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RAIN AND THE DEMOCRATIC WINDOW OF OPPORTUNITY

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We show that democratic change may be triggered by transitory economic shocks. Our approach uses within-country variation in rainfall as a source of transitory shocks to sub-Saharan African economies. We find that negative rainfall shocks are followed by significant improvement in democratic institutions. This result is consistent with the economic approach to political transitions, where transitory negative shocks can open a window of opportunity for democratic improvement. Instrumental variables estimates indicate that following a transitory negative income shock of 1 percent, democracy scores improve by 0.9 percentage points and the probability of a democratic transition increases by 1.3 percentage points.

KEYWORDS: Democratization, transitory economic shocks.

1. INTRODUCTION

WHAT TRIGGERS DEMOCRATIC CHANGE? At least since Lipset (1959), it has been argued that democratic change is often sparked by economic recessions (see also Huntington (1991), Haggard and Kaufman (1995)). We examine the link between recessions and democratic improvements by exploiting within-country variation in rainfall as a source of transitory shocks to sub-Saharan African economies. Our main finding is that negative rainfall shocks are followed by significant improvements in democratic institutions. There are several theoretical explanations of the link between economic recessions and democratization in the literature (e.g., Lipset (1959), Huntington (1991), Acemoglu and Robinson (2006)). An explanation that fits our framework well is that of Acemoglu and Robinson's (2001) theory of political transitions. In their theory, negative economic shocks may spark democratic improvement even if shocks are (known to be) exogenous and transitory. This is because transitory negative shocks give rise to a window of opportunity for citizens to contest power, as the cost of fighting ruling autocratic regimes is relatively low. When citizens reject policy changes that are easy to renege upon once the window closes, autocratic regimes must make democratic concessions to avoid costly repression. Hence, democratic improvement is seen as a concession of ruling autocratic regimes when citizens' opportunity cost of contesting power is temporarily low.

Our main measure of democratic institutions is the revised combined Polity IV project score (Marshall and Jaggers (2005)). The Polity score is based on the competitiveness of political participation, the openness and competitiveness of executive recruitment, and constraints on the executive. The

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Polity IV project attempts to capture not only outcomes, but also procedural rules. The extent to which this goal is achieved is debated, but even critics of the Polity score argue that it is probably the best of the democracy measures used in the literature (e.g., Glaeser, La Porta, Lopez-de-Silanes, and Shleifer (2004)).

The data show some striking instances of democratic improvement following negative rainfall shocks in sub-Saharan Africa. Madagascar transited from autocracy to free democratic elections following a severe drought in 1990. Droughts also preceded free and competitive elections in Mali in 1992 and the multiparty constitution in Mozambique in 1994. Figure 1 shows the evolution of the Polity score for 10 sub-Saharan African countries where democratic improvement was preceded by droughts, defined as rainfall levels below the 20th percentile (a higher Polity score denotes more democratic institutions). Another interesting aspect of the sub-Saharan African data is that there are twice as many democratic transitions following droughts than following rainfall levels above the 80th percentile.

Our empirical analysis yields a statistically significant link between negative rainfall shocks and subsequent improvements in the Polity score. This continues to be the case when we consider improvements in the Polity subscores for the competitiveness of political participation, the openness and competitiveness of executive recruitment, and constraints on the executive. We also find that negative rainfall shocks lead to a statistically significant increase in the

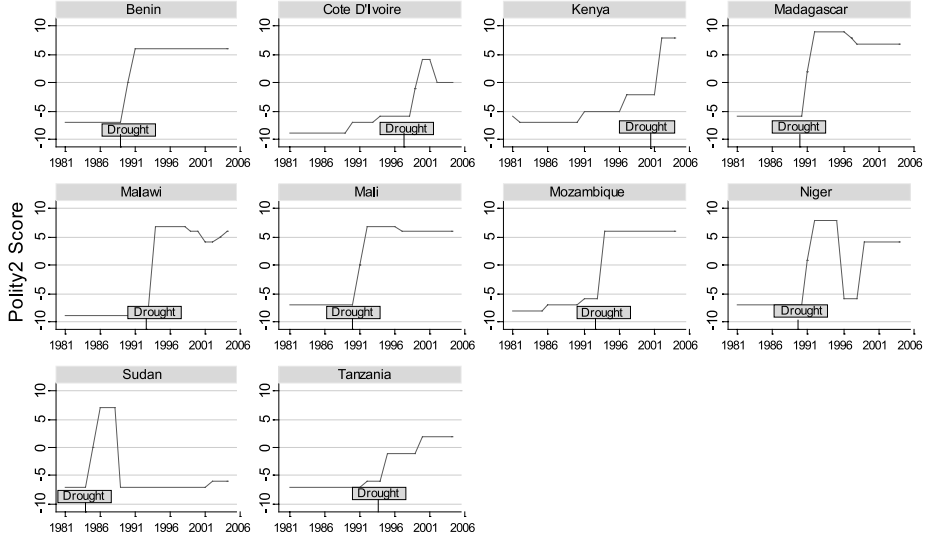

FIGURE 1.—Time series plots of Polity change and drought years. The variable on the *y*-axis is the revised combined Polity IV score; droughts denote years with rainfall below the 20th percentile of the country-specific rainfall distribution.

probability of a democratic transition, defined following Persson and Tabellini (2003), and to a statistically significant increase in the probability of a step toward democracy, defined following Epstein, Bates, Goldstone, Kristensen, and O'Halloran (2006). The democratic improvements experienced by sub-Saharan African countries following negative rainfall shocks are consistent with Acemoglu and Robinson's theory of political transitions as negative rainfall shocks lead to transitory drops in gross domestic product (GDP) in our data.[2]

When citizens' cost of contesting power is proportional to income, as in Acemoglu and Robinson's theory of political transitions, we can push the empirical analysis further and estimate the democratic window-of-opportunity effect of transitory, negative income shocks by using rainfall shocks as an instrument. Our instrumental variables estimates indicate that a transitory negative income shock of 1 percent is followed by an improvement in the Polity score of 0.9 percentage points. The executive constraints score improves by 1 percentage point, the political competition score improves by 0.8 percentage points, and the openness and competitiveness of executive recruitment score improves by 0.9 percentage points. When we consider transitions from autocracy to democracy, we find that a transitory negative income shock of 1 percent increases the probability of a democratic transition by 1.3 percentage points (the unconditional probability of a transition to democracy in our sample is 3.6 percent). These estimates reflect the effect of negative transitory income shocks on democratic improvement under the assumption (exclusion restriction) that rainfall shocks affect democratic change only through their effect on income. This condition would not be satisfied if rainfall had a direct effect on the cost of contesting autocratic rule.[3]

[2]A positive effect of rainfall on the GDP of sub-Saharan African countries also was reported by Benson and Clay (1998), Miguel, Satyanath, and Sergenti (2004), and Barrios, Bertinelli, and Strobl (2010). Benson and Clay reported annual time-series evidence for 6 sub-Saharan African countries between 1970 and 1992, and Miguel, Satyanath, and Sergenti reported annual time-series evidence for 41 sub-Saharan African countries between 1981 and 1999. Our analysis extends the sample further and also differs in that we control for common time effects (shocks affecting all sub-Saharan African countries) and check on the robustness of the rainfall–GDP link. Barrios, Bertinelli, and Strobl examined the effect of rainfall on GDP growth averaged over 5-year periods.

[3]There are at least two plausible scenarios where this could be the case. First, road flooding could make it more costly for citizens to coordinate against autocratic regimes. In this case, negative rainfall shocks could lead to democratic improvement because of their direct (negative) effect on the cost of contesting power or because of their (indirect, negative) effect through income. Hence, direct negative effects of rainfall on the cost of contesting power imply that our instrumental variables estimates cannot be interpreted as the effect of transitory income shocks. But the window-of-opportunity theory of political transitions can still be tested by examining whether negative rainfall shocks lead to democratic improvement (this is true as long as the total—direct plus indirect—effect of negative rainfall shocks is a reduction of the cost of contesting autocratic regimes). Second, there is evidence that droughts lead to rural families sending their young men

If rainfall shocks open a window of opportunity for democratic change because of their effect on income, then rainfall shocks should have a weak effect on democratic change in countries where the effect of rainfall shocks on income is weak because agricultural sectors are small. This is consistent with our finding of a statistically insignificant effect of rainfall shocks on democratic change and on GDP in countries with agricultural GDP shares below the sample median.[4] The result that rainfall shocks have an insignificant effect on democratic change in the sample where they have an insignificant effect on income also suggests that rainfall does not have (strong) direct effects on democratic change.

Our work fits into the empirical literature on the economic determinants of democratic change; see, for example, Przeworski and Limongi (1997), Barro (1999), Przeworski, Alvarez, Cheibub, and Limongi (2000), and Epstein et al. (2006). This literature has found evidence of a positive link between income and democracy, but recent work by Acemoglu, Johnson, Robinson, and Yared (2008, 2009) indicates that this relationship is absent when one focuses on within-country variation using fixed effects specifications (as we do). Our work differs in that we are interested in democratic change following transitory economic shocks. It is for this reason that we rely on rainfall variation as a source of transitory shocks to the aggregate economy. Haggard and Kaufman (1995), Geddes (1999), Berger and Spoerer (2001), and Acemoglu and Robinson (2006) also document democratic improvements following negative economic shocks. Methodologically, our work is related to Paxson (1992), which appears to be the first paper using rainfall shocks to test theoretical implications of transitory economic shocks.[5]

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to urban areas (see Cekan (1993)), which could reduce the (coordination) cost of contesting power.

[4]The average agricultural share in these countries is 18 percent, which is about half the average agricultural share in sub-Saharan Africa. Rainfall has a significantly positive effect on GDP and a significantly negative effect on democratic improvement in countries with agricultural GDP shares above the median.

[5]Paxson's objective is to test the validity of the permanent income hypothesis (see also Fafchamps, Udry, and Czukas (1998)). Miguel, Satyanath, and Sergenti (2004) examine the link between year-to-year rainfall growth, income growth, and civil conflict. Their aim was to reexamine empirical work arguing that civil conflict is caused by low income growth using instrumental variables (for an early contribution to the civil conflict literature, see Collier and Hoeffler (1998)). Burke and Leigh (2010) use a similar approach to estimate the effect of income growth on democratic transitions. Miguel, Satyanath, and Sergenti's approach cannot be used to test the democratic window-of-opportunity theory. This is because the approach tests whether civil conflict outbreak is more likely following years where rainfall turned out to be low compared to rainfall in previous years. What matters for the window-of-opportunity theory is whether rainfall is low compared to expected future rainfall, not compared to past rainfall. The Supplemental Material Appendix (Brückner and Ciccone (2011)) shows that the effect of year-to-year rainfall growth on democratic improvement in sub-Saharan Africa is statistically insignificant, significantly positive, or significantly negative, depending on the measure of democracy used.

Our work also relates to the political sociology literature that examines the determinants of democratization. Lipset (1959) and Huntington (1991) argued that economic recessions lead to autocratic regimes losing legitimacy, which ends up increasing the probability of democratic change. One explanation for the legitimacy loss following recessions could be that recessions are taken as a sign of government incompetence. The often enormous human costs of government incompetence could motivate altruistic individuals to fight for political change even when they expect the private cost of doing so to be high.

The remainder of this paper is organized as follows. Section 2 discusses data and measurement, Section 3 presents the estimation framework and Section 4 presents our results. Section 5 concludes.

2. DATA AND MEASUREMENT

Our main measure of democratic institutions is the revised combined Polity score (Polity2) of the Polity IV data base (Marshall and Jaggers (2005)). This variable combines scores for constraints on the chief executive, the competitiveness of political participation, and the openness and competitiveness of executive recruitment. It ranges from -10 to $+10$, with higher values indicating more democratic institutions. Polity2 is based on the combined Polity score, but is modified for time-series analysis. In particular, changes in the combined Polity score during transition periods are prorated across the span of the transition. Polity IV defines transition periods as periods where new institutions are planned, legally constituted, and put into effect. Democratic and quasi-democratic polities are particularly likely to be preceded by such transition periods (Marshall and Jaggers (2005)). Moreover, Polity2 assigns a score of zero (which Polity IV refers to as neutral) to periods where polities cannot exercise effective authority over at least half of their established territory (Polity IV refers to such periods as interregnum periods).

We perform a separate empirical analysis for the Polity IV subscores for constraints on the chief executive, political competition, and the openness and competitiveness of executive recruitment (Polity IV refers to these variables as concept variables). Constraints on the executive denote a measure of the extent of institutionalized constraints on the decision making powers of chief executives and ranges from 1 to 7, with greater values indicating tighter constraints. Political competition measures the extent to which alternative preferences for policy and leadership can be pursued in the political arena. This indicator ranges from 1 to 10, with greater values denoting more competition. Finally, the openness and competitiveness of executive recruitment measures the extent to which the politically active population has an opportunity to attain the position of chief executive through a regularized process and the degree to which prevailing modes of advancement give subordinates equal opportunities to become superordinates. It ranges from 1 to 8, with greater values indicating more open and competitive executive recruitment. We follow the revised

combined Polity score in prorating changes during a transition period across its span, and we treat interregnum periods as missing values (in contrast to the combined Polity variable, the Polity concept variables do not have a score that Polity IV considers as neutral). To facilitate the comparison of results for Polity2 with those for the Polity concept variables, we present results for a modified version of Polity2 where we drop interregnum periods.

We also examine transitions to democracy. Persson and Tabellini (2003, 2006, 2008) and the Polity IV project consider countries to be democracies if their Polity2 score is strictly positive; other Polity2 scores correspond to nondemocracies. To capture transitions to democracy, we define a year t democratic transition indicator variable for country c that is unity if and only if democratic improvements between t and $t+1$ lead to the country being upgraded to a democracy; if the country already is a democracy at t, the year t indicator is not defined. Transitions away from democracy are defined analogously. The Polity IV project and Epstein et al. (2006) further separate democracies into partial democracies, with Polity2 scores 1–6, and full democracies, with Polity2 scores 7–10. To analyze the effect of rainfall and income shocks on democratic improvement using this classification, we define a year t democratization step indicator variable for country c that is unity if and only if democratic improvements between t and $t+1$ lead to the country being upgraded to a partial or full democracy; if the country already is a full democracy at t, the year t indicator is not defined. We also examine the effect of rainfall shocks on coups d'état in democracies. Polity IV defines coups d'état as a forceful seizure of executive authority and office by a dissident/opposition faction within the country's ruling or political elites that results in a substantial change in the executive leadership and the policies of the prior regime (although not necessarily in the nature of regime authority or mode of governance). We define a coup d'état in democracy indicator variable for year t and country c that is unity if the country is a democracy and there has been a coup, and that is zero if the country is a democracy and there has not been a coup. Our measures of political change are summarized in Table I.

The country–year rainfall estimates come from the National Aeronautics and Space Administration (NASA) Global Precipitation Climatology Project (GPCP). NASA GPCP rainfall estimates are based on data from gauge stations, and microwave, infrared, and sounder data from satellites. Specifically, the NASA GPCP combines special sensor microwave imager emission and scattering algorithms, a geostationary orbital environmental satellite precipitation index, an outgoing long wave precipitation index, information from Tiros operational vertical sounders and National Oceanic and Atmospheric Administration polar orbiting satellites, and measurements from gauge stations to obtain monthly rainfall estimates on a $2.5^\circ \times 2.5^\circ$ latitude–longitude grid. A detailed explanation of how gauge measurements are merged with satellite data

TABLE I

MEASURES OF POLITICAL CHANGE[a]

Variable	Description
ΔPolity2	The t to $t+1$ change in the revised combined Polity score. The maximum range of this variable is from -20 to 20. Positive (negative) values indicate an improvement (deterioration) in democracy. We also analyze the effect on Polity scores after excluding interregnum periods.
ΔExrec	The t to $t+1$ change in the executive recruitment concept (Polity IV) score. The maximum range of this variable is from -7 to 7. Positive (negative) values indicate an improvement (deterioration) in the executive recruitment concept.
ΔPolcomp	The t to $t+1$ change in the political competition concept (Polity IV) score. The maximum range of this variable is from -9 to 9. Positive (negative) values indicate an improvement (deterioration) in the political competition concept.
ΔExconst	The t to $t+1$ change in the executive constraint concept (Polity IV) score. The maximum range of this variable is from -5 to 5. Positive (negative) values indicate an improvement (deterioration) in the executive constraint concept.
Democratic transition	Indicator variable that is equal to unity in year t if and only if the country is a democracy in $t+1$ but a nondemocracy in t (the year t indicator is not defined if the country is a democracy in t).
Democratization step	Indicator variable that is equal to unity in year t if and only if the country is upgraded to either a partial or full democracy between t and $t+1$ (the year t indicator is not defined if the country is a full democracy in t).
Autocratic transition	Indicator variable that is equal to unity in year t if and only if the country is a nondemocracy in $t+1$ but a democracy in t (the year t indicator is not defined if the country is a nondemocracy in t).
Coup in democracy	Indicator variable that is unity if and only if in period t there was a coup d'état in countries that have strictly positive Polity2 scores (democracies).

[a]Source: Polity IV data base (Marshall and Jaggers (2005)).

is provided in Adler et al. (2003).[6] In comparison to rainfall estimates based exclusively on gauge measurements, there are two main advantages of the GPCP estimates. First, the GPCP rainfall estimates are less likely to suffer from classical measurement error due to the sparseness of operating gauge stations in sub-Saharan African countries (especially after 1990).[7] Moreover, the num-

[6]The data are available at http://precip.gsfc.nasa.gov. For a validation study of the GPCP satellite-based rainfall data, see Nicholson et al. (2003).

[7]Matsuura and Willmott (2007) provided gauge-based rainfall estimates for a large part of the world and a long time period. The spatial gauge density underlying their rainfall estimates

TABLE II

DESCRIPTIVE STATISTICS[a]

Variable	Mean	Std. Dev.	Observations
ΔPolity2	0.249	2.097	955
ΔExrec	0.083	0.763	902
ΔPolcomp	0.183	1.007	902
ΔExconst	0.071	0.700	902
Democratic transition indicator	0.036	0.186	700
Democratization step indicator	0.035	0.183	867
Autocratic transition indicator	0.055	0.238	255
Coup in democracy indicator	0.106	0.308	255
Real per capita GDP	1585.14	1732.38	955
Rainfall (mm per year)	980.39	501.41	955

[a]See Table I for detailed definitions of the measures of political change.

ber of operating gauge stations in a country may be affected by socioeconomic conditions, which could lead to nonclassical measurement error in rainfall estimates. Such errors are less of a concern for GPCP rainfall estimates than rainfall estimates based exclusively on gauge measurements.[8] GPCP rainfall estimates are available from 1979 onward.

Our measure of per capita income is real per capita GDP from the Penn World Tables 6.2 (Heston, Summers, and Aten (2006)), which are available up to 2004. Table II contains summary statistics for key data.

3. ESTIMATION FRAMEWORK

To estimate the effect of country-specific rainfall shocks on income, we relate log income per capita in country c at time t ($\log y_{c,t}$) to a country-specific fixed effect plus time trend ($\alpha_c + \beta_c t$), time-varying shocks that affect all sub-Saharan African countries (ϕ_t), and country-specific rainfall levels ($\log \text{Rain}_{c,t}$),

$$\log y_{c,t} = \alpha_c + \beta_c t + \phi_t + \gamma \log \text{Rain}_{c,t} + \theta \log \text{Rain}_{c,t-1} + v_{c,t}, \quad (1)$$

for sub-Saharan African countries appears to be relatively good for the 1960s and 1970s, but declines thereafter. For example, while the average number of gauge stations per country was 40 in the 1960s, the average drops to 32 in the 1980s, 18 in the 1990s, and 8 after 2000. As a result, gauge coverage after 1990 appears to be unsatisfactory according to the criteria of the World Meteorological Organization (1985) and Rudolf, Hauschild, Rüth, and Schneider (1994).

[8]For example, a regression of the Matsuura and Willmott rainfall estimates on lagged per capita GDP, country-specific fixed effects plus time trends, and common time effects yields a statistically significant, negative effect of lagged income on rainfall for the 1980–2004 period we focus on (lagged per capita GDP also has a significant effect on the number of reporting gauges in the Matsuura and Willmott data set). By contrast, lagged GDP has no significant effect on GPCP rainfall.

where v is a disturbance term. The parameter γ captures the contemporaneous effect of country-specific rainfall shocks on income, while θ captures the lagged effect. The inclusion of lagged effects allows us to examine how quickly the effect of rainfall peters out.

To examine the effect of rainfall shocks on democratic change, we maintain the right-hand-side explanatory variables of (1) but use measures of democratic change on the left-hand side. Our main measure of democratic change is the change in the Polity2 score between t and $t+1$, $\Delta D_{c,t} = D_{c,t+1} - D_{c,t}$, where $D_{c,t}$ refers to the year t Polity2 score of country c. In this case, the estimating equation becomes

$$\Delta D_{c,t} = a_c + b_c t + f_t + c \log \text{Rain}_{c,t} + d \log \text{Rain}_{c,t-1} + e_{c,t}, \tag{2}$$

where e is a disturbance term. We use the same estimating equation to examine the effect of rainfall shocks on the change in each of the three Polity concept variables and on the indicator variables for transition to democracy and step toward democracy.[9] Moreover, (2) is the basis for our analysis of the effect of rainfall shocks on transitions away from democracy and coups d'état in democracies.

Under the assumption that rainfall shocks affect democratic change only through income, we can estimate the effect of transitory income shocks on democratic institutions using an instrumental variables approach. Our analysis of the effect of income shocks on democratic change uses two specifications. The first controls for log income, country-specific fixed effects plus time trends, and common time effects, while the second specification replaces log income by a country-specific recession indicator. This indicator is unity if and only if income in a country falls below its trend for reasons other than shocks affecting all sub-Saharan African countries. Specifically, we first estimate

$$\log y_{c,t} = \alpha_c + \beta_c t + \phi_t + \eta_{c,t}, \tag{3}$$

where η is a disturbance term, using least squares. Then we define a country-specific recession indicator that is unity if $\log y_{c,t}$ is below the predicted value $\hat{\alpha}_c + \hat{\beta}_c t + \hat{\phi}_t$ and is zero otherwise.

[9] We use linear specifications because probit and (unconditional) logit with fixed effects yield inconsistent slope estimates due to the incidental parameter problem (Greene (2003)). Consistent slope estimates can be obtained using conditional fixed effects logit, which yields qualitatively and statistically the same results as the corresponding linear probability model (the magnitude of estimates cannot be compared without knowing the distribution of fixed effects; see Wooldridge (2002)). The main drawback of conditional fixed effects logit is that estimates do not converge when we include country-specific time trends and common time effects (this is a general problem associated with maximum likelihood estimation of many coefficients in nonlinear models; see, for instance, Greene (2004)).

4. EMPIRICAL RESULTS

Table III, column 1 shows our estimates of the effect of rainfall shocks on the change in the Polity2 score using equation (2). We report least squares estimates and Huber robust standard errors clustered at the country level (in parentheses). All our results refer to the 1980–2004 period.[10] The estimates indicate that negative rainfall shocks at $t-1$ are followed by statistically significant democratic improvement. In particular, 10 percent lower rainfall levels lead to an improvement of 0.146 points in the Polity2 score, and the effect is statistically significant at the 95 percent confidence level. Given the [−10, 10] range of Polity2, a 0.146 point increase corresponds to an improvement of 0.73 percentage points.

Table III, column 2 estimates the same specification as column 1 but codes interregnum years as missing observations (which is why the number of observations drops to 902) to make the results more readily comparable with our analysis for Polity subscores in columns 3–5. This yields an effect of $t-1$ rainfall shocks that is stronger both quantitatively and statistically than in column 1.

Table III, columns 3–5 estimate the effect of rainfall shocks on the change in the Polity subscores for constraints on the executive, political competition, and the openness and competitiveness of executive recruitment. The results show that negative $t-1$ rainfall shocks lead to significant democratic improvement

TABLE III

RAINFALL AND POLITY CHANGE[a]

	ΔPolity2		ΔExconst	ΔPolcomp	ΔExrec
	(1)	(2)	(3)	(4)	(5)
Log rainfall, t	0.261	0.031	0.093	−0.153	0.091
	(0.347)	(0.381)	(0.111)	(0.152)	(0.171)
Log rainfall, $t-1$	−1.461**	−1.660**	−0.459*	−0.578**	−0.485**
	(0.723)	(0.740)	(0.256)	(0.286)	(0.244)
Country fixed effect	Yes	Yes	Yes	Yes	Yes
Country time trend	Yes	Yes	Yes	Yes	Yes
Common time effect	Yes	Yes	Yes	Yes	Yes
Observations	955	902	902	902	902

[a]The method of estimation is least squares; Huber robust standard errors (in parentheses) are clustered at the country level. The dependent variable in columns 1 and 2 is the t to $t+1$ change in the revised combined Polity score (Polity2); column 2 excludes observations that correspond to interregnum periods. The dependent variable in columns 3–5 is the t to $t+1$ change in Polity IV subscores that reflect changes in a country's constraints on the executive (Exconst), political competition (Polcomp), and executive recruitment (Exrec). The range of the dependent variables is as follows: Polity2 [−10, 10], Exconst [1, 7], Polcomp [1, 10], and Exrec [1, 8]. *Significantly different from zero at 90 percent confidence; **95 percent confidence; ***99 percent confidence.

[10]The first Polity2 observation used corresponds to 1980, but the first rainfall observation corresponds to 1979 (the starting date of the rainfall data), as our specifications include rainfall levels at t and $t-1$.

in all three dimensions. Ten percent lower rainfall levels result in an increase of 0.046 points in the executive constraints score, and the effect is statistically significant at the 90 percent confidence level. As this score has a [1, 7] range, a 0.046 point increase amounts to a tightening of executive constraints by 0.77 percentage points. The political competition and executive recruitment scores increase by 0.058 and 0.049 points, respectively, and both effects are statistically significant at the 95 percent confidence level. These changes amount to improvements of 0.64 and 0.69 percentage points, respectively, as political competition has a [1, 10] range and executive recruitment has a [1, 8] range.

Table IV contains our estimates of the effect of rainfall on GDP per capita and the probability of a country-specific recession. Column 1 estimates the effect of contemporaneous rainfall shocks on GDP per capita using equation (1). Our results indicate that 10 percent lower rainfall levels lead to a 0.79 percent drop in income per capita, and that the effect is statistically significant at the 99 percent confidence level. Columns 2 and 3 augment the specification in column 1 by lagged rainfall levels.[11] Column 2 shows that rainfall at $t-1$ has a statistically insignificant effect on GDP at t. Column 3 includes rainfall at $t-2$ as an additional control and finds that the effect is also statistically insignificant. Hence, the main effect of rainfall shocks on income per capita is contemporaneous. Combined with our finding in Table III, where rainfall shocks took 1 year to translate into political change, this suggests that political change follows income shocks with a 1 year lag. Acemoglu and Robinson's (2001) theory of political transitions would have predicted a contemporaneous impact, but the discrepancy seems small given the difficulties in dating political changes precisely. In Table IV, column 4, we check whether the contemporaneous effect of rainfall shocks depends on countries' Polity2 score, but find the interaction effect to be statistically insignificant.

Table IV, columns 5–8 consider the effect of rainfall shocks on the country-specific recession indicator. In column 5, we find that 10 percent lower rainfall levels raise the probability of a recession by 3.9 percentage points, and that the effect is statistically significant at the 99 percent confidence level. Columns 6 and 7 show that the effect of lagged rainfall levels is statistically insignificant, and column 8 shows that the contemporaneous effect of rainfall shocks does not vary significantly with countries' Polity2 score.

[11]The Supplemental Material Appendix contains a series of robustness checks. In particular, we reestimate the effect of rainfall on income using rainfall levels rather than log levels, examine the relationship in first differences rather than levels, control for temperature, check for nonlinearities, drop the top 1 percent rainfall observations, account for potential spatial correlation of rainfall, and use a variety of different approaches to calculate standard errors. We also use the Matsuura and Willmott (2007) rainfall data and find a statistically significant effect of rainfall shocks on income for (pre-1990) periods where spatial gauge density is relatively good; see footnote 7. The Matsuura and Willmott rainfall estimates do not yield a significant effect of rainfall on income for the 1980–2004 period we focus on, however. We think that this is most likely due to the unsatisfactory gauge density in the second half of this period.

TABLE IV

RAINFALL, PER CAPITA GDP, AND COUNTRY-SPECIFIC RECESSIONS[a]

	Log GDP				Country Specific Recession			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log rainfall, t	0.079***	0.075***	0.076***	0.082***	−0.399***	−0.382***	−0.383***	−0.376**
	(0.029)	(0.026)	(0.027)	(0.030)	(0.140)	(0.127)	(0.130)	(0.154)
Log rainfall, $t-1$		0.048	0.046			−0.191	−0.189	
		(0.032)	(0.029)			(0.139)	(0.125)	
Log rainfall, $t-2$			0.010				−0.018	
			(0.035)				(0.147)	
Log rainfall, t*Polity2, t				0.001				0.005
				(0.003)				(0.013)
Polity2, t				−0.002				−0.048
				(0.021)				(0.091)
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Common time effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	955	955	955	955	955	955	955	955

[a]The method of estimation is least squares; Huber robust standard errors (in parentheses) are clustered at the country level. The dependent variable in columns 1–4 is log real per capita GDP (PWT 6.2). The dependent variable in columns 5–8 is an indicator variable (Country-Specific Recession) that is unity if and only if per capita GDP falls below the country-specific time trend for reasons other than shocks affecting all sub-Saharan countries (see equation (3)). *Significantly different from zero at 90 percent confidence; **95 percent confidence; ***99 percent confidence.

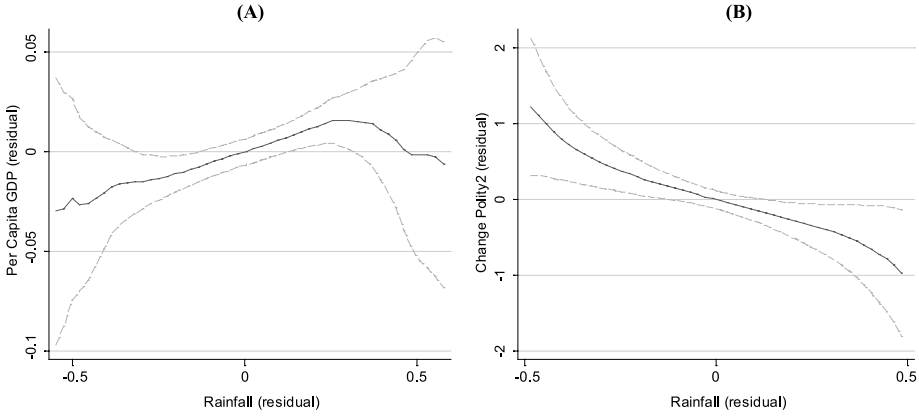

FIGURE 2.—(A) Rainfall and per capita GDP. (B) Rainfall and Polity change. Nonparametric local polynomial estimates are computed using an Epanechnikov kernel. The bandwidth in (A) is 0.1 and in (B) 0.25 as suggested by cross-validation criteria. Dashed lines indicate 95 percent confidence bands.

To check whether our (linear) specifications miss important aspects of the data, we reestimate the effect of rainfall shocks on per capita GDP and the change in Polity2 using nonparametric local polynomial estimators. Figure 2(A) presents nonparametric local polynomial estimates of the effect of rainfall on GDP.[12] We use an Epanechnikov kernel and select the bandwidth as suggested by cross-validation criteria.[13] It turns out that the relationship is monotonically increasing except for large positive rainfall shocks, where the relationship is estimated to be hump-shaped.[14] The hump is very imprecisely estimated however, because less than 1 percent of rainfall observations are to the right of its peak.[15] (Reestimating equations (1) and (2) after dropping the top 1 percent of rainfall observations yields results that are slightly stronger statistically; see the Supplemental Material Appendix.) Figure 2(B) uses the same approach to obtain nonparametric local polynomial estimates of the effect of rainfall shocks on the change in the Polity2 score. This relationship is monotonically decreasing over the whole range.

[12]Estimation proceeds in two steps. In the first step, we regress log income per capita and log rainfall on country-specific fixed effects plus time trends and common time effects. Then we take the residuals from these two regressions and use the nonparametric local polynomial estimator to examine the relationship between rainfall and per capita income.

[13]See Bowman and Azzalini (1997). Intuitively, cross-validation amounts to choosing the bandwidth to minimize the mean-square error.

[14]We also present nonparametric local polynomial estimates using half and twice the bandwidth recommended by cross-validation in the Supplemental Material Appendix.

[15]The Supplemental Material Appendix tests for nonlinearities by including dummy variables for rainfall levels above or below certain percentiles. These dummy variables turn out to have small and statistically insignificant effects, while the linear effect remains statistically significant.

TABLE V

INCOME SHOCKS AND POLITY CHANGE[a]

	ΔPolity2				ΔExconst	ΔPolcomp	ΔExrec
	(1) 2SLS	(2) 2SLS	(3) LS	(4) LS	(5) 2SLS	(6) 2SLS	(7) 2SLS
Log GDP, $t-1$	−18.021**	−21.410**	−0.045	−0.836	−5.809*	−7.680**	−6.137*
	[0.049]	[0.026]	(0.348)	(0.564)	[0.073]	[0.037]	[0.054]
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Common time effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	955	902	3191	955	902	902	902
	First Stage for Log GDP per capita, $t-1$						
Log rainfall, $t-1$	0.079***	0.077***			0.077***	0.077***	0.077***
	(0.029)	(0.029)			(0.029)	(0.029)	(0.029)
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Common time effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	955	902	3191	955	902	902	902

[a]The method of estimation for the first-stage regressions in the bottom panel is least squares; below the least squares estimates, we report Huber robust standard errors (in parentheses) that are clustered at the country level. The method of estimation used in the top panel is two-stage least squares in columns 1 and 2 and 5–7; below the two-stage least squares estimates, we report p-values [in square brackets] based on the Anderson–Rubin test of statistical significance. A key property of this test is that it is robust to weak instruments; 2SLS standard errors are not robust to weak instruments, and inference based on 2SLS standard errors can be very misleading as a result. See Andrews and Stock (2005) for a review of these issues. We implement a version of the Anderson–Rubin test that is robust to heteroskedasticity and arbitrary within-country correlation of the residuals. For comparison with the two-stage least squares estimates, the top panel also reports least squares estimates for the world sample (in column 3) and the sub-Saharan African sample (in column 4) with standard errors that are robust to heteroskedasticity and arbitrary within-country correlation below the estimates. The dependent variable in the top panel, columns 1–4 is the t to $t+1$ change in the revised combined Polity score (Polity2); column 2 excludes observations that correspond to interregnum periods. The dependent variable in the top panel, columns 5–7 is the t to $t+1$ change in Polity IV subscores of constraints on the executive (Exconst), political competition (Polcomp), and executive recruitment (Exrec). The range of the dependent variables is as follows: Polity2 [−10, 10], Exconst [1, 7], Polcomp [1, 10], and Exrec [1, 8]. The dependent variable in the bottom panel is the log of real per capita GDP. *Significantly different from zero at 90 percent confidence; **95 percent confidence; ***99 percent confidence.

Table V presents two-stage least squares (2SLS) estimates of the effect of transitory income shocks on the change in the Polity2 score. These estimates assume that the effect of $t-1$ rainfall shocks on democratic change documented in Table III is through income.[16] The top panel of Table V contains

[16]In the Supplemental Material Appendix, we examine whether the effect of rainfall shocks on democratic change could be through government expenditures, military expenditures, or consumer prices (rather than GDP per capita). Our analysis does not yield a statistically significant effect of rainfall shocks on these variables. In the case of military expenditures, this could be because limited data force us to work with a quite reduced subsample (interestingly, however, we do find a statistically significant effect of rainfall on GDP per capita and democratic change in this subsample).

estimates of the effect of log income per capita on democratic change, while the bottom panel presents first-stage effects (when applicable). The result in column 1 indicates that a transitory 1 percent negative income shock at $t-1$ leads to an improvement in the Polity2 score of 0.18 points.[17] This effect is statistically significant at the 95 percent confidence level and amounts to an increase of 0.9 percentage points given the $[-10, 10]$ range of the score.[18] In column 2 we drop interregnum periods. The effect continues to be statistically significant at the 95 percent confidence level and is somewhat larger in absolute value than in column 1.[19]

For comparison, we show the results using least squares for the world sample (the largest possible sample for 1980–2004) and sub-Saharan Africa in columns 3 and 4, respectively. The least squares estimates have the same sign as the 2SLS estimates, but are much smaller in absolute value and statistically insignificant. For example, in the world sample, a negative income shock of 1 percent leads to an improvement in Polity2 scores of less than 0.01 of a percentage point. For sub-Saharan Africa, the effect is less than 0.05 of a percentage point.[20] Our finding that 2SLS estimation yields a stronger negative effect of income shocks on democratic improvements than least squares estimation is most likely explained by the combination of three factors.[21] First, the window-of-opportunity theory of political transitions stresses transitory economic shocks; permanent shocks change the balance of power permanently and will therefore allow citizens to demand and obtain policy concessions in the future even in the absence of democratic reforms. When we instrument income shocks using rainfall shocks, we isolate transitory income shocks. Hence, the stronger negative effect obtained using 2SLS in column 1 compared to using least squares in column 4 is consistent with theory. Second, the income estimates in the Penn World Tables contain a substantial amount of noise, especially for sub-Saharan African countries (e.g., Heston (1994), Deaton (2005)). Classical measurement error would affect our least squares estimate in column 4, but not our instrumental variables estimate in column 1 as long as

[17]In Table V, the p-values in square brackets below 2SLS estimates are based on the Anderson–Rubin test of statistical significance. A key property of this test is robustness to weak instruments. 2SLS standard errors, on the other hand, are not robust to weak instruments, and inference based on 2SLS standard errors can be very misleading as a result. See Andrews and Stock (2005) for a review of these issues. The power properties of the Anderson–Rubin test are also good (it is a uniformly most powerful unbiased test under certain conditions). We implement a version of the Anderson–Rubin test that is robust to heteroskedasticity and arbitrary within-country correlation of the residuals.

[18]In the Supplemental Material Appendix, we show that the effect of year t income shocks is statistically insignificant.

[19]In the Supplemental Material Appendix, we show that results are similar when we measure democratic institutions using the Freedom House (2007) political rights indicator.

[20]A formal test yields that there is no statistically significant difference between the results for the world sample and for sub-Saharan Africa.

[21]In Table V, a Hausman test rejects the equality of the least squares estimate in column 4 and the 2SLS estimate in column 1 at the 90 percent confidence level.

noise in income estimates is uncorrelated with noise in rainfall estimates. Classical measurement error could therefore lead to the least squares estimate in column 4 being attenuated relative to the instrumental variables estimate in column 1. A third reason why the least squares estimate is larger than the instrumental variables estimate could be that democratic reforms are partly anticipated, and that this leads to increases in income before reforms are actually in place. This would bias the least squares estimate upward but leave the instrumental variables estimate unaffected.

Table VI uses the country-specific recession indicator to examine democratic change following recessions. The top panel presents our estimates of the effect of recessions on democratic change, while the bottom panel presents first-stage

TABLE VI

COUNTRY-SPECIFIC RECESSIONS AND POLITY CHANGE[a]

	ΔPolity2				ΔExconst	ΔPolcomp	ΔExrec
	(1) 2SLS	(2) 2SLS	(3) LS	(4) LS	(5) 2SLS	(6) 2SLS	(7) 2SLS
Country-specific recession, $t-1$	3.584**	4.166**	−0.085	0.199*	1.130*	1.494**	1.194*
	[0.049]	[0.026]	(0.059)	(0.115)	[0.073]	[0.037]	[0.054]
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Common time effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	955	902	3191	955	902	902	902
	First Stage for Country-Specific Recession, $t-1$						
Log rainfall, $t-1$	−0.399***	−0.398***			−0.398***	−0.398***	−0.398***
	(0.140)	(0.141)			(0.141)	(0.141)	(0.141)
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Common time effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	955	902	3191	955	902	902	902

[a]The method of estimation for the first-stage regressions in the bottom panel is least squares; below the least squares estimates, we report Huber robust standard errors (in parentheses) that are clustered at the country level. The method of estimation used in the top panel is two-stage least squares in columns 1 and 2 and 5–7; below the two-stage least squares estimates, we report p-values [in square brackets] based on the Anderson–Rubin test of statistical significance. A key property of this test is that it is robust to weak instruments; 2SLS standard errors are not robust to weak instruments, and inference based on 2SLS standard errors can be very misleading as a result. See Andrews and Stock (2005) for a review of these issues. We implement a version of the Anderson–Rubin test that is robust to heteroskedasticity and arbitrary within-country correlation of the residuals. For comparison with the two-stage least squares estimates, the top panel also reports least squares estimates for the world sample (in column 3) and the sub-Saharan African sample (in column 4) with standard errors that are robust to heteroskedasticity and arbitrary within-country correlation below the estimates. The dependent variable in the top panel, columns 1–4 is the t to $t+1$ change in the revised combined Polity score (Polity2); column 2 excludes observations that correspond to interregnum periods. The dependent variable in the top panel, columns 5–7 is the t to $t+1$ change in Polity IV subscores of constraints on the executive (Exconst), political competition (Polcomp), and executive recruitment (Exrec). The range of the dependent variables is as follows: Polity2 [−10, 10], Exconst [1, 7], Polcomp [1, 10], and Exrec [1, 8]. The dependent variable in the bottom panel is a country specific recession indicator that is unity if and only if per capita GDP falls below the country-specific time trend for reasons other than shocks affecting all sub-Saharan countries (see equation (3)). *Significantly different from zero at 90 percent confidence; **95 percent confidence; ***99 percent confidence.

effects (when applicable). Columns 1 and 2 measure democratic change using the Polity2 score. The 2SLS estimates in column 1 imply that recessions increase the Polity2 score by 18 percentage points and that the effect is statistically significant at the 95 percent confidence level. The effect is somewhat stronger statistically and quantitatively when we exclude interregnum periods in column 2. Columns 3 and 4 show that least squares estimates of the effect of recessions on Polity2 are much smaller than 2SLS estimates, whether we consider the world sample in column 3 or sub-Saharan Africa in column 4. Columns 5–7 indicate that recessions also lead to statistically significant improvements in the Polity subscores. Our 2SLS estimates imply that the score for executive constraints improves by 19 percentage points, while the scores for political competition and for the openness and competitiveness of executive recruitment both improve by 17 percentage points.

Table VII augments our baseline estimating equations by including the lagged Polity2 score as an additional control. Columns 1 and 2 use the augmented specifications to reexamine the effect of rainfall shocks on the change in the Polity2 score. Column 1 contains least squares results, while column 2 contains system–generalized method of moment (GMM) estimates (Blundell and Bond (1998)). Both show an effect of $t-1$ rainfall shocks that is very similar to our baseline result in column 1 of Table III. Columns 3 and 4 of Table VII contain 2SLS estimates of the effect of income shocks on the change in the Polity2 score, and columns 5–8 add further Polity2 lags on the right-hand side of the estimating equation. Results are again very similar to our baseline estimates.[22]

Table VIII, column 1 shows the effect of rainfall shocks on the probability of democratization using the Persson and Tabellini (2003, 2006, 2008) and Polity IV project definition of democracy. Our results indicate that negative $t-1$ rainfall shocks lead to an increase in the probability of a transition to democracy between t and $t+1$, and that the effect is statistically significant at the 95 percent confidence level. The point estimate implies that 10 percent lower rainfall levels increase the probability of a democratic transition by 1.25 percentage points.[23] Column 2 repeats the analysis using the democratization step indicator based on the Epstein et al. (2006) and Polity IV trichotomous classification of polities. This yields that 10 percent lower rainfall levels raise the probability of a step toward democracy by 1.4 percentage points and that the effect is statistically significant at the 95 percent confidence level.

Columns 3 and 4 of Table VIII estimate the effect of rainfall shocks on the probability of transitions away from democracy (autocratic transitions) and

[22]In the Supplemental Material Appendix, we show that results are very similar when we put the Polity2 level (instead of the Polity2 change) on the left-hand side of these estimating equations.

[23]In an earlier working paper version (see Brückner and Ciccone (2008)), we showed that negative rainfall shocks also have a significantly positive effect on the probability of a transition to democracy when using the Przeworski et al. (2000) democracy indicator.

TABLE VII

INCOME SHOCKS, POLITY CHANGE, AND DEMOCRATIC CONVERGENCE[a]

	ΔPolity2							
	(1) LS	(2) SYS-GMM	(3) 2SLS	(4) 2SLS	(5) LS	(6) SYS-GMM	(7) 2SLS	(8) 2SLS
Polity2, t	−0.294***	−0.293***	−0.282***	−0.286***	−0.174***	−0.175***	−0.199***	−0.215***
	(0.023)	(0.023)	(0.043)	(0.036)	(0.034)	(0.034)	(0.040)	(0.043)
Polity2, $t-1$					−0.171***	−0.171***	−0.120**	−0.102*
					(0.025)	(0.025)	(0.052)	(0.055)
Log rainfall, t	0.213	0.227			0.169	0.142		
	(0.317)	(0.324)			(0.296)	(0.318)		
Log rainfall, $t-1$	−1.404**	−1.562**			−1.403**	−1.581**		
	(0.690)	(0.692)			(0.661)	(0.690)		
Log GDP, $t-1$			−17.360**				−17.416**	
			[0.046]				[0.036]	
Country-specific recession, $t-1$				3.450**				3.460**
				[0.046]				[0.036]
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Common time effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	955	955	955	955	955	955	955	955

[a]The method of estimation in columns 1 and 5 is least squares, in columns 2 and 6 is system–GMM, and in columns 3, 4, 7, and 8 is two-stage least squares; below the least squares estimates, we report Huber robust standard errors (in parentheses) that are clustered at the country level; below the two-stage least squares estimates, we report p-values [in square brackets] based on the Anderson–Rubin test of statistical significance. A key property of this test is that it is robust to weak instruments; 2SLS standard errors are not robust to weak instruments, and inference based on 2SLS standard errors can be very misleading as a result. See Andrews and Stock (2005) for a review of these issues. We implement a version of the Anderson–Rubin test that is robust to heteroskedasticity and arbitrary within-country correlation of the residuals. The dependent variable is the t to $t+1$ change in the revised combined Polity score (Polity2). The instrumental variable in columns 3 and 4 and 7 and 8 is rainfall. Country-specific recession is an indicator variable that takes on the value of unity if and only if per capita GDP falls below the country-specific time trend for reasons other than shocks affecting all sub-Saharan countries (see equation (3)). *Significantly different from zero at 90 percent confidence; **95 percent confidence; ***99 percent confidence.

TABLE VIII

RAINFALL AND POLITY TRANSITIONS[a]

	Democratic Transition (1)	Democratization Step (2)	Autocratic Transition (3)	Coup in Democracy (4)
Log rainfall, t	0.027	0.016	−0.021	−0.005
	(0.034)	(0.027)	(0.048)	(0.089)
Log rainfall, $t-1$	−0.125**	−0.140**	0.169	−0.003
	(0.057)	(0.064)	(0.113)	(0.115)
Country fixed effect	Yes	Yes	Yes	Yes
Country time trend	Yes	Yes	Yes	Yes
Common time effect	Yes	Yes	Yes	Yes
Observations	700	867	255	255

[a]The method of estimation is least squares; Huber robust standard errors (in parentheses) are clustered at the country level. The dependent variable in column 1 is a democratic transition indicator that is equal to unity in year t if and only if the country is a democracy in $t+1$ but a nondemocracy in t (the year t indicator is not defined if the country is a democracy in t). The dependent variable in column 2 is a democratization step indicator that is equal to unity in year t if and only if the country is upgraded to either a partial or full democracy between t and $t+1$ (the year t indicator is not defined if the country is a full democracy in t). The dependent variable in column 3 is an autocratic transition indicator that is equal to unity in year t if and only if the country is a nondemocracy in $t+1$ but a democracy in t (the year t indicator is not defined if the country is a nondemocracy in t). The dependent variable in column 4 is the incidence of a coup in African countries that were democracies. Coup data are taken from Polity IV, where a coup is defined as a forceful seizure of executive authority and office by a dissident/opposition faction within the country's ruling or political elites that results in a substantial change in the executive leadership and the policies of the prior regime. For further detail on the coding of the dependent variables, see the main text. *Significantly different from zero at 90 percent confidence; **95 percent confidence; ***99 percent confidence.

coups d'état in democracies. The estimates in column 3 indicate that autocratic transitions are more likely following positive $t-1$ rainfall shocks. The effect of rainfall shocks is actually larger in absolute value than for democratic transitions in column 1, but very imprecisely estimated and therefore statistically insignificant. For coups d'état in democracies, the effect of rainfall shocks is small and statistically insignificant.[24]

Table IX, columns 1–3 summarize our findings on the effect of income shocks on transitions to democracy. The least squares effect of income shocks on democratic transitions is very small and statistically insignificant. The effect also turns out to have the wrong sign from the point of view of the democratic window-of-opportunity theory (it implies that negative income shocks decrease the probability of a democratic transition). But the 2SLS estimate in column 2 indicates that negative income shocks lead to an increase in the probability of a democratic transition and that the effect is statistically significant at the 95 percent confidence level. The point estimate implies that a transitory negative

[24]The sample of autocratic transitions and coups d'état in democracies is much smaller than the sample of democratic transitions. It is also interesting to note that Acemoglu and Robinson's (2001) theory of political transitions is consistent with negative economic shocks leading to democratic transitions but not to democratic reversals.

TABLE IX

INCOME SHOCKS AND TRANSITIONS TO DEMOCRACY[a]

	Democratic Transition			Democratization Step		
	(1) LS	(2) 2SLS	(3) 2SLS	(4) LS	(5) 2SLS	(6) 2SLS
Log GDP, $t-1$	0.056	−1.285**		−0.053	−1.471**	
	(0.058)	[0.027]		(0.051)	[0.029]	
Country specific recession, $t-1$			0.235**			0.279**
			[0.027]			[0.029]
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Country time trend	Yes	Yes	Yes	Yes	Yes	Yes
Common time effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	700	700	700	867	867	867
First Stage for Log GDP per capita/Country Specific Recession, $t-1$						
Log rainfall, $t-1$		0.095***	−0.519***		0.094***	−0.494***
		(0.037)	(0.164)		(0.032)	(0.151)
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Country time trend	Yes	Yes	Yes	Yes	Yes	Yes
Common time effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	700	700	700	867	867	867

[a]The method of estimation in columns 1 and 4 is least squares and columns 2, 3, 5, and 6 is two-stage least squares; below the least squares estimates, we report Huber robust standard errors (in parentheses) that are clustered at the country level; below the two-stage least squares estimates, we report p-values [in square brackets] based on the Anderson–Rubin test of statistical significance. A key property of this test is that it is robust to weak instruments; 2SLS standard errors are not robust to weak instruments, and inference based on 2SLS standard errors can be very misleading as a result. See Andrews and Stock (2005) for a review of these issues. We implement a version of the Anderson–Rubin test that is robust to heteroskedasticity and arbitrary within-country correlation of the residuals. The dependent variable in columns 1–3 is a democratic transition indicator that is equal to unity in year t if and only if the country is a democracy in $t+1$ but a nondemocracy in t (the year t indicator is not defined if the country is a democracy in t). The dependent variable in columns 4–6 is a democratization step indicator that is equal to unity in year t if and only if the country is upgraded to either a partial or full democracy between t and $t+1$ (the year t indicator is not defined if the country is a full democracy in t). For further detail on the coding of the dependent variables, see the main text. Country specific recession is an indicator variable that is unity if and only if per capita GDP falls below the country-specific time trend for reasons other than shocks affecting all sub-Saharan countries (see equation (3)). *Significantly different from zero at 90 percent confidence; **95 percent confidence; ***99 percent confidence.

income shock of 1 percent increases the probability of democratization by 1.3 percentage points. Column 3 shows that following recessions, the probability of a democratic transition increases by 23.5 percentage points and that the effect is statistically significant at the 95 percent confidence level.[25]

[25]Bratton and van de Walle (1997) discussed democratic transitions in Africa over the 1988–1994 period and argued that transitions are largely explained by domestic political forces rather than by domestic economic conditions. Our results indicate that country-specific economic factors did play a role over the 1980–2004 period (there are too few transitions for the 1988–1994 period for statistical analysis).

The results for the democratization step indicator in Table IX, columns 4–6, are similar to the results for democratic transitions. Least squares estimation in column 4 yields a very small and statistically insignificant effect. But 2SLS estimation in columns 5 and 6 yields a statistically significant increase in the probability of a step toward democracy following negative income shocks. For example, according to column 5, a transitory negative income shock of 1 percent increases the probability of a step toward democracy by 1.5 percentage points, and the effect is statistically significant at the 95 percent confidence level. Column 6 indicates that a step toward democracy is 27.9 percentage points more likely following a recession and that this effect is also statistically significant at the 95 percent confidence level.

Our interpretation of the effect of rainfall shocks on democratic change is that a negative rainfall shock opens a window of opportunity for democratic improvement because it translates into a transitory negative GDP shock and hence a lower opportunity cost of contesting power. If this interpretation is correct, the effect of rainfall shocks on democratic change should be absent in countries where rainfall shocks do not affect GDP. Moreover, if rainfall shocks affect GDP through agricultural output, the effect of rainfall shocks on GDP should be weak in countries with small agricultural sectors.[26] It is, therefore, interesting to examine whether there is evidence of weak effects of rainfall shocks on democratic change and on per capita GDP in countries with relatively small agricultural sectors. To do so, we use data from the World Development Indicators (WDI) (2009) to calculate the average agricultural GDP share over the 1980–2004 period for each country in our sample and we analyze the effect of rainfall shocks on GDP and on democratic change in countries with agricultural GDP shares below the median.[27] The results in the top panel of Table X show that the effect of rainfall shocks on GDP per capita is statistically insignificant in these countries (see column 1) and that the effect of rainfall shocks on democratic change is also statistically insignificant (see columns 2–5). This result is consistent with rainfall shocks affecting democratic institutions through income. The finding also suggests that rainfall does not have (strong) direct effects on democratic change.[28]

[26]The Supplemental Material Appendix shows that rainfall has a highly statistically significant, positive effect on agricultural output in our sample (see Dell, Jones, and Olken (2008), for evidence on the positive effect of rainfall on agricultural value added in a wider sample of countries).

[27]The median agricultural GDP share in our sample is 34 percent and the average agricultural share in below-median countries is 18 percent.

[28]The bottom panel of Table X shows results for countries with agricultural sectors above the median (the average agricultural share in these countries is 44 percent). Rainfall has a significantly positive effect on GDP and a significantly negative effect on democratic improvement in these countries (and the point estimates are larger in absolute value than for countries with agricultural shares below the median).

TABLE X

RAIN, AGRICULTURE, GDP, AND DEMOCRATIC CHANGE[a]

	Log GDP	ΔPolity2		Democratic Transition	Democratic Step
	(1)	(2)	(3)	(4)	(5)
			Panel A: Below the Sample Median		
Log rainfall, t	0.031	0.240	0.181	−0.010	0.021
	(0.032)	(0.380)	(0.386)	(0.039)	(0.020)
Log rainfall, $t-1$	0.003	−0.885	−1.010	−0.083	−0.042
	(0.036)	(0.734)	(0.730)	(0.084)	(0.067)
Country fixed effect	Yes	Yes	Yes	Yes	Yes
Country time trend	Yes	Yes	Yes	Yes	Yes
Common time effect	Yes	Yes	Yes	Yes	Yes
Observations	468	468	450	336	396
			Panel B: Above the Sample Median		
Log rainfall, t	0.130***	0.519	0.011	0.070	0.021
	(0.045)	(0.685)	(0.840)	(0.070)	(0.049)
Log rainfall, $t-1$	0.088	−2.773*	−3.490***	−0.207**	−0.297***
	(0.056)	(1.430)	(1.329)	(0.090)	(0.105)
Country fixed effect	Yes	Yes	Yes	Yes	Yes
Country time trend	Yes	Yes	Yes	Yes	Yes
Common time effect	Yes	Yes	Yes	Yes	Yes
Observations	487	487	452	364	471

[a]The method of estimation is least squares; Huber robust standard errors (in parentheses) are clustered at the country level. Panel A computes regressions for countries whose 1980–2004 agricultural share in GDP was below the sample median; Panel B computes regressions for those whose 1980–2004 agricultural share is above the sample median. The dependent variable in column 1 is the log of real per capita GDP; in column 2, the dependent variable is the t to $t+1$ change in the revised combined Polity score (Polity2); column 3 excludes observations that correspond to interregnum periods; in column 4, the dependent variable is a democratic transition indicator that is equal to unity in year t if and only if the country is a democracy in $t+1$ but a nondemocracy in t (the year t indicator is not defined if the country is a democracy in t); in column 5, the dependent variable is a democratization step indicator that is equal to unity in year t if and only if the country is upgraded to either a partial or full democracy between t and $t+1$ (the year t indicator is not defined if the country is a full democracy in t). For further detail on the coding of the dependent variables, see the main text. The average share of agriculture in GDP is from WDI (2009). *Significantly different from zero at 90 percent confidence; **95 percent confidence; ***99 percent confidence.

5. CONCLUSIONS

It has long been argued that democratic improvement is often triggered by economic recessions. As emphasized by the literature on political sociology, this could be for several reasons. For example, Lipset (1959) and Huntington (1991) argued that economic recessions lead to autocratic regimes losing legitimacy, partly because recessions are taken as a sign of government incompetence. In Acemoglu and Robinson's (2001) economic approach to political transitions, on the other hand, economic shocks may give rise to political change even if shocks are (known to be) exogenous and transitory. This is because such shocks imply a temporary fall in the opportunity costs of contesting power. We examine the effect of exogenous, transitory income shocks on po-

litical transitions by exploiting within-country rainfall shocks in sub-Saharan Africa, where such shocks have a significant but transitory impact on GDP. Our analysis yields that negative rainfall shocks lead to significant democratic improvement and, in particular, a tightening of executive constraints, greater political competition, and more open and competitive executive recruitment. Our instrumental variables results indicate that improvements in democratic institutions triggered by transitory negative income shocks can be substantial. For example, rainfall-driven recessions are followed by an improvement in the score for executive constraints by 19 percentage points and an improvement in the scores for political competition and for the openness and competitiveness of executive recruitment by 17 percentage points.

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