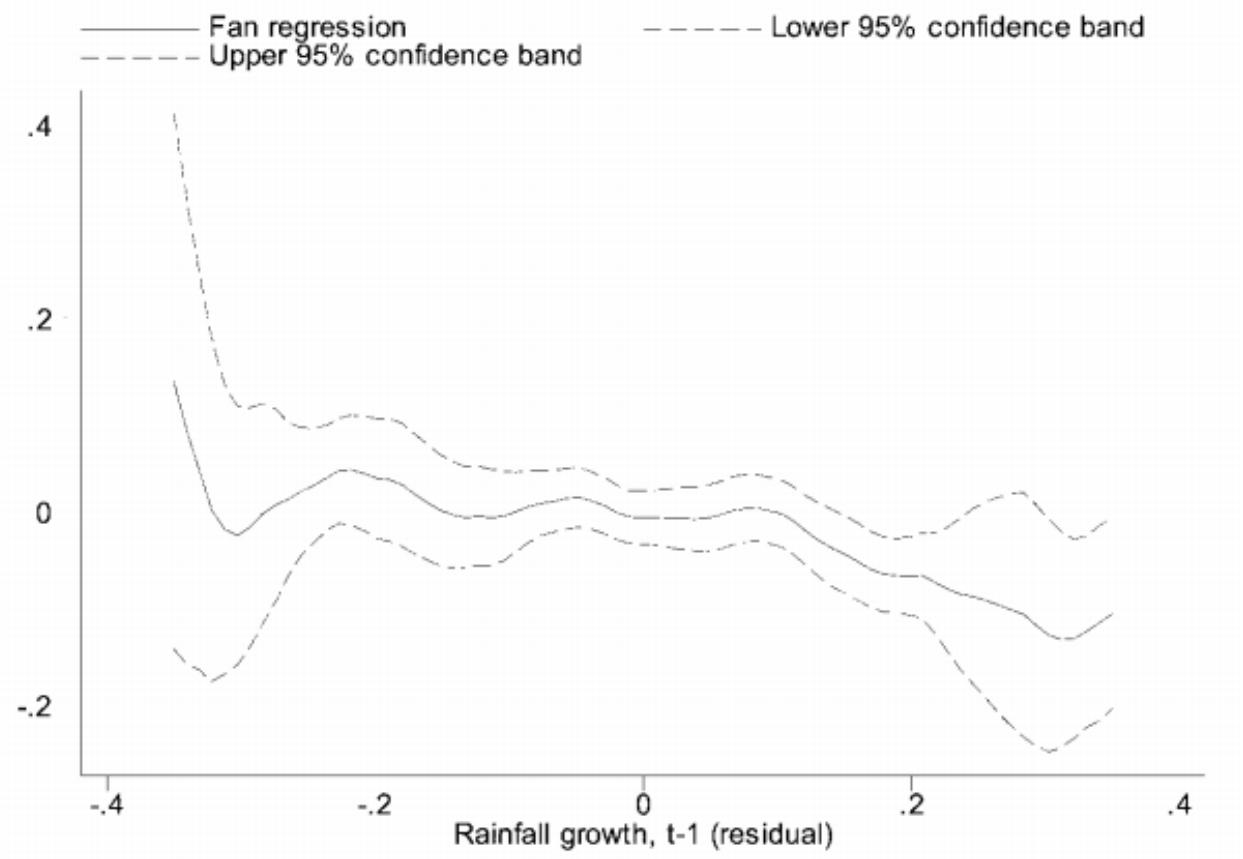

FIG. 2.—Current likelihood of civil conflict (≥25 battle deaths) on lagged rainfall growth. Nonparametric Fan regression, conditional on current rainfall growth, country fixed effects, and country-specific time trends.

Instrumental variables specification

- The first stage equation in this case regresses per capita economic growth on current and lagged rainfall growth, including country-specific controls and country and year fixed effects.

$$growth_{it} = a_{1i} + X'_{it} b_1 + c_{1,0} \Delta R_{it} + c_{i,1} \Delta R_{i,t-1} + d_{1i} year_i + \epsilon_{1it}$$

- (Note that the subscript 1 refers to the equation number in the paper.)
- First stage is positive and significant as expected, but the authors note that the instruments are somewhat weak; this can be a source of bias.

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Graphical evidence: Rainfall and economic growth

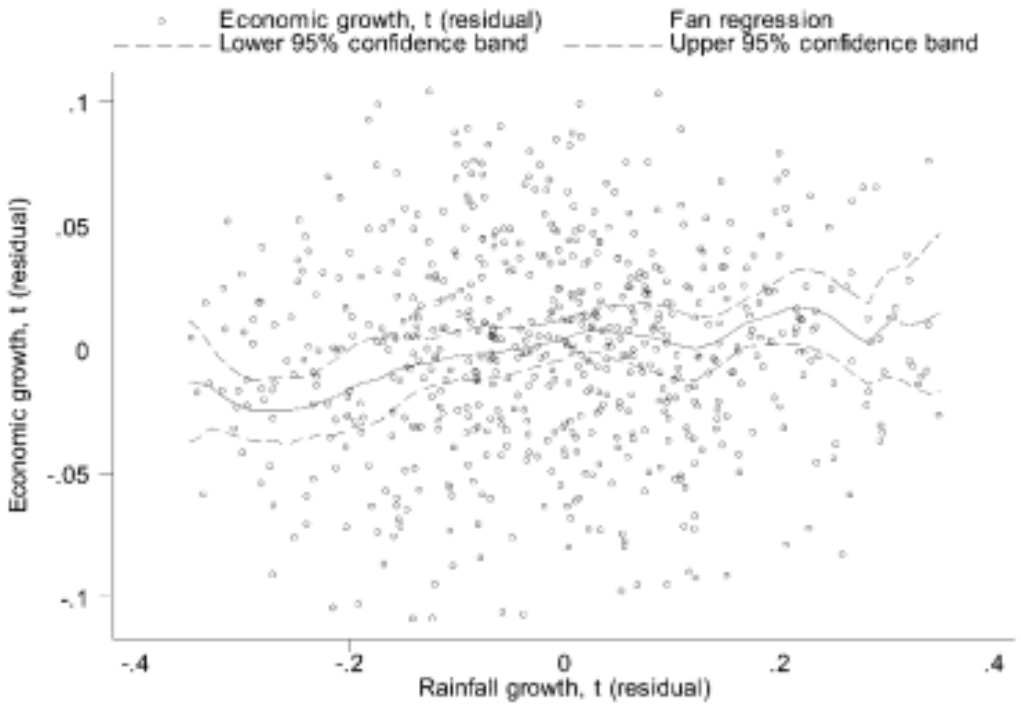

FIG. 1.—Current economic growth rate on current rainfall growth. Nonparametric Fan regression, conditional on country fixed effects and country-specific time trends.

Regression results: First stage

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)

Second-stage equation

- The second-stage equation has exactly the same structure, regressing conflict on income growth including country and year fixed effects.

$$conflict_{it} = \alpha_{2i} + X'_{it}\beta_2 + \gamma_{2,0} growth_{it} + \gamma_{2,1} growth_{i,t-1} + \delta_{2i} year_t + \epsilon_{2it}$$

- The coefficients thus estimated are significant and negative for both current and lagged growth; the coefficients are not significantly different.
- Estimated magnitude suggests that a 1% decline in GDP growth increases the likelihood of civil conflict by two percentage points.

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Regression results: 2SLS

TABLE 4
ECONOMIC GROWTH AND CIVIL CONFLICT

	Dependent Variable: Civil Conflict ≥25 Deaths						Dependent Variable: Civil Conflict ≥1,000 Deaths
Explanatory Variable	Probit (1)	OLS (2)	OLS (3)	OLS (4)	IV-2SLS (5)	IV-2SLS (6)	IV-2SLS (7)
Economic growth rate, t	−.37	−.33	−.21	−.21	−.41	−1.13	−1.48*
	(.26)	(.26)	(.20)	(.16)	(1.48)	(1.40)	(.82)
Economic growth rate, $t-1$	−.14	−.08	.01	.07	−2.25**	−2.55**	−.77
	(.23)	(.24)	(.20)	(.16)	(1.07)	(1.10)	(.70)

Comparing OLS and 2SLS results

- In this case, the 2SLS estimates are more negative than the OLS estimates.
- What direction bias would be induced by endogeneity? (I.e., some countries are enduringly dysfunctional; they experience both conflict and low growth).
- What direction bias would be induced by classical measurement error?
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- The authors analyze a set of interaction variables to check whether there are heterogeneous effects across countries with different characteristics (political regime, growth rate, oil exporters, etc.)
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Regression results: Heterogeneous effects

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

	IV-2SLS				
EXPLANATORY VARIABLE	(1)	(2)	(3)	(4)	(5)
Economic growth rate, t	−1.20	.92	−9.9	−.99	−1.85
	(1.43)	(2.62)	(22.9)	(1.26)	(1.81)
Economic growth rate, $t-1$	−2.86*	−3.01*	−6.4	−2.37**	−2.97**
	(1.46)	(1.70)	(6.1)	(1.04)	(1.39)
Economic growth rate, t × democracy (Polity IV), $t-1$	.01				
	(.21)				
Economic growth rate, $t-1$ × democracy (Polity IV), $t-1$	−.10				
	(.16)				
Economic growth rate, t × log(per capita income, 1979)		−1.98			
		(2.70)			
Economic growth rate, $t-1$ × log(per capita income, 1979)		.58			
		(1.09)			
Economic growth rate, t × ethnolinguistic fractionalization			12.1		
			(30.1)		
Economic growth rate, $t-1$ × ethnolinguistic fractionalization			5.1		
			(8.1)		
Economic growth rate, t × oil-exporting country				−2.8	
				(6.9)	
Economic growth rate, $t-1$ × oil-exporting country				3.2	
				(3.1)	
Economic growth rate, t × log(mountainous)					.39
					(.83)
Economic growth rate, $t-1$ × 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

Regression results: Conflict onset

TABLE 6
ECONOMIC GROWTH AND CONFLICT ONSET

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

NOTE.—Huber robust standard errors are in parentheses. Regression disturbance terms are clustered at the country level. The instrumental variables for economic growth are growth in rainfall, t and growth in rainfall, $t-1$. A country-specific year time trend is included in all specifications (coefficient estimates not reported).

* Significantly different from zero at 90 percent confidence.
** Significantly different from zero at 95 percent confidence.
*** Significantly different from zero at 99 percent confidence.

Violations of the exclusion restriction

- The authors briefly discuss other potential channels of impact from rainfall to violence that could be a source of bias: weather could destroy infrastructure, or heat waves could raise tempers.
- They find no evidence for these channels.
- There are still other channels - rainfall could change time allocation; could alter patterns of grazing, migration or agriculture in a way that sparks conflict over land or water access; etc.
- The challenge in analyses like this is that while rainfall undoubtedly has an enormous impact on low-income economies, that impact is often multifaceted.

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Miguel and Roland, Long-run effect of bombing Vietnam

- The authors begin by noting that the long-run effects of war are almost certainly massive, but theoretically unclear: wars destroy capital and alter institutions.
- On the other hand, capital can be rapidly rebuilt, and institutions may be changed for the better if wars promote nation-building, induce social change, or alter political coalitions.
- They seek to exploit a data-rich historical episode to estimate bombing impacts on long-run economic performance using data from Vietnam, where U.S. bombing represented at least three times as much by weight as both European and Pacific theater WWII bombing combined.

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Conceptual framework

- The authors present a simple growth model that is a modification of the Solow model.
- District y is assumed to have a Cobb-Douglas returns to scale function: $Y_{it} = AK_{it}^{\alpha} L_{it}^{1-\alpha}$ where Y_{it} is output, K_{it} is capital, and L_{it} is labor.
- There is a constant savings rate s, and a constant depreciation rate δ (corresponding to capital lost every period).
- Thus we have the following equations for capital accumulation, in aggregate and per capita terms; for simplicity, I set population growth $n = 0$.

$$\begin{aligned} K_{i,t+1} &= (1-\delta)K_{it} + sY_{it} \\ k_{i,t+1} &= (1-\delta)k_{it} + sy_{it} \end{aligned}$$

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Poverty trap

- Now, assume (plausibly) there is a minimum subsistence consumption level $c_{min} > 0$; in that case, per capita savings in district i are given by $s_{it} = \min\{y_{it} - c_{min}, sy_{it}\}$.
- If per capita consumption hits the c_{min} constraint, there is a poverty trap: there is no further per capita capital accumulation ($k_{i,t+1} \leq k_{it}$), and no further growth.
- Intuition: if enough capital is destroyed in bombing, then levels of output suffice only to provide subsistence consumption, not to reinvest, and there is no further growth.

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Empirical strategy

- The authors are interested in testing whether the particularly intense bombing campaign implemented in Vietnam, then one of the poorest countries in the world, generated a poverty trap.
- What is the key empirical challenge? Endogeneity of bombing.
- To address this, they exploit the fact that the most heavily bombed areas were around the 17th parallel (border between north and south); this border was arbitrarily drawn.
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Map

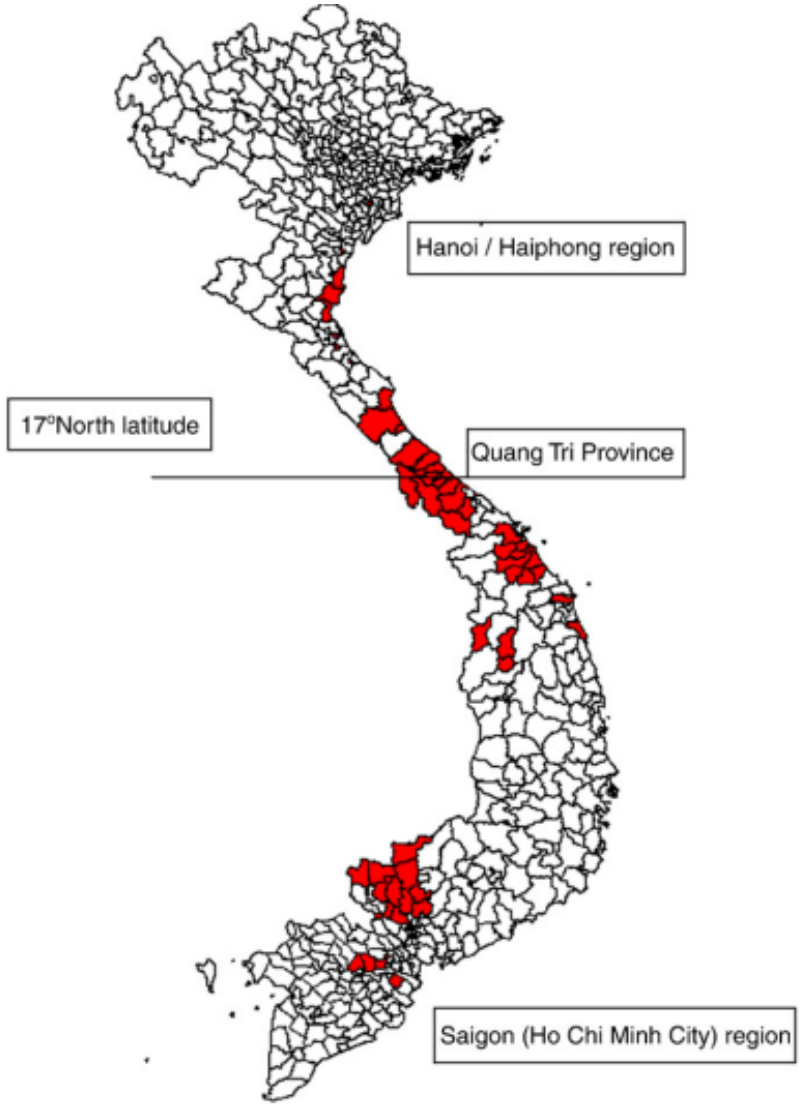

Fig. 1. Map of Vietnam — 10% of districts with the highest total U.S. bombs, missiles, and rockets per km^2 shaded.

First stage

Table 3
Predicting bombing intensity.

	Dependent variable: Total U.S. bombs, missiles, and rockets per km^2		
	(1)	(2)	(3)
|Latitude − 17°N|	−14.8***	−17.0***	−10.2***
	(5.3)	(6.0)	(2.2)
Population density (province), 1960–61	0.0050	−0.0035**	−0.0034**
	(0.0043)	(0.0016)	(0.0014)
Former South Vietnam	−138.5*	−134.5	−37.1
	(74.9)	(87.2)	(27.7)
Proportion of land area 250–500 m	89.5*	−27.6	−26.6*
	(47.1)	(20.5)	(14.2)
Proportion of land area 500–1000 m	−49.6	−17.7	−10.5
	(65.3)	(18.9)	(16.8)
Proportion of land area over 1000 m	156.3*	−6.0	−6.0
	(81.4)	(30.4)	(19.1)
Average precipitation (cm)	0.26	0.22	0.15*
	(0.17)	(0.18)	(0.08)
Average temperature (Celsius)	15.2	−0.2	−0.6
	(0.8)	(4.4)	(3.6)
Latitude (°N)	−8.7	−10.0	−2.3
	(6.3)	(7.1)	(2.6)
District soil controls	No	Yes	Yes
Exclude Quang Tri province	No	No	Yes
Observations	55	584	576
R^2	0.54	0.33	0.25
Mean (S.D.) dependent variable	30.6 (51.7)	32.3 (68.5)	27.1 (50.6)

Notes: Ordinary least squares (OLS) regressions. Robust Huber–White standard errors in parentheses. Significant at 90(*), 95(**), and 99(***) percent confidence. Disturbance terms are clustered at the province level in regressions 2–3. The district soil type controls include the proportion of district land in 18 different soil categories. The omitted altitude category is 0–250 m.

OLS

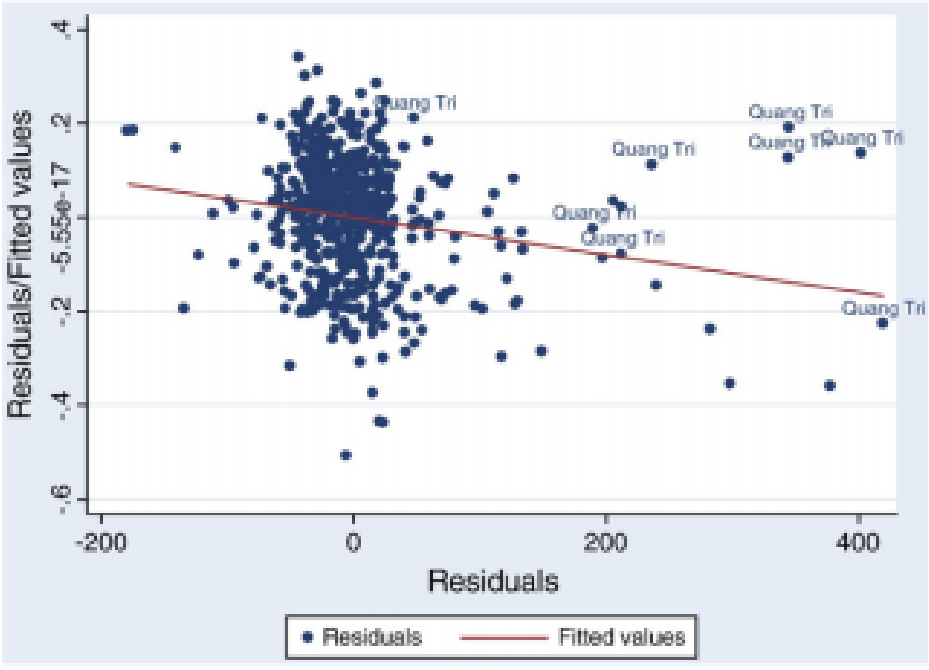

Fig. 2. 1999 estimated district poverty rate vs. total U.S. bombs, missiles, and rockets per km² in the district (conditional on 1960–61 province population density, South Vietnam indicator, district average temperature, average precipitation, elevation, soil controls, and latitude).

Discussion questions

- What are the authors' main findings about the long-term impact of bombing Vietnam?
- What is the exclusion restriction in the primary specification? Do you find this restriction to be plausible? What evidence do the authors present that is consistent with the exclusion restriction?
- Are the results surprising? This was an extremely intense bombing campaign in a very poor region.
- Is this result generalizable? What about Afghanistan, the Congo, Somalia? Will these countries soon be recovering from the conflict they've experienced?

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