Climate Shocks, Democratization and (a Culture of) Cooperation.*

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Abstract

While the direct economic effects of adverse climate shocks are well-known, their indirect institutional impact is still poorly understood. To clarify this issue, we focus on developing countries and we test the idea that adverse climate shocks push elites unable to commit to future transfers to enact inclusive political institutions and non-elites, endowed with complementary inputs, to embrace strong norms of cooperation. While democratization transfers to the non-elites the power to design fiscal policies and thus, assures them that they will enjoy a sufficient part of the returns on investing in farming innovations with the elites, cultural accumulation delivers an intrinsic return on cooperation allowing the non-elites' credible commitment to investment. Consistent with these predictions, data on a panel of 38—among the 42—most agricultural countries observed over the 1960-2018 period imply that the severity of droughts has both a negative and direct effect on agricultural output and a positive and indirect institutional impact. The latter can be decomposed in a persistent rise in the inclusiveness of the political process, which in turn, shifts the allocation of the tax revenues from military to public health service expenditures, and the horizontal, oblique and vertical transmission of norms of trust and respect. Only a culture of cooperation is, in turn, significantly—and positively—related, with a one-year lag, to the agricultural output. Crucially, our results hold across several identification strategies. *Keywords*: climate change; time inconsistency; inclusive political process; culture of cooperation; public goods. *JEL classification*: D72; H10; O13; P00; Z10.

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1 Introduction

Mitigating climate change represents a key policy challenge of our time (Bechtel et al., 2017). To inform this effort, a growing literature has documented that an inclusive political process and stronger norms of cooperation might facilitate a more efficient provision of the public goods necessary to adapt to global warning (Bättig and Bernauer, 2009; Mubaya and Mafongoya, 2017; Yomo et al., 2020). A parallel institutional persistence literature, however, has focused on the opposite channel of causation, reporting strong correlations between past climatic shocks and persistent formal and informal institutions (Nunn, 2020). Together, the conclusions of these two strands of literature make it difficult to identify the interplay among climate shocks, institutions and economic outcomes and, in particular, distinguish the negative and direct economic effect of adverse climate shocks from their positive and indirect impact going through state formation and evolution—i.e., state-building—and cultural accumulation (Zhang et al., 2011; Contreras, 2016; Degroot, et al. 2021).[1]

The inspiration for untangling this yarn comes from a recent body of research combining data on either Medieval Europe or Bronze Age Mesopotamia and a credible empirical strategy based on the time inconsistency theory of state-building and cultural accumulation (Boranbay and Guerriero, 2019; Benati and Guerriero, 2021; 2022; 2023; 2024). Two are the key results of this literature. First, adverse climate conditions pushed elites lacking the credibility to commit to future transfers to enact an inclusive political process and disenfranchised non-elites endowed with complementary inputs to accumulate a forceful "culture of cooperation," intended as the intrinsic reward from cooperating in economic activities (Tabellini, 2008). While political reforms convinced the non-elites that a sufficient part of the returns on investing with the elites in farming innovations would be shared via public good provision, cultural accumulation relaxed their participation constraint allowing them to credible signal their participation despite its limited return (Benati and Guerriero, 2024). Second, these institutional discontinuities supported cooperation in farming despite climate crises, favoring, in turn, the resilience of ancient societies (Benati and Guerriero, 2024).

Because of the relevance of these results for policy intervention in the developing countries

[1]Since equilibrium cultural norms are in our setup evolutionarily stable strategies (see section 2), we indistinguishably refer to either the "accumulation" or "selection" of cultural norms.

most affected by global warming (D'Alpoim Guedes et al., 2012; Haldon et al., 2018; Jackson et al., 2018; Van Bavel et al., 2019), a test of their validity for these economies is necessary. To construct it, we follow Brückner and Ciccone (2011) and Ciccone and Ismailov (2022), and we analyze the links among coeval and historical availability of soil moisture, state-building and the accumulation of norms of cooperation in the panel of 38—among the 42—most agricultural countries for which we can observe all variables over the 1960-2018 period.

We document three key patterns. First, the severity of droughts, as inversely captured by the growing season self-calibrating Palmer drought severity index, has a significant and negative effect on a coeval crop production index produced by the World Development Indicators project and a significant, positive and persistent impact on the inclusiveness of the political process measured by the POLITY V constraints on the executive authority score. In addition, reforms towards more inclusive political institutions shift the allocation of the tax revenues from military to public health service expenditures. Second, the severity of droughts has a significant and positive effect on a coeval measure of the strength of norms of trust and respect self-reported to the Afrobarometer and World Value Surveys. Given the annual frequency of our data, we interpret this last link as the impact of climate shocks on the evolution of coeval cultural norms driven by cross-punishment, stigmatization and restriction of direct, indirect and network reciprocity by peers—i.e., short run horizontal cultural transmission mechanisms—rather than by natural selection and indoctrination, i.e., long run vertical and oblique cultural transmission mechanisms (Nowak, 2006). To evaluate these last two channels, we construct a historical measure of the severity of droughts by calculating the share of years between time t and $t-34$ during which the country experienced droughts of intermediate severity, which, according to our model, most affect state-building. As discussed below, this temporal span includes all the years during which climate shocks could have shaped, via vertical and oblique cultural transmission, the prevailing culture. Our estimates suggest that the historical drought severity is positively and significantly linked to our proxy for the strength of norms of cooperation. Finally, both the availability of soil moisture and the strength of culture lagged one year are significantly and positively related to the agricultural product. We do not consider the second link as causal since state-building, cultural accumulation and agricultural output are all jointly determined by climate shocks.

Even if consistent with the main predictions of our theoretical framework, our estimates may be attenuated by measurement errors, may be capturing reverse causality and/or might be driven by unobserved heterogeneity. We evaluate these three issues in turn.

First, we assess the severity of measurement error by showing that our conclusions remain the same when we substitute our proxy for the inclusiveness of the political process with a dummy for the presence of a democratic regime, when we switch our focus on the reallocation of tax revenues from military to public education expenditures and when we either average climate variables over the entire year or consider a panel of decennial observations. This last robustness check confirms that institutions are designed not only to adapt to inter-annual climate fluctuations but also to handle multidecadal megadrought.

Second, the independence from human decisions of our proxy for climate shocks excludes reverse causation in our analysis of the determinants of institutions, and the fact that public good provision is unrelated to future values of the inclusiveness of the political process is inconsistent with the former driving the latter given the lag with which institutions adjust.

Finally, we embrace a two-step strategy to assess the role of unobserved heterogeneity. First, not only do we control for country and year fixed effects as well as temperature and rainfall, but we also consider the other key determinants of state-building and cultural accumulation identified by the extant literature. We divide the latter in exogenous observables—i.e., climate factors squared as well as region-specific fixed effects and trends (Ciccone and Ismailov, 2022), climate volatility (Boranbay and Guerriero, 2019), and value of natural resources (Ross, 2001)—and possibly "bad" controls, i.e., environmental circumscription (Carneiro, 1970; Mayshar et al., 2017), diffusion of irrigation systems (Dell et al., 2014), risk of unrest (Acemoglu and Robinson, 2000; Haseeb, 2024), severity of external threats (Besley and Persson, 2009), intensity of religiosity (Huntington, 1996), degree of ethnic heterogeneity (Montalvo and Reynal-Querol, 2005), human capital (Acemoglu et al., 2019), economic development (Inglehart and Welzel, 2005), degree of economic inequality (Boix, 2003) and economic policies (Przeworski and Limongi, 1997). These observable factors have little explanatory power and thus, our results remain almost intact. Second, we calculate that, to attribute the entire estimates to selection effects, selection on the main unobservable factors would have to be on average more than twenty-three times greater than

selection on all main observables. This seems unlikely. Together, these tests make it difficult to envision that our estimates are driven by mechanisms different from those we model and thus, we take our results as consistent with causality running from climate shocks to state-building and cultural accumulation and from state-building to public good provision.

Our analysis is linked to three main strands of the burgeoning literature on the interplay among environmental conditions, institutions and the farming output. First, it is closely related to the aforementioned body of research on the impact of climate extremes on the democratization of the most agricultural countries (Brückner and Ciccone, 2011; Ciccone and Ismailov, 2022). Different from this literature, not only do we consider the role of culture, but we document that both state-building and cultural accumulation are not driven by the elites' fear of being expropriated after an upheaval (Acemoglu and Robinson, 2000), but that they mainly respond to the time inconsistency issues created by the elites' inability to commit and thus, always assure the non-elites' participation. Unlike North and Weingast (1989), Barzel and Kiser (1991) and Myerson (2008), and similar to Boranbay and Guerriero (2019) and Benati and Guerriero (2024), we highlight that the main commitment device in the elites' hands is public good provision. While doing so, we also provide a formal justification for the empirical regularity that democratization is preceded by temporary dips in income (Acemoglu et al., 2019). Second, our test contributes to a recent literature on the environmental determinants of horizontal cultural transmission. While the existing analyses document the impact of pandemics, such as the COVID-19 (Eichengreen et al., 2021), on short run cultural changes, we assess the effect of climate shocks.[2] Finally, we qualify the meaning of some of the documented correlations between environmental shocks and vertical and oblique cultural transmission processes. While Buggle and Durante (2021) link medieval climate risk to present-day trust, Litina (2016) shows that low levels of land productivity are correlated with more intense present-day cooperation, and Linke et al. (2015) and De Juan and Hänze (2021) relate drought severity to trust and cooperation within and across ethnic groups. Unlike these articles, and like Boranbay and Guerriero (2019) and Benati and Guerriero (2024), we embrace a theory-based econometric approach to study culture and we escape the "compression of history" trap (Austin, 2008). This is the inclination of the

[2]Alesina and Fuchs-Schündeln (2007) and Giavazzi et al. (2019) study, instead, the role of political reforms.

literature on persistent institutions to neglect the events between a historical environmental shock and present-day institutions and therefore, to assume causation between the two.

Our paper delivers three contributions. First, we document that our time inconsistency theory can shed light on state-building as well as both short and long run cultural transmission processes in the sample of most agricultural countries. By focusing on this environment, we can exploit large panel variation on economies sufficiently simple to credibly link ecological factors to institutions. Moreover, being climate extremes heightened by the ongoing global warming process (Nordhaus, 2019), we consider our estimates as the first block of empirical evidence on the direct and indirect—i.e., going through institutions—effects of climate change on present-day developing countries (see for ancient societies Benati et al., [2022]; Benati and Guerriero, [2023, 2024]).[3] Second, by showing that norms of cooperation modulate the link between the elite's time inconsistency issues and an inclusive political process, we stress that climate change and culture are understudied determinants of fiscal capacity (Guerriero and Righi, 2022). Finally, we conclude by exploiting our theoretical framework to draw three crucial implications for the design of environmental policies.

The paper proceeds as follows. We illustrate the key intuitions of our time inconsistency theory of state-building and cultural accumulation in section 2. Next, we detail its predictions in section 3. Then, we discuss our test in sections 4 and 5, and we conclude in section 6.

2 State-building and Culture: Theory

Our model is an application of the Benati and Guerriero's (2024) theoretical framework.[4] While we report the formal analysis in the appendix, we focus here on its main intuitions.

The economy.—We consider the interaction between a representative elite and a representative non-elite, who can cooperate in a joint investment, i.e., a farming activity.[5] While the elite gathers the part of the population with control over scarce resources and the institutional design, the non-elite assembles the initially rightless citizens (Benati et al., 2022).[6]

[3] "Climate change refers to a change in the state of the climate that can be identified [...] by changes in the mean and/or the variability of its properties and that persists for an extended period" (IPCC, 2014).

[4] Boranbay and Guerriero (2019) study a similar setup, assuming, however, that investment must fail under autocracy, the elite picks her own culture and the group in power explicitly selects the type of public good.

[5] We label the elite as "she", the non-elite as "he" and a generic agent as "it."

[6] Group formation should be seen as driven by unforeseen military, organizational and technological shocks

The joint investment delivers an output whose value is $V > 0$ if the non-elite exerts an effort whose cost is $\gamma > 0$ and zero otherwise. The output value V is larger the more favorable are the production conditions, e.g., the more available is the soil moisture.

Political process.—The elite keeps the untaxed output because of her control over the distribution of arable lands, the credit necessary to buy seeds and fertilizers and the social programs directed to farmers (Treisman, 2020; Lansford, 2021; Fischer, 2021). She cannot, however, entice the non-elite by committing to either a non-contingent or state-contingent contract (North and Weingast, 1989; Barzel and Kiser, 1991; Acemoglu and Robinson, 2000; Fleck and Hanssen, 2006; Boranbay and Guerriero, 2019) and/or punishing him (Mayshar et al., 2017). While the second restriction is consonant with the fact that internal conflicts are unrelated to both institutions and the severity of droughts (see section 5),[7] the first one is justified in our sample by the observation that contracts were enforced by courts controlled by the same elite promising not to renege on future transfers (Acemoglu, 2003).[8]

The elite can, however, incentivize investment by granting an inclusive political process, which entrusts to the non-elite the power to select the tax rate and the type of public good choosing between the one that he prefers and the one preferred by the elite (Boranbay and Guerriero, 2019; Benati et al. 2022). Under autocracy, these decisions are left to the elite. Public good provision g_r has a technology linear in the tax revenues δ_r, where $r \in \{A, I\}$ picks the political regime, i.e., A for autocracy and I for the inclusive political regime. The assumption that the group in power can commit to a tax policy is without loss of generality in the case of the inclusive political regime since the non-elite would never deviate from full-taxation, and it can be justified in the case of autocracy by foreseeing that the non-elite can impose a sufficiently large punishment on an elite deviating to the zero-tax rate by revolting and/or refusing to fight external enemies (Acemoglu, 2003).[9] More generally, our

endowing the non-elite with skills complementary to those of the elite and leaving to the latter the control over scarce resources and the institutional design (Benati and Guerriero, 2022).

[7]Being unable to always garner the non-elite's participation through a contract, the elite cannot rely on punishment to incentivize investment by the non-elite (Benati and Guerriero, 2021; Benati et al., 2022).

[8]For instance, the post-civil war creation of Community Courts in Mozambique was exploited by the elites to protect their privileges via the selection of friendly judges and codification of customary law (Utter, 2021).

[9]The elite could also renege on her time t_1's regime choice. If she reinstated autocracy at time t_2, the non-elite would then switch to risk-sharing. If, instead, the elite could take her power back at time t_3, the non-elite could discourage this move by imposing a sufficiently large punishment (see Benati and Guerriero, [2024]).

analysis will be similar should we let the elite commit to direct transfers or should we allow her to offer a high-powered contract. Therefore, our assumptions on the asymmetry in the preferences, ability and property rights of the two groups are mild.

Culture.—The non-elite can accumulate, at a cost, norms c assuring him of an intrinsic return on cooperating in either investment or an alternative consumption risk-sharing activity, i.e., norms of trust and respect (Tabellini, 2010; Guerriero, 2020). The return on cooperative risk-sharing is only intrinsic, raises with the severity of consumption risk μ and, at the margin, is larger than the intrinsic gain from cooperative investment. There are two key justifications for this assumption. First, risk-sharing is a less complex activity, which does not require the elite's input and does not produce a taxable output. Second, its success entirely hinges on the non-elite's intrinsic motivations, as in the cases of interest-free loans of farming products and large-scale storage of foodstuff (Benati and Guerriero, 2024).

The hypothesis that the non-elite picks his norms to maximize the relative extrinsic and intrinsic returns captures two key insights of Malthusian growth theories and evolutionary psychology. First, a group dictates to its members norms maximizing its fitness via either short or long run transmission mechanisms (Barkow et al., 1992; Clark, 2005). Second, these values are stronger the larger the culturally-driven advantage is (Nowak, 2006). More generally, equilibrium culture turns out to be strict subgame perfect and thus, an evolutionarily stable strategy invading the entire non-elite's group even if experimented by a minority of households (Maynard Smith and Price, 1973), exactly as the preferences for actions studied by the literature on inter-generational cultural transmission (Bisin et al., 2023) and the beliefs about equilibrium plays analyzed by the strand of research on social organizations (Greif, 1994). Accordingly, our cultural accumulation process is strategically consistent with these alternatives, but, different from them, explicitly links production conditions to the equilibrium cultural norms and allows for sudden changes in informal institutions.

Payoffs.—All agents have a—normalized—zero outside option and are risk neutral. Hence, the elite's payoff from investing π_r equals the sum of the value of the untaxed output and the public good consumption payoff, and the non-elite's utility from investing U_r is given by his intrinsic reward on cooperating net of the cultural accumulation cost plus his public good consumption payoff net of the effort cost. Similarly, the non-elite's utility from risk-sharing

equals his intrinsic reward on cooperating net of the cultural accumulation cost.

Timing.—At time t_0, the non-elite accumulates culture. At time t_1, the elite picks the political regime. At time t_2 and under autocracy (the inclusive political regime), the elite (non-elite) selects fiscal policies. At time t_3, the non-elite chooses between investment and risk-sharing and the elite decides whether to participate in investment. At time t_4, either risk is shared or private and public goods are produced. Next, the payoffs are realized.

Equilibrium.—When the output value is tiny—i.e., droughts are severe, the public good consumption payoff is also small when compared to the effort cost, and the non-elite opts for sharing risk and accumulating the culture maximizing the relative payoff. Since the marginal intrinsic return on risk-sharing is larger than the marginal intrinsic return on investment, the strength of the non-elite's culture of cooperation in risk-sharing is greater than the strength of the non-elite's culture of cooperation in investment. When, instead, the output value is small but not tiny—i.e., the severity of droughts is intermediate, investment becomes for the non-elite sufficiently more appealing than risk-sharing and thus, the elite's time inconsistency issues also get severe but not insurmountable. Then, the non-elite picks the more complex economic activity—i.e., investment—and cooperates with the elite provided that his political rights are strong and he has accumulated norms maximizing the intrinsic reward from investment. While the inclusive political process allows the non-elite to fully tax the output and produce his preferred public good (Levi, 1988; Blanton and Fargher, 2016; Murshed et al., 2022), embracing a forceful culture relaxes his participation constraint making credible his commitment to participate. When, finally, the output value is large—i.e., mild climate, the elite, who prefers private to public consumption, keeps control over fiscal policies and selects a tax rate just sufficient to assure to the non-elite his reservation utility. This tax rate falls with the output value. The non-elite, instead, accumulates the optimal strength of a culture of cooperation in investment. Ultimately, the non-elite's cultural accumulation is stronger the smaller is the investment return and the more severe is consumption risk.

3 Empirical Predictions

The central implications of the model can be restated in terms of testable predictions applicable to our sample of postwar most agricultural societies as follows:

Predictions: *1. Adverse climate shocks and, notably, harsh droughts favor reforms towards inclusive political institutions. 2. Adverse climate shocks foster the non-elites' accumulation of a culture of cooperation, i.e., more forceful norms of trust and respect. 3. Democratization encourages the provision of the public goods preferred by the non-elites.*

4 State-building and Culture: Anecdotal Evidence

While the appendix discusses five case studies consistent with our predictions, we illustrate here the experience of Malawi, which constitutes, within our sample (see table 1), the most transparent poster child of the institutional dynamics captured by our model.

Starting from the 1964 independence, president Banda autocratically ruled the country exploiting the landless peasants, who cultivated government estates and relied on fertilizers and seeds acquired thanks to public credit (Chinsinga, 2017). Such a status quo collapsed when staple production was ruined by the unprecedented droughts of the beginning of the 1990s (see figure 1), when our inverse measure of the severity of droughts felt from the - 1 level of 1990 to the -6.3 level of 1992. The resulting economic downfall pushed Banda to hold a general referendum on structural reforms, which, in turn, paved the way to the 1994 general elections, a new constitution and a larger provision of public health service (Chinsinga, 2017; Treisman, 2020; Lansford, 2021), whose government expenditures in percentage of the GDP and deviation from the military ones rose from 0.03 in 1990 to 1.12 in 1995.

The contemporary strengthening of the constraints on the executive authority, whose Polity V measure jumped from the value of 1 in 1990 to the value of five in 1995, alleviated civil conflicts, restrictions on press freedom, voting irregularities, corruption and inefficient regulation, until a new series of droughts and floods hit again the country between the end of the 1990s and the beginning of 2000s [Masih et al. 2014, Table 3]. The anew farming crisis persuaded the newly elected government to launch the 2004 anti-corruption and economic reform to incentivize the agricultural sectors through a more equal distribution of land ownership [Tchale 2014, p. 20-24; Lansford 2021, p. 1014-1016]. Funds for resettling more than 15,000 displaced households on voluntary basis, purchasing estates, and registering land titles were granted to local communities in areas where poverty was pervasive. These projects were supported by even stronger constraints on the executive, which rose from 4

in 2002 to 6 in 2006, and more forceful norms of trust and respect, whose normalized—to range between 0 and 1—proxy increased from 0.3 to 0.7 over the same period (see section 5 for details). Ultimately, coeval and cumulated climate shocks reinforced both pro-social attitudes and democratic political institutions (De Juan and Hänze, 2021).

5 State-building and Culture: Empirical Evidence

While anecdotal evidence is informative, empirical evidence is more convincing. Our empirical exercise is organized in two steps. First, we show that country and year fixed effects Ordinary Least Squares—OLS—estimates confirm the main implications of our theoretical framework as summarized in section 3. Second, we construct tests evaluating the possible endogeneity biases, which might affect these results. To implement this empirical approach, we need, first and foremost, sufficient variation on appropriate proxies.

5.1 The Sample

We follow Brückner and Ciccone (2011) and Ciccone and Ismailov (2022), and we focus on the world's most agricultural countries, which are the 42 jurisdictions with agriculture, forestry, and fishing value added as a share of the GDP averaged over the 1960-2020 period in the top quintile of the distribution. This information is available from the World Development Indicators. Among these 42 countries, we focus in our analysis of state-building (cultural accumulation) on the 38 (24) jurisdictions for which we can observe all dependent and independent variables over the maximum available sample (see table 1), i.e., 1960-2018 (1981-2018) period.[10] Two features of the most agricultural countries justify our interest.[11]

First, as documented by Ciccone and Ismailov (2022), these countries display significantly fewer irrigation infrastructures and thus, the saliency of droughts and, in turn, their institutional impact must be larger in these jurisdictions than elsewhere, especially over a period during which the process of global warming has heightened the frequency and consequences

[10] We substitute missing observations with the data points closest in time and, in the case of norms of respect, we also predict the values of missing countries through a regression including country and year fixed effects. These choices do not affect the message of our analysis (see table III of the Internet appendix).

[11] Sample selection seems unlikely since the natural logarithm of the value added of the agricultural sectors is unrelated, in the larger sample for which this information is available (see table I of the Internet appendix), to our institutional proxies, conditional on country and time fixed effects. Notably, countries endowed with a less inclusive political process and/or weaker cultural norms do not specialize in the agricultural sectors.

of climate extremes (Nordhaus, 2019). Second, the average value added of the agricultural sectors as a share of the GDP averaged over the 1960-2020 period is significantly—at 1%—larger within our sample than outside, i.e., 34.5% versus 11.8%. Therefore, compared to other jurisdictions, the populations of the most agricultural countries accumulated over the sample norms of cooperation predominantly meant to maximize the return on economic activities, which were crucially shaped by the availability of soil moisture.

Consistent with these two remarks, we document in the Internet appendix that the impact of the availability of soil moisture on both the inclusiveness of the political process and the accumulation of a culture of cooperation is significantly weaker in the sample of all the 161 countries for which information on the value added of the agricultural sectors is available from the World Development Indicators (see tables I and III of the Internet appendix).

5.2 Measurement

In the following, we discuss each of our dependent and independent variables (see table 2 and table II of the Internet appendix for their exact definition and sources).

5.2.1 Agricultural Production

Starting with the agricultural output, we rely on a real crop production index, i.e., *Production*. This score measures from 1960 on agricultural production relative to the base value of 100 assigned to the 2004-2006 period, excludes fodder crops and is available at the country level from the World Development Indicators project.

5.2.2 State-building

To proxy the inclusiveness of political institutions, we consider both its main multivalued measure and the most used metrics classifying regimes into democracies and nondemocracies (Guerriero, 2020; Acemoglu et al., 2019). The former is the Polity V Project constraints on executive score, i.e., *Democracy*. This variable refers to the strength of the institutionalized constraints on the decision-making power of chief executives, whether individual or collective. Such limitations may be imposed by any accountability group. In Western democracies, these are usually legislatures. Other kinds of accountability groups are the ruling party in a one-party state, councils of nobles or powerful advisors in monarchies, the military in coup-prone polities and an independent judiciary in many states. Thus, our measurement focuses

on the checks and balances between the various parts of the decision-making process. A seven-category scale is used with a value of one picking unlimited authority by the executive and a value of seven gauging executive parity or subordination, i.e., accountability groups have effective authority equal to or greater than the executive in most areas of activity. As stressed by Acemoglu et al. (2019), *Democracy* might be subject to measurement error and changes in its cardinal values could only correspond to ordinal switches or, even, no institutional evolution. To tackle this issue, we also consider the dichotomous regime classification proposed by Acemoglu et al. (2019), i.e., *Democracy-D*. This dummy equals one only if several sources classify a jurisdiction as a democracy, and it is available up to the 2010. Finally, to evaluate the persistent effect of climate shocks, we compute the difference between the value that *Democracy* (*Democracy-D*) takes in, respectively, $t+2$, $t+4$ and $t+9$ and the value recorded in $t-1$, i.e., Δ*3-Democracy*, Δ*5-Democracy* and Δ*10-Democracy* (Δ*3-Democracy-D*, Δ*5-Democracy-D* and Δ*10-Democracy-D*). Given the available data, relying on these alternative variables induces a loss of degrees of freedom.

Finally, we construct two proxies for a rise in the non-elites' payoff from public good consumption. The first one is the difference between the public health service expenditures—i.e., *Health*—and the military expenditures—i.e., *Military*, both expressed as a percentage of GDP, i.e., *Public-Good-H*. The second one is the difference between the expenditures on public education—i.e., *Education*—and those on the military, again denominated in percentage of GDP, i.e., *Public-Good-E*.[12] The underlying data are available from the World Development Indicators and the 1960 on, and the intuition guiding our choice is as follows. While a powerful military helps the elites maintain control over scarce resources, both public health service and schooling raise the non-elites' returns on both economic cooperation and civic participation (Besley and Kudamatsu, 2006; North et al. 2009; Alesina et al., 2023).

5.2.3 A Culture of Cooperation

Regarding the strength of a culture of cooperation, we consider the intensity of self-reported norms of respect and trust (Tabellini, 2010; Boranbay and Guerriero, 2019). These values represent internalized norms of "generalized" morality applied outside the group of

[12] Albeit different views survive, the mix of universal coverage and the adoption of social insurance systems makes the two goods close toward being public, i.e., non-excludable and non-rivalrous (Galea, 2016).

friends and relatives (Platteau, 2000), and they have been employed by Guerriero (2020) to capture the intrinsic reward from cooperating in any economic activity analyzed in Tabellini (2008), Boranbay and Guerriero (2019) and Benati and Guerriero (2024).[13] To elaborate, respectful individuals are more reluctant to free ride on others and are more willing to participate in joint partnerships (Tabellini, 2010). Similarly, not only does trust favor cooperation in prisoner's dilemma games, as documented by a broad experimental evidence, but it also helps parties share common views and reduce transaction costs, expanding in this way market exchange and division of labor (Heider, 1958; Dixit, 2004; Guerriero, 2020).

To capture both norms,[14] we follow Tabellini (2010) and Guerriero (2020) and we build on the Afrobarometer and World Values Surveys waves run over the sample to construct the synthetic variable *Culture* as the normalized—to range between 0 and 1—first principal component extracted from the share of answers mentioning "respect for other people" as important quality that children should be encouraged to learn and the share of answers "most people can be trusted" to the question "[g]enerally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?" *Culture* is available for a sub-sample of 24 most agricultural countries over the 1981-2018 period.

5.2.4 Severity of Droughts

A large agricultural economics literature suggests that growing season climate extremes, as determined by the combined effect of temperature and rainfall, explain most of the yield anomalies at the global scale (Vogel et al., 2019).[15] Accordingly, we capture climate shocks relevant for both agricultural production and institutions through the self-calibrating Palmer drought severity index averaged between May and September, which is the growing season

[13] Building on European data, Guerriero (2020) shows that the main alternative proxies for culture—i.e., conviction that effort will pay off and acceptance of hierarchies (Tabellini, 2010)—are uncorrelated with historical measures of the intrinsic reward from cooperating. While, indeed, the former concerns "the desirability of individuals independently pursuing their own ideas," the latter "refers to a cultural emphasis on obeying role obligations within a legitimately unequal distribution of power" [Licht et al. 2007, p. 662].

[14] An obvious issue with *Culture* is that its persistent nature might limit the variation available conditional on the fixed effects. Two pieces of evidence clarify why this is not our case. First, the "within" variation of *Culture* is almost half of its "between" variation, i.e., 0.085 versus 0.207. Second, the Hausman specification test tends to reject the null hypothesis that the random effects estimator is both consistent and efficient.

[15] In the case of cereals, they explain more than 80% of the variation of yield anomalies (Vogel et al., 2019). Focusing on the linear-quadratic effects of climate variables only, instead, would not account for the fact that extreme climate events, like tropical storms, can greatly affect the rainfall and temperature levels without re-establishing soil moisture and thus, relieving the aftermath of a drought (Moreland, 1993).

period common to most of the tropical and temperate countries in the sample, i.e., *PDSI*. This score is based on a nonlinear combination of temperature and precipitation and, different from its single components, constitutes an—inverse—measure of the severity of droughts, i.e., periods during which the supply of soil moisture fails to meet its demand (Redmond, 2002; Dai, 2021). To elaborate, its values range between - 10—i.e., extreme droughts—and 10—i.e., extremely wet conditions, zero identifies a situation of normal soil moisture, and negative values above - 4 pick droughts of intermediate severity (Redmond, 2002). The underlying data are calculated by Dai (2021) for each month between 1850 and 2018 and over the entire globe at a 2.5-degree spatial resolution.[16] While Palmer (1965) mixes temperature and rainfall via parameters derived from U.S. Great Plains data, Dai (2021) exploits regional surface meteorological—forcing—data. Operationally, we, first, average the monthly observations over the May to September period and then, we calculate country means weighted by the contribution of each cell to the country area. Since the growing season of tropical regions tends to last the entire year, we show that our conclusions are similar when we average climate data over the entire calendar year (see table IV of the Internet appendix). Similarly, the gist of our analysis remains unchanged when we characterize the long run impact of climate shocks on state-building and cultural accumulation by averaging our climate data over decennial subperiods (see table V of the Internet appendix).

While the relationship between our proxy for the strength of norms of cooperation and coeval values of the drought severity index can be interpreted as the impact of climate shocks on contemporaneous cultural changes driven by horizontal cultural transmission mechanisms (Nowak, 2006), House et al. (2020) suggest that a measure of the historical severity of droughts is needed to evaluate the effect of climate extremes on cultural innovations due to vertical and/or oblique cultural transmission mechanisms. To elaborate, these authors show that, according to data from eight societies, children significantly respond to innovations in the norms transmitted by adults at home and/or at school only between the age of ten and eighteen. Since respondents to the Afrobarometer and World Values Surveys represent the population aged eighteen and older, which in our sample roughly coincides with the

[16]Selecting as cross-section identifiers these cells is unfeasible because of the lack of sufficiently granular cultural data. Nevertheless, our conclusions are similar when we switch to weighted least squares employing analytic weights equal to the number of within-country cells (see table III of the Internet appendix).

population in the age between eighteen and forty-four,[17] we elect as our measure of the historical severity of droughts the share of years between t and $t-34$ during which the country experienced growing season droughts whose severity was between - 4 and 0, i.e., *PDSI-H*. Two are the key intuitions underlying this choice. First, $t-34$ is the first year during which the oldest respondents to the aforementioned surveys were reacting to innovations in the adults' norms of cooperation due to climate shocks, while t is the last year during which the youngest respondents to the aforementioned surveys were reacting to similar innovations. Second, as seen in section 2, values of the drought severity index lying between - 4 and 0 pick those negative, but not unbearable, climate shocks favoring the most state-building, i.e., such that the elite finds optimal to enact the inclusive political process and the non-elite reciprocates by accumulating cultural norms maximizing the returns on investment.

To control for the single effects of temperature and rainfall, we also consider their averages over either the May to September period or the entire year, i.e., either *Temperature* and *Rainfall* or *Temperature_Y* and *Rainfall_Y*. To construct these variables, we rely on monthly observations produced by the CRU CY dataset from 1901 on and for the entire globe at the 0.5 spatial resolution. Again, we, first, average this data for each time period in the sample over either the May to September period or the entire year and then, we calculate country means weighted by the contribution of each cell to the country area (Harris et al., 2020).

5.2.5 Discussion

Figure 2 displays the sizable variation in our environmental and institutional variables and suggests that our model testable predictions are consistent with the data. To elaborate, the sharp post-1980s rise in the incidence of droughts was accompanied by democratization, a large provision of the public goods preferred by the non-elites—i.e., public health service—and, in the last part of the sample, a recovery of the strength of norms of cooperation.

5.3 Estimating Equation

We follow Brückner and Ciccone (2011) and Ciccone and Ismailov (2022), and we run country and year fixed effects OLS panel models of the following type:

[17] 93% of the populations in our sample lie in the 1-44 range (https://www.populationpyramid.net).

$$Y_{c,t} = \alpha_c + \beta_t + \gamma' \mathbf{X}_{c,t} + \delta' \mathbf{Z}_{c,t} + \varepsilon_{c,t}, \tag{1}$$

where $Y_{c,t}$ is a proxy for either democratization, the strength of the non-elites' culture of cooperation, the non-elites' payoff from public good consumption or agricultural production. α_c incorporates country fixed effects controlling for time-independent and predetermined determinants of $Y_{c,t}$. Among the former, stand out long-lived factors modulating the impact of climate shocks, such as ruggedness, land suitability for agriculture and pasture, irrigation potential, access to water and livestock conditions (Acemoglu and Robinson, 2000; Litina, 2016; Bentzen et al., 2016). Among the latter, are noteworthy the timing of the agricultural revolution, religious norms and the incidence of slavery and, more generally, colonial heritage (Ashraf and Galor, 2013; Olsson and Paik, 2016). β_t encapsulates year dummies picking up global climate shocks and macro events like democratization waves and epidemics, which modulate the incentives to escape the Malthusian trap (Acemoglu, 2019; Voigtländer and Voth, 2009). Crucially, our results are similar when we also experiment with region fixed effects and region-specific time trends (see table VI of the Internet appendix).

$X_{c,t}$ always gathers either *Temperature*, *Rainfall*, *PDSI* and possibly, its first two lags or their yearly counterparts. When, moreover, $Y_{c,t}$ labels *Culture*, it also includes *PDSI-H*, which fully encompasses the impact of the lagged severity of droughts on culture. Finally, when $Y_{c,t}$ represents a measure of public good provision (*Production*), $\mathbf{X}_{c,t}$ incorporates also *Democracy* (institutions and some of their lags). Finally, the vector $\mathbf{Z}_{c,t}$ possibly includes lead values of *Democracy* as well as the observables further discussed in section 5.5.3.

Should the error $\varepsilon_{c,t}$ be heteroskedastic and/or correlated over time because of, for instance, the autoregressive structure of the proxy for drought severity (Dai, 2021; Palmer, 1965), the standard errors of our estimates will be biased (Angrist and Pischke, 2009). To assess this issue, we experiment with errors clustered at the country level—and possibly bootstrapped á la Cameron et al. (2008) when $Y_{c,t}$ labels *Culture* and the number of available clusters becomes small, and we obtain similar results (see table III of the Internet appendix).

5.4 Basic Empirical Results

Table 3 documents five facts about the direct and indirect impact of climate shocks, the

link between democratization and public good provision and the interplay among droughts, institutions and agricultural production, which are consistent with our testable predictions.

First, worse climate conditions—lower values of *PDSI*—induce reforms towards a more inclusive political process (columns (1) and (2) of panel A). This effect is only contemporaneous and a shift from extremely wet to extremely dry conditions—a 20-fall in *PDSI*—leads to a significant—at 5%—0.54-standard-deviation rise in *Democracy* (column (2)).

Second, the institutional effect of soil moisture is permanent as revealed from the coefficients attached to *PDSI* in the regressions with dependent variables the changes in the constraints on the executive over three, five and ten years (columns (3) to (5) of panel A).

Third, more adverse coeval and historical farming conditions encourage cultural accumulation (column (6) of panel A). While a jump from extreme wet to extreme dry conditions is associated with a significant—at 5%—0.45-standard-deviation increase in the strength of norms of trust and respect via horizontal cultural transmission, a one-standard-deviation increase in the historical availability of soil moisture over the growing season—i.e., *PDSI-H*—induces a significant—at 1%—0.13-standard-deviation rise in the strength of norms of cooperation via both vertical and oblique cultural transmission processes.[18]

Fourth, democratization is significantly—at 1%—related to a shift towards the provision of the public goods preferred by the non-elites. To elaborate, a reform from unlimited executive authority to executive parity—a 7-rise in *Democracy*—entails a 0.27-standard-deviation rise in the difference between public health service and military expenditures (columns (1) of panel B).[19] This change can be decomposed in a significant—at 5%—0.22-standard-deviation decrease in the military expenditures and a significant—at 5%—0.15-standard-deviation increase in the public health service expenditures (columns (2) and (3) of panel B).

Finally, the severity of droughts is a key determinant of the agricultural output and a rise in the growing season soil moisture has the direct effect of significantly—at 5%—increasing *Production*. This last result, together with the four patterns discussed before, corroborates the three testable predictions illustrated in section 3 (columns (4) to (6) of panel B). Crucially, our crop production index is also significantly related to *Democracy* lagged

[18] Crucially, democratization is an insignificant predictor of cultural accumulation and the other way around. This evidence confirms that institutions are jointly determined by the drought severity (see section 2).

[19] Results available upon request reveal that the impact of *Democracy* is only contemporaneous.

two periods in the sample for which the inclusiveness of the political process is observed and to *Culture* lagged one period in the sample for which the proxy for norms of cooperation is available (columns (4) to (6) of panel B). Albeit consonant with an indirect—i.e., via institutional formation and evolution—impact of climate shocks on the agricultural output, we do not assign to these last links a causal interpretation since state-building, culture and the farming production are all jointly determined by climate shocks.

5.5 Gaining More Insights About Causality

Even if consistent with the main prediction of our theoretical framework, our estimates may be attenuated by measurement errors, may be capturing reverse causality and/or might be driven by unobserved heterogeneity. We evaluate these issues in turn.

5.5.1 Evaluating the Impact of Measurement Error

To evaluate the impact of measurement error, three observations are key. First, *PDSI* is designed to minimize errors in its measurement since it considers regional meteorological forcing data (Dai, 2021). Moreover, tables IV and V of the Internet appendix entail that the conclusions of our analysis remain substantially unaffected when we average climate data over the entire year and when we consider, instead, the six decennial subperiods in which our sample can be divided. The first of these last two robustness checks assures that our results do not rest on our choice of focusing on the growing season climate extremes, whereas the second one evaluates the possibility that society would find it more difficult to adapt to multidecadal megadrought. This does not seem to be the case in our data. Second, columns (1) to (5) of panel A of table 4 clarify that the message of our empirical exercise remains intact when we switch to the aforementioned discrete measures of the inclusiveness of political institutions and when we proxy the non-elites' payoff from public good consumption with its alternative proxy *Public-Good-E*. Interestingly, expenditures on public education do not seem to be significantly related to democratization (column (1) of panel B of table 4). Finally, it is worth to notice that the noise in the measurement of the strength of the non-elite's culture decreases only the precision of the estimated coefficient on *PDSI* when *Culture* is the dependent variable. When, instead, the strength of norms of cooperation is an independent variable, errors in its measurement make the estimate of the coefficient attached

to *Culture* a lower bound of its true value (Angrist and Pischke, 2009).

5.5.2 Evaluating the Impact of Reverse Causality

While the independence of climate extremes from both human effort and institutional decisions excludes reverse causation in our analysis of the determinants of institutions, a more direct test is necessary to rule out that public good provision drives the constraints on the executive. To construct it, we follow Angrist and Pischke (2009), and we expand the model in column (1) of panel B of table 3 to also include the proxy for the inclusiveness of political institutions lead one year, i.e., *Democracy*$(+1)$. If reverse causality was an issue, then one would expect even stronger correlations between current values of public good provision and future values of *Democracy* because of the lag with which institutions adjust. As column (2) of panel B of table 4 reveals, this is not what we observe in our data.

5.5.3 Evaluating the Impact of Unobserved Heterogeneity

We assess the impact of unobserved heterogeneity in two steps. First, we control for the other main determinants of state-building and cultural accumulation identified by the extant literature. Second, we build on this exercise to calculate how much selection on unobservables would have to be to attribute the entire estimated coefficients to selection effects.

We focus on the observable factors that are most likely exogenous in the main text, analyzing those that might be endogenous and thus, constitute "bad" controls in the Internet appendix. The first group encompasses three sets of controls. First, we evaluate the possible non-linear impact of rainfall and temperature on formal and informal institutions by incorporating in the analysis the square of both *Temperature* and *Rainfall* as proposed by Brückner and Ciccone (2011) and Ciccone and Ismailov (2022). Second, we consider *PDSI-V*, which is the standard deviation between year t and year $t-1$ of *PDSI*. As suggested by our model, Boranbay and Guerriero (2019) and Benati and Guerriero (2024), the more volatile is the availability of soil moisture during the growing season, the larger is the non-elite's return on accumulating culture to share consumption risk. Finally, we evaluate the possibility that a larger non-produced output, and thus, a weaker disincentive effect of autocracy dilutes the elites' incentive to democratize (Ross, 2001). To do so, we consider the total natural resources rents as a percentage of GDP, i.e., *Natural-Resources*.

In the Internet appendix, we document, instead, that the message of our analysis remains the same when we also evaluate, one at the time, degree of environmental circumscription (Carneiro, 1970; Mayshar et al., 2017), diffusion of irrigation systems (Dell et al., 2014), risk of unrest (Acemoglu and Robinson, 2000; Haseeb, 2024),[20] severity of external threats (Besley and Persson, 2009), intensity of religiosity (Huntington, 1996), degree of ethnic heterogeneity (Montalvo and Reynal-Querol, 2005), human capital (Acemoglu et al., 2019), economic development (Inglehart and Welzel, 2005), degree of economic inequality (Boix, 2003) and economic policies (Przeworski and Limongi, 1997).

The estimates listed in columns (3) to (5) of panel B of table 4 entail that, conditional on our main observable factors, our conclusions remain unchanged. To put this remark into perspective, we calculate the index proposed by Bellows and Miguel (2009) to measure how much stronger selection on unobservable factors, relative to selection on observables, must be to explain away the entire estimated effects. To understand the index, consider a regression with a restricted set of controls and one with a full set of controls, and denote the estimate of the coefficient on the relevant variable—i.e., either *PDSI*, *PDSI-H* or *Democracy*—from the first regression λ_R, where R stands for "restricted," and that from the second regression λ_F, where F stands for "full." Then, the index is the absolute value of $\lambda_F/(\lambda_R - \lambda_F)$. The smaller the absolute value of $(\lambda_R - \lambda_F)$ is, the less the estimate of the coefficient attached to the variable of interest is affected by selection on observables, and the stronger selection on unobservables needs to be to explain away the entire effect. Similarly, the larger the absolute value of λ_F is, the greater is the effect that needs to be explained away by selection on unobservables. We consider the specifications reported in columns (2) and (6) of panel A of table 3 and column (1) of panel B of table 3 as the restricted regressions and the specifications illustrated in columns (3) to (5) of panel B of table 4 as the full regressions, and we report the indexes calculated from these regressions in columns (1) to (3) of table 5, respectively. The key observations are that no index is lower than one and that their mean (median) is 23.4 (24.9). Therefore, to attribute the entire estimates to selection effects, selection on unobservable factors would have to be on average more than twenty-three times

[20] Inconsistent with Acemoglu and Robinson (2000), internal conflicts are unrelated to institutions and the severity of droughts, conditional on country and year fixed effects and at the yearly or decennial frequency.

greater than selection on all main observable variables. This seems unlikely.

6 Concluding Comments

Our analysis suggests that, in a sample of most agricultural countries, the severity of droughts has both a negative and direct effect on agricultural output and a positive and indirect institutional impact. The latter can be decomposed in a persistent rise in the inclusiveness of the political process, which, in turn, shifts the allocation of the tax revenues from military to public health service expenditures, and the horizontal, oblique and vertical transmission of norms of trust and respect. This evidence is consistent with the idea that adverse climate shocks push the elites to enact an inclusive political process and the non-elites to accumulate a forceful culture of cooperation. While reforms towards inclusive political institutions convince the non-elites that they will enjoy a sufficient part of the returns on investing in farming innovations with the elites, accumulating culture allows the non-elites' credible commitment to cooperation despite its limited extrinsic return.

Our conclusions, together with recent evidence on the pivotal role of formal and informal institutions in guiding the adaptation of developing countries to climate change (Bättig and Bernauer, 2009; Mubaya and Mafongoya, 2017; Yomo et al., 2020), entail three key policy implications. First, severe droughts have the direct effect of depressing the economy, but they can also sustain, via institutional formation and evolution, an otherwise unattainable cooperation between elites and non-elites endowed with complementary inputs. As a result, in the aftermath of major adverse climate shocks, policymakers should calibrate their intervention on the bases of the degree of complementarity of the inputs of differently powered groups. When this is large, cooperation must be elicited by favoring the participation of elites and non-elites in joint investments and, in turn, the endogenous rise of an inclusive political process and a forceful culture. When, instead, input complementarity is limited, policymakers should stimulate sectors fostering input complementarity if this strategy does not create too large misallocations (Levi, 1988; Guerriero, 2023). Second, provided that the production conditions generate a sufficiently large output to share, a moderate cultural accumulation under a less inclusive political regime can suffice to incentivize investment (North and Weingast, 1989; Benati et al., 2022; Benati and Guerriero, 2021). This second implica-

tion, together with the first one, emphasizes the need of supporting cultural accumulation by the non-elites rather than mechanically transplanting an inclusive political process (Guerriero, 2016), and it squares with recent evidence, included our own results, highlighting the primacy of culture over democracy in shaping long run economic development (Guerriero, 2020). While a culture of cooperation always fosters investment and trade, an inclusive political process can assure cooperative investments in the short run, but it might become irrelevant, if not detrimental, when technological shocks deprive joint endeavors of their role. Finally, our analysis suggests that it is desirable to properly combine natural and social sciences in the evaluation of climate change. Such an interdisciplinary approach requires not only credible data on climate shocks, institutions and economic outcomes but also convincing theoretical models of the interplay among all these variables, which, in turn, increase the credibility of the empirical analyses of the full impact of climate change (Zhang et al., 2011; Dell et al., 2014; Carleton and Hsiang, 2016; Contreras, 2016; Degroot et al. 2021).

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Appendix

Model: Details

Political process: details.—Public good provision has a technology linear in the tax revenues $g_r = V\delta_r$, and a supply g_r of public good delivers a sub-utility ρg_r to the group selecting δ_r and a sub-utility βg_r to its partner. We impose the following restrictions $0 < \beta < \rho < 1$. While $\rho < 1$ entails that the public good is less valuable than the private one, $\beta < \rho$ captures the degree of heterogeneity in the groups' preferences for the common goods and/or their lower ability to provide the public good favorite by a partner.[21] In our sample, the non-elite prefers to invest the tax revenues in the provision of public health service rather than defense, and the elite displays opposite preferences (Lansford, 2021; Fischer, 2021).

Culture: details.—By incurring a quadratic cultural accumulation cost $c^2/2$, the non-elite gains an intrinsic return c from cooperating in investment and an intrinsic reward μc from cooperating in an alternative risk-sharing activity.[22] The parameter μ picks the factors amplifying consumption risk—e.g., climate volatility, and it is larger than 1.

Payoffs: details.—While the elite's payoff from investment equals $\pi_A = (1-\delta_A)V + \rho\delta_A V$ for $r = A$ and $\pi_I = (1-\delta_I)V + \beta\delta_I V$ for $r = I$, the non-elite's ex ante utility from investment is given by $U_A = c^* - \frac{(c^*)^2}{2} + \beta\delta_A V - \gamma$ for $r = A$ and $U_I = c^* - \frac{(c^*)^2}{2} + \rho\delta_I V - \gamma$ for $r = I$. Similarly, the non-elite's ex ante utility from sharing risk equals $\mu c^* - \frac{(c^*)^2}{2}$.

Endogenous cultural accumulation.—We solve the game by backward induction.

A non-elite opting out of investment obtains an interim—at time t_3—payoff of μc^* and an ex ante—at time t_0—utility of $\mu c^* - \frac{(c^*)^2}{2}$. As a consequence, he accumulates a culture $c^* = \mu$, which entails an ex ante payoff of $\mu^2/2$ and an interim utility of μ^2.

Once the inclusive political process has been embraced, a non-elite foreseeing to partic-

[21] We also assume that elite cannot commit to contract away the inefficiency of public good provision. Our analysis will stand should we assume that $(\rho - \beta)\, g_r$ is the output share expropriated by the group in power.

[22] In our linear environment, risk aversion can be interpreted as the existence of another state of the world producing an expected utility lower than the certain scenario of no cooperation (Guerriero, 2023).

ipate in investment maximizes his net utility from redistributing via public spending the production value, subject to granting the elite a positive payoff. Since the elite's utility under full taxation is $\beta V > 0$, the non-elite picks $\delta_I^* = 1$ and obtains an ex ante utility of $c^* - \frac{(c^*)^2}{2} + \rho V - \gamma$ and an interim payoff of $c^* + \rho V - \gamma$ implying the interim participation constraint $c^* + \rho V - \gamma \geq \mu c^* \leftrightarrow V \geq \frac{\gamma + (\mu - 1)c^*}{\rho} \equiv \hat{\Omega}(c^*)$. At time t_0 and for $V \geq \hat{\Omega}(c^*)$, the non-elite maximizes his ex ante utility by choosing between the norms optimal under cooperative investment—i.e., 1—and μ.[23] The former is preferred if $\frac{1}{2} + \rho V - \gamma \geq \frac{\mu^2}{2} \leftrightarrow V \geq \frac{\gamma + \frac{\mu^2 - 1}{2}}{\rho} \equiv \underline{\Omega}$. Since $\frac{\mu^2 - 1}{2} > \mu - 1$, $\underline{\Omega} > \hat{\Omega}(1)$. Ultimately, for $r = I$, the non-elite picks $c^* = 1$, $\delta_I^* = 1$ and investment for $V \geq \underline{\Omega}$, and she selects $c^* = \mu$ and risk-sharing otherwise.[24]

After having kept autocracy, the elite selects a δ_A maximizing the linear utility function

$$\max_{\delta_A \in [0,1]} \quad (1 - \delta_A) V + \rho \delta_A V,$$

subject to satisfying all participation constraints. Since the elite favors private to public good consumption, she would select a tax rate $\hat{\delta}_A = \frac{\gamma + (\mu - 1)c^*}{\beta V}$ such that the non-elite's interim participation constraint binds. Given this policy, the non-elite prefers to accumulate a culture μ and share risk over picking $c^* = 1$ and investing since $\frac{1}{2} + \beta \hat{\delta}_A V - \gamma < \frac{\mu^2}{2}$ being $\frac{\mu^2 - 1}{2} > \mu - 1$. Hence, the elite selects a $\delta_A^* = \frac{\gamma + \frac{\mu^2 - 1}{2}}{\beta V} \leq 1$ such that, in t_0, the non-elite is indifferent between accumulating $c^* = 1$ to invest and embracing norms μ to share risk whenever $V \geq \frac{\gamma + \frac{\mu^2 - 1}{2}}{\beta} \equiv \overline{\Omega}$, with $\overline{\Omega} > \underline{\Omega}$. For $V \geq \overline{\Omega}$, $\pi_A = (1 - \delta_A^*) V + \rho \delta_A^* V$ is larger than the elite's payoff under the inclusive political regime—βV—and autocracy prevails.

Ultimately, in a world of inefficient public good provision, the elite prefers to direct fiscal policies and pick a tax rate falling with the output value if faced with mild time inconsistency issues, i.e., $V \geq \overline{\Omega}$. When, however, such failures are severe but not insurmountable—i.e., $\underline{\Omega} \leq V < \overline{\Omega}$, only a reform towards the inclusive political regime, combined with the non-elite's accumulation of a culture maximizing his payoff from investment, makes possible

[23] A zero cultural level is never an option since selecting $c^* = \mu$ and sharing risk bring to the non-elite an ex ante payoff of $\frac{\mu^2}{2} > 0$. Different from us, Boranbay and Guerriero (2019) assume that investment always delivers to the non-elite a payoff larger than that assured by risk-sharing and thus, they evaluate also the $\hat{c} = \frac{\gamma - \rho V}{1 - \mu} > 1$ satisfying the non-elite's interim participation constraint as well as his less restrictive ex ante participation constraint for $V < \hat{\Omega}(1)$. $\hat{c}$ is not an equilibrium of our game since $\hat{c} - \frac{\hat{c}^2}{2} + \rho V - \gamma = \mu \hat{c} - \frac{\hat{c}^2}{2} < \frac{\mu^2}{2}$.

[24] The non-elite will never deviate to $c^* = 1$ whenever $\hat{\Omega}(1) \leq V \leq \underline{\Omega}$ since $\frac{\mu^2 - 1}{2} < \mu^2 - \mu$.

cooperation. Crucially, cultural accumulation relaxes the non-elite's participation constraint, allowing his credible commitment to cooperation despite the limited payoff from public good provision.[25] When, finally, the investment return is tiny—i.e., $V < \underline{\Omega}$, the non-elite opts for risk-sharing and picks a culture maximizing the relative payoff. Notably, a larger marginal return on risk-sharing μ discourages investment—i.e., raises $\underline{\Omega}$—and makes the inclusive political regime more necessary to support cooperation, i.e., increases $\overline{\Omega} - \underline{\Omega}$. The following proposition summarizes the key implications of our analysis:

Proposition: *For* $0 < \beta < \rho < 1 < \mu$ *and: 1.* $V < \frac{\gamma + \frac{\mu^2 - 1}{2}}{\rho}$*, the non-elite accumulates a culture* μ *and shares risk under any regime* r*; 2.* $\frac{\gamma + \frac{\mu^2 - 1}{2}}{\rho} \leq V < \frac{\gamma + \frac{\mu^2 - 1}{2}}{\beta}$*, the elite grants strong non-elite's political rights, whereas the non-elite picks* $c^* = 1$*, selects the maximum tax rate* $\delta_I^* = 1$ *and invests; 3.* $V > (=) \frac{\gamma + \frac{\mu^2 - 1}{2}}{\beta}$*, the elite keeps the autocratic regime and selects* $\delta_A^* = \frac{\gamma + \frac{\mu^2 - 1}{2}}{\beta V} < (=) 1$*, whereas the non-elite accumulates* $c^* = 1$ *and invests.*

Anecdotal Evidence

Burundi

Burundi is a heavily agricultural country and indeed, 80% of the general population is involved in subsistence farming and coffee accounts for more than 70% of exports. The 2000 strikes against rising prices and taxes pushed the ruling parties to start developing an agenda for the peaceful resolution of the decennial civil conflicts. Political reforms were accelerated by farming conditions that significantly worsened because of the 2003-2007 droughts [Marih et al. 2014, Table 3; Nkuzimana et al., 2021], i.e., our inverse measure of the severity of the growing season droughts felt from 1.6 in 2002 to an average of -1.5 between 2003 and 2006.

The mix of climate extremes and devastating civil war caused a dramatic—i.e., more than a third—decline in GDP [Lansford 2021, p. 239]. By 2003, a new National Assembly was formed, the military heads resigned and a new constitution safeguarding ethnic diversity and female representation was signed. After the 2005 approval of this reform, several treaties and economic reforms were implemented [Treisman 2020, p. 293-295; Lansford 2021, p. 239-

[25] In an institutional vacuum, the elite can entice the non-elite only by credibly committing to transfers. Then, she would offer ϵV, with $\epsilon > \beta$, as either a direct transfer or a sharecropping contract. This payment induces cooperation for $\frac{\gamma}{\epsilon} < V < \overline{\Omega}$. When both transfers and institutions are available, an elite willing to invest will use the former only for $\frac{\gamma}{\epsilon} < V < \underline{\Omega}$ and $\epsilon > \rho$ since they are inferior to any public good consumption.

242]. To illustrate, demobilization went hand-in-hand with a shift of public spending from the military to public education expenditures (Specker et al., 2010), i.e., the constraints on executive rose from 3 in 1999 to 6 in 2011, while the military expenditures felt from 6.3% to 2.7% of GDP over the same period. Symmetrically, the expenditures on public health service increased from 1.5% to 3.5% of GDP over the same span of time.

Finally, the government adopted in 2010 a substantial package of reforms called "Burundi Vision 2025" and aimed at shepherding the country from a post-conflict to a sustained peace scenario (UNDP, 2011). These policies helped recovery light weapons from the population, settle land conflicts, return displaced persons to their homes, reintegrate victims of violence, abuse, and disease, and foster government accountability, political participation, judicial independence and administrative decentralization. These institutional discontinuities were accompanied by a strengthening of norms of trust and respect and in fact, our proxy for the strength of culture raised from a level of 0.17 in 1999 to 0.2 in 2009.

Ethiopia

Initially ruled by autocratic regimes involved in unrest and border disputes, post-colonial Ethiopia remained an agricultural country [Lansford 2021, p. 537], which, unsurprisingly, greatly suffered the series of droughts of the 2000s [Masih et al. 2014, Tables 2-3: Lansford 2021, p. 537-538]. This already complex situation deteriorated with president Mele's death in 2012 and a new string of increasingly harsh droughts and opened the way to two key institutional discontinuities. First, between 1998 and 2018, the constraints on executive rose from 3 to 5, the military expenditures felt from 7.3% to 0.6% of the GDP, and the expenditures on public health service rose from 2.8% to 4.7% of the GDP [Lansford 2021, p. 538-544]. Second, over the same period, self-reported norms of trust and respect jumped from the normalized—to range between 0 and 1—level of 0.07 to 0.36. These institutional changes resulted in the 2018 "Homegrown Economic Reform," which repelled repressive laws, encouraged gender-balance and incentivized farming through the provision of training programs and equipment, the integration of smallholders into the trade networks, and the enactment of regulations easing the peasants' access to finance (Hausmann et al., 2022).

India

While political rights were already extended to the entire Indian population since the

late 1960s, their intensity sharply increased in the aftermath of the 1990s droughts (Lansford, 2021), i.e., our inverse measure of the severity of the growing season droughts felt from 0.84 in 1998 to -1.98 in 2002. The federal government coped with the fiercer climate shocks by implementing risk-sharing projects like the 2005 Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), which was aimed at providing social safety nets to communities engaged in subsistence production (Fischer, 2021). The act guaranteed 100 days of minimum wage labor per year to the households involved in local infrastructural—and especially hydraulic—projects and favored their decentralized organization (Fischer, 2021).

Public meetings and elected village councils were entrusted the power to select and manage these endeavors. These reforms were supported by a significant strengthening of norms of trust and respect whose intensity more than quadrupled by the beginning of the 2010s, i.e., our proxy for the strength of culture jumped from 0.18 in 1998 to 0.80 in 2010. Furthermore, they favored "community-based adaptation" to climate change via a process of "democratic deepening" and went hand-in-hand with a shift of tax revenues towards the provision of public education, whose expenditures as a percentage of the GDP and in deviation from the military expenditures as a percentage of GDP rose from 0.85 in 1998 to 1.14 in 2011. These reforms shifted economic resources and political power towards marginalized sectors of society, helping reduce climate-related risk (Fischer, 2021). For instance, the state of Maharashtra, which has been severely affected by decades of droughts, has from 2016 not only pushed both public and private sectors to provide farmers with latest technology, such as greenhouse farming and artificial cross-breeding of crops, but also invested in water infrastructures to prevent soil erosion and provided know-how to farmers on how to transition to less water-intensive and organic cropping patterns (ORF, 2023).

Liberia

After the authoritarian turn of the 1980s, Liberia was plagued by a brutal civil war for much of the 1990s. Although a peace agreement was reached in 1996 and elections were held in 1997, conflicts between the government and internal opponents broke out in 1999. Liberia's support to rebel groups in Sierra Leone, moreover, pushed the international community to impose sanctions and embargos, and in 2003 an UN-sponsored special court indicted president Taylor for war crimes [Lansford 2021, p. 969]. From an economic standpoint, two

decades of mismanagement, intense internal fighting and failing climate conditions brought the collapse of commercial and productive activities and accordingly, the GDP per capita and exports declined by, respectively, 90% and 95% compared to the 1980s [Treisman 2020, p. 1067; Lansford 2021, p. 966].[26] Due to the combination of these internal and external pressures, Taylor stepped down and went into exile in Nigeria. In late 2003, the UN took over the peacekeeping process and oversaw disarmament and state-building efforts that led to the 2005 free elections won by Ellen Johnson-Sirleaf [Treisman 2020, p. 1067-1070].

The new government launched the 2006 reforms package [Lansford 2021, p. 966], which dramatically decreased military expenditures from 29.7% of GDP in 2003 to 0.4% of GDP in 2018, while increasing expenditures on public health service from 0.5% to 1.6% over the same period. Moreover, the government invested in an elaborate reconciliation and rehabilitation agenda, developed and enforced in coordination with UN and ECOWAS. These policies targeted conflict prevention, limitation of small arms proliferation, and the integration of ex-combatants in the economy (Kawja, 2017). The constraints on executive sharply rose from 2 in 2003 to 6 in 2018 and norms of trust and respect strengthened.

Sierra Leone

In the aftermath of the 1997 military coup, the "Armed Force Revolutionary Council" rose to power but, immediately, encountered fierce opposition by internal opponents, UN and Nigeria. As a result, the junta was forced to sign in 1998 a disarmament agreement reinstating the formerly elected president and in 2001 a final ceasefire. The year after, free elections were held. Nevertheless, the GDP continued to decline due to the civil conflicts and persistently dry conditions [Lubovich and Suthers, 2007; Treisman 2020, p. 1777-1780; Lansford 2021, p. 1467, 1469-1470]. To elaborate, our measure of the availability of land moisture during the growing season dropped from -1.13 in 1996 to an average of -4.72 over the 1997-2007 period. To handle these shocks, the newly elected "All People's Congress Party" implemented in 2007 a series of reforms aimed at boosting investments in infrastructures, fighting corruption, strengthening the rights of women and children as well as reducing military expenditures [Lansford 2021, p. 1467], which sharply felt from 2.7% of GDP in 2001 to 1.3% of GDP in 2007. Moreover, powerless groups, such as ex-combatants and women,

[26] Our measure of soil moisture felt from -0.74 in 1996 to an average of -5.2 over the 2000-2018 period.

were involved in civic education projects encouraging political awareness, non-violence and norms of trust and respect (Jarczewska, 2014; Lubovich and Suthers, 2007).

Crucially, the constraints on the executive rose from 5 in 1997 to 6 in 2009 and, over the same period, our proxy for the strength of culture grew from 0.52 to 0.54.

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Figure and Tables

Table 1: The Sample — Most Agricultural Countries

Afghanistan, Bangladesh*, Benin*, Burkina Faso*, Burundi*, Cambodia, Cent. African Rep., Chad, Congo Dem. Rep., Cote d'Ivoire*, Ethiopia*, Gambia, Ghana*, Guinea-Bissau, Guyana, India*, Kenya*, Kyrgyzstan*, Lao, Liberia,* Malawi,* Mali,* Mozambique,* Myanmar, Nepal, Niger,* Pakistan,* Papua New Guinea, Rwanda,* Sierra Leone,* Somalia, Sudan,* Syria, Tanzania*, Togo*, Uganda*, Uzbekistan*, Vietnam*.

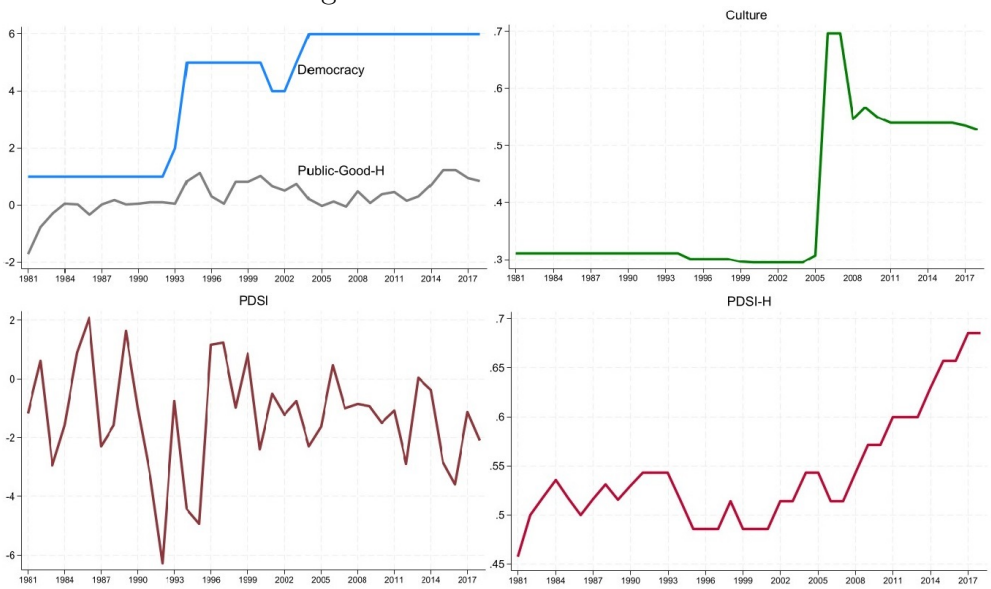
Note: 1. The 38 among the—42—countries with agriculture, forestry, and fishing value added as a share of the GDP averaged over the 1960-2020 period in the top quintile of the relative distribution and for which we observe all the variables that we use over their maximum common available sample, i.e., 1960-2018.
2. * denotes the countries for which our measure of a culture of cooperation is observable.

Table 2: Summary of Variables

	Variable	Definition and Sources	Statistics
Crop production:	*Production*:	Natural logarithm of a crop production index relative to the base period 2004-2006. Source: World Bank, https://databank.worldbank.org/	56.167 (30.516)
State-building and cultural accumulation:	*Democracy*:	POLITY V constraints on the executive authority score. Source: https://www.systemicpeace.org/csprandd.html	3.045 (1.898)
	Δ*3-Democracy*:	Difference between *Democracy* in t+2 and *Democracy* in t-1. Source: https://www.systemicpeace.org/csprandd.html	0.079 (1.209)
	Δ*5-Democracy*:	Difference between *Democracy* in t+4 and *Democracy* in t-1. Source: https://www.systemicpeace.org/csprandd.html	0.137 (1.463)
	Δ*10-Democracy*:	Difference between *Democracy* in t+9 and *Democracy* in t-1. Source: https://www.systemicpeace.org/csprandd.html	0.282 (1.848)
	Democracy-D:	Dummy for a democratic political regime. Source: http://economics.mit.edu/faculty/acemoglu/data/ddcg	0.230 (0.421)
	Δ*3-Democracy-D*:	Difference between *Democracy-D* in t+2 and *Democracy-D* in t-1. Source: http://economics.mit.edu/faculty/acemoglu/data/ddcg	0.017 (0.283)
	Δ*5-Democracy-D*:	Difference between *Democracy-D* in t+4 and *Democracy-D* in t-1. Source: http://economics.mit.edu/faculty/acemoglu/data/ddcg	0.031 (0.334)
	Δ*10-Democracy-D*:	Difference between *Democracy-D* in t+9 and *Democracy-D* in t-1. Source: http://economics.mit.edu/faculty/acemoglu/data/ddcg	0.063 (0.419)
	Culture:	See the main text. Source: https://afrobarometer.org/ and https://www.worldvaluessurvey.org/wvs.jsp	0.530 (0.220)
Provision of public goods:	*Military*:	Military expenditures as a percentage of the GDP. Source: World Bank, https://databank.worldbank.org/	2.400 (2.949)
	Health:	Public health service expenditures as a percentage of the GDP. Source: World Bank, https://databank.worldbank.org/	1.868 (1.701)
	Education:	Expenditures on public education as a percentage of the GDP. Source: World Bank, https://databank.worldbank.org/	3.309 (1.723)
	Public-Good-H:	Difference between *Health* and *Military*. Source: World Bank, https://databank.worldbank.org/ and https://countryeconomy.com	- 0.532 (3.405)
	Public-Good-E:	Difference between *Education* and *Military*. Source: World Bank, https://databank.worldbank.org/	0.909 (3.549)
Climate shocks:	*PDSI*:	Mean growing season self-calibrating Palmer drought severity index. Source: https://rda.ucar.edu/datasets/ds299.0/	- 0.570 (1.753)
	PDSI-H:	Share of years between t and $t-34$ during which *PDSI* lied between 0 and - 4. Source: https://rda.ucar.edu/datasets/ds299.0/	0.589 (0.113)
	Temperature:	Mean growing season temperature in degrees Celsius. Source: CRU Country File, https://crudata.uea.ac.uk/	25.029 (4.229)
	Rainfall:	Mean growing season monthly precipitation in mm. Source: CRU Country File, https://crudata.uea.ac.uk/	141.007 (117.775)
Other control variables:	*PDSI-V*:	Standard deviation of *PDSI* calculated over the years $t-1$ and t. Source: https://rda.ucar.edu/datasets/ds299.0/	1.007 (0.793)
	Natural-Resources:	Total natural resources rents as a percentage of GDP. Source: World Bank https://databank.worldbank.org/	8.729 (7.117)

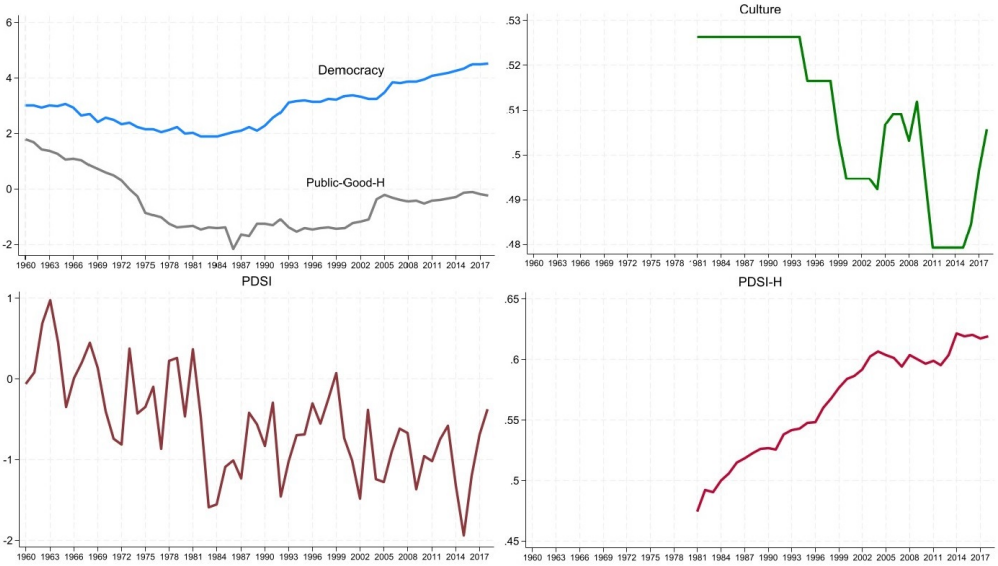
Note: 1. The last column lists means and, in parentheses, standard deviations for the samples employed in tables 3 to 5.

Figure 1: The Case of Malawi



Note: 1. The graphs illustrate the interplay among our measure of the inclusiveness of the political process—*Democracy*, our proxy for the strength of a culture of cooperation—i.e., *Culture*, our measure of the coeval severity of the growing season droughts—i.e., *PDSI*—and our proxy for their historical incidence—i.e., *PDSI-H*, all measured for Malawi between 1981 and 2018. Table 2 details definition and sources of each variable.

Figure 2: Climate Shocks, State-Building and (a Culture of) Cooperation



Note: 1. The graphs illustrate the interplay among our measure of the inclusiveness of the political process—*Democracy*, our proxy for the strength of a culture of cooperation—i.e., *Culture*, our measure of the coeval severity of the growing season droughts—i.e., *PDSI*—and our proxy for their historical incidence, i.e., *PDSI-H*. While the second and last variables are available for the 1981-2018 subsample, the other two are depicted for the whole 1960-2018 sample. Table 1 lists the polities part of the sample, whereas table 2 details definition and sources of each variable.

Table 3: Climate Shocks, State-Building and (a Culture of) Cooperation

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A. The dependent variable is:					
	Democracy	*Democracy*	*Δ3-Democracy*	*Δ5-Democracy*	*Δ10-Democracy*	*Culture*
PDSI	- 0.038	- 0.051	- 0.037	- 0.055	- 0.094	- 0.005
	(0.023)*	(0.021)**	(0.019)**	(0.023)**	(0.030)***	(0.002)**
PDSI(-1)	- 0.017					
	(0.021)					
PDSI(-2)	- 0.032					
	(0.020)					
PDSI-H						0.248
						(0.041)***
Estimation	OLS					
Within R^2	0.28	0.27	0.05	0.07	0.14	0.10
Number of Observations	2242	2242	2242	2166	1976	912
	Panel B. The dependent variable is:					
	Public-Good-H	*Military*	*Health*	*Production*	*Production*	*Production*
Democracy	0.129	- 0.093	0.036	0.024		
	(0.042)***	(0.038)**	(0.018)**	(0.373)		
Democracy(-1)				0.004		
				(0.503)		
Democracy(-2)				0.832		- 0.041
				(0.373)**		(0.299)
Culture					- 3.065	
					(10.987)	
Culture(-1)					9.035	7.853
					(15.384)	(4.357)*
Culture(-2)					2.614	
					(11.599)	
PDSI	- 0.001	- 0.019	- 0.020	0.604	0.835	0.957
	(0.041)	(0.037)	(0.017)	(0.201)***	(0.293)***	(0.274)***
PDSI(-1)				0.061	0.215	
				(0.189)	(0.273)	
PDSI(-2)				0.0005	0.273	
				(0.180)	(0.258)	
Estimation	OLS					
Within R^2	0.15	0.06	0.37	0.80	0.82	0.82
Number of Observations	2242	2242	2242	2242	912	912

Notes: 1. Standard errors in parentheses. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
2. All specifications include country and year fixed effects, *Temperature* and *Rainfall*.

Table 4: Gaining More Insights About Causality

	(1)	(2)	(3)	(4)	(5)
	Panel A. The dependent variable is:				
	Democracy-D	*Δ3-Democracy-D*	*Δ5-Democracy-D*	*Δ10-Democracy-D*	*Public-Good-E*
Democracy					0.105
					(0.041)***
PDSI	- 0.017	- 0.010	- 0.014	- 0.017	0.043
	(0.006)***	(0.005)**	(0.006)**	(0.008)**	(0.040)
Estimation	OLS				
Within R^2	0.16	0.04	0.05	0.09	0.07
Number of Observations	1938	1862	1786	1596	2242
	Panel B. The dependent variable is:				
	Education	*Public-Good-H*	*Democracy*	*Culture*	*Public-Good-H*
Democracy	0.012	0.076			0.124
	(0.015)	(0.080)			(0.042)***
Democracy(+1)		0.062			
		(0.080)			
PDSI	0.024	0.0002	- 0.040	- 0.005	0.004
	(0.015)	(0.041)	(0.021)*	(0.002)**	(0.041)
PDSI-H				0.242	
				(0.042)***	
$Temperature^2$			- 0.026	0.001	- 0.029
			(0.006)***	(0.001)**	(0.012)**
$Rainfall^2$			0.00001	0.00000003	0.000003
			(0.00001)*	(0.000001)	(0.00001)
PDSI-V			0.007	- 0.0002	0.010
			(0.038)	(0.0037)	(0.073)
Natural-Resources			- 0.008	- 0.001	0.034
			(0.007)	(0.001)	(0.013)***
Estimation	OLS				
Within R^2	0.05	0.15	0.28	0.10	0.15
Number of Observations	2242	2242	2242	912	2242

Notes: 1. Standard errors in parentheses. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
2. All specifications include country and year fixed effects, *Temperature* and *Rainfall*.

Table 5: Using Selection on Observables to Assess the Bias from Unobservables

	(1)	(2)	(3)
The index is calculated for:	*Democracy*	*Culture*	*Public-Good-H*
Democracy			24.8
PDSI	3.6	25	
PDSI-H		40.3	

APPENDIX (FOR ONLINE PUBLICATION)

Controlling for "Bad" Control Variables

Nine are the main determinants of institutions identified by the extant literature and possibly shaped by other factors modulating institutional formation and evolution.

First, we incorporate in our analysis *Circumscription*, which is defined as the ratio of *Production* to the average of the values that *Production* assumes in the neighboring countries, i.e., *Circumscription*. This variable accounts for the conjecture that the degree of environmental circumscription, which is the difference between the productivity of a territory and that of the surrounding areas, represents a deterrent to exit and unrest and should ease the extent of economic cooperation (Carneiro, 1970; Mayshar et al., 2017).

Second, we consider the diffusion of irrigation systems which, as discussed by Dell et al. (2014) and Ciccone and Ismailov (2022), might modulate the impact of the drought severity on the formation and evolution of formal and informal institutions, i.e., *Irrigated-Land*.

Third, we build on data from the Correlates of War project, and we construct a dummy for intra-state wars, i.e., *Internal-Conflicts*. Our prior is that internal conflicts are bound to discourage cooperation, especially outside the group of friends and relatives (Acemoglu and Robinson, 2000; Haseeb, 2024). Similarly, an expanding literature suggests that producing common interest goods, such as fighting external wars, is conducive to forceful non-elites' political rights and thus, relaxes the need of accumulating culture as a commitment device (Besley and Persson, 2009; Benati et al., 2022). To evaluate this link, we rely on a dummy for inter-state wars collected from the Correlates of War project, i.e., *External-Conflicts*.

Fourth, we assess the Huntington's (1996) claim that the Islamic religion's doctrine is less conducive to democratization by considering the percentage of Muslims in the total population collected from the composition of religious and ethnic groups project, i.e., *Muslims*.

Fifth, we ponder on the idea that more heterogeneous populations are less willing to cooperate (Montalvo and Reynal-Querol, 2005), by analyzing the historical ethnic fractionalization index proposed by the EUI Research Data, i.e., *Heterogeneity*.

Sixth, we test whether high levels of educational attainment are a prerequisite for a transition towards democratic institutions by evaluating the ratio of total enrollment to tertiary education, regardless of age, to the population of the relative age group produced by the World Development Indicators (Acemoglu et al., 2019), i.e., *Human-Capital*.

Seventh, we evaluate *Income*, which labels the GDP per capita in current U.S. dollars, is collected from the World Development Indicators and picks the modernization theory intuition that economic development should favor the adoption of sophisticated institutions.

Eighth, Boix (2003) claims that economic inequality magnifies the redistributive impact of democracy, decreasing the odds of a peaceful transition towards this institution. Hence, we consider the Gini index reported by the World Development Indicators, i.e., *Inequality*.

Finally, we evaluate the hypothesis that worse short-term performances, like a high inflation rate—i.e., *Inflation*, may jeopardize democratization (Przeworski and Limongi, 1997).

Supplementary Tables

Table I: Extended Sample

Afghanistan, Albania*, Algeria*, Angola, Argentina*, Armenia*, Australia*, Austria*, Azerbaijan*, Bahrain, Bangladesh*, Belarus*, Belgium*, Benin*, Bhutan, Bolivia*, Bosnia and Herzegovina*, Botswana*, Brazil*, Bulgaria*, Burkina Faso*, Burundi*, Cambodia, Cameroon*, Canada*, Central African Republic, Chad, Chile*, China*, Colombia*, Congo, Costa Rica, Croatia*, Cuba, Cyprus*, Czech Republic*, Democratic Republic of the Congo, Denmark*, Djibouti, Dominican Republic*, Ecuador*, Egypt*, El Salvador*, Equatorial Guinea, Eritrea, Estonia*, Ethiopia*, Fiji, Finland*, France*, Gabon, Gambia, Georgia*, Germany*, Ghana*, Greece*, Guatemala*, Guinea*, Guinea-Bissau, Guyana, Haiti*, Honduras, Hungary*, Iceland*, India*, Indonesia*, Iran*, Iraq*, Ireland*, Israel*, Italy*, Ivory Coast*, Jamaica, Japan*, Jordan*, Kazakhstan*, Kenya*, Kuwait*, Kyrgyzstan*, Laos, Latvia*, Lebanon*, Lesotho*, Liberia*, Libya*, Lithuania*, Luxembourg*, Macedonia*, Madagascar*, Malawi*, Malaysia*, Mali*, Malta*, Mauritania, Mexico*, Moldova*, Mongolia, Montenegro*, Morocco*, Mozambique*, Myanmar*, Namibia*, Nepal, Netherlands*, New Zealand*, Nicaragua*, Niger*, Nigeria*, Norway*, Oman, Pakistan*, Panama, Papua New Guinea, Paraguay, Peru*, Philippines*, Poland*, Portugal*, Puerto Rico*, Qatar*, Romania*, Russia*, Rwanda*, Saudi Arabia*, Senegal*, Serbia*, Sierra Leone*, Singapore*, Slovakia*, Slovenia*, Somalia, South Africa*, South Korea*, South Sudan, Spain*, Sri Lanka, Sudan*, Suriname, Sweden*, Switzerland*, Syria, Tajikistan*, Tanzania*, Thailand*, Togo*, Trinidad and Tobago*, Tunisia*, Turkey*, Turkmenistan, Uganda*, Ukraine*, United Arab Emirates, United Kingdom*, United States*, Uruguay*, Uzbekistan*, Venezuela*, Vietnam*, Yemen*, Zambia*, Zimbabwe*.

Note: 1. Countries for which data on the value added of the agricultural sectors is produced by the World Development Indicators.
2. * denotes the countries for which our measure of a culture of cooperation is observable.

Table II: Summary of Variables

	Variable	Definition and Sources	Statistics
Climate shocks:	*PDSI_Y*:	Mean self-calibrating Palmer drought severity index. Source: https://rda.ucar.edu/datasets/ds299.0/	- 0.558 (1.564)
	PDSI-H_Y:	Share of years between t and $t-34$ during which *PDSI_Y* lied between 0 and -4. Source: https://rda.ucar.edu/datasets/ds299.0/	0.622 (0.123)
	Temperature_Y:	Mean temperature in degrees Celsius. Source: https://crudata.uea.ac.uk/	23.222 (5.731)
	Rainfall_Y:	Mean monthly precipitation in mm. Source: https://crudata.uea.ac.uk/	98.151 (64.180)
Other control variables:	*Circumscription*:	Ratio of *Production* to its average in neighboring countries. Source: World Bank, https://databank.worldbank.org/index	1.106 (0.620)
	Irrigated-Land:	Agricultural irrigated land as a percentage of total agricultural land. Source: World Bank, https://databank.worldbank.org/	14.063 (17.189)
	Internal-Conflicts:	Dummy for intra-state wars. Source: Correlates of War Project, https://correlatesofwar.org/data-sets/COW-war	0.031 (0.173)
	External-Conflicts:	Dummy for inter-state wars. Source: Correlates of War Project, https://correlatesofwar.org/data-sets/COW-war	0.045 (0.207)
	Muslim:	Percentage of Muslims on total population. Source: CREG project and CIA factbook, https://clinecenter.illinois.edu/ and https://www.cia.gov	36.180 (35.265)
	Heterogeneity:	Historical ethnic fractionalisation index. Source: http://hdl.handle.net/1814/64606	0.618 (0.244)
	Human-Capital:	Ratio of total enrollment to tertiary education, regardless of age, to the population of the relative age group. Source: World Bank, https://databank.worldbank.org/	4.684 (7.045)
	Income:	Log GDP per capita in constant 2015 USD. Sources: World Bank, https://databank.worldbank.org/index	6.414 (0.657)
	Inequality:	Gini index. Sources: World Bank, https://databank.worldbank.org/index	40.561 (8.038)
	Inflation:	Annual inflation calculated through the GDP deflator in percentage. Sources: World Bank, https://databank.worldbank.org/index	40.889 (580.535)

Note: 1. The last column lists means and, in parentheses, standard deviations for the samples employed in tables III to VI.

Table III: Alternative Samples, Alternative Estimator and Clustered Standard Errors

	(1)	(2)	(3)	(4)
			Panel A. The dependent variable is:	
	Democracy	*Culture*	*Culture*	*Culture*
PDSI	- 0.035	- 0.0001	- 0.008	- 0.010
	(0.009)***	(0.0007)	(0.004)**	(0.002)***
PDSI-H		- 0.054	0.290	- 0.068
		(0.014)***	(0.064)***	(0.050)
Estimation			OLS	
Within R^2	0.19	0.03	0.14	0.67
Number of Observations	9263	4598	456	912
			Panel B. The dependent variable is:	
	Democracy	Δ*10-Democracy*	*Culture*	*Culture*
PDSI	- 0.051	- 0.094	- 0.005	- 0.005
	(0.034)	(0.033)***	(0.003)*	(-1.67)*
PDSI-H			0.248	0.248
			(0.129)*	(1.92)*
Estimation			OLS	
Within R^2	0.27	0.14	0.10	0.10
Number of Observations	2242	1976	912	912

Notes: 1. While columns (1) and (2) of panel A are obtained from the sample of all countries for which data on the value added of the agricultural sectors is available, those in columns (3) and (4) of panel A are obtained, respectively, from the countries for which *Culture* is not imputed and from data weighted with analytic weights equal to the number of climatic cells within a country. In column (2) of panel A, we also exploit all the waves of the European Value Studies run over the sample.
2. The parentheses report standard errors except those of columns (1) to (3) of panel B, which list standard errors clustered at the country level, and those in column (4) of panel B where the T-test obtained from wild bootstrapped standard errors clustered at the country level is displayed. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
3. All specifications include country and year fixed effects, *Temperature* and *Rainfall*.

Table IV: Self-calibrating Palmer Drought Severity Index Averaged Over the Entire Year

	(1)	(2)	(3)
		The dependent variable is:	
	Democracy	Δ*10-Democracy*	*Culture*
PDSI_Y	- 0.051	- 0.125	- 0.006
	(0.025)**	(0.036)***	(0.002)**
PDSI-H_Y			0.324
			(0.039)***
Estimation		OLS	
Within R^2	0.28	0.14	0.13
Number of Observations	2242	1976	912

Notes: Notes: 1. Standard errors in parentheses. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
2. All specifications include country and year fixed effects, *Temperature_Y* and *Rainfall_Y*.

Table V: Decennial Fluctuations in Droughts

	(1)	(2)	(3)	(4)
			The dependent variable is:	
	Democracy	*Culture*	*Democracy*	*Culture*
PDSI	- 0.194	- 0.027	- 0.194	- 0.025
	(0.098)**	(0.013)**	(0.099)**	(0.013)*
PDSI-H		0.125		0.123
		(0.094)		(0.094)
Internal-Conflicts			0.055	- 0.165
			(1.596)	(0.192)
Estimation			OLS	
Within R^2	0.38	0.15	0.38	0.16
Number of Observations	228	96	228	96

Notes: 1. Estimates are obtained from data averaged over five time periods 1960-1970, 1970-1980, 1980-2000, 2000-2010 and 2010-2018.
2. Standard errors in parentheses. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
3. All specifications include country and decennial fixed effects, *Temperature* and *Rainfall*.

Table VI: Alternative Control Variables

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A. The dependent variable is:					
	Democracy	*Culture*	*Democracy*	*Culture*	*Democracy*	*Culture*
PDSI	- 0.051	- 0.005	- 0.017	- 0.005	- 0.049	- 0.005
	(0.021)**	(0.002)**	(0.022)	(0.002)**	(0.021)**	(0.002)**
PDSI-H		0.248		0.275		0.253
		(0.041)***		(0.048)***		(0.041)***
Circumscription					0.621	0.048
					(0.070)***	(0.013)***
Region Fixed Effects	YES	YES	NO	NO	NO	NO
Region-specific Time Trends	NO	NO	YES	YES	NO	NO
Estimation				OLS		
Within R^2	0.27	0.10	0.29	0.10	0.30	0.11
Number of Observations	2242	912	2242	912	2242	912
	Panel B. The dependent variable is:					
	Democracy	*Culture*	*Democracy*	*Culture*	*Democracy*	*Culture*
PDSI	- 0.004	- 0.007	- 0.051	- 0.005	- 0.051	- 0.005
	(0.039)	(0.004)*	(0.021)**	(0.002)**	(0.021)**	(0.002)**
PDSI-H		0.455		0.247		0.246
		(0.067)***		(0.041)***		(0.041)***
Irrigated-Land	- 0.238	0.039				
	(0.055)***	(0.004)***				
Internal-Conflicts			0.094	- 0.011		
			(0.168)	(0.017)		
External-Conflicts					0.286	0.023
					(0.160)*	(0.016)
Estimation				OLS		
Within R^2	0.21	0.29	0.27	0.10	0.28	0.10
Number of Observations	826	380	2242	912	2242	912
	Panel C. The dependent variable is:					
	Democracy	*Culture*	*Democracy*	*Culture*	*Democracy*	*Culture*
PDSI	- 0.041	- 0.005	- 0.052	- 0.005	- 0.053	- 0.005
	(0.021)**	(0.002)**	(0.021)**	(0.002)**	(0.021)***	(0.002)**
PDSI-H		0.252		0.246		0.250
		(0.041)***		(0.042)***		(0.041)***
Muslim	0.020	- 0.001				
	(0.005)***	(0.001)*				
Heterogeneity			- 1.396	0.048		
			(1.063)	(0.131)		
Human-Capital					- 0.030	- 0.002
					(0.010)***	(0.001)***
Estimation				OLS		
Within R^2	0.28	0.10	0.28	0.10	0.28	0.10
Number of Observations	2242	912	2242	912	2242	912
	Panel D. The dependent variable is:					
	Democracy	*Culture*	*Democracy*	*Culture*	*Democracy*	*Culture*
PDSI	- 0.047	- 0.005	- 0.052	- 0.005	- 0.051	- 0.005
	(0.021)**	(0.002)**	(0.021)**	(0.002)**	(0.021)**	(0.002)**
PDSI-H		0.248		0.267		0.239
		(0.041)***		(0.041)***		(0.041)***
Income	- 0.487	- 0.003				
	(0.113)***	(0.014)				
Inequality			- 0.047	- 0.003		
			(0.009)***	(0.001)***		
Inflation					- 0.0001	0.0001
					(0.0001)	(0.00004)***
Estimation				OLS		
Within R^2	0.28	0.10	0.28	0.11	0.27	0.11
Number of Observations	2242	912	2242	912	2242	912

Notes: 1. In panel A, we consider five regions, i.e., Asia, Sub-Saharan Africa, Saharan Africa, Oceania and America Latina.
2. Standard errors in parentheses. *** denotes significant at the 1% confidence level; **, 5%; *, 10%.
3. All specifications include country and year fixed effects, *Temperature* and *Rainfall*.