Rainfall, Human Capital, and Democracy

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ABSTRACT:
Why are some societies characterized by enduring democracy while other societies are persistently autocratic? We show that there is a systematic, non-linear relationship between rainfall levels and regime types in the post-World War II world: stable democracies overwhelmingly cluster in a band of moderate rainfall (550 to 1300 mm of precipitation per year); persistent autocracies overwhelmingly cluster in deserts and semi-arid environments (0 to 550 mm per year) and in the tropics (above 1300 mm per year). We also show that rainfall does not work on regime types directly, but does so through the its impact on the level and distribution of human capital. Specifically, crops that are both easily storable and exhibit modest economies of scale in production grow well under moderate amounts of rainfall. The modal production unit is a family farm that can accumulate surpluses. In such an economy there are incentives to make intergenerational investments in human capital. A high level and broad distribution of human capital makes democratic consolidation more likely.

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Why are some societies characterized by enduring democracy while other societies are persistently autocratic? This question motivated the research of the founding fathers of modern political science, including Lipset (1959, 1963), Huntington (1968), and Dahl (1971), and became one of the central preoccupations of the sub-discipline of comparative politics. Although these scholars did not share identical views about the specific channels by which societies democratized, each of them tried to make sense of the obvious correlation between wealth, a large middle class, broad access to education, and representative political institutions. They therefore were all of the view that certain "structural" preconditions increase the odds that a society will sustain democracy. A newer generation of scholars, using more sophisticated quantitative approaches, has corroborated the empirical regularities first identified by Lipset, Huntington, and Dahl (Przeworski et al. 2000; Epstein et al. 2006). The consistent co-occurrence of liberal values, high levels of economic development, and consolidated democracy has led some scholars to conceptualize a country's regime type as part of a more general equilibrium (e.g., Weingast 1997, Persson and Tabellini, 2009).

What is the fundamental cause of this "high income-democracy" equilibrium? A handful of scholars have pointed to geography, focusing in particular on disease environments, soil types, and climate (Engerman and Sokoloff 1997; Hibbs and Olsson 2004; Acemoglu et. al, 2001, 2005; 2008; Putterman 2007). There is general agreement in this literature that geographic factors have neither a direct nor contemporary effect; instead, geographic factors work through an historical process that effects fundamental institutions.[1] Beyond that, consensus breaks down. First, there is no agreement about mechanisms. Second,

[1] Other scholars, most notably Sachs (1999) have pointed to geography as an explanation for variance in GDP (leaving aside institutions), and posit that it works through transport costs and tropical diseases. For a critique showing that geography works through institutions, see Easterly and Levine (2003).

the literature tends not to specify fully whether the fundamental institutions are about social structures, legal systems that protect property rights, or cultural norms. Third, it is not clear why some institutions that emerge from geography have enduring effects, while others do not. In order to remedy this lacuna, we identify a geographic factor that has been employed in the literature on civil war (e.g. Miguel et. al 2004), but that has not received much attention in the literature on regime type as an equilibrium—the level of rainfall.

We show that there is a systematic, non-linear relationship between rainfall levels and regime types in the post-World War II world: stable democracies overwhelmingly cluster in a band of moderate rainfall (550 to 1300 mm of precipitation per year); persistent autocracies overwhelmingly cluster in deserts and semi-arid environments (0 to 550 mm per year) and in the tropics (above 1300 mm per year). In very dry and very wet places, stable democracies are exceedingly scarce. We also show that this finding is robust to controlling for possible confounders, such as GDP per capita, income inequality, the percentage of the population that is Muslim, ethnic fractionalization, linguistic fractionalization, the percentage of the population that is Arab, the prevalence of malaria, colonial heritage, natural resource income (the "resource curse"), and regional fixed effects. In fact, we find that many of these well-known correlates of democracy lose statistical significance once we condition on rainfall. Moreover, unlike many of these other correlates, rainfall is exogenous.

We argue that the non-linear relationship between levels of rainfall and regime types works through an historical process whose roots are found in the structure of agricultural production. In turn, the structure of agricultural production influenced social structures, sending some societies down a path of institutional development that was likely to lead to stable democracy, and sending other societies down a path that was likely to lead to persistent

autocracy. Briefly stated, the world's liberal democracies are situated in climate zones where the level of rainfall permitted the advent of an agricultural system based on grains and legumes, which are characterized both by a high degree of storability and modest economies of scale in production. Conversely, high storability and small minimum efficient scales of production do not characterize the crops that can be grown in other climate zones. In deserts, it is not possible to grow anything, except under special circumstances that dramatically raise the scale of production—a subject to which we shall return at some length. It is, of course, possible to grow food in the tropics—but what can be grown either has very low degrees of storability (e.g. tree crops, such as bananas) or is characterized by extremely large scale economies in production (e.g. sugar cane). Those specific features of grains and legumes created conditions that favored societies composed of family farmers, as opposed to societies composed of nomadic Bedouins or coerced plantation workers. High storability and small minimum efficient scales of production generated surpluses that could not be arrogated by political elites bent on political centralization. This structure of agricultural production therefore created incentives for economic specialization, trade, and inter-generational investments in human capital.

Over the course of long periods of time those outcomes of an agricultural system based on storable crops with modest scale economies in production gave rise to societies characterized by high levels and broad distributions of human capital. These characteristics are conducive to democratic consolidation because democracies tend to flourish when citizens are evenly matched in terms of education, political sophistication, and social standing. When they are not, "free and fair elections" can lead to a tyranny of the majority—a point first made by Aristotle, but echoed by generations of scholars since. Elites are not, as Acemoglu and

Robinson (2006) point out, sheep to be fleeced: the threat of a tyranny of the majority causes them to either resist democratization or undermine it. Moreover, when democracy arises in a social structure characterized by high levels and broad distributions of human capital, citizens are better able to monitor and discipline politicians, holding them accountable and incentivizing them to provide public goods that strengthen democracy (Levi 2002; Keefer and Vlacui 2008).

We test this theory against evidence, and show that moderate levels of rainfall correspond (for good scientific reasons that we discuss below) with lands that are highly suitable for growing grains. We also show that both rainfall and soil quality affect regime types through human capital, and we are able to rule out endogeneity between regime types and human capital.

We hasten to emphasize that the theory we are advancing is probabilistic, not determinative. Moderate levels of rainfall *tend to generate* societies with social structures that are conducive to the consolidation of democracy; they do not guarantee that every country with a moderate level of rainfall will be democratic. Our theory is not, therefore falsified by pointing to a single case of a democracy in a desert or on a tropical island, or by pointing to an autocracy on a prairie—anymore than the theory that cigarettes cause cancer is falsified by the fact that some people smoke like chimneys and live to be 100. What our theory does imply, however, is that, all things held equal, democracies should not be as common in deserts and the tropics as they are in areas with moderate rainfall. It also implies that the world's autocracies should be clustered in deserts and the tropics, and should be rare in countries with moderate rainfall. It fails if those *patterns* do not hold. By a similar logic, our theory is falsified if we find that the mechanism that we hypothesize to link moderate rainfall and

democracy is not supported by evidence in a *probabilistic* sense: it fails if we find that stable democracies are as common among societies with low levels and narrow distributions of human capital as among societies with high levels and broad distributions of human capital.

We also hasten to add that our theory has little to say about how a society democratizes, how long it takes to democratize, or if it will suffer setbacks along the way. Whether democracy has been implanted through a demonstration effect in a neighboring country, a foreign invasion whose goal is regime change, or the desire of the conservatives to split the working class by extending the franchise, is outside its purview. It also does not purport to explain why the United States has had representative institutions since the late 18th Century, but Portugal did not democratize until 1976. Finally, there is nothing about it that rules out deviations from trend, such as those that occurred in Germany and Italy in the 1930s and 1940s.

We are not saying that the particularities of history—the factors and events that drive outcomes in any particular time and place—are unimportant. We are saying, however, that the task of history is not just to explain outcomes in particular times and places; it is also to identify the patterns that emerge across a large number of cases and to explain why we observe those patterns. As Marx famously noted in the *The Eighteenth Brumaire of Louis Bonapart*: "Men make their own history, but they do not make it just as they please; they do not make it under circumstances chosen by themselves, but under circumstances directly encountered, given and transmitted from the past." We are simply saying that those "circumstances, directly encountered" include the constraints imposed by nature. These constraints have helped to sustain democracy in some areas of the world, such as Western

Europe, North America, Japan, India, and Australia, but not in others, such as the Middle East, North Africa, Sub-Saharan Africa, and Central Asia.

Our theory is motivated by the following brute fact. There is a vast area of extremely low precipitation, called the Afro-Asian Dry Belt, that extends from Mauritania, eastward across Mali, Niger, Chad, and the Sudan, and northwards across Morocco, Algeria, Libya, Tunisia, and Egypt, before continuing eastwards across the Arabian Peninsula, the Persian Gulf, Central Asia, Northwestern China, and Mongolia. Across that vast stretch of the earth, encompassing a broad range of ethnicities, language groups, and colonial experiences, there is only one country that has managed to create a stable democracy: Israel. The fact that it is the exception suggests the power of our rule: those responsible for consolidating democracy in Israel were immigrants who brought their human capital with them.

This paper continues as follows. We first demonstrate that there is a systematic, non-linear pattern between rainfall levels and regime types. We then advance a theoretical framework to make sense of those patterns. We then subject our theory to tests against evidence, employing unique datasets and a Tobit regression framework. We also show that these results are robust to an instrumental variables approach as well as a first-order Markov chain transition process using a dynamic logit approach. The final section concludes.

Literature Review

We do not claim that we are the first to have noticed that climate matters. There is a long literature about the effects of climate on human behavior that stretches all the way back to Aristotle. More recently, Hibbs and Olsson (2004) and Putterman (2007) have hypothesized that climate, working through the timing of the transition to agriculture from hunting and gathering, plays an important role in the long run process of economic growth.

Engerman and Sokoloff (1997) famously argued that variance in natural environments (differences in climate, soil quality, mineral endowments, and the size of the native population) across the Americas at the time of European colonization explains variance today in terms of per capita incomes and political institutions. Acemoglu, Johnson, and Robinson (2001) also exploit variance in climate to explain differences in per capita incomes today in former European colonies, but for them the mechanism linking climate and economic growth is the disease environment: where Europeans faced high mortality because heat and humidity favored the species of mosquitos that carry Malaria and Yellow Fever, they set up "extractive" institutions designed to maximize their economic return over the short run; but where they faced low mortality risk, because the climate was drier and cooler, they set up "settler" institutions designed to create a political and economic environment that resembled Western Europe. These initial colonial institutions then conditioned long-run paths of institutional development: places with extractive institutions (e.g., the Congo) went down a path leading to autocracy and underdevelopment; places with settler institutions (e.g., the United States) went down a path leading to democracy and high per capita incomes.

These seminal contributions have pushed social scientists to take geography—and history—seriously. They are, however, incomplete explanations of why we observe systematic relationships between geography and regime types. Hibbs and Olsson (2004) and Putterman (2007) focus on economic growth, not contemporary political regimes. Engerman and Sokoloff (1997) focus solely on the Americas. Acemoglu, Johnson, and Robinson (2001) restrict their analysis to Western European colonies. Places that were skipped over by European powers because they were inhospitable (e.g., the Arabian Peninsula), that were integrated into another country only to emerge as sovereign states more recently (e.g., the

countries of Central Asia, which were conquered and made part of Russia proper), that remained outside of the colonial system because they were buffer states (e.g., Thailand), or that remained sovereign states because they had the potential to resist colonization (e.g., Japan), lie outside of their frameworks. The countries of Europe itself—both those that were colonizers and those that were not—also fall outside of the Engerman-Sokoloff and Acemoglu, Johnson, and Robinson theoretical purviews.

We also do not claim to be the first to have argued that history matters. Moore (1966) made a seminal contribution to the study of comparative democratization by looking for its social roots in centuries past. He was followed by Luebbert (1991), Rueschemeyer, Stephens and Stephens (1992) and Collier (1999). More recently, Capoccia and Ziblatt (2010) stress that the roots of democracy in Europe and elsewhere were laid down centuries ago and in many cases, such as Eastern Europe, those roots remained dormant for decades. We follow very much in their footsteps.

Other researchers, going back to Lipset (1959), find a positive link between education/human capital and democracy. Recent work has used increasingly sophisticated statistical tools to demonstrate the robustness of the correlation (e.g., Przeworski et al. 2000). This work tends to focus, however, on the level of human capital, not its distribution. It has also been criticized for not clearly specifying a causal mechanism that outlines the progression of historical events that connects improvements in education to the broadening of the suffrage and the consolidation of representative institutions. Finally, it is possible that the results in the extant literature suffer from endogeneity bias: democracy may be driving the variation in education levels, not the other way around. We build upon the literature by remedying all three of these problems.

We also do not claim to be the first to have noticed that the structure of agriculture has implications for the political organization of states. Carneiro (1970) argued that centralized states first emerged in those areas where agricultural production had to take place in geographically circumscribed zones, where croplands were set off by mountains, seas, or deserts that limited the area that could be cultivated. His theory, however, focused on competition for scarce land, not the crops that could be grown on that land. It was also about explaining the rise of the first states, not about explaining variance in regime types in the contemporary world.

Additionally, we do not claim to be the first social scientists to have noticed that you cannot grow food without water, and that there is therefore a relationship between control of water and a range of outcomes, including regime types. Wittfogel (1957) famously argued that control of great rivers was the driving force behind authoritarianism in the ancient and modern worlds. A generation of historians has shown that Wittfogel's theory of hydraulic society was a fanciful set of assertions: irrigation does not inexorably lead to corvee labor, centralized bureaucracies, and totalitarian leaders. In fact, as Manning (2010) shows, most of the irrigation works on the Nile under the Pharaohs—Wittfogel's touchstone case—were *locally* run. We would suggest, however, that Wittfogel was on to something—but he had the wrong mechanism. Irrigated agriculture *is* fundamentally different from rain fed agriculture, but not because it leads directly to centralized political control. Rather, there are sizable economies of scale in building and maintaining an irrigation system. In addition, in a dry environment access to irrigation can serve as a barrier to entry: if you own all the water, no one can compete against you, regardless of how much land they own; hence if you own all the water, you will wind up owning all the land as well. That outcome cannot obtain when

agriculture is rain fed: nobody can own the rain. The result of these two factors, as anyone who has ever driven across both California's (irrigated) Central Valley and Iowa's (rain fed) rolling hills can attest, is that irrigation leads to much larger average farm sizes. The modal form of economic organization is not a family farm, but a tremendous enterprise worked by non-landowning laborers.

As far as we know, we are the first to offer a theory connecting the level of rainfall to the emergence of stable democracies and to the resilience of persistent autocracies. Our framework also specifies the intermediate steps between precipitation and the regime equilibria that are currently observed today. Finally, we offer an empirical test of the theory based on a cross-national dataset that includes both the postcolonial states that are the focus of the variation in institutions examined by Sokoloff and Engerman (1997) and Acemoglu et al. (2001), the countries that remained free of colonization, and the colonizing states from Western Europe whose rare democratic institutions first fascinated the likes of Lipset, Huntington, and Dahl.

The Geographic Distribution of Rainfall and Regime Types

We begin by documenting the non-linear relationship between rainfall zones and regime types around the world. Following the literature on regime types as equilibria, we create a measure of regimes that captures both the level of democracy and the stability of that level over time. We therefore take the average of the Combined Polity 2 score—an index of the competitiveness of political participation, the openness and competitiveness of executive recruitment, and the constraints on the chief executive that is standard in the comparative politics literature (Marshall and Jaggers 2008)—over the period 1965 to 2009. We choose

these dates out of practicality: if we go back before 1965 we would not have Polity observations for a large swathe of the globe because Polity only scores sovereign states. (When we get to multivariate analysis later, we will show that our results are not sensitive to the cutoff year). In order to make the graphs easier to interpret, we normalize average polity to run from 0 to 100.

The Y-axis of the graphs is the raw, average polity scores (which is also true of the multivariate analysis later). For the sake of making the graphed data easier to visualize and describe we identify the observations by whether the country's Polity averages can be considered "stable democracy," "persistent autocracy," or countries that are neither (countries that recently transitioned from autocracy to democracy, as well as weakly consolidated autocracies). Following Gleditsch and Ward (2006), we operationalize a stable democracy as a country that has had an average polity score of at least +7 (85 on our 0 to 100 scale). The countries that meet this criterion tend to be places that have been democratic for decades (e.g., Trinidad and Tobago, which has been a democracy since independence in 1962), if not centuries (e.g., England, whose representative institutions go back at least as far as the Glorious Revolution of 1688). We operationalize a persistent autocracy as a country that has had an average polity score of less than -4 (30 on our 0 to 100 scale). We do so because at average polity scores above 30 there are countries that periodically experiment with democracy before collapsing back into dictatorships (e.g., Nigeria) or that have recently undergone democratic transitions (e.g., Mexico). The countries that meet the criterion for persistent autocracy tend to be places that have remarkably durable authoritarian governments, with rulers who have held on to power for decades on end. In fact, the persistent autocracies include many of the world's oldest states—places that have persistently

given rise to highly authoritarian governance structures over the course of several millennia—such as Egypt, Iran, and China. The countries that fall between stable democracies and persistent autocracies have created neither enduring representative institutions nor intractable forms of autocratic rule.

We measure rainfall by taking the average level of precipitation within 100 miles of the largest city of every country during the period 1970-80 from the Global Historical Climatology Network Database version 2.0, available from the National Oceanic and Atmospheric Administration, National Climatic Data Center.[2] We take the average for this particular decade because it affords the broadest cross-sectional coverage, amassing readings from over 20,000 weather stations around the globe. We note, however, that the results are not sensitive to the decade chosen. Indeed, we get similar results when we used the NOAA precipitation data from 150 years ago.

We pick a 100-mile buffer around the largest city for both theoretical and practical reasons. As a theoretical matter, the fundamental institutions of modern nation states tended to originate in a core area, and were then transplanted to other areas by assimilation, conquest, and colonization as the state expanded. Examples of such core areas include the Ile de France (the area around Paris, from which the modern French state slowly emerged beginning in the 10th century), the Valley of Mexico (the central plateau around Mexico City, that was the center of the Teotihuacan, Toltec, and Aztec Empires, the Spanish colony of New Spain, and the nation state of Mexico after independence), the Tokyo region (from which emerged the modern nation of Japan beginning with the Tokugawa Shogunate in 1603), and the original 13 colonies of the United States. The United States is a particularly interesting example because

[2] Accessible at: http://www.ncdc.noaa.gov/ghcnm/

the process of institutional replication from the core to the frontier was, itself, institutionalized: in order to obtain statehood, a federal territory in the mid-west or west first had to ask for an enabling act of congress; it could then write a state constitution, which had to be approved by the federal congress. With very few exceptions, the largest city in any country today sits inside this original core area. Measuring the average level of rainfall within 100 miles of the largest city therefore allows us to capture the impact of precipitation on a country's fundamental institutions.

As a practical matter, picking a 100-mile buffer biases the results against our hypothesis. The world's driest countries tend to have the lowest polity scores—Saudi Arabia being an archetype. The largest cities in those countries tended to grow up, for obvious reasons, in zones that offered at least some precipitation. For example, the major cities of North Africa are not located in the Sahara, but are located on a thin strip of land along the Mediterranean Coast that receives enough rainfall to sustain farming. The more narrowly one draws the average rainfall circle around those cities, the higher those countries score on our rainfall measure. In short, drawing the circle at 100 miles, rather than 200 or 500 miles, or taking the average for the entire country, biases the rainfall levels of desertic countries upwards, making it more difficult for us to find a statistically significant relationship between precipitation and polity scores.

Figure 1 presents a scattergram of countries' average polity scores from 1965 to 2009 against the average annual level of precipitation in a 100-mile circle around their largest city during the decade 1970-80. The two vertical lines demarcate 550 mm and 1300 mm. Five features of the data are obvious. First, there is a non-linear relationship between rainfall and polity scores (depicted by the quadratic regression line), in which average polity scores rise as

rainfall increases, until roughly 1450 mm in precipitation per year, at which point they begin to decline. Second, at a precipitation level of less than 550 mm per year, there are only two stable democracies: Israel and Cyprus, both of which, interestingly, are at the right tail of the 0 to 550 mm rainfall band. That same rainfall band, however, boasts 14 of the world's persistent autocracies. More precisely, this narrow rainfall band accounts for only 22 percent of all countries in the world, but it contains 44 percent of the world's persistent autocracies and only eight percent of the world's stable democracies. Third, at a precipitation level of 550 to 1300 mm per year the pattern flips: this band boasts 18 stable democracies, but only seven persistent autocracies. This is particularly remarkable considering that there are only 26 stable democracies in our entire dataset. More precisely, this rainfall band accounts for 45 percent of all countries, but 69 percent of all stable democracies, and only 21 percent of all persistent autocracies. Fourth, above 1300 mm in average precipitation per year, the pattern flips back, but it is less pronounced: There are 11 persistent autocracies and six stable democracies. Fifth, at this high level of rainfall the countries with regimes that have neither succeeded in creating stable representative institutions nor durable forms of autocratic rule predominate. They account for 55 percent of the countries in this rainfall band.

Lest readers think these results are the outcome of some one in ten thousand fluke, we repeat the operation in Figure 2, but substitute average rainfall in 1850-60 for average rainfall in 1970-80—and we obtain materially the same results. Once again, average polity scores increase as rainfall increases, but only up to a point: beyond 2000 mm in precipitation the regression line turns strongly negative. Once again, below 550 mm in precipitation per year there is only one stable democracy, but 13 persistent autocracies. From 550 to 1300 mm in precipitation per year, the pattern again flips: there are 21 stable democracies and 11

persistent autocracies. That is to say, this rainfall band accounts for 44 percent of all countries in the world, but a full 80 percent of the stable democracies! Above 1300 mm in rainfall per year, the pattern flips back, but, as in Figure 1, it is less pronounced: there are eight persistent autocracies and four stable democracies. This band is populated by recent democracies and weakly consolidated autocracies. Indeed, they account for 63 percent of the cases.

We have hypothesized that rainfall works through agriculture, specifically that moderate levels of rainfall affect the suitability of land for growing grains and legumes. For our hypothesis to hold there should therefore be a correlation between soil suitability for those crops and regime types. The National Resources Conservation Service (NRCS) of the United States Department of Agriculture has developed a range of measures of soil quality covering soil moisture, soil temperature, soil depth, nutrient content, chemical composition, and slope, *at the local level* for every country on the planet.[3] The NRCS then creates an index from these measures: Inherent Land Quality (ILQ), which is scaled from 1 (high soil performance, high soil resilience) to 9 (low soil performance, low soil resilience). The regions coded as ILQ categories 1 through 4 coincide with the world's great grain belts: the U.S. Midwest, the Canadian Prairie, the Indian Punjab, the Argentine Pampa, Eastern Bulgaria and Romania, the Ukraine, and the wheat growing regions of Australia, Germany, France, and China. We therefore repeat the same procedure as in Figures 1 and 2, but substitute the percentage of land that scores from 1 to 4 on the ILQ index. That is, we use ILQ 1-4 as a rough proxy for land that is suitable for growing the kinds of crops that, we hypothesize, tend to be associated

[3] Data available at: http://soils.usda.gov/

with social structures that lead to stable democracy. As in Figures 1 and 2, we bias against ourselves by only including the land within 100 miles of the largest city.

Several patterns jump out of the graphed data in Figure 3. First, the scattergram and regression line suggest that as the percentage of suitable land for grains increases, polity scores increase in a linear fashion. Second, the data suggest that once the ratio of suitable land to total land falls below 15 percent, there are very few stable democracies. In fact, of the 46 countries that fall into the 0 to 15 percent range, only four are stable democracies (and one of those four is the United States, which is simply an artifact of constraining the analysis to the 100 miles around the largest city). Twenty of the countries in this range, however, are persistent autocracies. That is, a category that includes 39 percent of the countries in our sample, accounts for only 19 percent of the world's stable democracies, but 63 percent of the world's persistent autocracies.

Theory

Democracies tend to flourish in societies with high levels and broad distributions of human capital (Lipset 1959). In such societies, citizens are evenly matched in terms of political sophistication, social standing, and material well-being. This means, on the one hand, that it is very costly for political elites to buy votes. On the other, it means that citizens are able to monitor and discipline elites; they can hold them accountable, limiting the space for opportunistic behavior. The result is a system characterized by increasing returns: political elites are rewarded by constituents for providing public goods that strengthen democracy rather than for constructing clientilistic networks and practicing patronage politics (Keefer and Vlaciu 2008). In turn, these public goods underwrite the practices needed to make democracy work amongst strangers across large territorial expanses (Stasavage 2011).

Physical and communications infrastructure (e.g., post offices) helps to build and sustain the civic engagement and widespread voluntary association that supports democracy. An impartial legal system promotes impersonal contract enforcement in ways that discourage predatory behavior, thereby bolstering trust among citizens and citizens' trust in the government (Levi 2002: 45).

This begs the question of where the level and distribution of human capital in a society comes from in the first place. People only make costly investments in education and the acquisition of specialized skills when there is a return to doing so. This means that these investments must allow: 1) individuals to generate a surplus beyond subsistence and 2) secure rights over that surplus. It follows that the larger the stock and the broader the distribution of that tradable surplus, the larger the incentives are for people to invest in specialized skills, thereby building the stock and broadening the distribution of human capital. Moreover, a high level and broad distribution of human capital is a process that takes place over an extended period of time: it requires inter-generational investments on the part of large numbers of families. The level and distribution of human capital in any society at any point in time therefore reflects the circumstances faced by broad swathes of the population in the past.

Among the most crucial of those circumstances in the past was the structure and organization of agricultural production—the single most important economic sector in all societies from antiquity until the early twentieth century, and the single most important sector in developing countries even today. Plainly put, contemporary differences in the level and distribution of human capital between the Netherlands and Mongolia are not a function of per capita spending on public education over the past decade, or even the past 30 years. Rather, the gap between the Netherlands and Mongolia reflects fundamental differences in the

trajectories of the Dutch and Mongolian economies going back centuries, and those trajectories were indelibly shaped by the fact that it was far easier to accumulate tradable agricultural surpluses in Holland than in Mongolia.

Not all crops are created alike when it comes to generating a tradable agricultural surplus. First, in order to be tradable, agricultural surpluses have to be easily storable. Most tree crops and tubers can be stored for only a few days or weeks. Bananas and cassava root, for example, can only be stored for five to seven days. Yams will not keep beyond 12 to 18 weeks (Diop and Calverley1998; Abu-Goukh 1986). Grains, such as wheat, corn, rye, oats, barley, and rice, and legumes, such as peas and beans, however, can be stored almost indefinitely. Put plainly, there were numerous city-states and empires in antiquity built on surpluses of grains and beans, but none built on surplus mangoes and bananas.

Just as not all crops are the same when it comes to storability, not all crops are the same when it comes to the minimum efficient scale of production. As Engerman and Sokoloff (1997) point out, cereal cultivation is characterized by modest scale economies: there is no productivity advantage to growing wheat, corn, or oats on massive plantations. The same is true of legumes. The family farm is therefore the modal production unit. That is not true, however, of the vast majority of tropical crops. Precisely because they are highly perishable, most tropical crops are subject to hold-up problems between producers and refiners or distributors. That is, refiners/distributors can try to renegotiate the contracted price with farmers while the product rots. Farmers know this, and so refrain from production—or engage in their own forms of ex-post contractual opportunism, such as holding back on a delivery while the produce already purchased by a distributor rots in a ship's hold. The economically efficient solution is vertical integration: the creation of a single firm that owns

every stage of production and distribution. The classic cases are bananas (May and Plaza 1958) and sugar (Dye 1998), but the phenomenon holds for just about any tropical fruit or tuber. As a consequence, virtually all tropical crops are grown on large plantations, not family farms.

Is the scale of production really an inexorable byproduct of plant biology? Or is there perhaps some endogenous relationship between regime types and plantation agriculture? The United States provides a natural experiment of sorts. For most of the twentieth century, the Dole Pineapple Corporation grew 75 percent of the world's pineapples on a single, 200,000 acre plantation located in the United States (on the Hawaiian Island of Lāna'i). Large-scale plantations are also the rule for American sugar growing on Hawaii, Louisiana, and Florida. And, lest some readers think that this is some recent phenomenon driven by "globalization", we cannot help but point to the fact that sugar began to be grown on large-scale plantations using slave labor as soon as it began to be commercialized in Europe—*in the 15th century* (Mintz 1985; Schwartz 1985).

The key to the relationship between moderate rainfall and democracy is this: grains and legumes, the crops that are easily storable and that can be grown efficiently on a family farm, grow best under conditions of moderate rainfall. If there is not enough moisture, their seeds will not germinate or the seedlings will wilt before reaching maturity. If there is too much moisture, however, their roots will rot. In addition, heavy rains, particularly late in the growing season, knock grain stalks down in the field, destroying the crop.[4]

[4] It was for this reason that the Irish so quickly and widely adopted the potato. The rainy climate not only made it near impossible to grow wheat, it often destroyed the oat crop (Fagan 2000).

The relationship between moderate rainfall and grain/legume agriculture goes beyond having the right amount of rainfall at the right time of the year; it extends to the quality of the soil itself. Soil suitability includes a range of factors—moisture level and variance, temperature, depth, texture, chemical composition, slope, and nutrient content—many of which are themselves an outcome of the level of rainfall, over very long periods of time. The nutrient level of soil, for example, is an outcome of the decomposition of the plants that grew there in the past. The fact that vegetation is sparse in a desert means that, even if one were to miraculously find a source of water, the soil would be unproductive because it would have inadequate organic matter. Soil texture, to cite another example, is an outcome of the earthworms, insects, and mammals that burrowed in it—and those animals do not thrive when there is inadequate rainfall. The same is true of soil depth and chemical composition: in tropical environments, heavy rains give rise to thin soils with high levels of iron and aluminum oxides (lateritic soils) that are notoriously unfertile. In short, human beings can degrade soils in the space of a few generations, but creating fertile soils that are suitable for grains and legumes is a process that occurs on a geologic time scale—and that process is driven forward by climatological factors, including the level of precipitation.

In short, while the natural environment dictates what can be grown, that which can be grown affects both the extent to which there is a tradable surplus and the distribution of that surplus. The level and distribution of the tradable surplus, in turn, affects the abilities of, and incentives for, families to make inter-generational investments in human capital over very long spans of time. Storability at a small scale means that family farmers can enforce property rights over their surplus at a relatively low cost, incentivizing them to make investments in

education. The resulting differences in the level and distribution of human capital condition both the level of economic development and the likelihood of democratic consolidation.

Let us briefly characterize the differences in social structures and human capital across areas of moderate rainfall, low levels of rainfall, and high levels of rainfall. At moderate levels of rainfall grain and legume agriculture is possible. The modal form of agricultural production tends to be the family farm, and those family farms accumulate surpluses that can be traded, incentivizing them to invest in the human capital of family members. The result is that the society goes down a path of institutional development associated with increasing returns that are broadly distributed: trade, specialization, investments in human capital, and incomes drive each other upwards. Simply put, economic growth, a high level of human capital, and a broad distribution of that capital are likely to be built into the fabric of such a society.

Let us be clear here. We are not saying that democratization happens because of the political preferences of grain-growing family farmers. Indeed, small farmers may espouse all kinds of ideologies and may join all kinds of political coalitions—and some of these movements and parties may not be pro-democratic. Examples include the interclass coalitions between free farmers and urbanites that may have undergirded European fascism (Luebbert 1991). Rather, we are saying that a society made up of grain-growing family farmers is likely to have gone down a path of development that produced a high level and broad distribution of human capital. When democratization happens in such a society, *for whatever reason*, it is likely to stick because a broad swathe of citizens will have the knowledge and sophistication necessary to enforce their rights and hold politicians accountable.

Consider now what happens at very low levels of rainfall. In a genuine desert (areas with annual precipitation of less than 250 mm per year) rain fed agriculture is impossible. It is possible, however, to grow grain on the land that surrounds an oasis. Grain agriculture is also possible—indeed it can flourish—along the banks of great rivers, such as the Tigris, Euphrates, and Nile. There are, however, two fundamental differences between these agricultural systems and those found in areas of moderate rainfall. The first is that control of water serves as a barrier to entry in production. Whoever controls the oasis or the banks of the river can block competitors from entering the market. In this environment, land without property rights to water has no value, hence whoever has property rights to the water will have property rights to the land. The second is that building and maintaining an irrigation system is an enterprise characterized by sizable economies of scale. The combined effect is that average farm size increases beyond that which would exist under rain fed conditions. That is, the resulting system is not characterized by family farms, but by concentrated landholdings that distribute income narrowly. The resulting society may produce a sizable surplus, but that surplus is captured by a tiny elite—Pharaonic Egypt being an archetypal case. The incentives facing the rest of the population to invest in human capital, and the capacity to do so, are very small.

In semi-arid environments (roughly 250 to 500 mm of precipitation per year, depending on mean annual temperature and the percentage of rain that falls in the summer)[5] there will certainly be pockets where rain fed agriculture is possible, such as the narrow strips

[5] There is no single precipitation threshold for land to be classified as semi-arid: the threshold depends on the average annual temperature and the percentage of precipitation that falls during the summer months. In a warm environment (average temperatures of 20 C) and where more than one third (but less than 70 percent) of the rain falls in the hottest months, land would be classified as semi-arid if it fell between 250 mm and 540 mm in precipitation per year.

of Algeria, Tunisia, and Libya that sit next to the Mediterranean, the plains of Syria, and Southwest Iran. These pockets of agriculture are, however, exactly that: pockets. The environment circumscribes good farming territory more strictly than it does in areas where there is moderate rainfall, such as Europe, India, or China. Per capita incomes, the ability to accumulate surpluses, and the incentives for families to invest in human capital will necessarily be lower.

Much of the economic activity in both desertic and semi-arid environments is not, in fact, dedicated to producing agricultural surpluses directly, but is devoted to providing long distance transport for the specialized goods produced by the societies with moderate rainfall that border them. Classic examples include the Bedouin tribes that ran the caravan trade across the Arabian Peninsula, the Berbers who controlled the trans-Saharan trade between the Magreb and the Sahel, and the various tribal peoples of the Eurasian Steppe that provided the transport for the famed Silk Road between China and Western Europe. To the degree that this type of economy generates incentives to specialize, it is toward developing skills associated with mobility and violence. When such a society is lucky enough to find an extraordinary leader, such as Attila or Genghis Khan, it can be militarily potent. These societies may therefore, for short periods of time, attain considerable riches by raiding and conquering the grain-based agricultural societies next to them, but they are less likely to produce incentives for the population to make investments in specialized skills that are the basis of trade itself.

Given the weak incentives to develop human capital in both desertic and semi-arid environments, democratic consolidation is unlikely. Societies in these regions may sometimes attain a high level of human capital, but that capital is concentrated in a small elite (Pharaonic Egypt again being the archetypal case). Alternately, societies in these regions may have broad

distributions of human capital, but the level of that human capital in an absolute sense is quite low (the Mongol Empire being a classic case in point). In short, the level of rainfall has set these societies down a path of institutional development that is fundamentally different from that of areas of moderate rainfall. Not only is the level of economic development likely to be low, but democratic consolidation is unlikely.

If moderate rainfall is good for democracy, why is a lot of rainfall not even better? The answer is that too much rainfall—especially too much rainfall during the summer, or even worse during the harvest season—knocks down cereal crops or causes them to rot. At extremely high and persistent levels of rainfall, such as is found in the tropics, growing cereals or legumes is a fool's errand. Not only is it too damp, but high levels of persistent rainfall produce thin soils that are low in nutrients. It is why the Amazon basin is not South America's breadbasket.

This is not to say that no agriculture is possible at high levels of rainfall, but it is to say that the kind of agriculture that is possible is not conducive to the preconditions that are likely to give rise to democracy. The crops that are produced are neither storable nor characterized by modest economies of scale in production. The lack of storability hinders trade. The economies of scale in production hinder a broad distribution of whatever surplus is produced. These are not societies of family farmers who accumulate surpluses across generations that can be invested in attaining scarce skills that have value in a market. They are societies of large plantations and coerced labor. Is it any wonder that the only large-scale African state confronted by the Europeans in the sixteenth century, the Kingdom of the Kongo, was characterized by a low population density, miniscule cities, and a predatory, yet

impoverished, nobility—that is, until it found a ready export in the form of human beings (Broadhead 1979; Thornton 2001)?

The bottom line is this: democracies tend to flourish in societies with high levels and broad distributions of human capital. In those societies, elites cannot buy votes cheaply, and voters can easily monitor and discipline elites. The result is a political system characterized by increasing returns. The level and distribution of human capital is not, however, randomly distributed around the planet. They are outcomes of long, historical processes that are rooted in the storability characteristics and scale economies of the crops that can be grown in any particular biome.

A Moorian Challenge?

Some readers may wonder how we square our theory and results with Moore (1966) and the scholars who have followed him (e.g. Ziblatt 2010). Moore argued that the second serfdom in Eastern Europe—and most particularly Prussia—was the driving force behind authoritarianism. A nobility enserfed a free peasantry, and in doing so blocked the kind of transition to more representative forms of government that took place in Western Europe. Grain exports in Moore's view, drove the creation of a militarized, status-oriented, landowning elite that quashed a society of small farmers and ultimately contributed to the rise of fascism.

On a superficial level, the Moorian story is not consistent with our theory: grain agriculture produced authoritarianism, not democracy. Yet a careful reading of Moore, and the works on which he drew, such as Gerschenkron (1943) and Blum (1957, 1961), suggests that the two frameworks are indeed compatible. The whole point of this literature is that there had been a society composed of independent, grain growing small farmers in Eastern Europe

until the fifteenth century when labor became scarce as a result of the Black Death. The literature goes to great pains to point out that the enserfment of Eastern Europe's independent farmers was a deviation from an underlying trend. The literature does not contend that the second serfdom occurred because there were large economies of scale in growing grain. In point of fact, Moore (1966) argues that repression was needed precisely because Eastern Europe's system of large-scale landholding was economically inefficient (see p. 437). Indeed, the puzzle Moore and others tried to explain was why Eastern Europe adopted this "feudalistic" system at exactly the time that labor scarcity was promoting economic and political freedom in Western Europe—a puzzle that was later taken up by Brenner (1976) and is still largely unresolved (Aston and Philpin 1985).

The bottom line is this: in both Moore's framework and ours, property rights in European grain agriculture can be thought of as an equilibrium of small free-holdings punctuated by aberrant periods in which land was aggregated into large estates. Indeed, the evidence suggests that the second serfdom in Eastern Europe was followed by a period in which small farms again emerged as the modal form of property ownership. How else would we explain Stalin's drive to exterminate the kulaks of the Ukraine, a group of grain growing family farmers who, like their counterparts elsewhere in the world, were highly independent and resistant to the reduction of their political and economic rights?

Empirical Implications

The theoretical framework outlined above generates several testable implications. First, there should be a positive, reduced form correlation between average annual precipitation and regime type, where regime type is conceptualized as a long-run equilibrium. Furthermore, this relationship should be non-linear. At extremely low levels of rainfall,

persistent autocracy should be observed. As the amount of yearly rainfall increases from extremely high aridity to moderate amounts of precipitation, stable democracy should emerge. At relatively high levels of rainfall, persistent autocracy should return. The reason for this non-linearity, as explained earlier, is that while moderate rainfall is conducive to rain fed agriculture, such as grains, which can be stored and produced at a modest scale, both very low and very high levels of rainfall are inimical to this type of agriculture.

Second, once we control for the level and distribution of human capital, this correlation should weaken, if not wash out entirely. The reason, as explained earlier, is that the effect of precipitation on regime type is indirect: it works exclusively through its effect on the social structure; rather than directly by, say, affecting the disease environment or favoring selective pressures that affect genetics and/or culture.

Third, if we substitute the quality of the soil in terms of its fertility and suitability for grain agriculture for average annual precipitation, there should be a positive relationship between improvements in the quality of the soil and regime type: that is, as rain fed grain agriculture becomes more viable, stable democracy should become more common. Since soil quality is likely to deteriorate at both low and high levels of rainfall—albeit for unique reasons at each of the extremes—this relationship should be linear. In other words, both low and high levels of rainfall are ultimately proxies of poor soil quality, while moderate rainfall is a proxy of good soil. Consistent with the logic outlined above, once we control for the level and distribution of human capital this correlation should weaken, if not vanish because soil quality works exclusively through its effect on the social structure rather than directly.

Operationalization of the Variables

To test these hypotheses, we constructed a cross-sectional dataset with global scope. As described earlier, for each country we measure the regime equilibrium as the average Polity Score obtained between 1965 and 2009. The mean Polity Score is 52.4, with a standard deviation of 30.7. Because we want to ensure that this measurement strategy is reliably capturing the political-institutional equilibrium across countries, we relegate attention only to countries for which we have annual observations during this time period—sovereign countries with at least 500,000 inhabitants that have been in continual existence since at least 1965. The full universe consists of 119 countries. Later we also run robustness tests on a dataset of 160 countries that fulfill the same criteria since 1991.

As also described earlier, we measure rainfall as the average, annual precipitation within 100 miles of the country's largest city, taking the average between 1850 and 1860. The mean precipitation is 1053.9 millimeters with a standard deviation of 910 millimeters. Following the non-linear hypothesis outlined above, we generated non-linear transformations of the natural log of Rainfall (we logged rainfall because it is considerably right-skewed). Specifically, we constructed two restricted cubic splines of log(Rainfall) with three knots where rainfall is defined to be a continuous smooth function that is linear before the first knot, a piecewise cubic polynomial between adjacent knots, and is linear after the last knot. The location of these three knots was chosen according to Table 2.3 of Harrell (2001), where the smallest knot may not be less than the 5^{th} smallest value of rainfall and the largest knot may not be greater than the 5^{th} largest value of rainfall. The knots that were produced via this algorithm correspond to the following (non-logged) values of Rainfall: the first knot is located at 395.5 mm; the second knot is located at 738.4 mm; and the third knot is located at 1727.7 mm.

Why did we choose this approach instead of, say, entering linear and quadratic terms into the regressions? The reason is because these splines are purely functions of the measure of average, annual precipitation and the knots. They are therefore not influenced by our measure of the regime equilibrium. This means that, quite literally, we generated the splines *before* specifying the dependent variable or the particular regression approach. Specifically, these non-linear transformations are not affected by whether we use average Polity Scores between 1965 and 2009 or between 1991 and 2009, or by the estimation strategy employed—for example, whether it requires the introduction of instrumental variables or not.

We also continue to measure countries' soil quality as the percentage of high quality soil, which we code as the percentage of land 100 miles outside the largest city that falls in Categories 1-4 of the Inherent Land Quality (ILQ) measure. The mean value is 28.9 percent, with a standard deviation of 24.4 percent. Finally, we measure the level and distribution of human capital as Newspaper Circulation Per Capita in 1965 (following Lipset 1960, and taking the data from the Banks Cross National Time Series Dataset). The mean is .09 newspapers per person, with a standard deviation of .12 newspapers per person. A broader array of summary statistics for each of these variables is documented in Table 1, along with summary statistics for the larger dataset that covers the countries in existence from 1991 to 2009. This table also includes summary statistics for the main control variables that will be described ahead, in their order of appearance, for both the dataset of countries in existence from 1965 to 2009 and the larger dataset. We note that for the latter, we measure newspapers per capita in 1991.

Multivariate Analysis

There are seventeen countries that have the highest level of democracy (100 points). Are all the countries that receive an average Polity Score of 100 during this time period the same? It is unlikely that the quality and resilience of all of these democracies is exactly uniform. Rather, scoring 100 is most likely the lower limit for the highest echelon of democracies. That is to say, we cannot observe Sweden's true Polity Score because this index is bounded at 100; therefore, even though Sweden and Costa Rica both receive Polity Scores of 100, it is hard to believe that they actually share the same degree of democracy during this period.

An Ordinary Least Squares (OLS) estimation strategy treats a 100 Polity Score as an actual value, not as the lower limit for those countries that are above the highest threshold of democracy. Statistically speaking, this creates two problems. First, OLS provides inconsistent estimates of the parameters (Long 1997, chapter 7). Second, if there is a lot of right-censored data, OLS estimates will be biased upward. Moreover, the greater the number of observations that cluster at 100, the greater the upward bias on the OLS estimates. Because 15 percent of our observations (17 out of 117) are right censored, it behooves us to eliminate this bias, lest we inflate the magnitude and statistical significance of the effect of rainfall and/or social structure on regime type. The canonical way to solve this problem is to estimate a Tobit model through maximum likelihood, where the observations are divided into two sets and we estimate the odds of being a censored observation through a probit type approach and also estimate a linear model for the uncensored observations. The tobit model is defined as:

$$y_i^* = \alpha + X_i\beta + \varepsilon_i \qquad (1)$$

where y_i^* is a latent response variable, X_i is an observed 1 X k vector of explanatory variables and ε_i is the error term. Instead of observing y_i^* we observe y_i:

$$y_i = \begin{cases} R_i \; if \; y_i^* \geq R_i \\ y_i^* if \; L_i < y_i^* < R_i \\ L_i \; if \; y_i^* \leq L_i \end{cases} \qquad (2)$$

$$y_i = \begin{cases} R_i \; if \; y_i^* \geq R_i \\ y_i^* if \; L_i < y_i^* < R_i \\ L_i \; if \; y_i^* \leq L_i \end{cases}$$

where R_i is the upper bound and L_i is the lower bound and both are constants. We estimate a model with censorship on both sides because one of the Polity observations, Saudi Arabia, takes on a value of zero. Applying the probability density function and the standard normal cumulative distribution, the log-likelihood function can be written as:

$$l = \sum_{i \in \{L_i > y_i > R_i\}} \ln\left[\phi\left(\frac{y_i - X_i\beta}{\sigma}\right)/\sigma\right] + \sum_{i \in \{y_i = R_i\}} \ln\left[\Phi\left(-\frac{R_i - X_i\beta}{\sigma}\right)\right] + \sum_{i \in \{y_i = L_i\}} \ln\left[\Phi\left(\frac{L_i - X_i\beta}{\sigma}\right)\right]$$

Table 2 reports results for a series of regressions that conform to this regression framework. Eicker-Huber-White heteroskedastic-consistent standard errors are estimated throughout the table and the remainder of the paper. In Column 1, we introduce the two rainfall splines described above. The first spline is positive, as predicted by our theory, the second one is negative, also as predicted. Each is highly statistically significant ($p<.001$). Figure 4 depicts the impact made by rainfall on Polity. While the observed values of Polity for each country are plotted on the Y-axis against their values of log(Rainfall), a solid line connecting the predicted values of Polity as a function of increases in precipitation is grafted upon them; 95 percent confidence intervals are represented by grey bands. Starting at around 188.9 mm of rainfall there is a very steep increase in the level of democracy as a function of

increasing rainfall, which begins to somewhat level off at about 641 mm, Portugal's average annual rainfall. The apogee of this positive effect is reached at slightly above 900 mm, roughly corresponding to Canada's average annual rainfall, as well as Ireland's, Switzerland's and Australia's. Once that threshold is surpassed, the positive relationship between increases in rainfall and democracy reverses: increases in precipitation above 900 mm of rainfall lower the level of democracy. Once the 95th percentile of the rainfall distribution, 2359.9 mm, is surpassed, there is a cluster of Southeast Asian countries, Cambodia, Myanmar, Laos and Vietnam, with Polity Scores below 52, the sample mean. They are all within, or in the neighborhood of, the 95 percent confidence bounds for the predicted values of Polity.

Four obvious questions arise. First, could low and high levels of rainfall merely proxy for a regional fixed effect? Following Gleditsch and Ward (2006), it could very well be the case that there is significant spatial correlation in countries' Polity Scores within different world regions because of democratic demonstration and diffusion effects. Second, could either low or high levels of rainfall merely proxy for a colonial fixed effect? European colonial powers practiced unique strategies of rule, and each imposed similar institutions across their colonial possessions, often in spite of cultural and historical differences. Could it be the case, for example, that the absence of stable democracies in arid geographies be a lingering effect of British suzerainty? The British competed with the Ottoman Empire over control of the Middle East during the eighteenth and nineteenth centuries, eventually displacing the Ottomans and exercising indirect rule by dispatching a series of "political residents" throughout North Africa and the Persian Gulf –including agents who resided in Egypt and Somalia and what is now modern day Yemen, Bahrain, Kuwait, Oman, Qatar, and the United Arab Emirates. Perhaps the legacy of British institutions associated with their "protectorate" regime, and not the (lack of)

rainfall endemic to this region, accounts for the democratic deficit that characterizes these countries today? Likewise, perhaps French patterns of colonialism based on a strategy of political centralization and micro-management from Paris accounts for the lack of democracy at relatively high levels of rainfall beyond the "moderate rainfall belt"?

Therefore, in Column 2 we now add both regional dummy variables and colonial heritage dummies. Both the regions and colonial masters are defined and measured by Hadenius and Teorell (2005). The joint statistical significance of the region dummies is extremely high, as is the case for the colonial dummies (see the lower panels of Column 2). Although the substantive effect of the first rainfall spline is reduced considerably, it is still positive and statistically significant at the 5 percent level. Similarly, although the substantive effect of the second rainfall spline is also reduced, it continues to be negative and significant at the 10 percent level. Removing the colonial dummies and including only the region dummies with the rainfall splines hardly changes the results, suggesting that it is the regional dummies that are highly correlated with countries' precipitation (results not shown)—a result that stands to reason because climate is a regional phenomenon. That the non-linear relationship between rainfall and regime type still holds, despite such an exacting specification, increases our confidence in the results.

Precipitation as an indirect effect

Our theory is that moderate levels of rainfall influenced the historical development of the fundamental institutions that are conducive to stable democracy in the distant past. The main transmission channel linking this geographically defined historical juncture and today's regime equilibrium is the level and distribution of human capital. That is, the pattern of rainfall works through human capital to affect regime types. Therefore, in Column 3, we

introduce our measure of human capital into the regressions, Newspaper Circulation per Capita. The effect is, as predicted, positive. It is also very strong, both in terms of its magnitude and statistical significance. Moving from zero newspapers per person in 1965 to .50 newspapers per person, the sample maximum and the value corresponding to Sweden, increases the Polity Score by slightly more than 60 points! This result is significant at better than the .001 level. Moreover, the statistical significance of the first rainfall spline drops to only the 10 percent level, while the second rainfall spline is now statistically indistinguishable from zero. In other words, introducing human capital has allowed us to capture the indirect effect by which precipitation in the past affects regime types today.

How do we know, however, that our measure of human capital is not capturing some other feature of modernization? For example, moderate rainfall and the agricultural surpluses we attribute to it also induce economic growth, and there is a well-known relationship between high per capita income and democracy (Lipset 1959; Epstein et. al. 2006). Alternately, it could be the case that low levels of human capital and their unequal distribution is proxying for the resource curse (see Ross 2001). Or, perhaps there is a relationship between low levels of human capital and it unequal distribution and Islam? That is, perhaps it is really Islam that is antithetical to democracy, and low levels of human capital are simply a proxy for countries with large Islamic populations (Lewis 1994: 4; Ross 2001). Islam was, of course, born in the Arabian Desert and was spread by mounted warriors across the Middle East, North Africa, and Central Asia—all areas characterized by low precipitation and low levels of newspapers in circulation in 1965.

Therefore, in Column 4 we introduce log(Per Capita GDP) in real 2000 international dollars.[6] The coefficient on human capital suffers a trivial reduction in both statistical and substantive significance and remains positive. Per Capita Income is positive, as expected, but it is not statistically significant at conventional levels. In Column 5 we add *Total Natural Resources Income Per Capita* (measured in thousands of constant 2007 dollars). This measure is logged after adding 1 (to deal with the zero values) because the data is considerably right-skewed. Human capital is again highly robust to its inclusion and although the coefficient on natural resources is negative, it is far from statistically significant. Finally, in Column 6 we add *Percent Muslim*. The effect is to strengthen the statistical and substantive significance of human capital; the percentage of the population that practices Islam enters with the wrong (positive) sign and is not statistically significant.

Due to space limitations, we do not report the results for the stepwise inclusion of the following variables: ethnic fractionalization, linguistic fractionalization, the percent of the population that is Arab, income inequality, and the rate of malarial infection in 1965. What the results of these regressions share in common is that human capital never loses its substantive or statistical significance and none of these variables is ever statistically significant at conventional levels. We also hasten to add that removing any one of these variables, or any combination, does not affect the general results. In the reduced form specifications where we do not include human capital, both the first and second rainfall splines are always significant at least at the 10 percent level. When including human capital, the results of rainfall wash out and are unaffected by the exclusion of any controls.

[6] For a discussion of the sources and methods used to develop each of these control variables, see our Appendix on Sources and Methods.

Endogeneity

Could it be the case that the results suffer from endogeneity bias? Could the causal arrow be running from democracy to high levels and equal distributions of human capital? After all, newspaper circulation per capita in 1965 is a function of the investment a society has made in education in the decades before 1965, and the investment the society has made in education in the decades before 1965 might be endogenous to the regime type before 1965. Moreover, it is hard to believe that the polity level post 1965 is unrelated to the polity level in the decades before 1965. Empirically, however, we do not find this to be the case. After running an instrumental variables (IV) version of the Tobit regressions run above, where we instrument Newspaper Circulation Per Capita with the two rainfall splines there is no evidence that Newspaper Circulation is endogenous to Polity (results not shown). The Wald test of exogeneity returns a chi-squared statistic of 0.11, with a p-value of 0.74. In other words, we cannot reject the hypothesis that Newspaper Circulation Per Capita is exogenous.

The reason for the exogeneity of Newspaper Circulation Per Capita is that we have rendered it orthogonal to the error term by controlling for region and colonial heritage fixed effects. When we omit the region and colonial dummies from the IV regression, the Wald Test now returns a chi-squared statistic of 4.81, with a p-value of 0.03. In other words, without the region and colonial dummies, we can firmly reject the hypothesis that Newspaper Circulation Per Capita is exogenous. Moreover, once we drop these dummies, the results on Newspaper Circulation Per Capita in the second-stage regression are as we would expect: highly significant in both a substantive and statistical sense. In short, the results suggest that the addition of region and colonial dummies renders an IV approach unnecessary and less efficient.

Measuring Geography as Soil Quality

How can we be certain that the positive effect of moderate rainfall on democracy is a product of grain and legume agriculture and its concomitant effects on the economy, social structure, and political institutions? Could it instead be the case, for example, that certain cultural adaptations conducive to authoritarian rule have occurred in low and high rainfall areas? To allay such a concern we rerun the same regressions as in Table 2, but now substitute the percentage of a land within 100 miles of the largest city that is classified by the USDA as Inherent Land Quality categories 1-4 for average annual precipitation. We expect a positive, linear relationship between improvements in the quality of the soil and regime type, because soil quality is likely to deteriorate at both low and high levels of rainfall.

Table 3, Column 1 reports the results for a bivariate regression of Polity against land quality. Land quality is highly statistically and substantively significant. A one percentage point increase in high quality land increases the Polity Score by roughly 0.55 points. In Column 2 we add both colonial and region fixed effects. Although the magnitude of the effect diminishes, the sign of the coefficient on land quality remains positive and statistically significant: a one percentage point increase in high quality land increases the Polity Score by roughly 0.23 points. Does this effect, as theorized, run through human capital? In Column 3 we introduce newspaper circulation per capita to find out. Human capital is highly statistically significant ($p < .001$). It is also substantially significant: increasing newspapers in circulation from zero to .5 per person (Sweden's value), increases the Polity Score by 58 points. Moreover, the coefficient on land quality is no longer significant at conventional levels. In other words, introducing human capital has allowed us to capture the indirect effect by which land quality affects regime types. In Column 4 we control for Per Capita Income;

while the results on human capital are materially the same, Per Capita Income is not significant. In Column 5 we control for Natural Resources Income; the results on human capital are again materially the same and there is no evidence of a resource curse. In Column 6 we control for Percent Muslim. Once again, the results on human capital do not change.

Using the Larger Dataset of Countries in Existence since 1991

A skeptical reader might argue that the results obtained so far for rainfall, land quality, and human capital are an artifice of the fact that we have relegated attention only to countries that have existed for the full span of years 1965-2009. Perhaps the results would be different if we also included the countries that have come into existence since 1965, most particularly the countries that emerged after the collapse of the Soviet Union in 1991? We therefore turn to a dataset that includes the sovereign countries with at least 500,000 inhabitants that have been in continual existence since 1991 or later. This dataset now includes 160 countries; the dependent variable is the average Polity Score obtained between 1991 and 2009, or the first year of observation and 2009.

In Table 4, Column 1, we introduce the two rainfall splines described earlier. Echoing the results from Table 2, the first spline is positive, as predicted by our theory, and the second one is negative, also as predicted. Each is highly statistically significant ($p<.001$). In Column 2 we add region and colonial fixed effects. Although the magnitude of the coefficients is nearly halved, each coefficient is statistically significant at the 5 percent level. In Column 3 we add human capital, as well as the main control variables from Tables 2 and Tables 3 (Per Capita Income, Natural Resources Income, and Percent Muslim, with the first two averaged between 1991 and 2009). As before, the rainfall splines are no longer statistically significant. Moreover, the one variable that is significant is human capital: going from zero newspapers

per person to .5 increases the Polity Score by an amazing 39 points! Column 4 repeats the same steps as Columns 1 through 3, except that we now substitute Inherent Land Quality for rainfall. In Column 4, the coefficient on land quality is positive and highly significant: a one percentage point increase in high quality land is associated with a 0.62 percentage point increase in the Polity Score. In Column 5, which adds region and colonial dummies, the magnitude of the effect is somewhat reduced, but its statistical significance remains quite high. In Column 6, we add human capital and the other controls. Human capital enters as positive and significant, while the magnitude of land quality attenuates. Taken together, the results reported in Table 4 suggest that the effect of climate on regime type is not sensitive to the time period and sample size. Table 4 also suggests that the effect of human capital on regime type is not sensitive to the time period and sample size.

Distinguishing Democratic Transition from Democratic Consolidation

So far we have operationalized regime equilibria as the average Polity Score over a period of several decades. What happens if, instead of averaging the level of democracy, we conceptualize the regime equilibrium as a nominal variable and switch to the country-year as the unit of analysis? What happens if we extend the time period to explore the relationship between rainfall and regime type over the scale of a century, rather than decades? Addressing these two questions not only allows us to make sure that our results are robust, but also allows us to test an additional implication of our theory: we do not expect that rainfall should increase the probability of a transition to democracy, but it should increase the odds of democratic survival once a transition has occurred.

We therefore estimate a series of dynamic logit regressions on a time-series cross-sectional dataset that runs from 1900 to 2006. We operationalize the dependent variable as

"Coherent Democracy", which is coded as "0" if the country-year has a Polity Score of 85 or above and coded as a "1" otherwise. We calculate separate estimates for those countries observed as democratic and those observed as autocratic—and then see whether their odds of switching between regime types is influenced by their rainfall. Specifically, a dynamic logit model can estimate a first-order Markov chain transition process between different states over time, where the probability distribution of y_{it} for observation i at time t is modelled as a function of i's prior state at previous time periods, t -1,…, t-T. The conditional transition probabilities are estimated via the following functional form:

$$\Pr(y_{it} = 1 \mid y_{it-1,} \mathbf{X}_{it}) = \Lambda[\alpha_k + \mathbf{X}_{it-1}\beta + y_{it-1}\rho + \xi(y_{it-1} * \mathbf{X}_{it-1}) + \mathbf{u}_{kt}] \quad (3)$$

where $\Lambda(\cdot)$ is the logistic cumulative distribution; α represents separate intercept terms for each colonial master and region of the world that are potentially correlated with variables in $\mathbf{X}$, which is a (n×k) matrix of n observations on k explanatory variables; β is a vector of estimated parameters that indicate the effects of the covariates on the probability of a 1 at time t given a 0 at time t-1 and ρ is the estimated coefficient on the lagged dependent variable (LDV); the effects on the probability of a 1 at time t given a 1 at time t-1 are given by $\beta + \xi$ (the coefficients on the interactions between y_{it-1} and $\mathbf{X}_{it}$); and $\mathbf{u}$ is a (n×1) vector of disturbance terms that are unique to each colonial legacy and region. The first set of coefficients evaluates the correlates of democratic survival; the addition of these coefficients and their respective interaction terms evaluates the correlates of democratic transition.[7] Robust standard errors clustered by year address spatial correlation and the LDV addresses temporal dependence.

[7] Logistically, one must add this coefficient and its interaction term and subtract the sum of this addition from 1 identifies the impact of the independent variable on the odds of democratic transition. To calculate the z-statistics for the coefficients that gauge the probability of transitions from autocracy to democracy we use the Delta Method since we are calculating the statistical significance of the addition of a linear term and its interaction with the LDV.

We present the results in Table 5. Column 1 estimates the effect of the rainfall splines on democratic breakdown for countries that are observed in any year as democratic after controlling for region dummies, colonial dummies, year fixed effects, Per Capita Income, Natural Resources Income and Percent Muslim. The coefficient on the first rainfall spline is negative and highly statistically significant ($p < .001$): increases in rainfall from low to moderate precipitation decreases the odds of democratic breakdown. The coefficient on the second rainfall spline is positive and statistically significant ($p = .04$): increases in rainfall from moderate to high rainfall increases the odds of democratic breakdown. In short, moderate rainfall helps democracies survive, while high rainfall hastens their breakdown. What is important to note is that this is true even after controlling for Per Capita Income, which is, as expected, positive and highly statistically significant. In Column 2 we evaluate the relationship between the covariates and the odds of democratic transition. Neither of the rainfall splines is statistically significant. In other words, rainfall does not induce democratization, but it does influence whether a democratic transition produces a stable democracy.

Thus far, we have been able to measure the degree of "liberal democracy" because the Polity Score is a multidimensional index that captures not only the competitiveness of elections but the degree of constraints on the executive and pluralism. What if we switch to a bare-bones measure of electoral democracy? We now do so in Columns 3 and 4, where we use Regime, a binary, electoral-based measure of democracy coded by Cheibub and Gandhi (2010) and supplemented with data from Boix and Rosatto (2001) that merely indicates whether elections are free and fair and whether there is turnover in office. We expect that this experiment will produce weaker results because an electoral based measure of democracy does not embody the notion of a regime equilibrium in which elections are but one dimension of several political

institutions such as the rule of law. As in Column 1, Column 3 estimates the correlates of democratic survival. And, again as in Column 1, while the first rainfall spline is negative, the second rainfall spline is positive. However, as suspected, the first rainfall spline is barely statistically significant, at the 10 percent level and the second rainfall spline is not significant at conventional levels—although the p-value is .14. Column 4 tells the same story as Column 2: rainfall is not associated with a transition to democracy. In short, while moderate rainfall is good for democratic consolidation and heavy rainfall is bad for democratic consolidation, the level of rainfall does not matter for democratic transition.

Ancient Greece: An Out of Sample Test

Does the relationship between rainfall and democracy hold before the advent of modern democracy in the 19th Century? Does it also work through grain agriculture and human capital? Suffice it to say, we do not, as yet, have systematic measures of regime types in antiquity. Ancient historians provide, however, a wealth of knowledge about political regimes in antiquity. They also provide a wealth of knowledge about social structures. Two facts about the ancient world are a measuring rod of sorts that we can compare our theory to. The first is that the place where representative institutions first emerged, Greece in the fifth century (BCE), was located in the band of moderate rainfall. There is consensus among ancient historians that this was an intensively agricultural society that produced storable crops under rain fed technologies that had modest economies of scale in production: wheat, legumes of various types, grapes (stored as wine), and olives (stored as oil). The second is that the social structure of fifth century Greece was not only highly egalitarian (Morris 1996, 1997), but that the level of human capital was quite high and broadly distributed (Ober 1998, 2008). In all of these senses, Greece was very much unlike the ancient empires and states that ringed

the Middle East and North Africa, and that were its competitors, most particularly Persia and Egypt. Indeed, it is telling that even when Egypt was conquered by the Greeks in the fourth century BCE its basic political institutions remained unchanged: Egypt's foreign rulers, the Ptolemies, set themselves up as new Pharaohs, not as democrats.

Conclusion

We would be remiss to sidestep the fact that 2011 has proven to be the year of popular revolution in the Middle East and North Africa (MENA)—revolutions putatively fought under the banner of democratic reform. Protesters have taken to the streets and demanded political and economic rights. The sincerity of these demands is matched by survey evidence of strong support for democracy in this region of the world (e.g., Jamal 2006). Yet if the thirst for political freedom is so strong in the MENA, then why is it a veritable democratic desert?

While a bevy of researchers have weighed in on the persistence of autocracy in this part of the world, none of the extant explanations is particularly convincing. Some researchers have suggested that it is the region's oil wealth. Yet the countries of the MENA were autocracies for centuries before they found oil; moreover, some of them, like Bahrain and Libya, have lots of oil, while others, such as Yemen and Egypt, barely have any. Others have suggested Islam. Yet both Turkey and Indonesia are democracies; and the latter has the largest Islamic population in the world; moreover, many of the persistent autocracies of the Middle East and North Africa, most notably Iran, Iraq, and Egypt, antedate Islam by more than a millennium. Moreover, in this paper we have not found evidence that is strongly consistent with these explanations.

The states that make up the Middle East and North Africa are among the world's oldest—and have persistently settled into patterns of autocratic rule since their creation.

Egypt has been a territorial state since the first pharaoh in 3150 BC, but it has never once in five millennia experimented with democracy. The overthrow of the Alawiyya Dynasty in 1952 did not produce a republic; it resulted in the dictatorship of Gamal Abdel Nasser. Contrary to popular belief, present day Iraq has been a recognizable political entity since Sargon of Akkad united the city-states of Mesopotamia by conquest in the 23rd century BC. Although the last Iraqi monarch was overthrown in 1958, he was replaced by Saddam Hussein. Iran has been a state since the creation of the Persian Empire in the 6th century BC. Its last monarch, Shah Reza Pahlavi, was overthrown in 1979, but he was replaced by yet another autocrat, the Ayatollah Khomeini. Syria has an equally long history. In fact, Damascus is one of the oldest continually inhabited cities on the planet. Even before Bashar al-Assad and his father, Hafez al-Assad, created a dynasty that has endured since 1970, Syria was governed by a succession of tyrants. For a short period, it even united with Egypt as a single country under Nasser. A similar outcome was obtained in Libya when King Idris was overthrown in 1969, bringing Muammar Gaddafi to power. Yemen, too, successfully deposed its monarch in 1962, but he was replaced by the brutal dictatorship of Ali Abdullah Saleh.

In this paper we have argued that the reason for the democratic desert that has always characterized the MENA is indeed that it is a desert! Conversely, the world's moderate rainfall band includes its most stable democracies. Indeed, the first democracies—both in antiquity and in the modern era—were not only located in this band of moderate rainfall, but they emerged out of societies composed of citizens who not only had attained high average levels of education but who were relatively equally matched in terms of their educational endowment and sophistication. Colonial New England is, of course, the archetype: a society of highly literate, family farmers. What was true about New England was also true, however,

about Ancient Athens, 17th Century Holland, 18th Century England, and 19th Century Canada.

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Figure 1:
Average Precipitation 1970-80 vs Polity 1965-2009

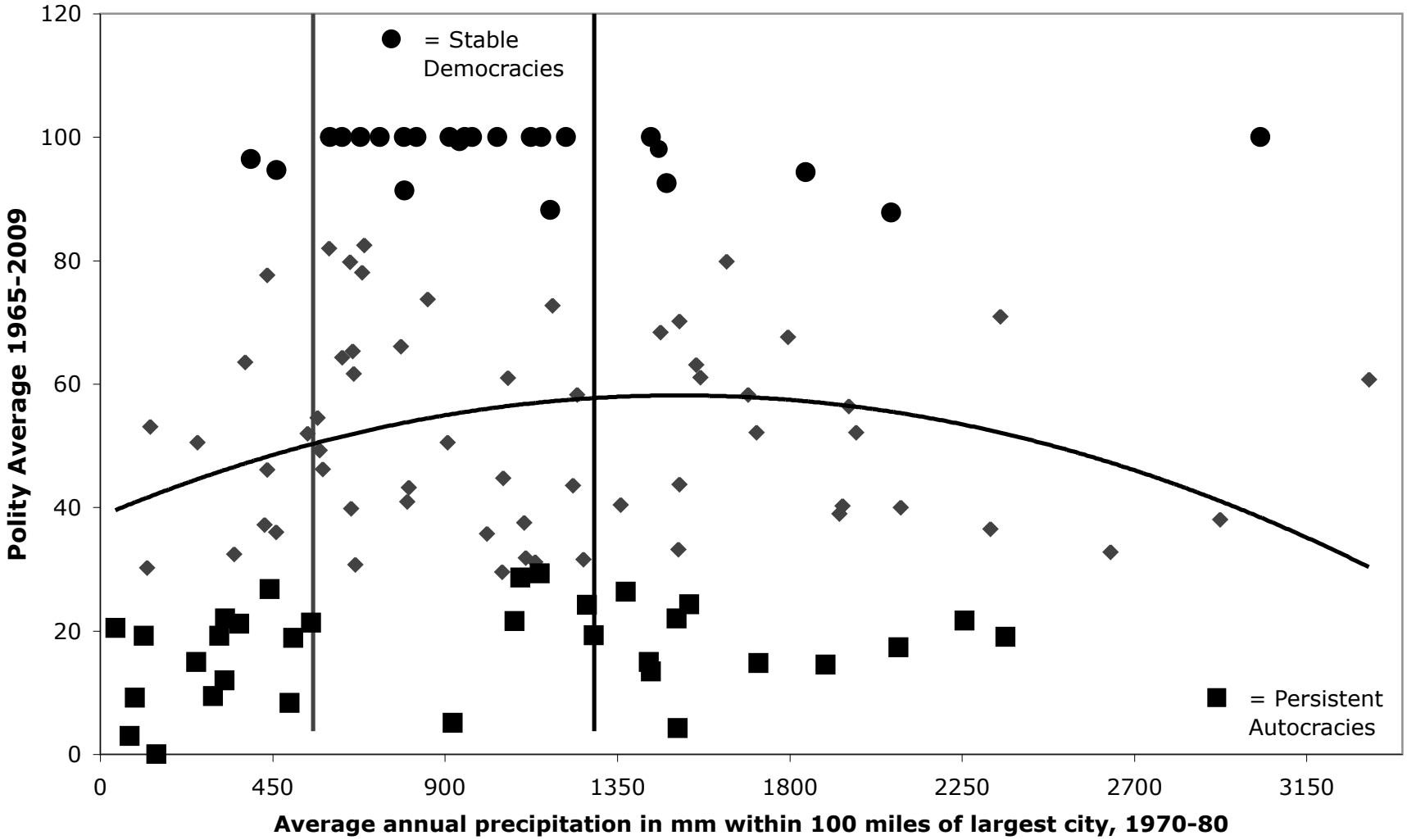

Figure 2
Average Precipitation 1850-60, versus Polity, 1965-2009

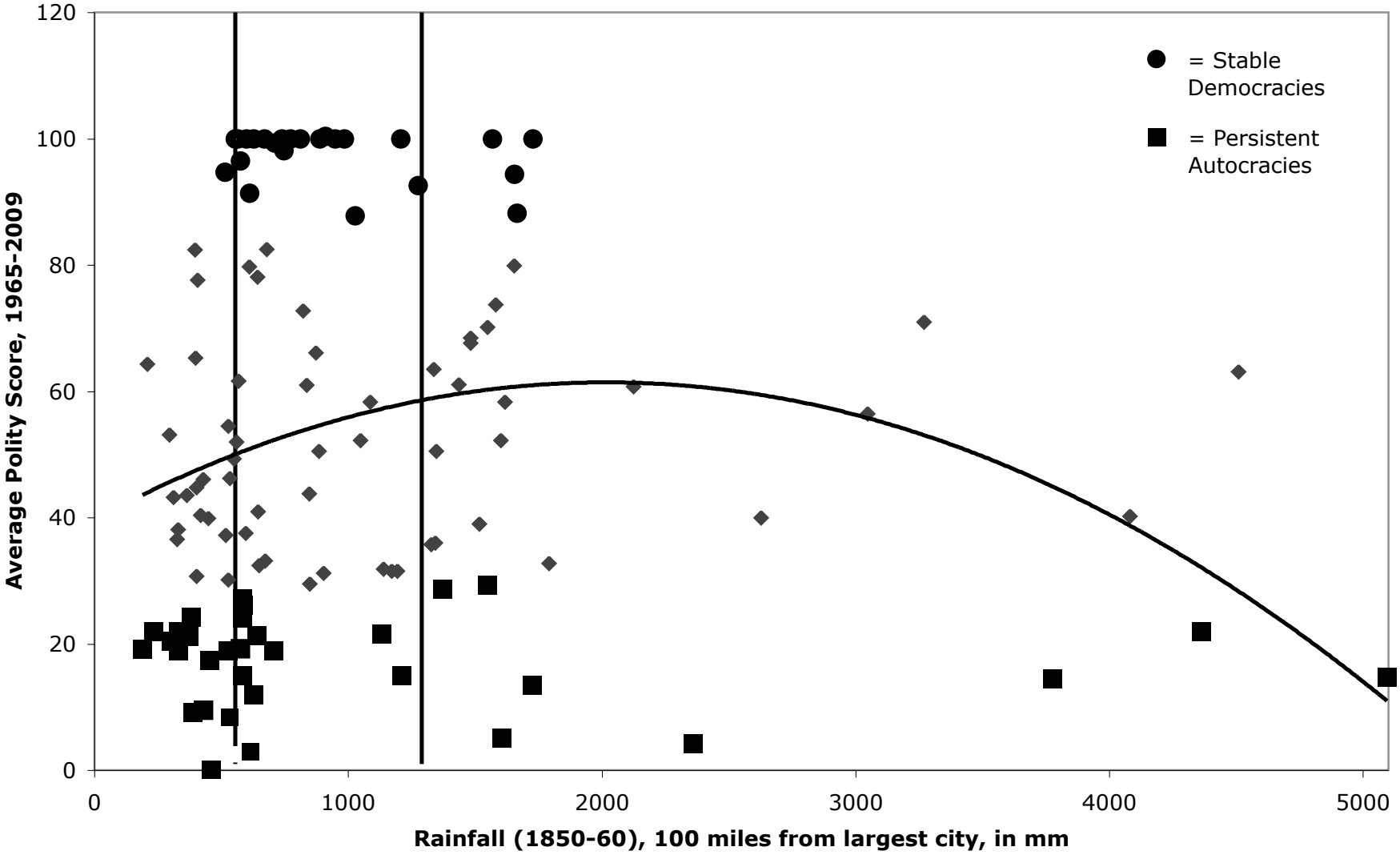

Figure 3
Polity (1965-2009) and Percent High Quality Land

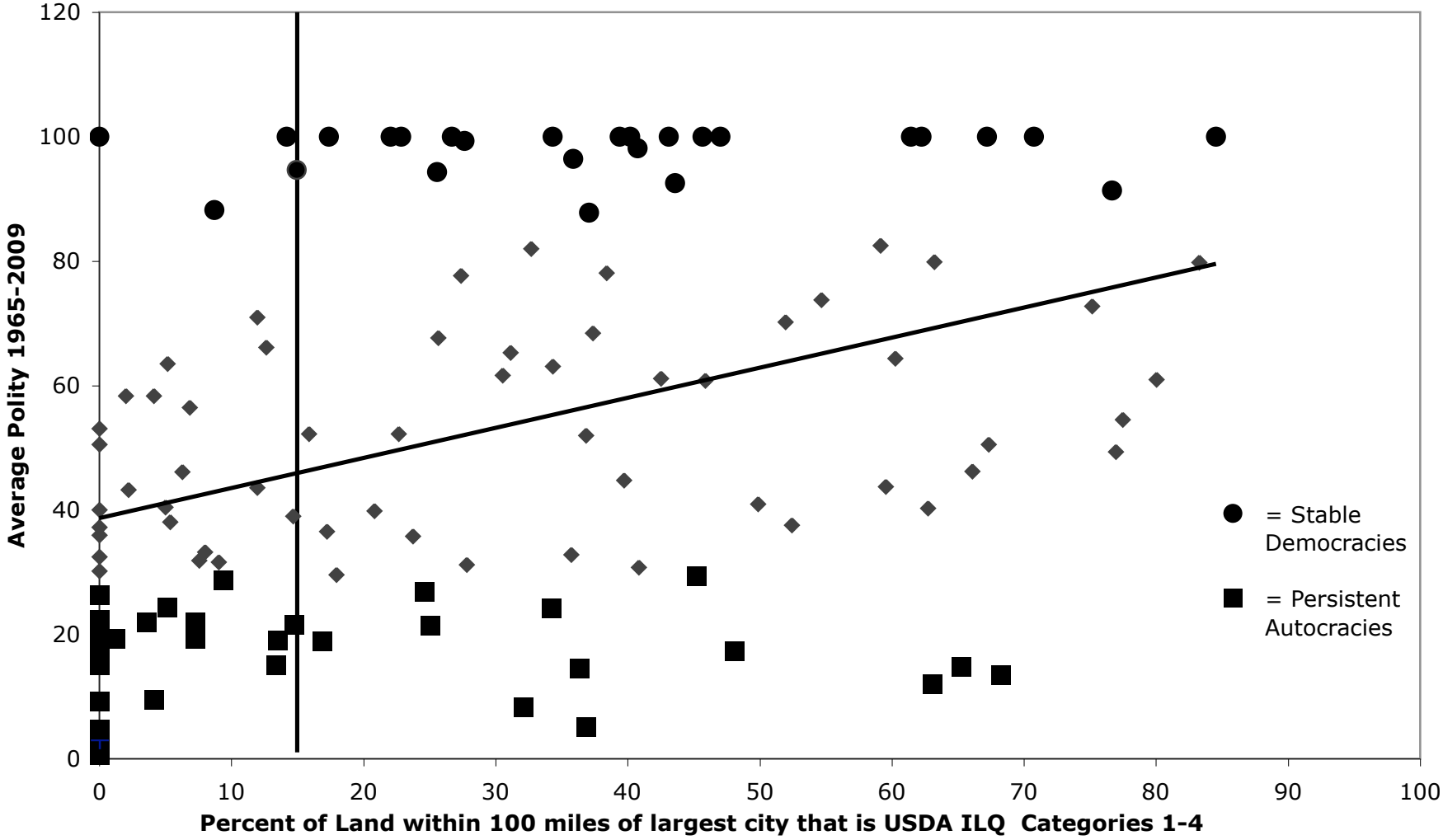

Figure 4. Using Rainfall to predict Regime Type

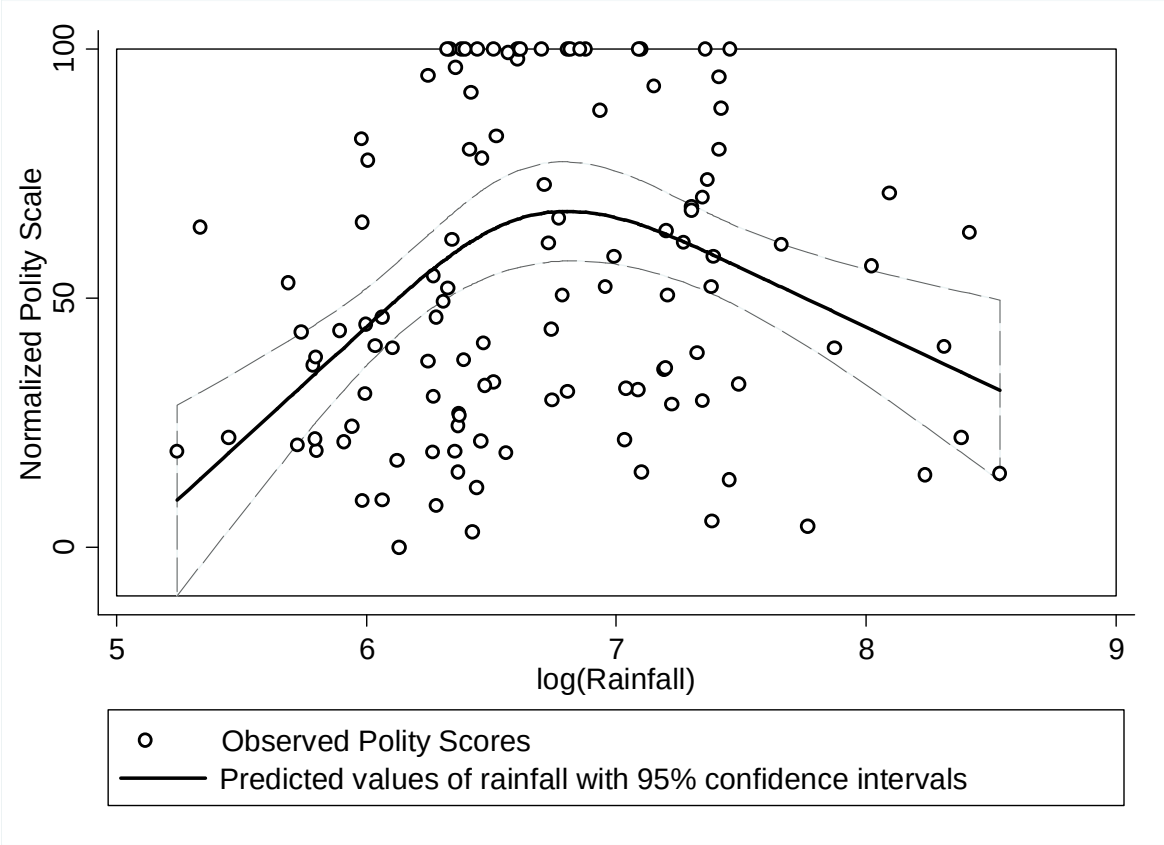

Table 1. Summary Statistics for Dependent Variable, Independent Variables and Controls

Sample 1: 1965-2009 (Only countries that are sovereign since 1965)

VARIABLE	Observations	Mean	Stand. Dev.	Minimum	Maximum	Units
Polity Regime Type Index	119	52.39	30.65	0	100	Ordinal Index
Rainfall (100 miles out)	117	1053.94	910	188.94	5094.45	millimeters
Land Quality (100 miles out)	117	28.9	24.4	0	84.5	% total land
Newspapers per Capita (1965)	119	0.09	0.12	0	0.5	Per Person
Per Capita Income	119	3829	3	406	33007	$ Per Person
Per Capita Natural Resources Income	119	82	5886	10	13985	$ Per Person
Muslim	119	26.88	37.88	0	100	% total population

Sample 2: 1991-2009 (Countries sovereign in 1991 or beyond)

VARIABLE	Observations	Mean	Stand. Dev.	Minimum	Maximum	Units
Polity Regime Type Index	160	64.31	31.56	0	100	Ordinal Index
Rainfall (100 miles out)	158	957.37	823.04	188.94	5094.45	millimeters
Land Quality (100 miles out)	158	27.2	25.3	0	89.6	% total land
Newspapers per Capita (1991)	141	0.1	0.14	0	0.61	Per Person
Per Capita Income	160	4438	3	436	32322	$ Per Person
Per Capita Natural Resources Income	160	843	6498	10	14702	$ Per Person
Muslim	159	27.8	38.07	0	100	% total population

For Sample 1, variables are averaged between 1965 and 2009 except for Newspapers Per Capita; for Sample 2, variables are averaged between 1991 and 2009, except for Newspapers Per Capita.

Table 2: The Relationship Between Rainfall, Human Capital, and Democracy

Dependent Variable is the average, Normalized Polity Score [0 to 100] between 1965 and 2009

Tobit regressions to address left and right censoring; robust t-statistics in brackets

	[1]	[2]	[3]	[4]	[5]	[6]
log(Rainfall Spline 1)	45.958	15.941	11.532	12.055	10.734	13.567
	[4.48]***	[2.46]**	[1.90]*	[1.95]*	[1.72]*	[1.91]*
log(Rainfall Spline 2)	-54.826	-21.325	-10.244	-9.809	-9.562	-10.632
	[4.32]***	[1.82]*	[0.82]	[0.79]	[0.76]	[0.82]
Human Capital			123.784	110.35	103.459	104.756
			[3.41]***	[2.84]***	[2.85]***	[2.89]***
log(Per Capita Income)				2.996	5.198	5.479
				[0.86]	[1.36]	[1.41]
log(Natural Resources PC)					-1.673	-1.449
					[1.06]	[0.92]
Percent Muslim						0.089
						[1.11]
Region Dummies	NO	YES	YES	YES	YES	YES
Colonial Dummies	NO	YES	YES	YES	YES	YES
F-test on Reg. Dummies		20.15	17.4	15.31	11.23	10.2
p-value		0	0	0	0	0
F-test on Col. Dummies		94.84	64.63	41.91	10.91	5.53
p-value		0	0	0	0	0
Observations	117	117	117	117	117	117

* significant at 10%; ** significant at 5%; *** significant at 1%

Control variables are averaged between 1965 and 2009; constant estimated but not reported.

For Rainfall we estimated Restricted Cubic Splines where log(Rainfall) is a continuous smooth function that is linear before the first knot, and a piecewise cubic polynomial between the second the third knots.

Table 3. The Relationship between Land Quality, Human Capital, and Democracy

Dependent Variable is the average, Normalized Polity Score [0 to 100] between 1965 and 2009

Tobit regressions to address left and right censoring; robust t-statistics in brackets

	[1]	[2]	[3]	[4]	[5]	[6]
Inherent Land Quality	0.552	0.229	0.186	0.183	0.168	0.186
	[4.55]***	[2.36]**	[1.92]*	[1.89]*	[1.77]*	[1.82]*
Human Capital			115.306	107.074	100.813	101.032
			[3.27]***	[2.75]***	[2.73]***	[2.72]***
log(Per Capita Income)				1.805	4.321	4.397
				[0.54]	[1.14]	[1.16]
log(Natural Resources PC)					-1.777	-1.711
					[1.18]	[1.13]
Percent Muslim						0.06
						[0.78]
Region Dummies	NO	YES	YES	YES	YES	YES
Colonial Dummies	NO	YES	YES	YES	YES	YES
F-test on Region Dummies		18.44	13.47	12.41	8.9	7.29
p-value		0	0	0	0	0
F-test on Colonial Dummies		109.22	96.84	53.32	9.88	5.53
p-value		0	0	0	0	0
Observations	117	117	117	117	117	117

* significant at 10%; ** significant at 5%; *** significant at 1%

Control variables are averaged between 1965 and 2009; constant estimated but not reported.

Inherent land quality measured as the average within 100 miles of the largest city.

Table 4. The relationship between Rainfall, Land Quality, Social Structure and Democracy

Dependent Variable is the average, Normalized Polity Score [0 to 100] between 1991 and 2009
Tobit regressions to address left and right censoring; robust t-statistics in brackets

	[1]	[2]	[3]	[4]	[5]	[6]
log(Rainfall Spline 1)	42.904	20.708	-0.079			
	[4.57]***	[2.55]**	[0.01]			
log(Rainfall Spline 2)	-50.855	-24.601	4.879			
	[4.19]***	[2.16]**	[0.38]			
Inherent Land Quality				0.623	0.356	0.206
				[6.06]***	[3.66]***	[2.05]**
Human Capital			77.713			72.697
			[2.53]**			[2.52]**
log(Per Capita Income)			9.05			8.45
			[2.16]**			[1.99]**
log(Nat. Resources PC)			-5.042			-4.768
			[3.03]***			[2.95]***
Percent Muslim			-0.137			-0.097
			[1.39]			[1.04]
Region Dummies	NO	YES	YES	NO	YES	YES
Colonial Dummies	NO	YES	YES	NO	YES	YES
F-test on Reg. Dummies		10.32	7.54		7.54	8.07
p-value		0	0		0	0
F-test on Col. Dummies		84.52	5.54		5.54	6.43
p-value		0	0		0	0
Observations	158	158	140	158	158	140

* significant at 10%; ** significant at 5%; *** significant at 1%

Constant estimated but not reported. Control variables averaged between 1991 and 2009, Human Capital measured in 1991.
For Rainfall we estimated Restricted Cubic Splines where log(Rainfall) is a continuous smooth function that is linear before the first knot, and a piecewise cubic polynomial between the second and third knots.

Table 5. Determinants of Transition from Democracy to Autocracy and from Autocracy to Democracy

Dynamic Logit Transition Models (First-order Markov Chain)

Dependent Variable is coded 1 if autocracy and 0 if democracy

Robust z statistics clustered by year in brackets

	Model 1, Coherent Democracy (Polity)		***Model 2, Electoral Democracy (Regime)***	
Regime transitioning *from*	Democracy	Autocracy	Democracy	Autocracy
Regime transitioning *to*	Autocracy	Democracy	Autocracy	Democracy
log(Rainfall Spline 1)	**-2.027**	**2.93**	**-0.75**	**-0.446**
	[3.65]* **	**[0.57]**	**[1.65]***	**[0.94]**
log(Rainfall Spline 2)	**1.888**	**-0.704**	**0.901**	**1.012**
	[2.06] **	**[0.88]**	**[1.47]**	**[1.57]**
log(Per Capita GDP) t-1	-1.047	0.562	-0.926	0.429
	[5.15]***	[3.06]***	[5.10]***	[2.81]***
log(Natural Resources P.C.) t-1	-0.041	-0.195	0.014	-0.179
	[0.30]	[2.01]**	[0.15]	[1.98]**
Percent Muslim	-0.009	0.001	-0.005	-0.002
	[1.42]	[0.33]	[0.82]	[0.05]
Colonial Dummies	YES	YES	YES	YES
Regime Dummies	YES	YES	YES	YES
Observations	8852	8852	8790	8790

* significant at 10%; ** significant at 5%; *** significant at 1%
Lagged dependent variable estimated but not shown: intercept and region and colonial dummies estimated but not shown.