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# Crop Yield and Democracy

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**ABSTRACT** *How does the historical legacy of agriculture affect democratic traditions in contemporary societies? This paper provides empirical evidence that inherent crop yield and democracy exhibit an inverted U-shaped relationship. This finding is supported by cross-country data from up to 147 countries, 186 pre-colonial societies, and the U.S. states. The relationship thus exhibits a highly persistent pattern. Crop yield is measured by kilocalories per hectare per year under rain-fed conditions, which has the advantage of being highly exogenous. The hump-shaped relationship holds up to a battery of robustness tests.* (JEL O11, O13)

## 1. Introduction

Since the Neolithic Revolution, agriculture has historically been the dominant sector and remains so today in many developing economies. How does this legacy affect democratic traditions in contemporary societies? This paper contributes to the literature by showing that the level of democracy is associated with the inherent productivity of land. In particular, crop yield and democracy form a robust inverted U-shaped relationship.

Stylized facts provide strong motivation for our analysis. Galor and Özak (2016) provide an index of potential crop yield in million kilocalories per hectare per year.[1] Countries with intermediate levels of crop yield (such as Austria, New Zealand, and the United States) tend to be democracies. In contrast, countries both in the bottom decile of the distribution of crop yield (including Egypt, Saudi Arabia, and Qatar) and in the top decile of the distribution (including Cuba, Swaziland, and Tanzania) tend to be autocracies or exhibit low levels of democracy (as measured by Polity2 for 1961–2015 by Marshall, Gurr, and Jaggers 2015).[2] In Swaziland, for example, land tenure is central to politics (Levin 1987). The allocation of land (“Swazi Nation Land”) by the king (an absolute monarch) through the chiefs is a prominent feature of royal rule. Essentially, the Swazi king is the elite holding power over the agricultural sector.

Using cross-country data from up to 147 countries, we first establish a hump-shaped relationship between crop yield and the average level of democracy from 1961 to 2015. Countries endowed with the least productive crop land tend to have low levels of democracy, similar to those countries with the highest crop yields. Democracy peaks in the intermediate range of crop yield. This result holds up to a host of robustness checks.

Second, we present results using the Standard Cross-Cultural Sample (SCCS) assembled by Murdock and White (1969). The SCCS provides a representative sample of world cultures in 186 societies in precolonial times, with minimum influence of the European colonizers. Our two measures of democ-

[1] Galor and Özak (2016) utilize data from the Global Agro-Ecological Zones (GAEZ) project of the Food and Agriculture Organization, and caloric content of various crops from U.S. Department of Agriculture Nutrient Database for Standard Reference.

[2] Appendix Table A1 provides more details. The table includes no democracy except Norway. While many countries in the bottom decile have ample oil reserves, the correlation between potential crop yield and (1) oil production/GDP, and (2) oil reserves, in our dataset are –0.39 and –0.27, respectively.

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Appendix materials are freely available at http://le.uwpress.org and via the links in the electronic version of this article.

racy reflect the process of succession and existing executive constraints. We find that the inverted U-shape existed before the colonial era. This suggests a highly persistent pattern.

Third, we analyze democracy at the state level in the United States, the oldest democracy. As for the measure of democracy, we follow Vanhanen (2000) and utilize voter turnout in parliamentary and presidential elections as a reflection of active participation of citizens in the selection of the executive. The hump-shaped relationship holds also at the state level in the United States.

Existing theories are unable to fully explain the hump-shaped relationship established in this paper. However, they jointly help facilitate our understanding and suggest that persistent inequality of income may be an important mechanism for the empirical pattern discovered here. We start with a discussion of areas with low crop yield under rain-fed conditions, which tend to be arid or semi-arid. In such areas, irrigation is necessary for crop production. Irrigated agriculture exhibits substantial scale economies. This raises the size of firms and creates barriers to entry. Bentzen, Kaarsen, and Wingender (2017) argue that a history of irrigation-based agriculture has created a resource curse. Economic and political elites who controlled the use of water engaged in rent-seeking activities, and high levels of inequality emerged. These elites have throughout history been unwilling to allow democracy to develop. On the other hand, suppose land was not irrigated (due to low inherent land fertility). In such areas people tended to engage in long distance transportation (e.g., the Bedouins on the Arabian Peninsula, the Berbers across the Sahara, and various tribes along the Silk Road) or in violent raiding and conquering of agricultural areas (Haber and Menaldo 2011). In these areas, democratic traditions were unlikely to develop.

At the middle range of crop yield, independent (often cereal producing) family farms tended to emerge with a more equal distribution of income (Sokoloff and Engerman 2000; Engerman and Sokoloff 2005a, 2005b). Small-scale farmers favored public goods such as the protection of property rights, enforceable contract law, and quality education. These factors facilitated the creation of democratic traditions.[3]

At sufficiently high crop yields, land provides large rents. Plantation crops such as bananas, cocoa, and sugar are often favored. Such crops are highly conducive to large scale production, owned by a small elite and associated with intense rent-seeking, slavery, and inequality (Wright 1970; Engerman and Sokoloff 1997, 2005a, 2005b; Sokoloff and Engerman 2000; Easterly 2007). Lagerlöf's (2009) theoretical model argues that sufficiently high land productivity causes the elite to utilize slavery in production. This enables the elite to pay workers less than their marginal product but necessitates costly guards. Fenske (2013) provides empirical evidence of a positive correlation between land quality and slavery in preindustrial Africa.[4] Wright (1970) argues that the cotton-slavery sector in the highly fertile U.S. South was associated with a high degree of concentration of income and wealth. The economic and political inequalities produced by rent-seeking and the institution of slavery have persisted for centuries (Engerman and Sokoloff 1997; Sacerdote 2005; Nunn 2008a, 2008b; Miller 2012).[5]

An advantage of Galor and Özak's (2016) potential crop yield measure is its high degree of exogeneity. Using a measure of potential calorie output facilitates comparisons across countries and sharpens the focus on the histor-

[3] Acemoglu and Robinson (2000) argue that in the late nineteenth and early twentieth centuries, democratization occurred in Western societies despite rising inequality associated with industrialization, because the elite wanted to avoid social unrest or a revolution. Haber and Menaldo (2011) argue that democracy is more likely to persist in areas with a broad distribution of human capital, and moderate rainfall levels led to a broad distribution of human capital through a greater prevalence crop types suitable for family farms. Family farm production yielded incentives to set up institutions that protect private property and make intergenerational investments in human capital.

[4] Lagerlöf's (2009) model also suggests that at high levels of agricultural productivity, slavery disappears because an associated high population density (building on a Malthusian argument) makes free labor cheaper than slaves. This model thus predicts an inverted U-shaped relationship between slavery and agricultural productivity. However, in practice the downward sloping part of this inverted U may occur out of sample.

[5] Appendix Figure A1 illustrates a positive correlation between our measure of crop yield and the fraction of slaves in 28 New World countries in 1750.

ical importance of calories in most of human history. This paper contributes to the literature by establishing a robust nonlinear empirical relationship between historical agricultural crop production and contemporary democratic institutions. We believe this is a more general finding than that discussed by, for example, Engerman and Sokoloff (1997), who provide case studies of crops such as wheat and sugar, not rigorous evidence.

Our findings are robust to a number of checks. These include using several alternative democracy and crop yield measures, controlling for the potential confounding effects of historical institutions, accounting for various linear and nonlinear effects of early development, allowing for various effects of contemporary development and social cleavages, among others. Additionally, we employ a battery of parametric and nonparametric methods to further establish our finding of a robust quadratic relationship.

## 2. Empirical Approach and Data

### Regression Model

In order to evaluate the influence of potential crop yield on the degree of democracy, we estimate the following regression model:

$$\text{democracy}_i = \beta_0 + \beta_1 \text{cropyield}_i + \beta_2 \text{cropyield}_i^2 + \beta_3 \textbf{controls}_i + \epsilon_i, \quad [1]$$

where $\text{democracy}_i$ is the average level of democracy in country $i$ over the period of study, $\text{cropyield}_i$ is the potential crop yield in country $i$, $\textbf{controls}_i$ is a vector of control variables included in the regression to minimize the possibility of getting spurious estimates, and $\epsilon_i$ is the country-specific error term.

Equation [1] represents a reduced-form specification that aims to examine the influence of potential crop yield on democracy. $\beta_1$ and $\beta_2$ are the coefficients of interest.

### Data

This section describes the data for the main variables. The summary statistics and a correlation matrix are provided in Appendix Tables A2 and A3, respectively.

*Democracy Measures*

Our baseline sample used in the cross-country analysis consists of data for up to 147 countries. Our main measure of democracy is the average value of the Polity2 score for the period 1961–2015. The data come from the Polity IV project (Marshall, Gurr, and Jaggers 2015). The database provides a democracy classification for all independent countries with a total population greater than 0.5 million in 2015 (167 countries). Polity2 classifies regimes on a 21-point scale ranging from –10 (hereditary monarchy) to +10 (consolidated democracy).[6]

We focus on the post-1960 period, as most of the former European colonies in sub-Saharan Africa, the Middle East, and South and East Asia had gained independence by 1960. This permits us to explore the effect of potential crop yield on democracy, while reducing the possibility that the results are confounded by the colonial powers' direct influence on their former colonies' domestic institutions. However, in the robustness analysis we test our model using data spanning alternative time periods starting from 1800. Alternative democracy measures from Freedom House (2016) are also used in robustness checks.

*Potential Crop Yield*

The independent variable of interest is an index of potential crop yield, measured in millions of kilocalories per hectare per year. The data are obtained from Galor and Özak (2016), who construct a dataset using the Global Agro-Ecological Zones (GAEZ) project of the Food and Agriculture Organization (FAO). GAEZ supplies global yield and growth cycle estimates for 48 crops (listed in Appendix Section 5) in grids with a cell size of 5 feet × 5 feet (approximately 100 km$^2$). GAEZ supplies crop yield estimates for each crop based on three alternative levels of input (high, medium, and low) and two feasible sources of water supply (rain-fed water supply and irrigation). The dataset provides potential yield estimates for each crop in each agroclimatic grid, while accounting for the effect of temperature and moisture on crop growth.

[6] Appendix Figure A2 shows the distribution of Polity2 (average score 1961–2015) across the world.

The index of potential crop yield is constructed using a low level of inputs and rain-fed agricultural cultivation methods (see Appendix Section 5 for more details). This reflects farming practices prevalent during the early stages of preindustrial development. Furthermore, the FAO dataset provides two alternative projections of potential yield estimates for each crop based on agroecological constraints and agroclimatic conditions, respectively. The potential crop yield based on agroecological constraints can be affected by human intervention, while the potential crop yield based on agroclimatic conditions is arguably unaffected by human intervention. To mitigate concerns of reverse causality, this index is computed from the potential crop yield based on agroclimatic conditions under rain-fed low-input agriculture. These estimates of potential crop yield account for the effect of temperature and precipitation on the growth of the crop. In addition to climate-related "workability constraints," these estimates also consider the impact of pests, disease, and weeds on yields. The FAO dataset also provides estimates of the growth cycle for each crop, capturing the number of days it takes for each crop from planting to maturity.

Each crop yield in the GAEZ data (measured in tons per hectare per year) is converted by Galor and Özak (2016) into caloric yield (millions of kilocalories per hectare per year). This represents the variation in nutrition across crops, which facilitates a comparison of crop yields. The U.S. Department of Agriculture (USDA) Nutrient Database for Standard Reference provides data on the caloric content of various crops. Using these measures, the estimated average regional crop yield reflects the average regional levels of two variables, crop yield and crop cycle, among crops that maximize the caloric yield in each cell. Our analysis focuses on averages across cells within each country. We include only cells where the maximum potential crop yield is positive, following Galor and Özak (2016).

The crop yield index addresses the limitations of other available weight-based agricultural yield indices. For example, the land productivity index constructed by Ramankutty et al. (2002) does not reflect the fact that equally suitable land can have a large variation in crop yield, since caloric-intensive crops may not be cultivated in some regions (see Galor and Özak 2015).

It is also worth highlighting that we use potential crop yield as a proxy for actual crop yield. Actual crop yield is likely to be affected by human intervention, which may result in spurious estimates. Moreover, autocratic regimes may potentially manipulate crop yield data or not share actual data with international agencies such as the FAO. Furthermore, GAEZ provides actual crop yield data for the year 2000 only, which does not provide sufficient exogeneity. Using potential crop yield data, however, is not without limitations. Potential sources of measurement errors include limited spatial weather data from developing countries, local variation in land quality, and differential data quality across different areas. As a sanity check, we regress (mean) actual crop yield on (mean) potential crop yield. These variables are significantly correlated, conditioning on the baseline geographic influences.[7] Hence, while there is no reliable way to tackle the issue of measurement errors, this simple analysis provides some credence to using the potential crop yield data.

*Control Variables*

Some geographic features may potentially confound the association between crop yield and the extent of democracy. In our regressions, we therefore control for absolute latitude, terrain ruggedness, elevation, variation in elevation, landlockedness and distance to nearest waterway. We also include continent dummies to account for any omitted variable bias due to time-invariant continent-specific geographical, cultural, or historical characteristics.

## 3. Main Results

### Baseline Regression Results

Table 1 presents our findings for the influence of crop yield on the extent of democracy.

[7] Appendix Figure A3 shows the distribution of potential crop yield (millions of kilocalories per hectare per year). The bottom decile of countries has a crop yield below 908, while the top decile has a yield above 11,474 (see Appendix Table A1).

**Table 1**
The Effect of Crop Yield on Democracy (Dependent Variable: Polity2)

| | (1) | (2) | (3) | (4) | Baseline (5) |
|---|---|---|---|---|---|
| Crop yield | 0.20** | 1.64*** | 1.45*** | 1.48*** | 1.04*** |
| | (2.58) | (6.33) | (6.72) | (6.54) | (4.05) |
| Crop yield squared | | –1.49*** | –1.17*** | –1.24*** | –0.91*** |
| | | (–5.60) | (–5.22) | (–5.39) | (–3.46) |
| Absolute latitude | | | 0.46*** | 0.48*** | 0.27** |
| | | | (7.22) | (7.40) | (2.06) |
| Terrain ruggedness | | | | –0.08 | –0.05 |
| | | | | (–0.68) | (–0.47) |
| Elevation (mean) | | | | –0.03 | 0.20 |
| | | | | (–0.18) | (1.41) |
| Elevation (standard deviation) | | | | –0.00 | –0.17 |
| | | | | (–0.00) | (–1.58) |
| Landlocked | | | | –0.05 | –0.08 |
| | | | | (–0.53) | (–1.10) |
| Distance to waterways | | | | –0.15 | –0.09 |
| | | | | (–1.47) | (–1.22) |
| Optimal crop yield | | 7,031 | 7,892 | 7,625 | 7,286 |
| Observations | 147 | 147 | 147 | 147 | 147 |
| Continent fixed effects | No | No | No | No | Yes |
| Adjusted $R$-squared | 0.04 | 0.18 | 0.37 | 0.40 | 0.54 |
| Test for inverted U-shape | — | 4.76 [$p$ = 0.00] | 3.85 [$p$ = 0.00] | 4.18 [$p$ = 0.00] | 2.83 [$p$ = 0.00] |

*Note:* This table presents standardized coefficients for the effect of average crop yield (measured in millions of kilocalories per hectare per year) on Polity2 over the period 1961–2015. All specifications use an intercept term, but it is not reported for brevity. The continent dummies are Africa, Asia, Australia, Europe, North America, Oceania, and South America. Robust $t$-statistics are given in parentheses.

**, *** Significance at the 5% and 1% levels, respectively. The test for an inverted U-shape uses Lind and Mehlum's (2010) approach.

Column (1) reports a positive and significant association between potential crop yield and the extent of democracy. In column (2) we add potential crop yield squared along with linear potential crop yield. The result suggests a potentially inverted U-shaped association between the extent of democracy and potential crop yield, with a positive coefficient for potential crop yield and a negative coefficient for the quadratic term. The quadratic pattern improves the fit, as both linear and quadratic terms are statistically significant and the adjusted $R^2$ increases.

In column (3), we include absolute latitude, which captures some climatic influences. Low latitudes are often associated with poor soil quality, highly variable rainfall, and a high incidence of debilitating tropical diseases (Olsson and Hibbs 2005). While absolute latitude helps explain the extent of democracy, the influence of crop yield on democracy remains intact. Our results remain robust to the inclusion of additional geographical controls in column (4), including terrain ruggedness, average elevation, elevation variation, landlockedness, and distance to waterways. Finally, we account for continent fixed effects in column (5). The coefficients of the linear and quadratic crop yield variables remain statistically significant at the 1% level. We choose the specification in column (5) as our baseline model and use it for the robustness analysis below.[8]

Adding the linear and quadratic effects along with other baseline controls, democracy reaches a maximum at a potential crop yield equal to 7,625 in column (4). The optimal potential crop yield declines marginally to 7,286 after controlling for continent fixed effects in column (5). The optimal level of potential crop yield for the United States equals 7,589, close to the democracy-maximizing yield in the baseline model.

It should be highlighted that a significant number of observations are located on either side of the peak of the inverted U. Examples of democracies (Polity2 score equal to 10)

[8] Appendix Figure A4 illustrates the estimated inverted U-shaped relationship between the potential crop yield and average democracy.

with crop yields close to the democracy-maximizing level are Austria (6,815), New Zealand (6,538), and the United States (7,590) (crop yields in parentheses). A total of 20 countries in our sample have average Polity2 scores equal to +10, and two countries have average scores equal to –10. This artificial censoring on the extreme values, imposed by design of the Polity2 measure, may affect our estimates, since we cannot observe the true value for part of the dependent variable and its probability density function becomes noncontinuous beyond the range. In an additional analysis, we therefore repeat the estimations reported in Table 1 using Tobit estimations (also known as censored regression estimations). The results are reported in Appendix Table A4. The results show that our findings are not driven by any arbitrary censuring of the Polity2 data.

### Evidence of an Inverted U-Shaped Relationship

We have established that the linear and quadratic terms are statistically significant after controlling for baseline controls. We utilize several statistical tests and approaches to establish a hump-shaped relationship, and to exclude the possibility of a higher-order nonlinear relationship between contemporary democracy and potential yield.

First, we follow Lind and Mehlum (2010), who improve upon Sasabuchi's (1980) test for an inverted U-shape. The test results are reported at the bottom of Table 1 and indicate that the slope of the estimated curve is increasing for low values of potential crop yield, but decreasing for high values. Moreover, the optimal yield value associated with a peak lies within the data range. Using our baseline specification in Table 1 (last column) as an illustration, the test of the positive slope at the lowest value of crop yield (0) yields a $t$-statistic of 4.047 ($p = 0.000$). In contrast, the test of the negative slope at the maximum value of potential crop yield (17,998) gives a $t$-statistic of –2.834 ($p = 0.000$). Overall, the test rejects the null hypothesis that the underlying relationship is monotonic at the 1% level of significance ($t$-statistic = 2.830; $p = 0.002$), thus providing evidence supporting our inverted U-shape hypothesis. The results are consistent for columns (2) to (4). Note that we also obtain the same result (unreported) when the sample is restricted to only non-OECD countries ($t$-statistic = 2.440; $p = 0.008$).

Second, while the results above provide evidence for the presence of a U-shaped relationship, doing so does not eliminate the possibility of a higher-order nonlinear relationship between contemporary democracy and potential crop yield. In particular, Simonsohn (2016) argues that imposing a quadratic relationship and interpreting it as evidence of a U-shaped association may be misleading. Rather, we should first identify a threshold and then use a "two-line" approach to estimate two separate linear models for observations above and below the threshold. In our baseline model (last column, Table 1), democracy is predicted to reach a maximum at the potential crop yield of 7,286 million kilocalories per hectare per year. Following Simonsohn (2016), we estimate the linear relationship both below and above this threshold. The two linear models presented in columns (1) and (2) of Appendix Table A5 confirm the presence of a statistically significant hump-shaped relationship between democracy and potential crop yield.

Third, to allow for the possibility of the presence of a higher-order relationship, we include a cubic term in the model specification along with the quadratic relationship. This provides a simple test for the presence of a possible S-shaped relationship. The results presented in column (3) of Appendix Table A5 reject the presence of an S-shaped relationship. Overall, the results of these various methods show that the quadratic relationship between the level of democracy and potential crop yield is robust.[9]

## 4. Robustness of Results

### Are the Results Robust to Institutions and Early Development?

This section accounts for institutions developed centuries ago, and other early devel-

[9]We provide the results of the Lind-Mehlum test in all subsequent tables (where applicable). This does not imply that we favor this approach relative to the other two, but is due to the ease of reporting.

opment indicators. These may possibly have confounding effects on the extent of contemporary democracy. The results are reported in Table 2. Column (1) reports the findings after accounting for dummies for the major categories of the origin of colonizers in our global sample: Britain, France, Spain, Portugal, and other European colonizers. In column (2), we restrict our sample to countries that were colonized by a European colonial power only. The results in columns (1) and (2) indicate that colonial history does not affect the finding of an inverted U-shape.

Olsson (2009) argues that a longer duration of colonization has had a positive influence on contemporary democracy. Column (3) accounts for this effect. The inverted U-shaped pattern survives, although the coefficient sizes decrease. The duration of colonization has a positive influence on democracy, consistent with Olsson (2009).

The European colonizers transferred their legal systems to the colonies, which remained after independence. Moreover, these legal systems served as role models for countries that were never colonized. In column (4) we account for British common law, French civil law, German civil law, Scandinavian law, and socialist law legal origins. Hall and Jones (1999) argue that social infrastructure, including institutions and government policies, are endogenously determined by geography and other regional factors. These may be captured by language. They utilize the share of European languages spoken. In a similar vein, Easterly and Levine (2016) propose that countries' economic characteristics were shaped by the share of the population of European descent during the colonial era. In column (5), we account for the possible confounding effects of these two channels. The number of observations falls to 118, as data on European language shares are available for fewer countries. The early disease environment and population health conditions have been shown to affect the historical development of institutions (Acemoglu, Johnson, and Robinson 2003). We account for disease environment in column (6) by using a measure of pathogen stress. Our main result holds.

Next, we focus on five measures of early development that may act as possible confounders. These are all strongly correlated with the current economic development, social capital, and the quality of institutions. First, Ang (2013b) provides evidence that the early development of a state influences the development of contemporary institutions. We use a measure of state antiquity (statehood experience) provided by Putterman (2012) for the period 1–1500 CE. This index reflects the existence of a government, how much territory it covered, and whether the government was indigenous or externally imposed. The period 1–1500 CE is divided into 50-year periods, discounted by 5% for each half century. Column (7) suggests that the inverted U-shaped relationship survives after accounting for state antiquity.

Second, we control for the timing of the agricultural transition (Neolithic revolution), namely, the year a country started sedentary agricultural practices, consumed mostly cultivated foods, and abandoned the hunter-gatherer lifestyle. The timing of this transition helps explain, for example, income levels, comparative financial development, and technological advancement (Putterman 2008; Ang 2013a, 2015). Accounting for the agricultural transition in column (8) leads to no qualitative changes in the main results.

Our third measure of early development is the estimated population density in 1500 CE (column 9). The Malthusian theory suggests that higher agricultural productivity leads to higher fertility, lower mortality, and higher population growth, thus hampering economic development. Next, Olsson and Hibbs (2005) establish that initial biogeographic conditions influenced contemporary levels of economic development via an early transition to agriculture. Furthermore, Ahlerup and Olsson (2012) show that the duration of human settlement in a region is positively associated with the level of ethnic diversity. This influences contemporary development. We account for these two indicators in columns (10) and (11), respectively. The relevant inverted U-shaped association continues to hold.

Column (12) accounts for the influence of (predicted) genetic diversity. Genetic diversity was determined tens of thousands of years ago as humans migrated out of Africa (Ashraf and Galor 2013). The literature suggests that

**Table 2**
Accounting for Institutions and Early Development (Dependent Variable: Polity2)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop yield | 1.12*** | 1.65*** | 1.00** | 1.13*** | 1.20*** | 1.08*** | 0.86*** | 1.04*** | 1.01*** | 0.99*** | 1.12*** | 0.99*** | 0.57* |
| | (4.17) | (4.16) | (2.63) | (4.54) | (3.68) | (4.24) | (3.09) | (3.89) | (3.70) | (3.53) | (4.31) | (3.82) | (1.97) |
| Crop yield squared | –0.98*** | –1.49*** | –1.00** | –0.97*** | –1.01*** | –0.85*** | –0.81*** | –0.97*** | –0.92*** | –0.97*** | –0.97*** | –0.89*** | –0.61** |
| | (–3.63) | (–3.74) | (–2.62) | (–4.13) | (–3.22) | (–3.42) | (–2.84) | (–3.71) | (–3.27) | (–3.54) | (–3.70) | (–3.44) | (–2.24) |
| Colonial history (*F*-statistics) | 1.63 | 2.63 | | | | | | | | | | | |
| | [$p = 0.16$] | [$p = 0.04$] | | | | | | | | | | | |
| Duration of colonization | | | 0.32*** | | | | | | | | | | |
| | | | (2.66) | | | | | | | | | | |
| Legal origin (*F*-statistics) | | | | 8.51 | | | | | | | | | |
| | | | | [$p = 0.00$] | | | | | | | | | |
| European population (%) | | | | | 0.16* | | | | | | | | 0.28*** |
| | | | | | (1.97) | | | | | | | | (2.99) |
| European language (%) | | | | | 0.14* | | | | | | | | |
| | | | | | (1.67) | | | | | | | | |
| Pathogen stress | | | | | | –0.24* | | | | | | | 0.02 |
| | | | | | | (–1.67) | | | | | | | (0.13) |
| State antiquity (1500) | | | | | | | –0.06 | | | | | | –0.01 |
| | | | | | | | (–0.74) | | | | | | (–0.09) |
| Years since agricultural transition | | | | | | | | –0.22* | | | | | –0.44*** |
| | | | | | | | | (–1.79) | | | | | (2.70) |
| Population density (1500), log | | | | | | | | | –0.02 | | | | –0.26** |
| | | | | | | | | | (–0.23) | | | | (–2.07) |

*(table continued on following page)*

**Table 2**

Accounting for Institutions and Early Development (Dependent Variable: Polity2) *(continued)*

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biogeography | | | | | | | | | | –0.30** | | | –0.15 |
| | | | | | | | | | | (–2.04) | | | (–0.80) |
| Human settlement | | | | | | | | | | | 0.04 | | –0.04 |
| | | | | | | | | | | | (0.33) | | (–0.31) |
| Genetic diversity (predicted) | | | | | | | | | | | | –0.30 | 0.40 |
| | | | | | | | | | | | | (–1.14) | (1.39) |
| Observations | 147 | 95 | 84 | 147 | 118 | 132 | 131 | 144 | 137 | 129 | 139 | 147 | 113 |
| Adjusted *R*-squared | 0.545 | 0.439 | 0.46 | 0.619 | 0.552 | 0.588 | 0.512 | 0.547 | 0.512 | 0.533 | 0.543 | 0.539 | 0.60 |
| Continent dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Baseline controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Optimal crop yield | 7,260 | 6,983 | 6,578 | 7,421 | 7,549 | 7,981 | 6,993 | 6,866 | 7,174 | 6,814 | 7,417 | 7,060 | 6,045 |
| Sample | Global | Former colonies | Global | Global | Global | Global | Global | Global | Global | Global | Global | Global | Global |
| Test for inverted U-shape | 2.99 | 3.20 | 2.45 | 3.52 | 2.67 | 2.55 | 2.46 | 3.31 | 2.76 | 3.30 | 3.00 | 2.94 | 1.97 |
| | [$p$ = 0.00] | [$p$ = 0.00] | [$p$ = 0.01] | [$p$ = 0.00] | [$p$ = 0.00] | [$p$ = 0.01] | [$p$ = 0.00] | [$p$ = 0.00] | [$p$ = 0.00] | [$p$ = 0.00] | [$p$ = 0.00] | [$p$ = 0.00] | [$p$ = 0.02] |

*Note:* This table presents standardized coefficients for the effect of (mean) crop yield (measured in millions of kilocalories per hectare per year) on Polity2 over the period 1961–2015. All specifications use an intercept term, but it is not reported for brevity. The continent dummies are Africa, Asia, Australia, Europe, North America, Oceania, and South America. Baseline controls used are absolute latitude, terrain ruggedness, elevation (average), elevation (variation), landlockedness, and distance to waterways. Robust *t*-statistics are given in parentheses.

*, **, *** Significance at the 10%, 5%, and 1% levels, respectively. The test for an inverted U-shape uses Lind and Mehlum's (2010) approach.

genetic diversity plays an important role in the determination of contemporary productivity, economic development, ethnic conflicts, and social hierarchy (Ashraf and Galor 2011, 2013; Arbatli et al. 2015; Ashraf, Galor, and Klemp 2015; Galor and Klemp 2015).

We account for the various potential confounders simultaneously in column (13). The number of observations declines to 113. However, even after controlling for these early development indicators, the hump-shaped relationship between potential crop yield and democracy survives.

Next, the recent literature suggests that the association between the early development indicators and contemporary economic development may be more complex than previously believed (see, e.g., Ashraf and Galor 2013; Borcan, Olsson, and Putterman 2016). A concave relationship may be more accurate. Appendix Table A6 provides estimates of alternative specifications where we add squared terms for most of the early development indicators discussed earlier. The linear and squared crop yield coefficients are statistically significant at the 1% level in all specifications. State history and population density appear to have concave effects on democracy. In contrast, disease environment, years since agricultural transition, and biogeography (which all had a linear influence in Table 2) show no significant effects when their squared terms are added. The coefficients of human settlement and genetic diversity remain insignificant. The "optimal crop yield" estimates remain fairly stable in Table 2, with an average deviation of 5% from the baseline model estimate (Table 1, column 5).

## Are the Results Robust to Contemporary Development and Social Cleavages?

According to Lipset (1959), a higher per capita GDP improves the level of democracy. Column (1) in Table 3 accounts for (log of) per capita GDP in 1960 (just before the start of the timing of the outcome variable). The sample size declines to 95 countries (due to the unavailability of data for some countries in the Penn World Table). While the coefficient of (log of) GDP per capita has a positive sign, it is statistically insignificant.

Next, we study the influence of human capital on democracy. We measure human capital by the amount of schooling. The influence of education on democracy is currently unsettled in the literature.[10] Column (2) controls for the average years of schooling in 1960. Our results suggest that average schooling in 1960 is complementary to potential crop yield and appears to promote democracy. We also use several alternative measures of human capital, including newspaper circulation per capita, following Haber and Menaldo (2011), and two human capital stock measures from Lee and Lee (2016). The estimates in columns (1) to (3) of Appendix Table A7 indicate that our results are not influenced by the choice of measure for human capital.

Several studies highlight a negative association between the production of oil and democracy (e.g., Barro 1999; Ross 2001; Tsui 2011; Van der Ploeg 2011), consistent with the resource curse hypothesis. Multiple countries in our sample produce oil or have large reserves. To mitigate any confounding effects, we account for average oil income as a proportion of GDP over the 1961–2015 period. Oil income has a negative association with democracy in column (3). A series of additional robustness tests account for the resource curse due to having more than one-third of export income made up by oil (Appendix Table A7, column 4). We use a dummy for OPEC countries (Appendix Table A7, column 5) and control for the presence of oil or diamonds (Appendix Table A7, column 6). The baseline results remain robust.

While the main objectives of foreign aid are to promote economic growth and improve

[10] On the one hand, education promotes a "culture of democracy" according to Dewey (1916). Similarly, Lipset (1959) argues that educated people understand the need for norms of tolerance; they make more rational electoral choices as education broadens people's outlook. Lipset (1959) suggests that education is "close to being a necessary condition" for democracy. Castelló-Climent (2008) finds a positive empirical association between education and democracy (see also Murtin and Wacziarg 2014). In contrast, Acemoglu et al. (2005) find no effect of education on democracy. They argue that the statistical associations between education and democracy in previous studies disappear when time and country fixed effects are introduced. However, they do not reject the possibility of a causal relationship between education and democracy in the long term.

**Table 3**

Accounting for Social Cleavages and Other Effects (Dependent Variable: Polity2)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop yield | 0.89*** | 0.97*** | 0.94*** | 1.37*** | 0.99*** | 0.89*** | 1.06*** | 1.10*** | 0.85*** | 0.55* | 1.09*** | 1.11*** |
| | (2.78) | (3.26) | (3.76) | (4.45) | (3.67) | (3.51) | (4.31) | (4.30) | (3.18) | (1.87) | (4.49) | (4.41) |
| Crop yield squared | –0.78** | –0.86*** | –0.83*** | –1.15*** | –0.96*** | –0.76*** | –0.94*** | –0.96*** | –0.72*** | –0.61** | –0.96*** | –0.95*** |
| | (–2.38) | (–2.99) | (–3.32) | (–3.63) | (–3.65) | (–3.03) | (–3.70) | (–3.67) | (–2.67) | (–2.23) | (–3.85) | (–3.73) |
| GDP/capita (1960), log | 0.18 | | | | | | | | | | | |
| | (1.11) | | | | | | | | | | | |
| Years schooling (1960) | | 0.45*** | | | | | | | | | | |
| | | (4.85) | | | | | | | | | | |
| Oil production/GDP | | | –0.12** | | | | | | | | | |
| | | | (–2.11) | | | | | | | | | |
| Foreign aid (% of GDP) | | | | 0.02 | | | | | | | | |
| | | | | (0.26) | | | | | | | | |
| Religion (*F*-statistics) | | | | | 3.40 | | | | | | | |
| | | | | | [*p*=0.02] | | | | | | | |
| Ethnic fractionalization | | | | | | –0.10 | | | | | | |
| | | | | | | (–0.97) | | | | | | |
| Language fractionalization | | | | | | 0.20* | | | | | | |
| | | | | | | (1.68) | | | | | | |
| Religion fractionalization | | | | | | 0.02 | | | | | | |
| | | | | | | (0.31) | | | | | | |

*(table continued on following page)*

**Table 3**

Accounting for Social Cleavages and Other Effects (Dependent Variable: Polity2) *(continued)*

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Birthplace diversity | | | | | | | –0.08<br>(–1.35) | | | | | |
| Emigration rate | | | | | | | | –0.05<br>(–1.06) | | | | |
| Crop yield variation | | | | | | | | | 0.15*<br>(1.82) | | | |
| Potential Irrigation | | | | | | | | | | –0.28**<br>(–2.59) | | |
| Trade openness | | | | | | | | | | | –0.11**<br>(–1.87) | |
| Share of agriculture in GDP | | | | | | | | | | | | –0.02<br>(–0.24) |
| Observations | 95 | 124 | 145 | 121 | 146 | 140 | 146 | 145 | 147 | 147 | 145 | 146 |
| Adjusted $R$-squared | 0.57 | 0.605 | 0.558 | 0.416 | 0.562 | 0.565 | 0.550 | 0.541 | 0.543 | 0.552 | 056 | 0.55 |
| Continent dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Baseline controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Optimal crop yield | 7,928 | 7,158 | 7,216 | 7,577 | 6,572 | 7,432 | 7,182 | 7,350 | 7,459 | 5,724 | 7,214 | 7,430 |
| Test for inverted U-shape | 1.88<br>[$p = 0.03$] | 2.60<br>[$p = 0.01$] | 2.77<br>[$p = 0.00$] | 2.81<br>[$p = 0.00$] | 3.36<br>[$p = 0.00$] | 2.44<br>[$p = 0.01$] | 3.06<br>[$p = 0.00$] | 2.99<br>[$p = 0.00$] | 2.15<br>[$p = 0.02$] | 1.87<br>[$p = 0.03$] | 3.18<br>[$p = 0.00$] | 2.97<br>[$p = 0.00$] |

*Note:* This table presents standardized coefficients for the effect of (mean) crop yield (measured in millions of kilocalories per hectare per year) on Polity2 over the period 1961–2015. All specifications use an intercept term, but it is not reported for brevity. The continent dummies are Africa, Asia, Australia, Europe, North America, Oceania, and South America. Baseline controls used are absolute latitude, terrain ruggedness, elevation (average), elevation (variation), landlockedness, and distance to waterways. Religion accounts for Protestant, Roman Catholic, Muslim, and Hindu. Robust $t$-statistics are given in parentheses.

*, **, *** Significance at the 10%, 5%, and 1% levels, respectively. The test for an inverted U-shape uses Lind and Mehlum's (2010) approach.

institutional quality in recipient countries, recent studies have questioned the effectiveness of foreign aid infusion (e.g., Svensson 2000; Rajan and Subramanian 2007; Nunn and Qian 2014). Column (4) accounts for average foreign aid (net official development aid as a fraction of the recipient country's GDP) over the period 1961–2015. Recent studies suggest that religion and political regime may have an association (e.g., Woodberry 2012).[11] Column (5) controls for the percentage of the population that follows Protestantism, Roman Catholicism, Islam, and Hinduism. The relevant inverted U-shaped relationship remains robust. Next, we control for the potentially confounding effects of population heterogeneity. Alesina et al. (2003) and Fearon (2003) construct measures of diversity including ethnic, linguistic, and religious fractionalization, utilized in column (6). Only language fractionalization has a significant effect.

Alesina, Harnoss, and Rapoport (2016) propose a diversity index for the place of birth of immigrants. With increased migration, the cultural norms and practices of a region may change. Similarly, Docquier et al. (2016) propose that the emigration rate is associated with the development of institutions in the country of origin. We account for birthplace diversity and emigration rate in columns (7) and (8). Next, including a measure of the variation in potential crop yield in column (9) suggests a positive association with democracy, contrary to expectations. Bentzen, Kaarsen, and Wingender (2017) argue that in arid and semi-arid regions, irrigation is necessary and exhibits scale economies. The elite have had control over water and restricted the development of democracy. The coefficient on irrigation potential in column (10) takes the expected negative sign and is significant. Finally, in columns (11) and (12) we control for trade openness and the contribution of agriculture to GDP, respectively. No qualitative changes occur in the inverted U-shaped association between potential crop yield and democracy. Similar to the earlier findings, the estimates of the "optimal crop yield" are found to be fairly stable when additional controls are considered.

## Are the Results Robust to Alternative Measures?

Many countries have historically experienced sharp changes in the level of democracy. The choice of time period of study may consequently affect our results. We therefore vary the time period over which the average democracy level is measured. In column (1) of Table 4, we use all available Polity2 data since 1800. The inverted U-shaped relationship between crop yield and democracy remains robust. The relevant coefficients are significant at the 1% level and are qualitatively similar to those in our baseline results in Table 1. The fit of the model declines by roughly one-third. However, being able to explain 36% of the average cross-country variation in democracy over more than two centuries is still notable, in our view. Column (1) supports our argument that the inverted U-shaped relationship holds in the very long run.

In columns (2) through (4), the starting year is 1901, 1931, and 1991, respectively. While the inverted U-shape survives in columns (2) and (3), the squared potential crop yield term becomes insignificant at conventional levels in column (4). This may be due to the third wave of democratization, which saw a sudden adoption of democracy by a number of countries after the end of the cold war (Russett et al. 1993). We also utilize various subsamples of data from the nineteenth century; the subsample periods are 1800–1850, 1800–1900, and 1851–1900 in columns (5) through (7). The inverted U-shaped relationship holds at the 10% level for sample period 1800–1900, and 1851–1900. However, the result does not hold for the 1800–1850 period. One possibility is that the number of observations has fallen dramatically, and another is that the Polity2 data for the earlier period are less reliable.

While Polity2 is the most widely used measure of democracy in the literature, it is

[11] Protestant missionaries may have spread moral and cultural values that facilitated the development of democracy. For instance, the emphasis on reading the bible in vernacular languages promoted education and the printing press, foundations of modern democracy (Woodberry 2012). In contrast, Barro (1999) and Karatnycky (2002) argue that Islam promotes cultural values that are impediments to democratic regimes. While there is a perception of a strong association between Islam and authoritative institutions, survey data provide contradictory results (Rowley and Smith 2009).

a composite score that may mask the degree of institutional democracy. To mitigate such concerns, we utilize several alternative measures of institutional democracy. First, we create a measure using Democ from the Polity IV dataset (Marshall, Gurr, and Jaggers 2015). Democ takes values between 0 and 10, where a higher value indicates a higher level of institutional democracy. The average over the years 1961–2015 is labeled DemocAve. Similarly, a higher value of Autoc from the Polity IV dataset (Marshall, Gurr, and Jaggers 2015) indicates a higher level of institutional autocracy. This variable is reverse coded so that higher values of Autoc imply greater democracy. AutocAve is the average Autoc value for the years 1961–2015. The results for using DemocAve and AutocAve are presented in columns (8) and (9), respectively. The findings remain intact.

Next, Polity2 is an ordinal variable taking values from –10 through +10. A higher positive (more negative) value indicates a higher level of democracy (autocracy). However, the boundary between democracy and autocracy is not exact. We therefore construct measures of democracy and autocracy using Polity2 that differentiate strong democracy from autocracy. For the democracy measure, we assign a value of 1 if Polity2 is above 5 in a particular year and 0 otherwise. We then calculate the mean value for 1961–2015. This represents the fraction of years that a country has democracy during this time period. The fraction of years that a country has autocracy is calculated using the same approach, but based on the criterion that Polity2 is below –5. These two outcome measures are used in columns (10) and (11), respectively. The hump-shaped influence of potential crop yield on democracy remains intact.[12]

Freedom House (2016) also provides data for a large number of countries from 1973 onward on civil liberties and political rights. The

[12] While these variables seem largely similar to Democ and Autoc (they contain similar information), their values are not identical to those of Democ and Autoc. For example, the United States is assigned a democracy value of 7 and an autocracy value of 3 for the year 1800 in the Polity IV database. Hence, the resulting Polity2 score is 4 for that year. According to our approach, Democ is assigned 1 but "Polity2 > 5" is assigned 0.

**Table 4**
Alternative Measures of Democracy and Crop Yield

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Dependent variable (Period) | Polity2 (1800–2015) | Polity2 (1901–2015) | Polity2 (1931–2015) | Polity2 (1991–2015) | Polity2 (1800–1850) | Polity2 (1800–1900) | Polity2 (1851–1900) | DemocAve (1961–2015) | AutocAve (1961–2015) [reverse coded] |
| Crop yield | 1.04*** | 1.01*** | 1.03*** | 0.71** | 0.86 | 0.99* | 1.08* | 0.98*** | 1.07*** |
| | (3.65) | (3.77) | (3.93) | (2.41) | (1.17) | (1.72) | (1.79) | (4.35) | (−3.41) |
| Crop yield squared | −0.94*** | −0.91*** | −0.92*** | −0.48 | −1.15 | −1.23* | −1.26* | −0.89*** | −0.90*** |
| | (−3.17) | (−3.34) | (−3.47) | (−1.62) | (−1.34) | (−1.96) | (−1.96) | (−3.76) | (2.93) |
| Observations | 147 | 147 | 147 | 146 | 42 | 49 | 49 | 147 | 147 |
| Continent dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Baseline controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Adjusted $R$-squared | 0.36 | 0.46 | 0.46 | 0.49 | 0.26 | 0.29 | 0.20 | 0.58 | 0.43 |
| Inverted U-shape test | 2.65 [$p$ = 0.00] | 2.82 [$p$ = 0.00] | 2.92 [$p$ = 0.00] | 0.93 [$p$ = 0.18] | 1.17 [$p$ = 0.13] | 1.72 [$p$ = 0.05] | 1.79 [$p$ = 0.04] | 3.15 [$p$ = 0.00] | 2.38 [$p$ = 0.01] |

*(table continued on following page)*

**Table 4**

Alternative Measures of Democracy and Crop Yield *(continued)*

| | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) |
|---|---|---|---|---|---|---|---|---|---|
| Dependent variable (Period) | Polity2 > 5 (1961–2015) | Polity2 < –5 (1961–2015) [reverse coded] | Freedom House (1973–2015) | Democ-Boix et al. (2012) (1961–2015) | Democ Cheibub et al. (2010) (1961–2015) | Checks&balances Keefer (2012) (1961–2015) | Polity2 (1961–2015) | Polity2 (1961–2015) | Polity2 (1961–2015) |
| Crop yield | 0.95*** | 1.01*** | 0.66*** | 0.67*** | 0.69*** | 0.57** | | | |
| | (4.17) | (2.92) | (2.85) | (2.85) | (3.07) | (2.59) | | | |
| Crop yield square | –0.86*** | –0.84** | –0.58** | –0.58** | –0.56** | –0.40* | | | |
| | (–3.49) | (–2.49) | (–2.26) | (–2.24) | (–2.43) | (–1.73) | | | |
| Crop yield (migration adjusted) | | | | | | | 0.80*** | | |
| | | | | | | | (3.19) | | |
| Crop yield squared (migration adjusted) | | | | | | | –0.61** | | |
| | | | | | | | (–2.42) | | |
| Land suitability | | | | | | | | 0.62*** | |
| | | | | | | | | (2.88) | |
| Land suitability square | | | | | | | | –0.57** | |
| | | | | | | | | (–2.55) | |
| Crop yield per capita | | | | | | | | | 0.45*** |
| | | | | | | | | | (2.77) |
| Crop yield per capita squared | | | | | | | | | –0.48*** |
| | | | | | | | | | (–2.83) |
| Observations | 147 | 147 | 147 | 147 | 147 | 147 | 145 | 146 | 119 |
| Continent dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Baseline controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Adjusted *R*-squared | 0.55 | 0.35 | 0.59 | 0.60 | 0.59 | 0.48 | 0.52 | 0.51 | 0.51 |
| Test for inverted U-shape | 2.86 [*p* = 0.00] | 2.01 [*p* = 0.02] | 1.77 [*p* = 0.03] | 1.74 [*p* = 0.04] | 1.85 [*p* = 0.03] | 1.01 [*p* = 0.15] | 1.67 [*p* = 0.04] | 2.10 [*p* = 0.02] | 2.77 [*p* = 0.00] |

*Note:* This table presents standardized coefficients for the effect of potential crop yield (measured in millions of kilocalories per hectare per year) on various measures of democracy. The dependent variable in columns (1) to (7) is average Polity2 score over various periods. DemocAve and AutocAve in columns (8) and (9) are average Democ and Autoc scores, respectively. The dependent variables in columns (10) and (11) are the fraction of years that has Polity2 score greater than 5, or less than –5, respectively. The dependent variables in columns (9) and (11) are transformed appropriately so that a higher value indicates a higher value of democracy. The dependent variable in column (12) is the average of civil liberties and political rights over the period 1973–2015. The dependent variables in columns (13) and (14) are alternative measures of democracy developed by Boix, Miller, and Rosato (2012) and Cheibub, Gandhi, and Vreeland (2010), respectively. The dependent variable in column (15) is the number of checks on executive averaged over 1961–2015. Column (16) uses ancestry-adjusted crop yield and its square as independent variables. The independent variable in column (17) is soil suitability from Ramankutty et al. (2002). The independent variable in column (18) is the potential crop yield per capita in 1500. Baseline controls used are absolute latitude, terrain ruggedness, elevation (average), elevation (variation), landlockedness, and distance to waterways. All specifications use an intercept term, but it is not reported for brevity. Robust t-statistics are given in parentheses.

*, **, *** Significance at the 10%, 5%, and 1% levels, respectively. The test for an inverted U-shape uses Lind and Mehlum's (2010) approach.

two indices have a correlation coefficient of 0.97. We transform these measures so that a higher value indicates the presence of a more democratic regime. Column (12) uses the mean of these two indices, averaged over the years 1973–2015, as the outcome variable. The inverted U-shaped relationship remains unbroken.

Moreover, we utilize three additional measures of democracy. First, Boix, Miller, and Rosato (2012) compile a dichotomous measure of democracy. A country is defined as democratic if it satisfies the conditions for both contestation and participation. Specifically, political leaders are chosen through free and fair elections, and the level of suffrage is above a threshold level. Next, Cheibub, Gandhi, and Vreeland's (2010) dichotomous measure of democracy focuses on how incumbent leaders are removed. Lastly, Keefer (2012) creates a measure of checks and balances. The results using these three additional measures are reported in columns (13) through (15). Potential crop yield and these three alternative measures of democracy continue to show inverted U-shaped associations, with the linear and squared term coefficients remaining statistically significant in all specifications.

In order to mitigate concerns that our results are driven by the choice of crop yield measure, we use several alternative measures. First, significant cross-country migration has occurred since the sixteenth century. In particular, a large proportion of the current populations in the New World migrated from the Old World. The migrants carried with them their knowledge, cultural traits, and institutional values (Putterman and Weil 2010). This cross-border exchange and dissemination of ideas may have impacted the formation of democratic regimes. We therefore account for the original location of the current populations' ancestors by premultiplying our crop yield measures with the world migration matrix constructed by Putterman and Weil (2010) to create the ancestry-adjusted potential crop yield measures. The adjusted measures in column (16) take the country of origin of the immigrants in each country's population into account so that we can shed some light on whether the diffusion of ideas via migration, apart from the actual location of crop yield, also matters. The inverted U-shaped association between ancestry-adjusted potential crop yield and the extent of democracy endures.

Second, in column (17) we use the land suitability index developed by Ramankutty et al. (2002). This index ranges from 0 to 1 and reflects suitability for farming based on soil quality and climate. The results are robust to this alternative measure of crop yield. Finally, we study the effect of potential crop yield per capita. The literature discusses the relevance of the land-labor ratio for institutional outcomes (e.g., Lagerlöf 2009; Fenske 2013). The Malthusian theory argues that a higher level of crop yield per person should result in higher population density. Column (18) uses potential crop yield per person. The inverted U-shaped relationship remains intact.

Overall, it appears that the identified association between potential crop yield and democracy is quite robust to different measures of crop yield. Reassuringly, Lind and Mehlum's (2010) test rejects the null hypothesis that the underlying relationship is monotone or U-shaped at conventional levels of significance in all columns, except columns (4), (11), and (15).

### Is the Democracy Index a Proxy for Risk Aversion?

Matranga (2017) argues that higher levels of climate seasonality induced risk-averse nomadic hunter-gatherers to invent sedentary agriculture, with more stable food sources. Seasonality and risk aversion may also have caused other cultural traits. To account for the possibility that democracy has been adopted by more risk averse populations, we add measures of risky behaviors to the baseline controls in Appendix Table A7. Our three measures of risky behavior come from the country averages on three questions in the World Values Survey (waves 5 and 6) (Inglehart et al. 2014). We construct the risk avoidance indices using individual-level response data from this survey (waves 5 and 6) for the following questions: "living in secure surroundings is important to this person (A191)" and "adventure and taking risks are important to this person (A195)." We further compile another index (wave 6) on things done for reasons of security (H003), including “didn’t carry much money,” “preferred not to go out at night,” and “carried a knife, gun, or other weapon.” Results after controlling for the confounding effects of these indices of risky behavior (or risk aversion) are reported in columns (7) to (9) in Appendix Table A7. The number of observations decreases by more than half. However, the hump-shaped relation between potential crop yield and the level of democracy remains intact.

### Distance to the Frontier

The literature shows that humans learn from and trust others who are similar to themselves (Guiso, Sapienza, and Zingales 2009). An exogenous measure of barriers to diffusion of ideas between societies is genetic distance (Spolaore and Wacziarg 2009). Genetic distance measures the time elapsed since two societies had a common ancestor. Using genetic distance, Spolaore and Wacziarg (2009) show that income difference between societies can be explained by genetic distance from the technological frontier. Similarly, Gorodnichenko and Roland (2017) use a measure of frequencies of blood types as genetic distance to explain the variation in income across countries. Could the variation in democracy across countries reflect different cultural traits? Could genetic distance constitute a barrier to the diffusion of democracy, whereas the oldest democracy the United States is the frontier? To account for these possible confounding effects, we control for both genetic distance and blood distance to the United States in columns (10) and (11) in Appendix Table A7. These variables are found to have no effect on the level of democracy.

### Are the Results Robust to Restricted Sample Estimation?

In this section, we restrict the sample using different criteria. First, the inverted U-shaped influence of potential crop yield on democracy may possibly be driven by a particular region. To mitigate such concerns, we sequentially drop all observations belonging to a particular continent. We then reestimate our baseline model in the last column of Table 1. Column (1) in Appendix Table A8 restates this baseline result using the global sample. Columns (2) through (7) report the results from dropping one continent at a time. The inverted U-shape remains robust in all six models. Next, the New World’s institutions were largely set up by the migrants from the Old World. Many characteristics of early development did not exist in the New World. When we exclude New World countries in column (8), the results remain intact in the Old World subsample. Finally, in column (9) we restrict the sample to 57 industrialized countries, defined as those with shares of agriculture below the global mean during the period 1991–2000. The decline of the importance of agriculture is likely to be most acute in these economies. Both the linear and quadratic crop yield coefficients are significant at the 1% level, despite the smaller sample. The results suggest a high degree of persistence in the effect of crop yield.

### Pre-1500 Potential Crop Yield and Trade Costs

We have utilized post-1500 potential crop yield data. An alternative would be pre-1500 potential crop yield data. There is a strong correlation between these two measures (0.92), due to most sample countries having added only a few new crops during the Columbian exchange. Here, we explore whether the introduction of new crops affects our main hypothesis.

Many areas in the New World were sparsely inhabited, and a large fraction of the indigenous population died after contact with the European explorers (Koch et al. 2019). Koch et al. (2019) argue that the total 1600 CE population in the Americas was 6.1 million. Thus, the population currently residing in New World countries has had little exposure to the pre-1500 potential crop yield. Columns (1) and (2) of Table 5 utilize the Old World subsample to study the relationship between contemporary democracy (average Polity2 over 1961–2015) and the pre-1500 and post-1500 potential crop yields, respectively. We note that the pre-1500 data may be of relatively lower quality. The proposed relationship holds in both cases. The pre-1500 coefficients in column (1) exhibit somewhat

**Table 5**
Pre-1500 versus Post-1500 Potential Crop Yield and Democracy

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Dependent variable | Polity2 (1961–2015) | Polity2 (1961–2015) | Polity2 (1961–2015) | Democracy (1500 CE) |
| Potential crop yield (pre-1500) | 1.24*** | | | 1.51*** |
| | (4.44) | | | (5.13) |
| Potential crop yield square (pre-1500) | –1.16*** | | | –1.45*** |
| | (–4.13) | | | (–5.14) |
| Potential crop yield (post-1500) | | 0.97*** | 1.39*** | |
| | | (3.53) | (3.92) | |
| Potential crop yield square (post-1500) | | –0.80*** | –1.25*** | |
| | | (–2.90) | (–3.46) | |
| Navigational distance | | | 0.12 | |
| | | | (0.80) | |
| Continent fixed effects | Yes | Yes | Yes | Yes |
| Baseline controls | Yes | Yes | Yes | Yes |
| Observations | 123 | 123 | 102 | 125 |
| Adjusted $R$-squared | 0.55 | 0.54 | 0.32 | 0.56 |
| Test for inverted U-shape | 3.91 | 2.25 | 2.83 | 5.03 |
| | [$p$ = 0.000] | [$p$ = 0.013] | [$p$ = 0.002] | [$p$ = 0.000] |

*Note:* This table presents standardized coefficients for the effect of potential crop yield (measured in millions of kilocalories per hectare per year) on Polity2 over the period 1961–2015 (column 1–3) and on a measure of democracy in 1500, using data from Acemoglu et al. (2008) in column (4). Baseline controls used are absolute latitude, terrain ruggedness, elevation (average), elevation (variation), landlockedness, and distance to waterways. All specifications use an intercept term, but it is not reported for brevity. Robust $t$-statistics are given in parentheses.

*** Significance at the 1% level. The test for an inverted U-shape uses Lind and Mehlum's (2010) approach.

greater levels of significance than the post-1500 coefficients in column (2).

The dispersion of both new crops and democracy may be related to trade costs. We account for contemporary trade openness in Table 3, column (11). However, the trade costs involved with the Columbian exchange in the fifteenth to sixteenth centuries are more relevant. To the best of our knowledge, no reliable data are available for bilateral trade costs for this period. However, assuming that imports of seeds and plants were free of customs duties during this period, the cost of trade should largely be reflected by distance.[13] We control for navigational distance between Camaret-sur-mer, France, and the closest port of historic importance in each country. We disregard routes going through the Suez or Panama canals. Column (3) in Table 5 indicates that the trade costs did not play a significant role in explaining the relationship between the potential crop yield and contemporary democracy. Our main result remains robust.

## Do the Results Hold for 1500 CE?

To emphasize that the level of crop yield has had a long-term influence on democracy, we construct a measure of democracy in 1500 CE using data from Acemoglu et al. (2008).[14] We repeat the Table 1 baseline model using pre-1500 potential crop yield data and the 1500 CE democracy measure. The results survive, as reported in column (4), Table 5. This suggests that the relationship between potential crop yield and democracy can potentially be interpreted in a causal sense rather than simply reflecting a correlation.

## Are the Results Robust to Specific Crops, Precipitation, and Temperature?

Easterly (2007) uses data on the suitability of cereals versus plantation crops to document

[13] Jacks, Meissner, and Novy (2008) find that between 1870 and 2000, a 1 standard deviation rise in distance raised trade costs by 0.4 standard deviations.

[14] Acemoglu et al. (2008) compile a dataset on the change in the level of democracy over 1500–2000.

that cereal production causes greater income equality and quality institutions, as discussed by Engerman and Sokoloff (Engerman and Sokoloff 1997; Sokoloff and Engerman 2000). Thus, these crops may have confounding effects. Moreover, Haber and Menaldo (2011) find an inverted U-shaped relationship between precipitation levels and democracy. They argue that rainfall levels affect the suitability for growing crops of different storability. Storable crops create incentives to trade, protect property rights, and invest in human capital. Rainfall is also an important determinant of actual crop yield. Columns (1) to (3) in Appendix Table A9 report the results from including different cereal and plantation crops suitability measures used by Easterly (2007). Columns (4) to (5) present results that control for average precipitation and its square.

Moreover, Haber and Menaldo (2011) use the average precipitation around a country's largest city. They argue that institutions tend to develop first in the main city and then diffuse around the country. Following Haber and Menaldo (2011), we construct an average precipitation index and two restricted cubic precipitation splines around the largest city for 1980–1989.

One alternative to using polynomials to check for nonlinearity is to use splines. The main advantage of this approach is that it involves a nonlinear transformation of the explanatory variable prior to running regressions. The splines are therefore not influenced by the dependent variable. Following Haber and Menaldo (2011), we construct a restricted cubic spline for the logs of precipitation. The underlying assumption is that precipitation is linear before the first and after the last knot, but forms a cubic piecewise polynomial shape between these knots. Our results remain intact in column (6) in Appendix Table A9. Similar to Haber and Menaldo (2011), the first spline of precipitation is positive, while the second spline is negative but insignificant.

Finally, since temperature levels should also affect crop suitability, in column (7) in Appendix Table A9 we add a measure of average temperature for the period 1961–1990. One of the measures of cereal to plantation crop suitability (column 2) and the linear effect of precipitation in all models (columns 4, 5, and 6) are significant. The presence of precipitation measures attenuates the influence of potential crop yield, indicating that precipitation is complementary to potential crop yield. Overall, the crop yield coefficients remain significant in all cases in Appendix Table A9.

## 5. Further Evidence

### Evidence from Precolonial Indigenous Societies

This section utilizes data from 186 precolonial societies. The data are available from the Standard Cross-Cultural Sample (SCCS), compiled by Murdock and White (1969). The SCCS provides a representative sample of world cultures "for the earliest period for which satisfactory ethnographic data are available or can be constructed" (Murdock and White 1969, 340). The aim is to avoid the influence of European colonizers on these societies (Murdock and White 1969).[15]

The SCCS database provides information on two important political dimensions in precolonial societies. The first relates to how the process of "local political succession" occurred. The database categorizes the process of succession into nine different categories, namely, no headmen or council, by appointment, seniority, divination, informal consensus, electoral process, patrilineal, matrilineal, and hereditary without personal qualifications. We consider the process of local political succession to be democratic if it took place through either "informal consensus" or "electoral process," otherwise not. Second, the SCCS provides information on the executive constraints. This could be either a council, the "executive and council," or "plural executives," or a "single leader." We consider a society to be democratic when the executive power rests with an "executive and council" (similar to a parliament in contemporary rep-

[15] The possibility exists that these societies' cultures had been influenced by contacts with Europeans. The years of observation are in the nineteenth or early twentieth century. Murdock and White (1969, 329) suggest that "cultural independence of each unit in terms of historical origin and cultural diffusion could be considered maximal with respect to the other societies in the sample."

**Table 6**
Using Preindustrial Societies Data from the Standard Cross-Cultural Sample

| Dependent Variable | (1a) Local Political Succession | (1b) Local Political Succession | (1c) Local Political Succession | (2a) Concentration of Power in Executive | (2b) Concentration of Power in Executive | (2c) Concentration of Power in Executive |
|---|---|---|---|---|---|---|
| Crop yield | 0.59** | 0.73*** | 0.69*** | 0.73** | 1.48*** | 1.43** |
| | (2.35) | (2.82) | (2.72) | (2.49) | (4.08) | (2.76) |
| Crop yield squared | –0.62** | –0.74*** | –0.69*** | –0.62** | –1.20*** | –1.14** |
| | (–2.69) | (–3.34) | (–2.80) | (–2.60) | (–3.90) | (–2.27) |
| Observations | 137 | 137 | 137 | 68 | 68 | 68 |
| Baseline controls | No | Yes | Yes | No | Yes | Yes |
| Region fixed effects | No | No | Yes | No | No | Yes |
| *R*-squared | 0.03 | 0.04 | 0.16 | 0.05 | 0.16 | 0.24 |
| Language clusters | 40 | 40 | 40 | 24 | 24 | 24 |
| Test for inverted U-shape | 2.32 | 2.79 | 2.63 | 2.48 | 3.48 | 1.78 |
| | [$p$ = 0.01] | [$p$ = 0.00] | [$p$ = 0.00] | [$p$ = 0.01] | [$p$ = 0.00] | [$p$ = 0.04] |

*Note:* This table presents standardized coefficients for the effect of crop yield (measured in millions of kilocalories per hectare per year) on two alternative definitions of democracy from the Standard Cross-Cultural Sample (SCCS). The baseline controls used are absolute latitude, roughness of elevation, elevation (average), elevation (variation), and distance to a coast. Latitude of the societies is from the SCCS database, while other controls—roughness of elevation, elevation (average), elevation (variation), and distance to a coast—are generated from G-Econ (2008) using a 200 km radius around each society. The region dummies are sub-Saharan Africa, Middle Old World, Southeast Asia/Insular Pacific, Sahul, North Eurasia/Circumpolar, Northwest Coast of North America, North and West of North America, Eastern Americas, Mesoamerica/Andes, and Far South America, as described in the SCCS database. All specifications use an intercept term, but it is not reported for brevity. Standard errors are clustered at the language group level. Robust $t$-statistics are given in parentheses.

**, *** Significance at the 5% and 1% levels, respectively. The test for an inverted U-shape uses Lind and Mehlum's (2010) approach.

resentative democracies), rather than with "plural executives" or a "single leader."

We follow the baseline specification in column (5) in Table 1. Using the SCCS database, the unit of analysis is at the society level. The SCCS database does not contain information about the land area covered by these precolonial societies. While the centroid of each society is obtained from the dataset, measuring their precise locations may involve errors. Following Alesina, Giuliano, and Nunn (2013), we use a buffer zone of 200 km around the centroid in order to extract the independent variables and other control variables from other datasets. The (mean) crop yield for a society is thus calculated using the circular land area around the centroid with a radius of 200 km. This is combined with the global crop yield dataset based on a raster image, made available by Galor and Özak (2015, 2016). We also control for geographic variables in the analysis such as distance to the coast, elevation, variation in elevation, and roughness of variation, which are generated from G-Econ (2008) by, again, using a radius of 200 km around the centroid of each society.

The empirical findings are reported in Table 6. Columns (1a) to (1c) use the "local political succession" measure of democracy, while columns (2a) to (2c) study the "concentration of power in executive." Columns (1a) and (2a) report the unconditional influence of crop yield on these two variables. The next columns include all baseline controls, and the last columns control for regional fixed effects. The evidence suggests an inverted U-shaped influence of crop yield on our measures of democracy in precolonial societies. The full model specifications in columns (1c) and (2c) are able to explain 16% and 24%, respectively, of the variation in democracy in precolonial societies.

## Evidence from the State Level

In this section, we address the possibility there may be some unobserved effects that are correlated with democracy and the measure of crop yield at the national level. We address this concern by running regressions at the state level for the United States.

Wright (1970) provides evidence that in 1860, the cotton (the only cash crop) producing South (Gini index equal to 57.7) had larger farms compared to six Northern states.[16] Within the South, the region with the most fertile soil type (alluvial soil), had the highest Gini index of 63.5.[17] Moreover, for every soil type region, an index of concentration is greater for farm value than for area (improved acreage). In the alluvial region, the largest 10% of farms had 50.6% of agricultural land, but the most valuable 10% of farms owned 64.1% of total farm value. The average index of concentration of farm value in the South was 67.8 in the year 1860, while it was 78.0 in the alluvial region. The concentration of slaveholdings in the alluvial region was roughly equal to the average in the South, however. Wright (1970) argues that high-quality land was very expensive, necessitating cotton (cash crop) production and the purchase of slaves; thus, all sizes of farms in highly fertile areas owned slaves. Wright (1970) concludes that the effect of the cotton-slavery sector was to raise the level of concentration of income and wealth. In our view, this has led to an agriculturally based resource curse within the United States.

One difficulty involved with estimating our model at the state-national level is the absence of a readily available index of democracy. Fortunately, a major component of composite democracy indices is the level of active participation of citizens in the selection of the executive (Vanhanen 2000). Most democratic theorists assert that without significant citizen involvement, the democratic process falls short of its goals. Therefore, participation by citizens in competitive elections is a distinctive feature of democratic politics (Powell 1982). In a high-quality democracy, citizens must have equal participation rights (Banducci, Donovan, and Karp. 2004; Paxton et al. 2003). Lijphart (1997) views low voter turnout as an indicator of unequal and socioeconomically biased political participation, a serious problem for democracy. Solijonov (2016) argues that high voter turnout is often a sign of the vitality of a democracy. In contrast, low turnout is usually associated with voter apathy and mistrust of the political process. Low electoral turnout is either inherently bad for democracy, or calls legitimacy into question by suggesting a lack of representation of a certain group (Franklin 1999). Following Powell (1982) and Diamond and Morlino (2005), we use voter turnout rates as the measure of citizen's participation in the governance of their country, and thus as a measure of the degree of democracy.

We use voter turnout as a fraction of the total electorate as a measure of the electorate's participation across states in the United States. We use average presidential election voter turnout for the period 1980–2012. We reuse the baseline regression model in the last column of Table 1 but replace country-level variables by state-level variables, including the geographical control variables.

Table 7 presents our findings for the influence of crop yield on democracy at the state level. Column (1) documents unconditional influences, while we add latitude and other baseline controls in columns (2) and (3), respectively. The inverted U-shaped association between potential crop yield and democracy survives at the state level in the United States. Then, we account for the four regional and nine divisional fixed effects in columns (4) and (5), respectively, to account for any unobserved effects. There is no qualitative change in our findings. Next, we control for the fraction of Blacks and Hispanics in the population in columns (6) and (7), respectively. While the nineteenth amendment granted women the right to vote in 1922, in some states this right had already been extended beforehand. In column (8) we account for whether a state had granted voting rights to women before 1922. These controls have negative signs, as expected, though all are insignificant. However, the inverted U-shape remains intact.

We also account for cultural values, including religious adherence, estimates of the population attending a place of prayer, and family ties. These account for confounding effects of informal institutions on democracy. Family ties can influence the quality of institutions (Alesina and Giuliano 2014). Next, we account for the age dependency ratio, school

[16] The Northern states for which data are available are (Gini index within parentheses) Illinois (43.6), Iowa (44.0), Indiana (45.2), Minnesota (34.2), Ohio (43.8), and Wisconsin (45.2).

[17] The alluvial soil region is located along the Mississippi River in Louisiana, Mississippi, and Arkansas; along the Red River in Louisiana; and in three Texas counties at the mouth of the Brazos River.

**Table 7**

Presidential Election Voter Participation (Turnout) in the United States (Dependent Variable: Voter Turnout)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop yield | 1.42** | 1.36*** | 1.68*** | 1.93*** | 2.08*** | 2.03*** | 1.79* | 2.33*** | 2.09*** | 2.19*** | 2.05*** | 1.98*** | 2.04*** |
| | (2.05) | (3.16) | (2.81) | (3.21) | (3.00) | (2.99) | (2.02) | (3.04) | (3.02) | (2.82) | (3.22) | (2.95) | (2.79) |
| Crop yield squared | –1.80*** | –1.43*** | –1.63*** | –1.76*** | –1.71*** | –1.62** | –1.58** | –1.95*** | –1.72*** | –1.85** | –1.65** | –1.64*** | –1.70*** |
| | (–2.75) | (–3.27) | (–3.60) | (–3.36) | (–2.80) | (–2.58) | (–2.25) | (–2.94) | (–2.86) | (–2.66) | (–2.56) | (–2.79) | (–2.76) |
| Latitude | | 0.65*** | 0.76*** | 0.68*** | 0.71*** | 0.71*** | 0.61** | 0.74*** | 0.71*** | 0.76** | 0.77*** | 0.75*** | 0.68** |
| | | (6.43) | (4.25) | (3.70) | (3.07) | (3.36) | (2.22) | (3.04) | (3.11) | (2.50) | (3.92) | (2.96) | (2.67) |
| Black (%) | | | | | | –0.17 | | | | | | | |
| | | | | | | (–0.97) | | | | | | | |
| Hispanic (%) | | | | | | | –0.11 | | | | | | |
| | | | | | | | (–0.86) | | | | | | |
| Women suffrage before 19th amendment | | | | | | | | –0.17 | | | | | |
| | | | | | | | | (–1.04) | | | | | |
| Religious adherence (%) | | | | | | | | | –0.05 | | | | |
| | | | | | | | | | (–0.32) | | | | |
| Family ties | | | | | | | | | | 0.07 | | | |
| | | | | | | | | | | (0.28) | | | |
| Age dependency ratio | | | | | | | | | | | 0.16 | | |
| | | | | | | | | | | | (1.09) | | |
| School enrolment | | | | | | | | | | | | –0.14 | |
| | | | | | | | | | | | | (–0.81) | |
| Per capita real GDP | | | | | | | | | | | | | 0.10 |
| | | | | | | | | | | | | | (0.62) |
| Observations | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 |
| Other baseline controls | No | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Region dummy | No | No | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Division dummy | No | No | No | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Adjusted $R^2$ | 0.25 | 0.58 | 0.60 | 0.62 | 0.63 | 0.63 | 0.62 | 0.63 | 0.62 | 0.62 | 0.64 | 0.63 | 0.62 |
| Test for inverted U-shape | 2.04 | 3.15 | 2.80 | 2.49 | 1.59 | 1.37 | 1.66 | 1.81 | 1.62 | 1.62 | 1.29 | 1.59 | 1.64 |
| | [0.02] | [0.00] | [0.00] | [0.00] | [0.06] | [0.08] | [0.05] | [0.04] | [0.06] | [0.06] | [0.10] | [0.06] | [0.06] |

*Note:* This table presents standardized coefficients for the effect of crop yield (measured in millions of kilocalories per hectare per year) on state-level voter turnout in U.S. general elections for president. Geographic controls used are absolute latitude, terrain ruggedness, elevation (average), elevation (variation), landlockedness, and distance to waterways. Regions are Northeast, Midwest, South, and West. Divisions are New England, Mid-Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, and Pacific, according to the U.S. Census Bureau. All specifications use an intercept term, but it is not reported for brevity. Robust *t*-statistics are given in parentheses.

*, **, *** Significance at the 10%, 5%, and 1% levels, respectively. The test for an inverted U-shape uses Lind and Mehlum's (2010) approach.

enrolment, and income per capita. Our main result survives in columns (9) through (13).

We caution that using voter turnout as an indicator of democracy has some limitations. For example, potential voters may face no barriers to participate in elections, but for various reasons abstain from voting. Nevertheless, we believe the results at the state level provide complementary evidence that lends further support to our hypothesis. Lind and Mehlum's (2010) test supports the notion that potential crop yield and democracy exhibit an inverted U-shaped relationship.

## 6. Conclusion

The evolution of most ancient civilizations and modern nations has, in one way or another, been centered on agriculture. Throughout history, agriculture has been a driving force in economic, social, and political development. This paper shows that geography helps explain the degree of democracy. We establish an inverted U-shaped empirical relationship between crop yield (measured in terms of calories) and the contemporary level of democracy. We establish this hump-shaped relationship using cross-country data, data from precolonial societies, and state-level data from the United States. Our results are robust to an array of tests and checks. We believe this is the first paper to provide rigorous evidence of an inverted U-shaped relationship between crop yield and the level of democracy.

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