1 Economic Shocks and Civil Conflict: An Instrumental Variables Approach

- Main Question: Do economic shocks lead to increases in probability of civil conflict?

- Problem: Economic growth can decline due to civil conflict; also both civil conflict and economic growth can decline due to things like ethnic tensions.

- Answer: Use instrumental variables - rainfall affects economic growth but probably doesn't affect civil conflict except through economic growth.

- Effect: Large, negative effect of one year lagged economic growth (instrumented with rainfall) on probability of current civil conflict.

- Is the exclusion restriction satisfied?
  - Lower ability for government to control potential rebels when rainfall is high (transportation ceases to function well) but this would only be a problem if higher rainfall was correlated with higher probabilities of civil conflict but lower rainfall is correlated with higher civil conflict.
  - Low rainfall could be correlated with high temperature and high temperature could more easily lead to conflict but (authors argue) that the main effect is from rainfall in one year to conflict in the following year so that heat coinciding with low rainfall is unlikely to be a causal factor.

- Data:
  - Measures of conflict: PRIO (International Peace Research Institute of Oslo) - constructed at Uppsala, Sweden and Oslo, Norway
    * Main one usually used is COW (Correlates Of War) - authors should at least use it as a robustness.
    * Authors use Collier/Hoeffler (2002), Doyle/Sambanis (2000), Fearon/Laitin (2003) as robustness
  - Rainfall data from GPCP (Global Precipitation Climatology Project) take average rainfall estimates by month and latitude/longitude pairs at 2.5 degree intervals dating back to 1979. Then average across all pairs by month and across all latitude/longitude pairs within a country:

$$R_{i,t} = \sum_{m} \sum_{l \in I} \frac{R_{i,l,m,t}}{\sum_{m} \sum_{l \in I} 1}$$

where l is a latitude/longitude pair, m is a month, t is year, and i is country.

  * Number of nodes: largest - Sudan with 34; Kenya is medium-sized and has 8 nodes.

  * Robustness: data used from National Centers for Environmental Protection (NCEP) and United Nations Food and Agricultural Organization Climactic Database (FAOCLIM)

- Other covariates from Fearon and Laitin (2003)

  * Log Per Capita Income (World Bank and Penn World Tables)

  * Meaures of Democracy (Polity IV)

  * Ethno-Linguistic Fractionalization (ELF) (probability two randomly chosen people are from a different ethnic group) taken from Atlas Maradov Mira

    * Religious Fractionalization (probability two randomly chosen people are from a different religion) taken from CIA Factbook

    * Log Population (World Bank)

    * Mountainous (Proportion of country that is mountainous)

    * Oil Exporter Dummy (1/3 or more of country exports is oil in a given year - from World Bank)

    * Log National Population (National Population is the population of the largest ethnicity in the country)

    * Not Used: Macroeconomic controls, income distribution controls. Why not?

– Only Use Data from African Countries... why?

– Why use so many covariates (like mountainous)?

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 ≥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: *Atlas Marodov Mira*)	.65	.24	743
Religious fractionalization (source: *CIA Factbook*)	.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

NOTE.—The source of most characteristics in panel D is the World Bank's World Development Indicators (WDI). Initial log per capita income for Namibia pertains to 1990, its first year in the sample (after independence).

B. Rainfall Data

We use the Global Precipitation Climatology Project (GPCP) database of monthly rainfall estimates, which stretches back to 1979, as a source of exogenous weather variation.[12] The GPCP data rely on a combination

[12] The GPCP data are publicly available on the Web at http://precip.gsfc.nasa.gov/.

Appendix C

Additional Tables

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.

- First stage regression equation

$$\begin{aligned}\Delta Y_{it} &= \alpha_{1i} + X'_{1it}b_1 + c_{1,0}\Delta R_{it} + \\ &\quad c_1\Delta R_{it-1} + d_{1i}year_{1t} + e_{1it}\end{aligned}$$

- Second stage regression equation

$$CON_{it} = \Phi\left(\begin{array}{c}\alpha_{2i} + X'_{it}b_2 + \gamma_{2,0}\Delta Y_{it} + \\ \gamma_{2,1}\Delta Y_{it-1} + \delta_{2i}year_t\end{array}\right) + e_{2it}$$

- Use non-parametric regression: locally linear weighted regression (Fan and Gijbels, 1996) to show linearity of functional form for rain in the income equation and linearity of functional form for fitted probability of likelihood of civil war on rainfall.

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)			
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

NOTE.—Huber robust standard errors are in parentheses. Regression disturbance terms are clustered at the country level. 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.

The first-stage relationship between rainfall and income growth is strongly positive: current and lagged rainfall growth are both significantly related to income growth at over 95 percent confidence (regression 1 in table 2), and this relationship is robust to the inclusion of country controls (regression 2) and fixed effects (regression 3). Positive rainfall growth typically leads to better agricultural production since most of sub-Saharan Africa lies within the semiarid tropics and is prone to drought. The rainfall instruments are somewhat weak (the F-statistic is 4.5 in regression 3), suggesting that the instrumental variable two-stage least squares (IV-2SLS) estimates may be somewhat biased toward ordinary least squares (OLS) estimates (Bound, Jaeger, and Baker 1995;

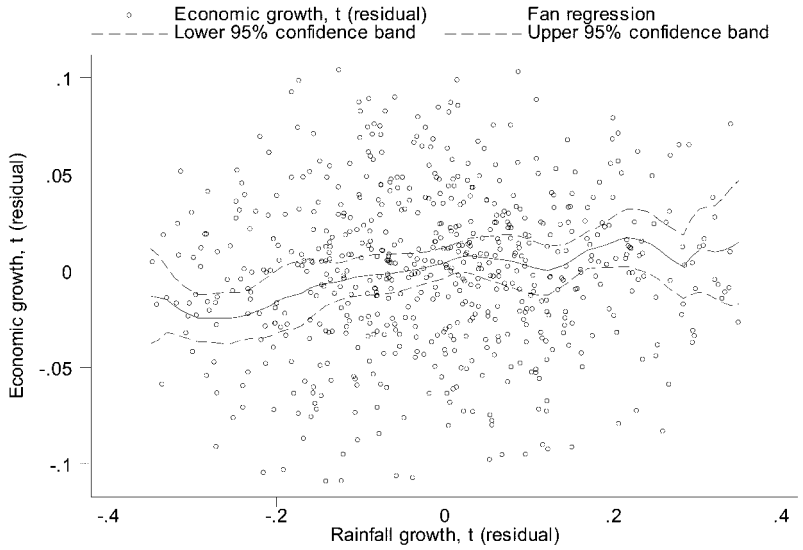

FIG. 1.—Current economic growth rate on current rainfall growth. Nonparametric Fan regression, conditional on country fixed effects and country-specific time trends.

Staiger and Stock 1997). As an identification check, we estimate a "false experiment" specification in which future rainfall growth—which should be orthogonal to current economic growth, conditional on country-specific time trends—is included as an additional explanatory variable, and we find that the coefficient estimate is indeed near zero (coefficient estimate 0.001, standard error 0.019, in regression 4).[17] Changes in country terms of trade, which are largely driven by commodity price movements, are not significantly related to economic growth (regression 5).

The positive and approximately linear first-stage relationship is presented graphically in figure 1, using a nonparametric Fan local regression method with an Epanechnikov kernel. Higher-order polynomial rainfall growth terms are not statistically significantly related to economic growth (results not shown). We experimented with a variety of other instrumental variables, including further lags of rainfall growth, the interaction of current and lagged rainfall growth, current and lagged rainfall levels, the interaction of rainfall growth with the share of agricultural sector value added in national GDP, and the interaction of rainfall growth with the rural share of the national population. In the latter two cases, the coefficient estimates on the interaction terms are positive as expected and sometimes marginally statistically significant (regressions not shown). However, the first-stage results in these cases

[17] We thank Guido Imbens for this suggestion.

- Estimate 2SLS by IV-Probit

- Could measurement error (in rainfall) affect the IV Estimate? What about misspecification of the functional form?

$$\left((Z+G)'X\right)^{-1}\left((Z+G)'Y\right)$$

  - Not assymptotically (i.e. the probability limit is consistent) but in small samples it can.

TABLE 3
RAINFALL AND CIVIL CONFLICT (Reduced-Form)

	DEPENDENT VARIABLE	
EXPLANATORY VARIABLE	Civil Conflict ≥25 Deaths (OLS) (1)	Civil Conflict ≥1,000 Deaths (OLS) (2)
Growth in rainfall, t	−.024	−.062**
	(.043)	(.030)
Growth in rainfall, $t-1$	−.122**	−.069**
	(.052)	(.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

NOTE.—Huber robust standard errors are in parentheses. Regression disturbance terms are clustered at the country level. A country-specific year time trend is included in all specifications (coefficient estimates not reported).
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*** Significantly different from zero at 99 percent confidence.

are weaker than the specifications presented in table 2 (results not shown), so we opt for the more parsimonious specification above.

Higher levels of rainfall are associated with significantly *less* conflict in the reduced-form regression, for all civil conflicts (regression 1 in table 3), with a point estimate of −0.122 (standard error 0.052) on lagged rainfall growth. In the case of major conflicts, those involving more than 1,000 deaths per year (regression 2), coefficient estimates on both current and lagged rainfall growth are statistically significant at 95 percent confidence. This is the first indication that better rainfall makes civil conflict less likely in Africa.[18] The nonparametric relationship between lagged rainfall growth and conflict is negative and roughly linear (fig. 2).

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

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

We performed both IV-2SLS estimation and a nonlinear two-stage procedure following Achen (1986) to correct standard errors in the

[18] The false experiment specifications again indicate that future rainfall is not statistically significantly related to either measure of current conflict: for the 25–battle death threshold, the coefficient estimate on rainfall in period $t+1$ is near zero, at 0.000, with a standard error of 0.055 (regression not shown).

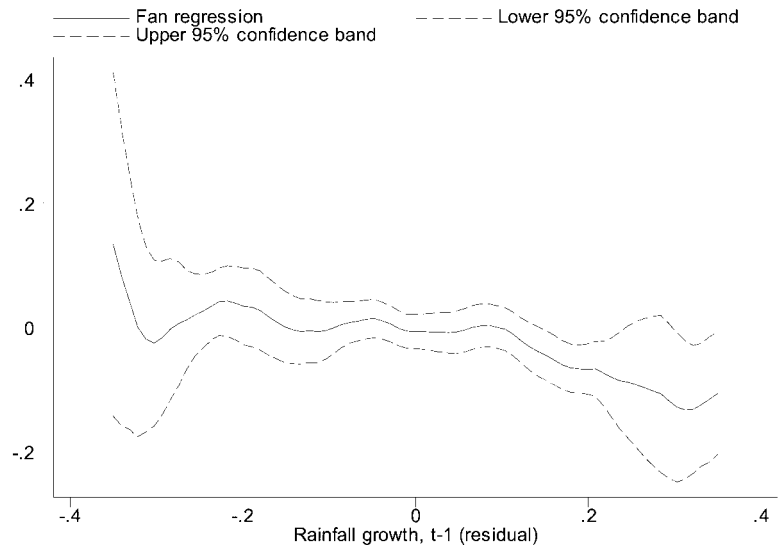


FIG. 2.—Current likelihood of civil conflict (≥25 battle deaths) on lagged rainfall growth. Nonparametric Fan regression, conditional on current rainfall growth, country fixed effects, and country-specific time trends.

presence of a dichotomous dependent variable in the second stage. The IV-2SLS method is typically preferred even in cases in which the dependent variable is dichotomous (see Angrist and Kreuger 2001; Wooldridge 2002) since strong specification assumptions are required to justify the Achen and related Rivers and Vuong (1988) methods. We thus focus on the IV-2SLS specification below. Note that results are similar with both specifications, although statistical significance falls somewhat in the nonlinear second-stage specification with bootstrapped standard errors (results not shown).

V. Main Empirical Results

Contemporaneous and lagged economic growth rates are negatively, though not statistically significantly, correlated with the incidence of civil conflict in probit (regression 1 in table 4) and OLS specifications with country controls (regression 2), and contemporaneous growth is negatively associated with conflict in OLS specifications with and without country fixed effects (regressions 3 and 4). The results using probit and linear specifications are nearly identical, and from now on we restrict our attention to the linear specifications. Note that among the other variables prominently cited in the existing literature, only the measure of mountainous terrain has statistically significant predictive power in

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)
Log(GDP per capita), 1979	−.067	−.041	.085		.053		
	(.061)	(.050)	(.084)		(.098)		
Democracy (Polity IV), $t-1$	.001	.001	.003		.004		
	(.005)	(.005)	(.006)		(.006)		
Ethnolinguistic fractionalization	.24	.23	.51		.51		
	(.26)	(.27)	(.40)		(.39)		
Religious fractionalization	−.29	−.24	.10		.22		
	(.26)	(.24)	(.42)		(.44)		
Oil-exporting country	.02	.05	−.16		−.10		
	(.21)	(.21)	(.20)		(.22)		
Log(mountainous)	.077**	.076*	.057		.060		
	(.041)	(.039)	(.060)		(.058)		
Log(national population), $t-1$	.080	.068	.182*		.159*		
	(.051)	(.051)	(.086)		(.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

NOTE.—Huber robust standard errors are in parentheses. Regression disturbance terms are clustered at the country level. Regression 1 presents marginal probit effects, evaluated at explanatory variable mean values. The instrumental variables for economic growth in regressions 5–7 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), except for regressions 1 and 2, where a single linear time trend is included.

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

these specifications, and national population is also marginally positively associated with conflict in one specification. These results confirm Fearon and Laitin's (2003) finding that ethnic diversity is not significantly associated with civil conflict in sub-Saharan Africa.

An instrumental variable estimate including country controls yields point estimates of −2.25 (standard error 1.07) on lagged growth, which is significant at 95 percent confidence, and −0.41 (standard error 1.48) on current growth (regression 5 of table 4). The two growth terms are jointly significant at nearly 90 percent confidence (p-value .12). The IV-2SLS fixed-effects estimate on lagged growth is similarly large, negative, and significant at −2.55 (standard error 1.10 in regression 6). Note that

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, $t \times$ 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, $t-1 \times$ ethnolinguistic fractionalization			5.1		
			(8.1)		
Economic growth rate, $t \times$ oil-exporting country				−2.8	
				(6.9)	
Economic growth rate, $t-1 \times$ oil-exporting 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

NOTE.—Huber robust standard errors are in parentheses. Regression disturbance terms are clustered at the country level. The instrumental variables are growth in rainfall, t and growth in rainfall, $t-1$ and these two terms interacted with the appropriate explanatory variable. A country-specific year time trend is included in all specifications (coefficient estimates not reported). Similar interaction patterns hold when civil conflict ≥1,000 deaths is the dependent variable and in most OLS specifications (results not shown).

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

Africa); for countries with socialist political regimes at the start of the sample period (from Barro [1991]); by religious fractionalization, or any of the social fractionalization measures from Alesina et al. (2003); by population density; across a range of measures of democracy, political competition, regulation of political participation, and constitutional constraints on executive power (from the Polity IV data set); for other political institutional measures, including the degree of federalism, and government checks and balances (from the World Bank Database of Political Institutions); and for political and civil freedom (from Freedom House; results not shown).

The simplest reading of these findings is that economic factors trump

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.

all others in determining the incidence of civil conflict and, in particular, that institutional and social characteristics have minimal impact in mitigating the effect of economic shocks. However, it is important to note that the relatively limited variation in many of these characteristics across African countries during the sample period—most were poor, ethnically diverse, and undemocratic, with similar colonial legacies—means that this finding may not generalize to other regions of the world. Despite attempts to examine the broadest possible range of country political and social characteristics, it also remains possible that some other characteristics not adequately captured in existing data sets—perhaps along the lines of the "shadow state" institutions described by Reno (1998) in West Africa—do mitigate the adverse effects of negative economic shocks, but we are unable to examine them here. Moreover, problems of measurement for the institutional and social characteristics exacerbate these concerns and may bias coefficient estimates on the interaction terms toward zero.

Finally, we explore how economic growth affects the onset of conflict, and to do so we restrict attention to country-year observations in which there was no civil conflict during the previous year. When either PRIO/Uppsala definition is used, 25 or 1,000 battle deaths, conflicts are significantly less likely to start as economic growth increases (regressions 1 and 2 of table 6), and once again we cannot reject the hypothesis that effects are the same for current and lagged economic growth. The results are robust to the inclusion of country controls rather than fixed effects, and there is once again no significant difference in the impact

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

	IV-2SLS		
EXPLANATORY VARIABLE	IV: GPCP Data (1)	IV: NCEP Data (2)	IV: FAOCLIM Data (3)
Economic growth rate, t	−1.13	.02	.45
	(1.40)	(1.82)	(.68)
Economic growth rate, $t-1$	−2.55**	−2.26	−1.35*
	(1.10)	(1.36)	(.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

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, $t-1$. Current and lagged growth in rainfall are the instrumental variables for economic growth. A country-specific year time trend is included in all specifications (coefficient estimates not reported). Regression 1 reproduces the result from regression 6 of table 4.

* Significantly different from zero at 90 percent confidence.

** Significantly different from zero at 95 percent confidence.

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

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

EXPLANATORY VARIABLE	DEPENDENT VARIABLE: Civil Conflict ≥25 Deaths (1)	DEPENDENT VARIABLE: Civil Conflict ≥ 1,000 Deaths (2)	(3)	(4)	(5)
Economic growth rate, t	−1.13	−1.48*	−.96	−1.62	−.84
	(1.40)	(.82)	(.77)	(1.07)	(.78)
Economic growth rate, $t-1$	−2.55**	−.77	−.65	−.96	−.84***
	(1.10)	(.70)	(.56)	(.68)	(.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

SOURCE.—Cols. 1 and 2: PRIO/Uppsala; col. 3: Collier and Hoeffler (2002); col. 4: Doyle and Sambanis (2000); col. 5: Fearon and Laitin (2003).

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, $t-1$ with the GPCP measures. A country-specific year time trend is included in all specifications (coefficient estimates not reported). Regression 1 reproduces the result from regression 6 of table 4, and regression 2 reproduces the result from regression 7 of table 4.

* Significantly different from zero at 90 percent confidence.

** Significantly different from zero at 95 percent confidence.

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

2 Diamonds Are Forever, Wars Are Not. Is Conflict Bad for Private Firms?

- Massimo Guidolin and Eliana La Ferrara, forthcoming *American Economic Review*

- Literature on conflict and development; natural resource curse

- War in Angola
  - 1974 Decolonization; Coup in Portugal
  - Conflict between MPLA and UNITA
  - Ethnic Differences
  - September, 1992: Election - MPLA wins.

  - 1994 Lusaka Peace Protocol gives UNITA mining rights and foreign company partnership rights

  - Angola: 4th largest Diamond Producer: $1.1 Billion in 2000 (15% of world production)

  - Both sides used diamonds to fund conflict

- Jonas Savimbi (leader of UNITA) killed on February 22, 2002. April 4th, 2002: final peace treaty signed ending the war.

- Regression Equation:

$$r_t = \alpha + \beta r_t^M + \theta S_t + e_t$$

  where r_t is the one day return of the stock, r_t^M is the one day return of the market portfolio and S_t is a set of dummy for country specific events such as mergers and acquisitions, stock splits, joint ventures, new mining liscenses or discovery of new mineral resources.

- Angola portfolio: equal-weighted returns (overweights small companies). Most of Angolan diamond extraction due to one company: De Beers.

- Control Portfolio: diamond companies not invested in Angola.

- Construction of Control Portfolio:

$$E_t^C = \sum_{j=1}^{J} w_j e_{j,t}^C$$

- where w_j comes from

$$\begin{aligned} & \min_w \left(v - V^C w\right)' Q \left(v - V^C w\right) \\ s.t.\ w'1 &= 1,\ w_j \geq 0\ \forall j \end{aligned}$$

- where $v = \left[\hat{\mu}_E, \hat{\sigma}^2_E, \hat{\beta}_E\right]$, $\tau =$

$$\begin{aligned}
\hat{\mu}_E &= \tau^{-1} \sum_{t=1}^{\tau} E_t \\
\hat{\sigma}^2_E &= \tau^{-1} \sum_{t=1}^{\tau} (E_t - \hat{\mu}_E) \\
\hat{\beta}_E &= \frac{\sum_{t=1}^{\tau} (E_t - \hat{\mu}_E) \left(R^W_t - \tau^{-1} \sum_{t=1}^{\tau} R^W_t \right)}{\sum_{t=1}^{\tau} \left(R^W_t - \tau^{-1} \sum_{j=1}^{J} R^W_t \right)^2}
\end{aligned}$$

- and weighting matrix Q = matrix of inverse of asymptotic standard deviations of the MLE estimators of the mean, variance and market model beta:

$$\begin{matrix}
\frac{\sqrt{\tau}}{\hat{\sigma}_E} & 0 & 0 \\
0 & \frac{\sqrt{\tau}}{\hat{\sigma}_E} & 0 \\
0 & 0 & \frac{\sqrt{\tau}\hat{\sigma}_W}{\hat{\sigma}_E}
\end{matrix}$$

- Results on Savimbi's Deaths
- Other Events
- Graphs:
- Involvement in Conflict Zones
- Cease Fire: Could Savimbi's death lead to an increase in expected length of war? - Evidence from signing of peace accord.

Tables

Table 1: Testing the impact of Savimbi's death

			ANGOLAN portfolio			
Event window	**Rank stat**	Two-tailed p-value	One-tailed p-value	**Sign stat**	Two-tailed p-value	One-tailed p-value
(-0; +0)	-4.883	**0.000**	**0.000**	-0.447	0.655	0.327
(-1; +1)	-3.241	**0.001**	**0.001**	-3.500	**0.000**	**0.000**
(-3; +3)	-1.912	**0.056**	**0.028**	-5.629	**0.000**	**0.000**
(-5; +5)	-1.776	0.076	**0.038**	-7.757	**0.000**	**0.000**
(-0; +1)	-2.843	**0.004**	**0.002**	-1.162	0.245	0.123
(-0; +3)	-3.159	**0.002**	**0.001**	-2.683	**0.007**	**0.004**
(-0; +5)	-3.096	**0.002**	**0.001**	-3.578	**0.000**	**0.000**
			CONTROL portfolio			
Event window	**Rank stat**	Two-tailed p-value	One-tailed p-value	**Sign stat**	Two-tailed p-value	One-tailed p-value
(-0; +0)	1.213	0.225	0.112	1.000	0.317	0.159
(-1; +1)	0.751	0.453	0.226	1.000	0.317	0.159
(-3; +3)	0.487	0.626	0.313	1.000	0.317	0.159
(-5; +5)	0.667	0.505	0.252	2.000	**0.046**	**0.023**
(-0; +1)	1.329	0.184	0.092	2.000	**0.046**	**0.023**
(-0; +3)	0.925	0.355	0.178	2.000	**0.046**	**0.023**
(-0; +5)	0.770	0.441	0.221	2.000	**0.046**	**0.023**

Table 2: Abnormal returns and different types of events

	"Angolan"	Control
End of conflict	-.032**	.015
	(.009)	(.011)
Government victories	.007	-.001
	(.008)	(.006)
UNITA attacks civilians	.017	-.002
	(.019)	(.008)
UNITA attacks mines	-.034*	.036*
	(.017)	(.021)
UNITA attacks garimpeiros	-.014	-.004
	(.015)	(.024)
Industry regulation	-.011**	.000
	(.004)	(.007)
Company fixed effects	Yes	Yes
No. obs.	8,079	47,095

Notes:
Table reports estimated OLS coefficients. Standard errors in parenthesis are corrected for heteroskedasticity and clustering of the residuals at the company level.
* denotes significance at the 10 percent level, ** at the 5 percent level.

Figures

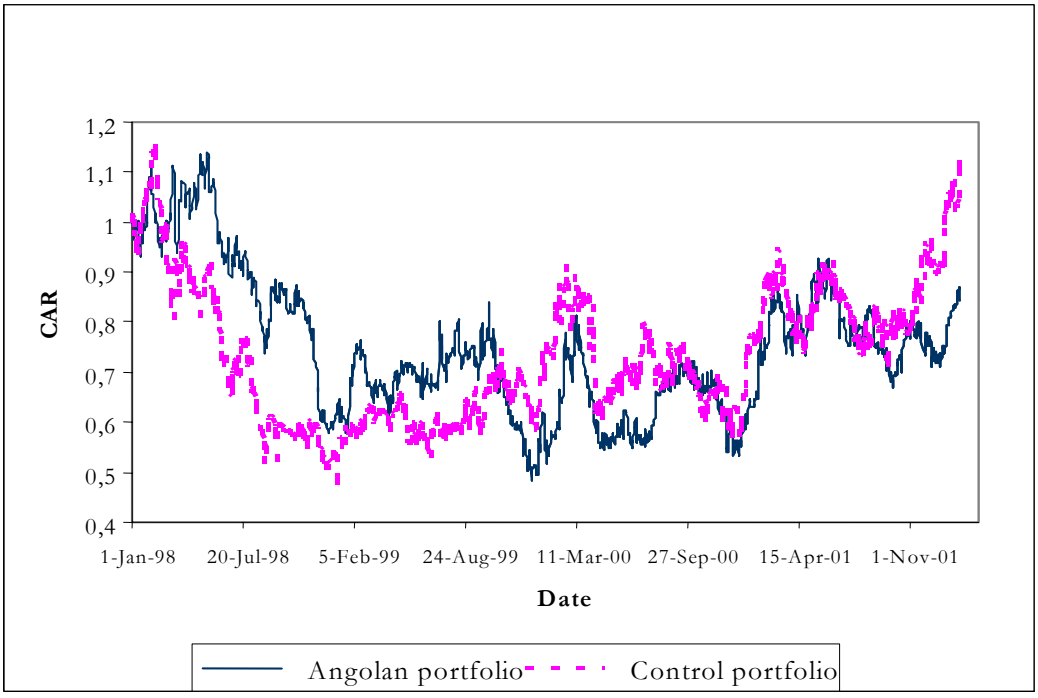
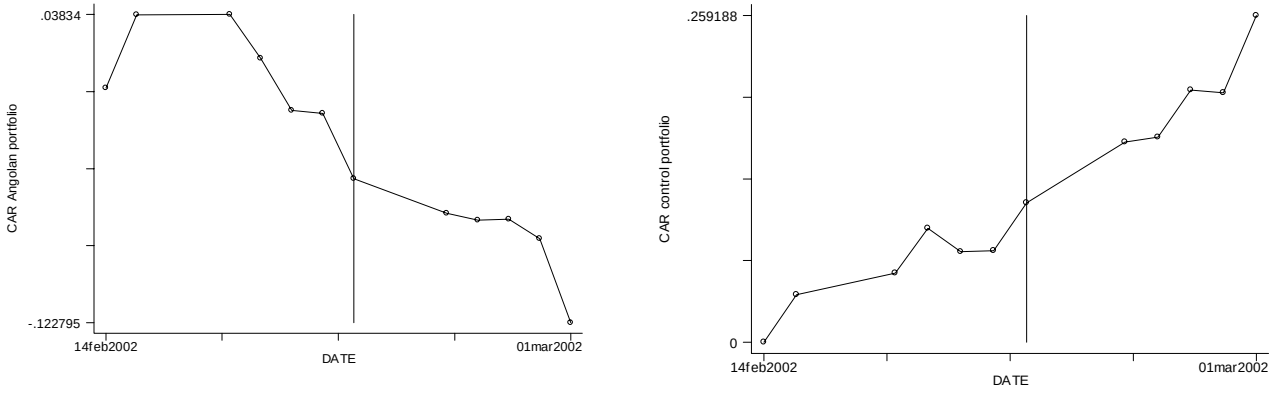


Figure 1: Angolan and Control Portfolio



(a) Angolan portfolio (b) Control portfolio

Figure 2: Savimbi's death

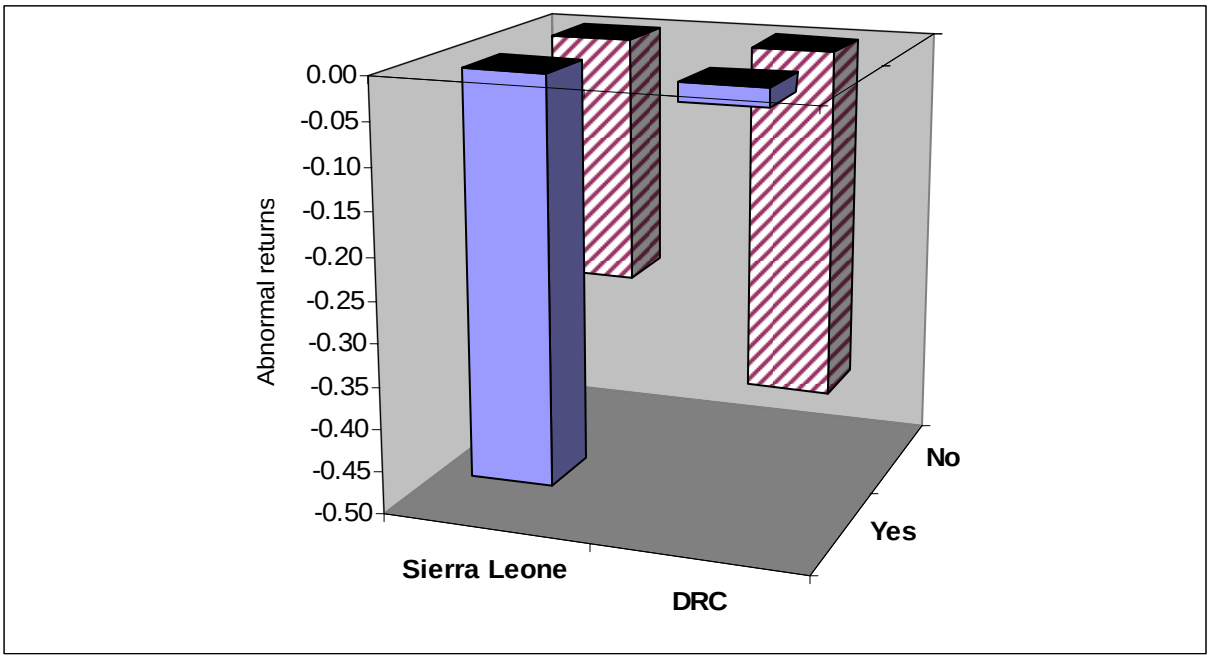
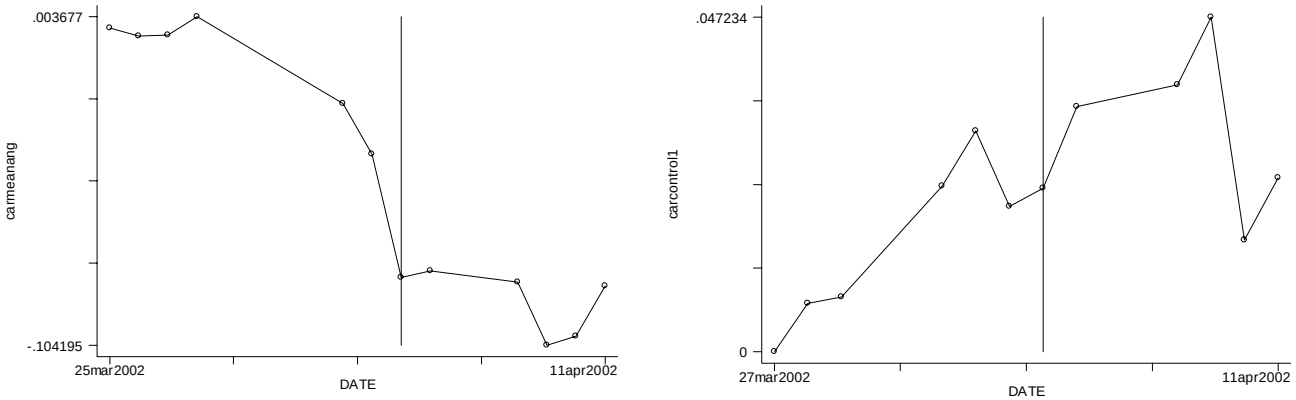


Figure 3: Involvement in conflict zones



(a) Angolan portfolio (b) Control portfolio

Figure 4: Cease fire

Appendix Table A1: Composition of Control Portfolio

	Variance weights	*A-G weights*
AKD	0.000740	0.010477
ALCASTON MINING	0.322474	0.006931
BHP BILLITON	0.007829	0.000509
CONQUEST MINING	0.002982	0.021795
CROWN DIAMONDS	0.022246	0.008443
GONDWANA RESOURCES	0.042796	0.013287
GRAVITY CAPITAL	0.012951	0.017100
KIMBERLEY DIAMOND	0.010838	0.010684
MOUNT BURGESS MINING	0.001082	0.008603
OROPA	0.000105	0.012539
PLENTY RIVER CORP.	0.001267	0.010051
REEFTON MINING	0.000062	0.040211
RESOURCE MINING	0.001510	0.015470
RIMFIRE PACIFIC MINING	0.000307	0.009562
TAWANA RESOURCES	0.128893	0.001658
AFMINEX	0.000292	0.021050
CLUFF RES. PAC	0.002982	0.010592
GOLDSEARCH	0.004222	0.040666
STRIKER RESOURCES	0.007642	0.006108
ASTRO MINING	0.020920	0.020919
FORTUNE MINERALS	0.000530	0.002566
GUYANOR RES.SA (TSE)	0.023896	0.024351
PLATINOVA A/S	0.000503	0.023102
SOUTHWESTERN RES.	0.001558	0.002771
ABER DIAMOND	0.011098	0.001223
DIAMOND FIELDS INTL.	0.008398	0.003664
ETRUSCAN RESOURCES	0.001746	0.138440
REX DIAMOND MNG.	0.001257	0.001728
BAND ORE RES.NEW	0.001514	0.012428
BRAZILIAN DIAMONDS	0.005741	0.021033
CALDERA RES.	0.077662	0.038493
COMAPLEX MINERALS	0.106517	0.004729
GOLDEN STAR RESOURCES	0.000646	0.006813
MOUNTAIN PROV.DIAS.	0.010972	0.004452
PURE GOLD MRLS.	0.049468	0.011660
SUDBURY CONTACT MNS.	0.000666	0.015087
TAHERA	0.004296	0.014619
RNC Gold	0.002504	0.135893
AFRICAN GEM RES.	0.001972	0.000775
GOOD HOPE DIAMONDS	0.083849	0.098646
THABEX EXPLORATION	0.001308	0.133183
ZENITH CONCESSIONS	0.011762	0.017689

- Interpretations
  - Decline in conflict leads to increased entry of foreign firms and decline in domestic profits
  - Greater ability of government to control mining and tax
  - Desperation from the war kept corruption down and thus terms of contracts with foreign comanies were favorable
  - Less extension of credit after end of war from foreign governments lead to greater desperation of firms and worse bargaining position with international contractors
  - End of war leads to greater demand for transparency and lower rent extraction from corruption by diamond firms