

1. Introduction

What triggers democratic change? At least since Lipset (1959), it has been argued that democratic change tends to be sparked off by economic recessions (see also Huntington, 1991; Haggard and Kaufmann, 1995). Acemoglu and Robinson's (2001, 2006) theory of political transitions provides an explanation. Transitory, negative economic 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.¹

Testing the window-of-opportunity effect of transitory economic shocks on political institutions is difficult. The key issue is singling out aggregate economic shocks that are transitory. Another concern is that economic changes may reflect shocks to expectations about future democratization; for example, income levels may rise when countries are more likely to be freed from expropriatory autocratic regimes. Empirical analysis of the window-of-opportunity theory of democratic change therefore requires observing transitory, exogenous shocks to aggregate economic activity. We argue that yearly rainfall shocks in Sub-Saharan African countries satisfy these requirements. This results in a probably unique opportunity to test the theory by examining whether democratic improvement tends to follow negative rainfall shocks.

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

¹ Lipset and Huntington argue that recessions lead to autocratic regimes losing legitimacy which ends up increasing the probability of democratic change.

political participation, the openness and competitiveness of executive recruitment, and constraints on the executive. The 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 et al., 2004).

The data show some striking instances of democratic improvement following negative rainfall shocks in Sub-Saharan Africa. Madagascar transitioned 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 multi-party constitution in Mozambique in 1994. Figure 1 shows the evolution of the Polity score for ten 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 sub-scores 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 probability of a democratic transition, defined following Persson and Tabellini (2003), and to a statistically significant increase in the probability of a step towards democracy, defined following Epstein et al. (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 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 by 0.8 percentage points; and the openness and competitiveness of executive recruitment score 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. 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 is also reported by Benson and Clay (1998); Miguel et al. (2004); and Barrios and Bertinelli (2008). Benson and Clay report annual time-series evidence for six Sub-Saharan African countries between 1970 and 1992, and Miguel et al. report annual time-series evidence for forty-one 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 and Bertinelli examine the effect of rainfall on GDP growth averaged over five-year periods.

³ For example, 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).

If rainfall shocks open a window of opportunity for democratic change because of their effect on income, 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 literature on the economic determinants of democratic change. One of the most thoroughly investigated issues is the modernization hypothesis, which posits a positive link between income and democracy (Lipset, 1959). For empirical work see, for example, Przeworski and Limongi (1997); Barro (1999); Przeworski et al. (2000); and Epstein et al. (2006). This literature has found evidence of a positive link between income and democracy, but recent work by Acemoglu et al. (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 from the modernization literature 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

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 et

The remainder of this paper is organized as follows. Section 2 discusses data and measurement, Section 3 presents the estimation framework, and Section 4 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 database (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 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 their established territory (Polity IV refers to such periods as interregnum periods).

al., 1998). Miguel et al. (2004) examine the link between year-to-year rainfall growth, income growth, and civil conflict. Their aim is to re-examine 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 (2008) use a similar approach to estimate the effect of income growth on democratic transitions. Miguel et al.'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 Supplementary Appendix (available as a separate document at www.antonioiciccone.eu) 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.

We perform a separate empirical analysis for the Polity IV sub-scores 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 is 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 non-democracies. 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 $t-1$ and t lead to the country being upgraded to democracy; if the country already is a democracy at $t-1$, 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 to 6, and full democracies, with Polity2 scores 7 to 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 $t-1$ and t lead to the country being upgraded to partial or full democracy; if the country already is a full democracy at $t-1$, 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 zero if the country is a democracy and there has not been a coup. Our measures of political change are summarized in Table 1.

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 longwave 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

