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Optimal Weather Conditions, Economic Growth, and Political Transitions

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Summary. — Studies that test the effect of economic outcomes on political transitions using weather variations as instruments have generally overlooked findings from climate science that economic output is a hill-shaped, rather than linear, function of temperature and precipitation levels. We design an improved set of instruments for growth based on this fact, and find that growth-maximizing temperatures coincide with levels that maximize energy sector output in the climate response literature. Previous studies significantly overestimate the increase in the probability of democratic transitions resulting from negative growth shocks, although we find leadership transition frequencies rise significantly following transitions to democracy.

Key words — leadership, economic growth, political economy, democratic transitions, climate

1. INTRODUCTION

This paper's primary contribution is to demonstrate that temperature, and to a lesser extent precipitation, can have important non-linear effects on economic growth for countries around the world. Having established this fact, we then use our novel, weather-related instruments for growth to revisit a fundamental problem in political economy: the extent to which economic shocks cause political transitions.

The causal relationship between economic and political outcomes—while central to many debates in political economy and economic development—is often difficult to sort out, because the decisions of political leaders can influence the economy, just as realizations of output and growth can influence the fate of political leaders. In establishing causality in either direction, identifying relevant and plausibly exogenous instruments for political or economic outcomes, respectively, is of fundamental importance. A well-known example of the former is provided by Jones and Olken (2005), who exploit exogenous leadership transitions induced by deaths of national leaders to demonstrate that leaders matter for growth, especially in autocratic settings where leaders face fewer constraints on their power. Going in the other direction, several recent papers, among them Burke and Leigh (2010), Brückner and Ciccone (2011), and Burke (2012), use instruments for growth based on weather variations to tease out the causal effect of shocks to growth on political transitions. [1]

Methodologically, these works build upon earlier contributions by Miguel, Satyanath, and Sergenti (2004), who use rainfall variation to test the impact of economic conditions on the likelihood of civil conflict in African countries, and Paxson (1992), who as Brückner and Ciccone (2011) note, appears to have been the first paper using rainfall shocks to test theoretical implications of transitory economic shocks in the literature. A core assumption of previous literature has been that variations in output, usually of the agricultural sector, in response to exogenous climatic variations drive political outcomes. Overwhelmingly, authors working from this premise have also assumed that the effects of weather variations on agricultural output are linear. [2]

The core observation in our paper is that, while linearity is a workable assumption in some cases, it is strongly at odds with findings in the climate response function literature, exemplified by the contributions of Mendelsohn, Nordhaus, and Shaw (1994), Mendelsohn and Schlesinger (1999), and Mendelsohn, Morrison, Schlesinger, and Andronova (2000), which show that average agricultural and energy sector output follow a hill-shaped, rather than linear, function of average temperature. In the case of Ricardian models of the agricultural sector, these studies find that agricultural output is a hill-shaped function of average precipitation, as well. Our focus on growth also builds upon recent work by Dell, Jones, and Olken (2012) on the relationship between temperature and economic growth, which shows that higher temperatures appear to reduce the growth rate of TFP directly, as well as through the level of output itself.

In light of the above findings, our paper proceeds as follows. First, we develop and test a set of nonlinear weather instruments for growth, consistent with findings of hill-shaped relationships in the climate response function literature, which allows for the possibility that weather variations can affect either output or TFP growth, as emphasized by Dell et al. (2012). Second, we apply our new set of instruments to test the causal effect of economic outcomes, in particular shocks to growth, on both democratic transitions and transitions in the national leadership of countries around the world. For the latter purpose, we employ an international database of

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democratic and leadership transitions, growth, policies, and political variables for 157 countries during the period 1964–2004, which builds closely upon the datasets of Burke and Leigh (2010) and Burke (2012), respectively.

Our focus on the worldwide sample is crucial because the nonlinear weather effects we emphasize arise primarily from cross-sectional, rather than time series, variation. The idea is that shocks to temperature and precipitation may affect output and growth in cold *versus* hot, or wet *versus* dry, countries differently. To motivate our focus on the potential nonlinear effects of temperature and precipitation on growth, Table 1 displays average levels of democratic change event frequencies, job loss frequencies for the chief executive, and average levels of the growth rate of real GDP-per-capita for the country-years in each of five quintiles for the time averages of precipitation and temperature, by country, worldwide.

The data in Table 1, while inconclusive regarding causality, reveal several suggestive patterns. First, real average economic growth per capita rises for lower levels of average precipitation, peaks for countries whose average precipitations are between the 40th and 60th percentiles, and then falls, with the exception of a significant increase in the upper 20th percentile of precipitation. Second, for real economic growth-per-capita as a function of average temperatures, a hill-shaped relationship is plain to see: average growth rises to peak at the group of countries with average temperatures between the 20th and 40th percentiles worldwide, and then falls for each quintile thereafter. While much has been made in the literature of the fact that higher temperatures are associated with lower rates of economic growth (see e.g., Dell et al., 2012), the fact that countries in the lowest quintile of average temperatures have lower growth than those in the second quintile seems to have received comparatively little discussion. Somewhat surprisingly, average democratic change event frequencies and leadership transition frequencies also seem to display a nonlinear, and in the latter case a hill-shaped relation, to average precipitation levels as well, with the exception of average leadership transition frequencies, which are strictly decreasing as a function of average temperature levels.

These patterns relating weather variables to average economic growth rates are highly consistent with the findings of Mendelsohn and co-authors relating sector outputs with temperature and precipitation using data on US economic regions. The output effects of increases in temperature or precipitation from one year to the next in a given country, in other words, depend crucially on what side of the "hill" the country is on (Mendelsohn et al., 2000). It is reasonable to expect the same could be true of economic growth as well.

To preview our results, we find that nonlinear terms in and interaction terms between temperature and precipitation instruments are highly significant in our first stage regressions for economic growth. In addition, growth-maximizing values for temperature derived from our models are consistent with energy sector output-maximizing values of temperature in the climate response function literature. Using our set of growth instruments based on notions of optimal climatic conditions, we confirm that positive growth shocks significantly reduce the probability of a transition in national leadership, and find that negative shocks to growth affect the probability of a transition to democracy significantly less than what previous authors, in particular Burke and Leigh (2010), have estimated. Finally, we document an "Arab Spring effect": the probability of a leadership transition increases significantly in the wake of a transition to democracy, although this phenomenon does not appear to change the effect of growth on the probability of leadership transitions.

The rest of this paper is organized as follows. Section 2 briefly reviews the relevant literature. Section 3 describes our dataset on leaders, growth, policies, and institutions. Section 4 lays out and tests our instrumentation strategy for economic growth. Section 5 presents our main results on the effect of economic growth on democratic and leadership transitions from linear 2SLS models. Section 6 evaluates the robustness of our main results to use of data from alternative data sources, alternative definitions of growth, the inclusion of additional control variables, and restrictions of the model to different sub-samples of interest. Section 7 concludes.

2. LITERATURE REVIEW

Knowledge of the drivers of political transitions at the international level, as opposed to the drivers of US election results, is somewhat limited. [3] The theoretical prior is generally that faster growth contributes to the political longevity of both political systems and individual leaders. In their theory of

Table 1. *Average political transition frequencies and economic growth rates by quintiles of precipitation and temperature*

Source	Burke and Leigh (2010)		Burke (2012)	
	Dem. Change Events (mean)	GDP per capita growth (mean)	Leadership Transitions (mean)	GDP per capita growth (mean)
Precipitation				
Group 1: ⩽20 percentile	0.016	1.630	0.073	2.001
Group 2: >20 percentile & ⩽40 percentile	0.020	2.317	0.164	2.205
Group 3: >40 percentile & ⩽60 percentile	0.016	2.122	0.168	2.339
Group 4: >60 percentile & ⩽80 percentile	0.030	1.483	0.191	1.521
Group 5: >80 percentile	0.020	2.121	0.145	2.137
Temperature				
Group 1: ⩽20 percentile	0.012	2.478	0.202	2.523
Group 2: >20 percentile & ⩽40 percentile	0.019	2.608	0.190	2.660
Group 3: >40 percentile & ⩽60 percentile	0.023	1.957	0.136	2.120
Group 4 :>60 percentile & ⩽80 percentile	0.019	1.555	0.131	1.599
Group 5: >80 percentile	0.028	1.226	0.100	1.340

Notes: The dependent variable for columns 1 and 2 indicate the commencement of democratic change events, which involve a three or more point increase in POLITY score that occurs within three years, flagged by a positive REGTRANS score. The dependent variable for columns 3 and 4 indicate a transition of the head-of-state, which is coded as a one if in that year the head-of-state loses his/her job, and zero otherwise. GDP per capita growth is scaled so that one percentage point of additional growth is 1, not 0.01. The sample for columns 1 and 2 exclude country-years in which the $t-1$ POLITY score exceeds 7.