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Re-examining Economic Shocks and Civil Conflict[†]

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Miguel, Satyanath, and Ernest Sergenti (2004), henceforth MSS, show that economic growth is negatively related to civil conflict in Africa, using annual rainfall variation as an IV for growth. Antonio Ciccone (2011) argues that thanks to rainfall's mean-reverting nature, rainfall levels are preferable to annual changes. We make three points. First, MSS's findings hold using rainfall levels as instruments. Second, Ciccone (2011) does not provide theoretical justification for preferring rainfall levels. Third, the first-stage relationship between rainfall and growth is weaker after 2000, suggesting that alternative instruments are needed when studying recent conflicts. We highlight the accumulating microeconomic evidence that adverse economic shocks lead to political violence. (*JEL* D74, E32, O11, O17, O47)

Previous work by Miguel, Satyanath, and Sergenti (2004), henceforth MSS, addressed the question of whether poor economic performance has a causal effect on civil conflict in sub-Saharan Africa. Using year-to-year rainfall variation as an instrumental variable for economic growth, MSS (2004) find that economic growth is strongly, negatively related to civil conflict: a negative growth shock of 5 percentage points increases the likelihood of civil conflict in the next year by nearly one half. The paper "Economic Shocks and Civil Conflict: A Comment" by Ciccone (2011) has the goal of showing that, thanks to the mean-reverting nature of rainfall, MSS (2004) should have used levels of rainfall rather than year-to-year changes in their regression specifications. Ciccone's main claim is that the use of levels in place of year-to-year changes leads to a different understanding of the effects of economic shocks on civil conflict.

As should be clear from the above summary, Ciccone (2011) is not a replication critique, but rather a critique of the regression functional form that we use, namely, the use of rainfall growth rather than rainfall levels as instruments. We have had the complete replication dataset and STATA do files on our websites since 2004, and scores of scholars have replicated our results. Ciccone (2011) replicates our results, as he shows in his tables, and the main results of MSS (2004) remain unchanged. In this note, we respond primarily to the question of whether our understanding of the relationship of economic shocks and conflict is altered by Ciccone's critique of our

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functional form choices. We do so with three brief points. A more detailed response to Ciccone's comments is available in Miguel and Satyanath (2010).

Point 1: The main findings in MSS (2004) *hold using rainfall levels variables as instruments for economic growth.*

As indicated in the titles of both MSS (2004) and Ciccone (2011), the goal of the analysis is to understand the impact of economic shocks on the likelihood of civil conflict. The opening sentence of Ciccone's article is "Does poor economic performance cause violent civil conflict?" The original insight of MSS (2004) was that exogenous rainfall variation could be used to identify the relationship between economic growth and civil conflict in Africa, given the strong relationship between rainfall and economic performance in a largely agrarian region of the world.

In light of the above, it is surprising that Ciccone does not present any instrumental variable results in his paper. These are the focus of MSS (2004) and directly assess the hypothesis that economic shocks affect civil conflict. Instead Ciccone focuses solely on the reduced form results, namely, regressions of civil conflict on measures of rainfall. To check if Ciccone's preferred functional form for rainfall makes any difference to our results on the impact of economic shocks, it is a simple matter of replacing year-to-year changes in rainfall with rainfall levels as instrumental variables. We thus begin with this test, holding everything else constant as a means of accurately assessing the independent effect of the functional form of rainfall on the results.

In Table 1, column 1, we reproduce our original results using year-to-year changes in rainfall as instruments for economic growth, and find a negative effect of economic growth on civil conflict. In column 2, we instead use rainfall levels as instruments, and show that the negative relationship between economic growth and civil conflict is unchanged, with a p-value of 0.053 (using the weak-instrument robust Anderson-Rubin test). It appears that Ciccone's critique of how MSS (2004) have specified the rainfall measures thus gives us no grounds for altering our understanding of the fundamental relationship between economic growth and civil conflict.

Point 2: Ciccone does not provide adequate theoretical justification for preferring rainfall levels to rainfall growth as instruments for economic growth.

Ciccone assumes that MSS (2004) uses the wrong functional form of rainfall shocks—namely, rainfall growth rather than levels (in logs)—and attempts to characterize the nature of the resulting bias in our regressions under this maintained assumption. However, he does not provide a persuasive discussion of why rainfall levels are preferable to rainfall growth from a theoretical perspective.

As one example, Ciccone focuses at times on the role of high rainfall in year $t - 2$, but, from his article, we are unable to glean any persuasive theoretical discussion as to why higher rainfall levels two years in the past would increase conflict risk today. In contrast, the causal mechanisms supporting a rainfall growth specification are abundant. Consider the past two decades of research in behavioral economics. Through the elaboration of such concepts as loss aversion, reference points, framing effects, and prospect theory, behavioral economists have shown both theoretically and empirically that individuals often respond strongly to seemingly small changes in current consumption, and especially to negative changes (Matthew Rabin 1998;

Table 1—IV–2SLS, First-Stage and Reduced-Form Estimates of the Relationship between Rainfall, Economic Growth, and Civil Conflict

	Rainfall growth 1981–1999 (1)	Rainfall levels 1981–1999 (2)	Rainfall growth 2000–2008 (3)
Panel A. IV–2SLS, dependent variable is civil conflict incidence (t)			
GDP growth (t)	−0.0113	−0.0116	
	(0.0131)	(0.0108)	
GDP growth $(t-1)$	−0.0255**	−0.0190*	
	(0.0103)	(0.0103)	
Observations	743	743	
Anderson-Rubin χ^2 p-value	0.0250	0.0526	
Panel B. First-stage, dependent variable is per capita annual GDP growth (t)			
Rainfall (t)	4.858***	5.787***	0.738
	(1.702)	(2.036)	(1.392)
Rainfall $(t-1)$	2.800*	−1.880	0.274
	(1.419)	(2.249)	(2.013)
Rainfall $(t-2)$		−3.493*	
		(1.806)	
Observations	743	743	369
R^2 (adj)	0.0233	0.0264	0.0023
F-stat rainfall vars.	4.491	3.258	0.793
Panel C. Reduced-form, dependent variable is civil conflict incidence (t)			
Rainfall (t)	−0.0238	−0.0762	
	(0.0432)	(0.0645)	
Rainfall $(t-1)$	−0.122**	−0.115	
	(0.0518)	(0.0763)	
Rainfall $(t-2)$		0.110	
		(0.0789)	
Observations	743	743	
R^2 (adj)	0.672	0.672	
p-value rainfall$(t-1)$ + rainfall$(t-2)=0$	N/A	0.966	

Notes: All regressions include country fixed effects, linear country-specific time trends, and a constant. Robust standard errors are in parentheses, clustered at the country level. Columns 1 and 2 use the data from MSS (2004) for the period 1981–1999. Column 3 uses the same sample countries as MSS (2004) but employs the most recent releases of the Peace Research Institute Oslo (PRIO) armed conflict data, Global Precipitation Climatology Project (GPCP) 2.1, and Penn World Table (PWT) 7 data series.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Stefano DellaVigna 2009). This literature indicates that individuals are often sensitive to recent *changes* from the status quo, which would be well captured by growth rates, rather than just to levels per se.

A simple econometric test also lends some support for the "growth" formulation. We directly test the hypothesis that the coefficient estimates on lagged rainfall in years $t-1$ and $t-2$ have equal and opposite sign, i.e., that a growth formulation is appropriate. If Ciccone is correct and the growth formulation is inappropriate, we should be able to reject this hypothesis. In fact, these two coefficient estimates are nearly identical in magnitude but of opposite signs in the reduced form results in column 2, at -0.115 and $+0.110$, and as shown in the bottom row of the Table 1, we are unable to reject the hypothesis that these coefficient estimates have equal but opposite signs (p-value $= 0.966$).

Point 3: The first-stage relationship between rainfall shocks and economic growth loses statistical significance after 1999 *in sub-Saharan Africa, suggesting that alternative identification strategies will need to be employed to estimate the impact of economic growth on civil conflict in the recent period.*

In an ancillary point, Ciccone criticizes us on the grounds that the reduced-form relationship between rainfall and civil conflict (in rainfall levels as well as growth) is not robust when the data is extended to 2008–2009. For him, this apparently implies that economic shocks do not have a robust effect on civil conflict in the 1981–2009 period. In the absence of a detailed justification for the use of rainfall as an instrument for economic shocks over this extended period, we are unable to evaluate this claim. It is not automatic that an instrument that is valid for one time period is also valid for other periods. For instance, we find that the first-stage relationship between rainfall shocks and economic growth loses statistical significance in the post-1999 period. For us, this casts doubt on the relevance of Ciccone's discussion of the recent data to the broader debate over the effects of economic shocks (as opposed to weather shocks) on civil conflict.

In column 3 of Table 1, we show that after 1999 neither rainfall growth in year t or $t-1$ is significantly correlated with economic growth (in year t), and the F-statistic on the joint significance of the instruments is just 0.793. The reasons for this apparent decline in the sensitivity of economic growth to rainfall remain unclear, but may be related to Africa's unprecedented recent economic growth in the past decade in nonagricultural sectors, as well as public policy changes perhaps stemming from spreading democratization (Miguel 2009). It is also worth noting that Ciccone's point about the lack of a reduced-form relationship between rainfall and civil conflict over the extended period has already been made in a recent article we wrote with co-authors (Marshall B. Burke et al. 2010). The bottom line is that it is a conceptual mistake to automatically conflate rainfall shocks with economic shocks when studying the post-1999 period.

None of the above is intended to imply that the results in MSS (2004) are robust to all specifications, time periods, and data series. In fact, we believe that major concerns in this literature relate to the inherent technical difficulties and judgment calls that need to be made when trying to capture hard-to-measure phenomena like armed conflict and rainfall shocks in the context of sub-Saharan Africa. Over roughly the past year, new versions of the PRIO and GPCP data series have been released (George J. Huffmann et al. 2009; Lotta Harbom and Peter Wallensteen 2010), and unfortunately both the new civil conflict data and new precipitation data show rather low correlations with the previous data versions.[1] Unsurprisingly, when new versions of datasets offer low correlations with previous versions, empirical results over the exact same time period that hold with one version of a dataset do not always carry over to the next version. This can explain some of the apparent discrepancy between the results for the 1981–2008 period presented in Ciccone (2011), where he does not find significant reduced-form impacts of rainfall growth on civil conflict (using the latest data series) versus the findings for the 1981–2007 period presented

[1] The correlation between the most recent PRIO/Uppsala conflict data and the PRIO/Uppsala data used in MSS (2004) is 0.853. For precipitation, the correlation between the most recent GPCP data and the one used in MSS (2004) is only 0.894.

in Miguel and Satyanath (2010), which uses the previous data releases. Relative to the importance that data construction and coding choices play in driving the results in the empirical conflict literature, issues of the functional form of rainfall measures used as instrumental variables appear to be a minor concern.

Ciccone concludes by recommending the use of more disaggregated data to uncover the relationship between economic shocks and conflict. We agree. From our point of view, once a plausible link has been uncovered in macroeconomic data, microeconomic analyses are often preferable to judgment calls over the "right" national coding of a civil conflict indicator variable, calls that are generally made at a great distance from the scene of conflict. Although the shift to microeconomic research has already occurred, Ciccone neglects to mention the accumulating body of research that is precisely in the disaggregated vein he favors. This literature finds strong links between adverse economic shocks and political violence in a wide range of settings, including as a cause of land invasions in Brazil (F. Daniel Hidalgo et al. 2010), armed conflict in Colombia (Oeindrila Dube and Juan Vargas 2010), rebel recruitment in Burundi (Eleonora Nillesen and Philip Verwimp 2010), and communal riots in India (Anjali Thomas Bohlken and Sergenti 2010). In contrast, we have yet to encounter a micro study that associates better rainfall with more conflict.

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