Rain and the Democratic Window of Opportunity

by

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Abstract. According to the economic approach to political transitions, negative transitory economic shocks can give rise to a window of opportunity for democratic change. We examine this hypothesis using yearly rainfall variation over the 1980-2004 period in 41 Sub-Saharan African countries. We find that a 25% drop in rainfall increases the probability of a transition to democracy during the following two years by around 3 percentage points. A 5% fall in income due to low rainfall raises the probability of democratization by around 7 percentage points. We also find that rainfall does not affect transitions from democracy to autocracy.

Key words: democratization, transitory economic shocks

JEL codes: O0, P0

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1. Introduction

In their economic theory of political transitions, Acemoglu and Robinson (2001, 2006) show that democratization becomes more likely after transitory, negative economic shocks. These 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 of opportunity closes, autocratic regimes must make democratic concessions to avoid costly repression (see, for example, Acemoglu and Robinson 2006, page xii).

Identifying the effect of transitory economic shocks on the likelihood of democratization is not straightforward. A basic difficulty is singling out (sources of) economic shocks that are transitory. Another reason why correct inference is often difficult is that aggregate income may respond to changing expectations about future democratization. For example, a greater likelihood of democratization may lead economic elites to disinvest because they fear high taxation or the uncertainty accompanying political transitions. In this case, democratization episodes could be preceded by dips in income, although there is no causal effect of transitory, negative economic shocks on the probability of democratization. It is also possible that economic growth accelerates when countries are more likely to be freed from expropriatory autocratic regimes. In such a scenario, economic growth could be stronger before democratic transitions. Estimating the causal effect of transitory, negative economic shocks on the probability of democratization therefore requires data on exogenous and transitory shocks to the economy. We focus on yearly rainfall variation as a cause of transitory changes in income in 41 Sub-Saharan African countries.

We start by asking whether past rainfall levels affect the probability of observing a transition from autocracy to democracy over the 1980-2004 period, the longest period for

which rainfall data is available. We find that lower rainfall leads to a statistically significant increase in the probability of democratization. In our simplest specification, which controls for country fixed effects, a 25% drop in rainfall increases the probability of a democratic transition during the following two years by approximately 3 percentage points. This effect changes little when we control for country-specific time trends in the probability of transiting from autocracy to democracy and/or time effects affecting the probability of a democratic transition across all Sub-Saharan African countries. Low past rainfall levels do not affect the likelihood of a transition from democracy to autocracy once common time effects across all Sub-Saharan African countries are taken into account. Transitory, negative economic shocks therefore increase the probability of a political transition from autocracy to democracy, but not from democracy to autocracy.[1]

It is known that the empirical link between rainfall levels and income per capita is quite strong in Sub-Saharan African countries (e.g. Benson and Clay 1998; Miguel et al. 2004). This is not too surprising as Sub-Saharan African countries have large agricultural sectors and agricultural productivity is weather dependent (e.g. Intergovernmental Panel on Climate Change 2001). In our sample, a 25% drop in rainfall reduces real income per capita by around 2% relative to trend, and this effect is statistically significant at the 1% level (the t-statistic is 2.7). Differences in the impact of rainfall on income per capita in democracies and in autocracies are small. For example, the effect of a 25% drop in rainfall on income per capita in democracies is -2.00%; in autocracies, the effect on income per capita is -1.88%. The difference between these effects is statistically insignificant at any conventional

[1] Acemoglu and Robinson's (2001, 2006) theory gives rise to different cases. The most relevant for our work is where transitory, negative economic shocks trigger a transition from autocracy to democracy but not the other way around. But there is also a case where transitory, negative economic shocks trigger transitions in both directions.

confidence level. Moreover, we find that the effect of rainfall on income per capita is transitory in democracies as well as autocracies.

Our instrumental variables analysis of the effects of transitory economic shocks on political transitions uses rainfall levels as an instrument for deviations of income per capita from trend. Our main finding is that a fall in income due to low rainfall increases the likelihood of a political transition from autocracy to democracy. According to our point estimates, a 5% fall in income raises the probability of democratization by around 7 percentage points. This conclusion is robust to using a variety of instrumental variables estimators. Income shocks do not affect the probability of a political transition from democracy to autocracy however.

We also analyze the effect of rainfall-driven income shocks on biennial political transitions. Our biennial democratic transition indicator takes the value of 1 if a country is classified as an autocracy in a given year but as a democracy two years later; the indicator is 0 if the country remains an autocracy. We define an analogous biennial autocratic transition indicator. Our findings regarding the effect of income shocks on biennial democratic transitions are very similar to the case where we consider annual transitions. In particular, a 5% drop in income per capita increases the probability of democratization over the following two years by around 7 percentage points. Also, just as in the case of annual transitions, we fail to find statistically significant effects of rainfall-driven income shocks on the likelihood of political transitions from democratic to autocratic regimes.

Our work fits into the literature on the economic determinants of democratic transitions. One of the most thoroughly investigated issues in this literature is the modernization hypothesis, which posits a positive effect of higher income per capita on democracy. For recent work investigating this hypothesis see, for example, Przeworski and Limongi (1997); Przeworski et al. (2000); Epstein et al. (2006); Acemoglu et al. (2007a,b);

and Papaioannou and Siourounis (2007).[2] Our objective is to test for Acemoglu and Robinson's (2001, 2006) democratic window-of-opportunity effect, and we therefore focus on within-country rainfall variation as a source of transitory economic shocks. As a result, our empirical results are not comparable to those in the modernization literature. Paxson (1992) also uses rainfall data to isolate transitory income shocks, but her objective is to estimate marginal propensities to save out of transitory income.

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

2. Data and Measurement[3]

We will employ two indicators of transitions to democracy (as well as a combination of the two). The first indicator is the Polity IV based democratic transition indicator used by Persson and Tabellini (2003, 2006, 2007) and Epstein et al. (2006) for example. The Polity IV database assigns a so-called revised combined Polity score between -10 (full autocracy) and +10 (full democracy) to a wide range of countries over a long period of time (Marshall and Jaggers 2005). These scores are based on four elements: (i) competitiveness of executive recruitment; (ii) openness of executive recruitment; (iii) constraints on the chief executive; and (iv) competitiveness of political participation. Persson and Tabellini as well as Epstein et al. define countries as democracies when their Polity IV score is strictly positive; otherwise they are considered autocracies.[4] The Polity IV data are available up to 2004. The second

[2] In related work, Przeworski (2005) and Benhabib and Przeworski (2006) argue that higher income per capita helps democracy prevail once established.

[3] A STATA file with the data and estimation programs used is available at www.antoniociccone.eu.

[4] Following Persson and Tabellini, we use the Polity2 variable of the Polity IV database. It seems likely that Epstein et al. use the same variable, but there is no reference to the exact variable used in

indicator of transitions to democracy we employ is due to Przeworski and Limongi (1997) and Przeworski et al. (2000) and has also been used by Acemoglu et al. (2007b) for example. This indicator emphasizes the turnover of political power in free and fair elections, and is only available up to 2002.[5,6]

Our basic democratic transition (democratization) indicator takes the value of 1 if the country is an autocracy in period *t* but a democracy in *t*+1. The indicator takes the value 0 if the country is classified as an autocracy in *t* and *t*+1. We also consider a biennial democratic transition indicator, which takes the value of 1 if the country is an autocracy in *t* = 1980, 1982,…, 2002 but a democracy in *t*+2. This indicator takes the value 0 if the country is classified as an autocracy in both *t* and *t*+2. See Table 1 for summary statistics on annual and biennial democratic transitions.

We also want to examine whether rainfall-driven economic shocks have an effect on transitions away from democracy (from democracy to autocracy). We therefore define an autocratic transition indicator that takes the value of 1 if the country is classified as a democracy in *t* but as an autocracy in period *t*+1 (*t*+2 for the biennial indicator), and the value 0 if the country is classified as a democracy in *t* and *t*+1 (*t*+2 for the biennial indicator).

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their article. The Polity2 variable of the Polity IV database is meant to facilitate the use of the Polity IV regime measure in time-series analyses (Marshall and Jaggers 2005).

[5] The data are available at http://politics.as.nyu.edu/object/AdamPrzeworski.html.

[6] Freedom House (2007) classifies countries into free, partially free, and not free. This classification also reflects civil liberties (e.g. freedom of the media; registration requirements for religious institutions; freedom of assembly and demonstration; equality of opportunities). In Acemoglu and Robinson's (2001, 2006) theory of political transitions, such civil liberties appear closer to policy changes that autocratic regimes can quickly renege upon than democratic concessions that increase citizens' capacity to decide on economic policies.

Data on rainfall come from the NASA Global Precipitation Climatology Project. Monthly rainfall is observed on a 2.5' latitude/longitude grid.[7] We follow Miguel, Satyanath, and Sergenti (2004) in assigning gauge stations to countries and obtaining countries' yearly rainfall levels as an average across gauge stations and months.

Real income per capita data are taken from the Penn World Tables 6.2 (Heston et al., 2006).[8] See Table 1 for summary statistics.

3. Estimation Framework

We capture the link between democratization and past rainfall levels with the following reduced form equation,

$$(1) \qquad Democratization_{c,t\to t+1\ (t+2)} = a_c + b_c t + \tau_t + c_1 \log Rain_{c,t} + c_2 \log Rain_{c,t-1} + \varepsilon_{c,t};$$

Democratization is a democratic transition indicator that takes the value of 1 if the country was classified as an autocracy in *t* and as a democracy in *t+1* (*t*+2 for the biennial indicator) and the value of 0 if the country is an autocracy in both *t* and *t+1* (*t*+2 for the biennial indicator); a_c is a country fixed effect that captures cross-country heterogeneity in the likelihood of democratization; the log*Rain* terms denote the log levels of rainfall in the country; and ε captures a disturbance term that can be correlated across years for the same country. Equation (1) also accounts for country-specific time trends in the likelihood of democratization ($b_c t$), and for common time effects (τ_t), which capture trends in the likelihood of democratization that affect all Sub-Saharan African countries. We focus on linear specifications because non-linear (e.g. Probit, Logit) specifications are

[7] See Adler et al. (2003). The data are available at http://precip.gsfc.nasa.gov.
[8] The dataset is available at http://pwt.econ.upenn.edu.

computationally difficult in the presence of fixed effects and also inconsistent due to the incidental parameter problem (e.g. Wooldridge, 2002, Chapter 15.8.2).[9]

The second-stage equation to estimate the effects of transitory income shocks on the likelihood of democratization takes the same form as (1), but with income per capita instead of rainfall on the right-hand side,

$$(2) \qquad Democratization_{c,t\to t+1\ (t+2)} = \alpha_c + \beta_c t + \delta_t + \gamma_1 \log y_{c,t} + \gamma_2 \log y_{c,t-1} + e_{c,t}\,.$$

Our main empirical results treat deviations of past income from trend as endogenous and instrument them using log rainfall levels.

The main estimation method is two-stage least squares (IV-2SLS) as non-linear estimation approaches require strong specification assumptions (Angrist and Krueger, 2001; Wooldridge, 2002). We also implement Fuller limited-information maximum-likelihood estimators, as these estimators have been shown to be more robust to weak instruments than two-stage least squares (e.g. Stock, Wright, and Yogo, 2002; Hahn and Hausman, 2003).

4. Empirical Results

Rainfall and political regime transitions. Table 2, columns (1)-(3) contain our reduced form estimates of the effects of past rainfall on the probability of democratization using the Polity IV definition. The estimates in column (1) are conditional on country fixed effects (these fixed effects are jointly significant at the 1% level). The results indicate a negative and statistically significant effect of *t*-1 rainfall levels on the probability of a political

[9] In fact, we do not get non-linear estimates to converge when we include country fixed effects, country-specific time trends, and time effects. When we exclude either country-specific time trends or common time effects, Probit and Logit specifications yield very similar results to least squares (results not shown).

transition from autocracy to democracy between *t* and *t*+1 (the estimate is statistically significant at the 4% level; all t-statistics are based on Huber robust standard errors clustered at the country level). The point estimate implies that a 25% drop in rainfall levels increases the probability of democratization by approximately 3.3 percentage points. This estimate remains almost unchanged in column (2), where we also control for country-specific time trends (which are jointly significant at the 1% level). In column (3), we add controls for common time effects (which are jointly significant at the 5% level). The negative effect of past rainfall levels on democratization remains statistically significant at the 6% level. The point estimate is somewhat smaller than in column (1). Now a 25% fall in rainfall levels increases the probability of democratization by approximately 3 percentage points.[10]

Table 2, columns (4)-(6) consider the effect of past rainfall levels on transitions from democracy to autocracy. In this case, past rainfall levels have a statistically significant positive effect in the specification with country fixed effects only (column (4)). But the effect becomes statistically insignificant when we include time effects. Hence, there is no evidence that past rainfall levels affect transitions from democracy to autocracy.

Rainfall and income per capita in democracies and autocracies. Table 3 examines the impact of rainfall on per capita income. Column (1) only controls for country fixed effects; column (2) adds country-specific time trends; and column (3) also accounts for time effects that affect the whole of Sub-Saharan Africa. The estimates show that rainfall has a positive

[10] We also examined how results vary when we differentiate among Polity IV autocracies. In particular, we defined a deep autocracy dummy that takes the value of 1 for autocracies with revised combined Polity scores smaller or equal -6 (results did not prove sensitive to the threshold used). We then included the deep autocracy dummy in the estimating equations to capture that transitions to democracy may be more difficult in deep autocracies. The reduced-form and second-stage results of interest changed very little. For example, the (reduced-form) effect of lagged rainfall in Table 2, column (3) is -0.116 (-1.9) when we control for the deep autocracy dummy; and the (second-stage) effect of lagged income in Table 4, column (2) is -1.64 (-1.86).

effect on income per capita once time trends are accounted for, and that this effect is highly statistically significant. The estimate in column (3) indicates that a 25% drop in rainfall levels lowers income per capita by 2%, and that this effect is statistically significant at the 1% level (t-statistic 2.7; all t-statistics are based on Huber robust standard errors clustered at the country level). Column (4) checks whether rainfall impacts income differently in autocracies compared to democracies. This is done by interacting rainfall levels with a dummy that takes the value of 1 if the country is a Polity IV autocracy in *t*-1. This interaction captures the differential impact of rainfall in autocracies. The (small) point estimate on the interaction indicates that the effect of rainfall on income is similar in democracies and autocracies. In particular, according to our point estimates, the effect of a 25% drop in rainfall on income per capita in democracies is -2.00%. In autocracies, the effect on income per capita is -1.88%. The difference between these effects is statistically insignificant at any conventional confidence level. The results in column (5) show that the income effects of rainfall are transitory in democracies as well as autocracies, as rainfall levels in *t*-1 and *t*-2 are statistically insignificant for both political regimes.

Income shocks and political regime transitions. Table 4, columns (1)-(4) summarize our findings regarding the effect of income shocks on transitions from autocracy to democracy using the Polity IV definition. Column (1) contains least squares estimates, controlling for country fixed effects, country-specific time trends, and common time effects. In this case, deviations of income per capita from trend are a statistically insignificant determinant of democratization (t-statistics are based on Huber robust standard errors clustered at the country level). Columns (2)-(4) contain our instrumental variables results, with past log incomes instrumented by log rainfall. Using two-stage least squares, we find that negative income shocks increase the probability of a democratic transition between the following year

and the year thereafter, and that this effect is statistically significant at the 6% level (column (2)). The point estimate implies that a 5% drop in income increases the probability of democratization by almost 9 percentage points. Columns (3) and (4) rely on Fuller limited-information maximum-likelihood estimators. These estimators are more robust to weak instruments than two-stage least squares (e.g. Stock, Wright, and Yogo, 2002; Hahn and Hausman, 2003). The two Fuller limited-information maximum likelihood estimates are calculated for Fuller constants 4 and 1. The Fuller 1 estimator yields the most unbiased estimator and is recommended when one wants to test hypotheses; the Fuller 4 estimator minimizes the mean squared error of the estimator (Fuller, 1977). The Fuller limited-information maximum likelihood estimates of the effects of *t*-1 income shocks on democratization are also negative, although somewhat smaller (in absolute value) than the two-stage least squares estimate. According to the Fuller 4 estimate, a 5% drop in income increases the probability of democratization by 5.7 percentage points, and this effect is statistically significant at the 4% level. The Fuller 1 estimate of the same effect is larger, 7.7 percentage points, but estimated slightly less precisely (statistically significant at the 6% level).

Table 4, columns (5)-(8) examine the effects of income shocks on transitions from autocracy to democracy. In this case there is no evidence of a statistically significant effect, whether we use a least squares approach (in column (5)) or an instrumental variables approach (in columns (6)-(8)). Moreover, point estimates can be positive or negative depending on the instrumental variables estimator used. Overall, we do not find evidence of a link between income shocks and transitions from democracy to autocracy.

Rainfall and biennial political regime transitions. In Table 5, we examine the effect of past rainfall levels on biennial political transitions using the Polity IV definition. Our

biennial democratic transition indicator takes the value of 1 if a country is classified as an autocracy in 1980, 1982,…, or 2002 but as a democracy two year later. The indicator is 0 if the country remains an autocracy. We also define an analogous biennial autocratic transition indicator. Regarding democratic transitions, our empirical results indicate that a 25% drop in rainfall increases the probability of observing a political transition from autocracy to democracy over the following two years by around 8 percentage points in the specifications where we control for country fixed effects only. This effect is statistically significant at the 1% level (t-statistic 3.2; t-statistics continue to be based on Huber robust standard errors clustered at the country level). When we also control for country-specific time trends and common time effects, a 25% fall in rainfall levels increases the probability of a biennial democratization episode by approximately 5 percentage points (statistically significant at the 3% level). Just as in the case of annual transitions, we fail to find a statistically significant effect of rainfall variation on the likelihood that countries switch from democratic to autocratic political regimes once common time effects are taken into account.

Table 6, columns (1)-(4) contain our results on the effect of income shocks on biennial democratization episodes. The findings are very similar to the evidence on annual transitions to democracy. For example, according to our two-stage least squares results, a 5% negative income shock increases the probability of a transition from autocracy to democracy over the following two years by around 9 percentage points, and this effect is statistically significant at the 3% level. The Fuller limited-information maximum-likelihood estimates of this effect are somewhat smaller, 5.9 percentage points according to the Fuller 4 estimator and 7.9 percentage points according to the Fuller 1 estimator, but continue to be statistically significant.

Table 6, columns (5)-(8) examine the effect of income shocks on biennial transitions from democracy to autocracy. Just as in the case of annual transitions, there is no statistically

significant evidence that rainfall-related income shocks result in countries moving away from democratic institutions.

Rainfall, income shocks, and the Przeworski et al. indicator of transitions to democracy. Table 7, Panel A examines the link between past rainfall and transitions to democracy using the democracy indicator by Przeworski et al. (2000).[11] Columns (1)-(3) refer to annual transitions and columns (4)-(6) to biennial transitions. Overall, the estimates point in the same direction as our previous findings. For example, in column (1) where we analyze the effect of past rainfall on the probability of democratization controlling for country fixed effects, the point estimate and significance levels are almost identical to what we obtained with the Polity IV indicator. Once we control for country-specific time trends and common time effects, effects are weaker but there continues to be evidence that the likelihood of democratization increases after years of low rainfall (the common time effects are actually jointly insignificant at the 10% level in this specification). Columns (4)-(6) consider the same specification as the previous columns but examine biennial transitions to democracy. Findings are similar as in the case of the Polity IV democratic transition indicator. For example, according to the results in column (4), a 25% drop in rainfall increases the probability of a transition to democracy over the following two years by 6 percentage points, and this effect is highly statistically significant. When we control for country-specific time trends and common time effects, the magnitude of the effect falls somewhat. A 25% drop in rainfall is now found to raise the probability of democratization by 4 percentage points; but the effect remains statistically significant at the 5% level.

[11] Just as in the case of the Polity IV indicators, we fail to find evidence of statistically significant effects of rainfall on the likelihood of transition away from democracy (results not shown).

Table 7, Panel B examines the link between rainfall-driven income shocks and transitions to democracy using the democracy indicator by Przeworski et al. (2000). The main findings for annual transitions, in columns (1)-(3), are again quite similar to those using the Polity IV indicator. For example, according to the two-stage least squares results in column (1), a 5% drop in income increases the probability of democratization by almost 10 percentage points (a somewhat larger effect than using the Polity IV indicator but also somewhat less precisely estimated). According to the Fuller 4 estimate, on the other hand, a 5% drop in income increases the probability of democratization by 5.6 percentage points, almost exactly the effect we found with the Polity IV indicator, and the precision of the estimate is also very similar. Finally, the Fuller 1 estimate of the same effect is larger, 8 percentage points approximately, but estimated somewhat less precisely. Columns (4)-(6) examine the effect of income shocks on biennial transitions from autocracy to democracy. The two-stage least squares point estimate in column (4) indicates a stronger effect of rainfall on transitions to democracy than found using the Polity IV transition. But the effect is also very imprecise and therefore statistically insignificant. The Fuller 1 limited-information maximum-likelihood estimator, on the other hand, yields a point estimate that is smaller in absolute value (now a 5% drop in income is estimated to increase the probability of democratization over the following two years by 5 percentage points) but statistically significant at the 5% level. Finally, the Fuller 4 estimate indicates a stronger effect (a 5% income drop raises the probability of democratization by almost 10 percentage points) but is also less precise (statistically significant at the 8% level).

Table 8 examines the determinants of transitions to democracy using an indicator that reflects whether autocratic regimes have become a democracy according to at least one of the two available democracy indicators. Specifically, we take a country to be an autocracy in a given year if both the Polity IV indicator and the Przeworski et al. (2000) indicator agree

on the political regime being autocratic. And we code a political transition to democracy as a situation where the country is an autocracy according to both indicators in *t*, but a democracy according to one of the indicators in *t*+1 (*t*+2 for biennial transitions). This identifies autocracies that have taken a step towards democracy according to at least one of the indicators, which is why we refer to this indicator as the democratization step indicator.

Table 8, Panel A presents the reduced form effects of rainfall on annual and biennial transitions to democracy using the democratization step indicator. The results confirm our previous findings, but are somewhat stronger. For example, according to the point estimate in column (1), a 25% drop in rainfall leads to an increase in the probability of 5.5 percentage points of the country becoming a democracy according to at least one of the two indicators (using one of the two indicators the same effect was around 3 percentage points). Moreover, this effect is highly statistically significant. The effect of rainfall on the probability of a democratic transition decreases somewhat when we control for country-specific time trends and common time effects in columns (2) and (3), but remains stronger than in previous tables (in magnitude and statistical significance). The same remains true when we consider the biennial democratization step indicator. For example, according to the point estimate in column (4), a 25% drop in rainfall leads to an increase in the probability of above 10 percentage points of the country becoming a democracy over the following two years according to at least one of the two indicators (using one of the two indicators this effect was between 6 and 8 percentage points).

Table 8, Panel B contains our findings on the effect of rainfall-driven economic shocks on annual and biennial transitions to democracy using the democratization step indicator. The point estimates indicate that a 5% drop in income increases the probability of a transition towards democracy according to at least one of the two indicators by between 6 and 12 percentage points (using one of the two indicators, the effect tended to be somewhat

weaker), and all estimates are statistically significant at the 6% level. Hence, countries are significantly more likely to become a democracy according to at least one of the two indicators after rainfall-driven, negative income shocks.

5. Conclusions

Testing the implications of economic theories of political transitions is not straightforward, as clean measures of the exogenous driving forces are usually difficult to obtain. For example, according to the economic approach to democratization (Acemoglu and Robinson 2001, 2006), a transition to democracy should be more likely after a transitory, negative shock to the economy. To test this theory it is important to identify exogenous and transitory shocks. Our approach relies on yearly rainfall variation over the 1980-2004 period in 41 Sub-Saharan African countries. Our reduced form analysis yields that democratization is more likely after years of low rainfall. Transitions away from democracy on the other hand are unrelated to past rainfall levels. Our instrumental variables results indicate that a (rainfall-driven) 5% drop in income per capita raises the probability of democratization by approximately 7 percentage points.

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Table 1: Descriptive Statistics

A. Measures of Political Regime Transitions			
	Mean	Std. Dev.	Observations
Annual Democracy Indicator	0.274	0.446	995
Annual Transition to Democracy (Polity IV)	0.034	0.182	733
Annual Transition to Autocracy (Polity IV)	0.057	0.233	262
Annual Transition to Democracy (Przeworski et al.)	0.027	0.162	775
Annual Democratization Step Indicator	0.048	0.214	690
Biennial Democracy Indicator	0.285	0.452	477
Biennial Transition to Democracy (Polity IV)	0.071	0.257	352
Biennial Transition to Autocracy (Polity IV)	0.112	0.316	125
Biennial Transition to Democracy (Przeworski et al.)	0.054	0.227	369
Biennial Democratization Step Indicator	0.093	0.291	333
B. GDP and Rainfall			
Log Real Per Capita GDP	7.028	0.751	1001
Log Rainfall (mm per year)	6.719	0.638	1001

Table 2. Rainfall and Regime Transitions (Polity IV)

	Transitions to Democracy			Transitions to Autocracy		
	(1)	(2)	(3)	(4)	(5)	(6)
	LS	LS	LS	LS	LS	LS
Log Rainfall, t	-0.037 (-1.09)	-0.014 (-0.42)	0.032 (0.91)	0.003 (0.04)	-0.046 (-0.73)	-0.035 (-0.62)
Log Rainfall, t-1	-0.134** (-2.10)	-0.105* (-1.87)	-0.120* (-1.91)	0.178* (1.64)	0.096 (0.77)	0.167 (1.22)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country Time Trend	No	Yes	Yes	No	Yes	Yes
Common Time Effects	No	No	Yes	No	No	Yes
Observations	733	733	733	262	262	262

Note: Method of estimation is least squares with Huber robust standard errors clustered at the country level; t-values in brackets. The dependent variable in columns (1)-(3) is a *Transition to Democracy Indicator* that takes on the value of 1 if the revised combined Polity IV score is strictly positive in period *t+1* conditional on being negative in period *t*. The dependent variable in columns (4)-(6) is a *Transition to Autocracy Indicator* that takes on the value of 1 if the revised combined Polity IV score is negative in period *t+1* conditional on being strictly positive in period *t*. *Significantly different from zero at 90 percent confidence, ** 95 percent confidence, *** 99 percent confidence.

Table 3. Rainfall and Per Capita GDP

	Log Per Capita GDP				
	(1)	(2)	(3)	(4)	(5)
	LS	LS	LS	LS	LS
Log Rainfall, t	-0.113 (-1.27)	0.057** (2.25)	0.076*** (2.70)	0.080*** (2.80)	0.063*** (2.77)
Log Rainfall, t-1					0.043 (1.35)
Log Rainfall, t-2					0.034 (0.78)
Log Rainfall, t* Autocracy Dummy				-0.005 (-1.12)	-0.002 (-0.55)
Log Rainfall, t-1* Autocracy Dummy					0.020 (0.62)
Log Rainfall, t-2* Autocracy Dummy					-0.025 (-0.80)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country Time Trend	No	Yes	Yes	Yes	Yes
Common Time Effects	No	No	Yes	Yes	Yes
Observations	1001	1001	1001	995	954

Note: Method of estimation is least squares with Huber robust standard errors clustered at the country level; t-values in brackets. The dependent variable is log real per capita GDP (PWT 6.2). The autocracy dummy variable is defined as an indicator function that takes on the value of one if the revised combined Polity IV score is negative in period *t-1* and zero if in period *t-1* the combined Polity IV score is strictly positive. *Significantly different from zero at 90 percent confidence, ** 95 percent confidence, *** 99 percent confidence.

Table 4. Per Capita GDP and Regime Transitions (Polity IV)

	Transitions to Democracy				Transitions to Autocracy			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	LS	2SLS	Fuller 1	Fuller 4	LS	2SLS	Fuller 1	Fuller 4
Log GDP, t	0.087 (0.91)	0.864 (1.23)	0.751 (1.23)	0.533 (1.19)	0.026 (0.08)	18.600 (0.28)	1.479 (0.60)	0.810 (1.01)
Log GDP, t-1	0.001 (0.01)	-1.703* (-1.85)	-1.523* (-1.91)	-1.115** (-2.03)	0.287 (1.30)	2.329 (0.25)	0.057 (0.03)	0.730 (1.06)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Time Trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Common Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	733	733	733	733	262	262	262	262

Note: Method of estimation in columns (1) and (5) is least squares, and in columns (2) and (6) two-stage least squares. Huber robust standard errors are clustered at the country level; t-values in brackets. Columns (3)-(4) and (7)-(8) show second stage estimates when the Fuller adjusted IV-LIML estimator is used with an alpha parameter set equal to 1 or 4 as indicated by the heading "Fuller 1" or "Fuller 4". See page 10 in the main text for details on these estimators. The instruments in columns (2)-(4) and columns (6)-(8) are current and lagged log rainfall levels. The dependent variable in columns (1)-(4) is a *Transition to Democracy Indicator* that takes on the value of 1 if the revised combined Polity IV score is strictly positive in period *t+1* conditional on being negative in period *t*. The dependent variable in columns (5)-(8) is a *Transition to Autocracy Indicator* that takes on the value of 1 if the revised combined Polity IV score is negative in period *t+1* conditional on being strictly positive in period *t*. *Significantly different from zero at 90 percent confidence, ** 95 percent confidence, *** 99 percent confidence.

Table 5. Rainfall and Biennial Regime Transitions (Polity IV)

	Transitions to Democracy			Transitions to Autocracy		
	(1)	(2)	(3)	(4)	(5)	(6)
	LS	LS	LS	LS	LS	LS
Log Rainfall, t	-0.324***	-0.275***	-0.200**	0.242	0.125	0.389
	(-3.20)	(-2.88)	(-2.28)	(1.29)	(0.57)	(1.07)
Log Rainfall, t-1	-0.019	-0.045	-0.050	0.204	0.101	0.335
	(-0.20)	(-0.47)	(-0.46)	(1.30)	(0.61)	(0.96)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country Time Trend	No	Yes	Yes	No	Yes	Yes
Common Time Effects	No	No	Yes	No	No	Yes
Observations	352	352	352	125	125	125

Note: Method of estimation is least squares with Huber robust standard errors clustered at the country level; t-values in brackets. The dependent variable in columns (1)-(3) is a *Transition to Democracy Indicator* that takes on the value of 1 if the revised combined Polity IV score is strictly positive in period *t+2* conditional on being negative in period *t*. The dependent variable in columns (4)-(6) is a *Transition to Autocracy Indicator* that takes on the value of 1 if the revised combined Polity IV score is negative in period *t+2* conditional on being positive in period *t*. *Significantly different from zero at 90 percent confidence, ** 95 percent confidence, *** 99 percent confidence.

Table 6. Per Capita GDP and Biennial Regime Transitions (Polity IV)

	Transitions to Democracy				Transitions to Autocracy			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	LS	2SLS	Fuller 1	Fuller 4	LS	2SLS	Fuller 1	Fuller 4
Log GDP, t	0.109	-1.789**	-1.592**	-1.179**	0.369	-5.231	-1.029	-0.099
	(0.72)	(-2.11)	(-2.16)	(-2.23)	(0.91)	(-0.42)	(-1.15)	(-0.36)
Log GDP, t-1	-0.042	0.336	0.305	0.233	0.267	-2.298	-1.600	-0.326
	(-0.27)	(0.39)	(0.42)	(0.46)	(0.32)	(-0.89)	(-1.49)	(-0.99)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Time Trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Common Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	352	352	352	352	125	125	125	125

Note: Method of estimation in columns (1) and (5) is least squares; in columns (2) and (6) two-stage least squares. Huber robust standard errors are clustered at the country level; t-values in brackets. Columns (3)-(4) and (7)-(8) show second stage estimates when the Fuller adjusted IV-LIML estimator is used with an alpha parameter set equal to 1 or 4 as indicated by the heading "Fuller 1" or "Fuller 4". See page 10 in the main text for details on these estimators. The instruments in columns (2)-(4) and (6)-(8) are current and lagged log rainfall levels. The dependent variable in columns (1)-(4) is a *Transition to Democracy Indicator* that takes on the value of 1 if the revised combined Polity IV score is strictly positive in period *t+2* conditional on being negative in period *t*. The dependent variable in columns (5)-(8) is a *Transition to Autocracy Indicator* that takes on the value of 1 if the revised combined Polity IV score is negative in period *t+2* conditional on being positive in period *t*. *Significantly different from zero at 90 percent confidence, ** 95 percent confidence, *** 99 percent confidence.

Table 7. Rain, Economic Shocks, and Democratic Transitions (Przeworski et al. 2000)

	Annual Transitions to Democracy			Biennial Transitions to Democracy		
			Panel A: Reduced Form			
	(1)	(2)	(3)	(4)	(5)	(6)
	LS	LS	LS	LS	LS	LS
Log Rainfall, t	0.025	0.032	0.072	-0.249***	-0.230***	-0.157**
	(0.54)	(0.59)	(1.14)	(-3.04)	(-2.78)	(-1.98)
Log Rainfall, t-1	-0.130**	-0.105**	-0.082*	0.022	0.021	-0.054
	(-2.09)	(-2.11)	(-1.65)	(0.29)	(0.33)	(-0.60)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country Time Trend	No	Yes	Yes	No	Yes	Yes
Time Effects	No	No	Yes	No	No	Yes
Observations	775	775	775	369	369	369
			Panel B: Second Stage			
	(1)	(2)	(3)	(4)	(5)	(6)
	2SLS	Fuller 1	Fuller 4	2SLS	Fuller 1	Fuller 4
Log GDP, t	1.346	1.145	0.785	-2.925	-1.945*	-1.001**
	(1.39)	(1.44)	(1.50)	(-1.35)	(-1.72)	(-2.11)
Log GDP, t-1	-1.928*	-1.638*	-1.126**	0.360	0.386	0.322
	(-1.68)	(-1.79)	(-1.99)	(0.32)	(0.52)	(0.79)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country Time Trend	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	775	775	775	369	369	369

Note: Method of estimation in Panel A is least squares with Huber robust standard errors clustered at the country level; t-values in brackets. Method of estimation in Panel B in columns (1) and (4) is two-stage least squares. Columns (2) and (5), and (3) and (6) show second stage estimates when the Fuller adjusted IV-LIML estimator is used with an alpha parameter set equal to 1 or 4 as indicated by the heading "Fuller 1" or "Fuller 4". See page 10 in the main text for details on these estimators. The instruments in Panel B are current and lagged log rainfall levels. The dependent variable in panel A and B is an indicator function that is 1 if Przeworski et al. (2000) classify the country as a democracy in period $t+1$ but as an autocracy in period t. *Significantly different from zero at 90 percent confidence, ** 95 percent confidence, *** 99 percent confidence.

Table 8. Rain, Economic Shocks, and Democratic Transitions (Step Indicator)

	Annual Transitions to Democracy			Biennial Transitions to Democracy		
			Panel A: Reduced Form			
	(1)	(2)	(3)	(4)	(5)	(6)
	LS	LS	LS	LS	LS	LS
Log Rainfall, t	-0.019	-0.014	0.048	-0.421***	-0.327***	-0.223**
	(-0.31)	(-0.25)	(0.72)	(-3.40)	(-3.02)	(-2.20)
Log Rainfall, t-1	-0.222**	-0.163**	-0.149**	0.029	0.024	-0.006
	(-2.50)	(-2.55)	(-2.04)	(0.23)	(0.24)	(-0.05)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country Time Trend	No	Yes	Yes	No	Yes	Yes
Time Effects	No	No	Yes	No	No	Yes
Observations	690	690	690	333	333	333
			Panel B: Second Stage			
	(1)	(2)	(3)	(4)	(5)	(6)
	2SLS	Fuller 1	Fuller 4	2SLS	Fuller 1	Fuller 4
Log GDP, t	1.377	1.140	0.731	-1.919**	-1.680**	-1.191**
	(1.29)	(1.30)	(1.27)	(-2.03)	(-2.08)	(-2.14)
Log GDP, t-1	-2.325*	-2.004**	-1.418**	0.765	0.694	0.524
	(-1.88)	(-2.00)	(-2.23)	(0.81)	(0.87)	(1.01)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country Time Trend	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	690	690	690	333	333	333

Note: Method of estimation in Panel A is least squares with Huber robust standard errors clustered at the country level; t-values in brackets. Method of estimation in Panel B in columns (1) and (4) is two-stage least squares. Columns (2) and (5), and (3) and (6) show second stage estimates when the Fuller adjusted IV-LIML estimator is used with an alpha parameter set equal to 1 or 4 as indicated by the heading "Fuller 1" or "Fuller 4". See page 10 in the main text for details on these estimators. The instruments in Panel B are current and lagged log rainfall levels. The dependent variable in Panel A and B is a *Democratization Step Indicator* that is 1 if either Przeworski et al. (2000) or Polity IV classify countries in period *t+1* (*t+2* for biennial) as a democracy but both classify it as an autocracy in period *t*. *Significantly different from zero at 90 percent confidence, ** 95 percent confidence, *** 99 percent confidence.