

*Online Appendix for:*

“CLIMATE SHOCKS, DEMOCRATIZATION AND  
(A CULTURE OF) COOPERATION.”

Giacomo Benati (University of Barcelona)  
and Carmine Guerriero (University of Bologna)

November 12, 2025

# 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 evaluate *Circumscription*, which is defined as the ratio of *Production* to the average of the very same variable over the neighboring countries, i.e., *Circumscription*.

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 fraction-

alization 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

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|---|--|
| 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*. |  |
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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          |
|----------------------------------|----------------------------------|---|---------------------|
| Alternative dependent variables: | <i>Primary-D</i> :               | Dummy for the natural logarithm of the value added of the primary sectors smaller than the yearly mean over the sample. Source: <a href="https://databank.worldbank.org/">https://databank.worldbank.org/</a>                 | 0.434<br>(0.496)    |
|                                  | <i>Primary-S</i> :               | Natural logarithm of the value added of the primary sectors. Source: <a href="https://databank.worldbank.org/">https://databank.worldbank.org/</a>  | 2.310<br>(1.241)    |
| Climate shocks:                  | <i>PDSLY</i> :                   | Mean self-calibrating Palmer drought severity index. Source: <a href="https://rda.ucar.edu/datasets/ds299.0/">https://rda.ucar.edu/datasets/ds299.0/</a>  | - 0.558<br>(1.564)  |
|                                  | <i>PDSI-H<sub>Y</sub></i> :      | Share of years between $t$ and $t - 34$ during which <i>PDSLY</i> lied between 0 and -4. Source: <a href="https://rda.ucar.edu/datasets/ds299.0/">https://rda.ucar.edu/datasets/ds299.0/</a>                                  | 0.622<br>(0.123)    |
|                                  | <i>Temperature<sub>Y</sub></i> : | Mean temperature in degrees Celsius. Source: <a href="https://crudata.uea.ac.uk/">https://crudata.uea.ac.uk/</a>  | 23.222<br>(5.731)   |
|                                  | <i>Rainfall<sub>Y</sub></i> :    | Mean monthly precipitation in mm. Source: <a href="https://crudata.uea.ac.uk/">https://crudata.uea.ac.uk/</a>   | 98.151<br>(64.180)  |
| Other control variables:         | <i>Circumscription</i> :         | Ratio of <i>Production</i> to its average in neighboring countries. Source: World Bank, <a href="https://databank.worldbank.org/index">https://databank.worldbank.org/index</a>   | 1.106<br>(0.620)    |
|                                  | <i>Irrigated-Land</i> :          | Agricultural irrigated land as a percentage of total agricultural land. Source: World Bank, <a href="https://databank.worldbank.org/">https://databank.worldbank.org/</a>   | 14.063<br>(17.189)  |
|                                  | <i>Internal-Conflicts</i> :      | Dummy for intra-state wars. Source: Correlates of War Project, <a href="https://correlatesofwar.org/data-sets/COW-war">https://correlatesofwar.org/data-sets/COW-war</a>  | 0.031<br>(0.173)    |
|                                  | <i>External-Conflicts</i> :      | Dummy for inter-state wars. Source: Correlates of War Project, <a href="https://correlatesofwar.org/data-sets/COW-war">https://correlatesofwar.org/data-sets/COW-war</a>  | 0.045<br>(0.207)    |
|                                  | <i>Muslim</i> :                  | Percentage of Muslims on total population. Source: CREG project and CIA factbook, <a href="https://clinecenter.illinois.edu/">https://clinecenter.illinois.edu/</a> and <a href="https://www.cia.gov">https://www.cia.gov</a> | 36.180<br>(35.265)  |
|                                  | <i>Heterogeneity</i> :           | Historical ethnic fractionalisation index. Source: <a href="http://hdl.handle.net/1814/64606">http://hdl.handle.net/1814/64606</a>  | 0.618<br>(0.244)    |
|                                  | <i>Human-Capital</i> :           | Ratio of total enrollment to tertiary education, regardless of age, to the population of the relative age group. Source: World Bank, <a href="https://databank.worldbank.org/">https://databank.worldbank.org/</a>            | 4.684<br>(7.045)    |
|                                  | <i>Income</i> :                  | Log GDP per capita in constant 2015 USD. Sources: World Bank, <a href="https://databank.worldbank.org/index">https://databank.worldbank.org/index</a>   | 6.414<br>(0.657)    |
|                                  | <i>Inequality</i> :              | Gini index. Sources: World Bank, <a href="https://databank.worldbank.org/index">https://databank.worldbank.org/index</a>  | 40.561<br>(8.038)   |
|                                  | <i>Inflation</i> :               | Annual inflation calculated through the GDP deflator in percentage. Sources: World Bank, <a href="https://databank.worldbank.org/index">https://databank.worldbank.org/index</a>  | 40.889<br>(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 Estimators and Clustered Standard Errors

|                        | (1)                                 | (2)                   | (3)                            | (4)                   | (5)                  |
|------------------------|-------------------------------------|-----------------------|--------------------------------|-----------------------|----------------------|
|                        | Panel A. The dependent variable is: |                       |                                |                       |                      |
|                        | <i>Democracy</i>                    | <i>Culture</i>        | <i>Culture</i>                 | <i>Culture</i>        | <i>Primary-D</i>     |
| <i>Democracy</i> (-1)  |                                     |                       |                                |                       | 0.165<br>(0.146)     |
| <i>Democracy</i> (-2)  |                                     |                       |                                |                       | - 0.061<br>(0.143)   |
| <i>Culture</i> (-1)    |                                     |                       |                                |                       | 1.082<br>(0.733)     |
| <i>Culture</i> (-2)    |                                     |                       |                                |                       | - 1.298<br>(0.742)*  |
| <i>PDSI</i>            | - 0.035<br>(0.009)***               | - 0.0001<br>(0.0007)  | - 0.008<br>(0.004)**           | - 0.010<br>(0.002)*** |                      |
| <i>PDSI</i> (-1)       |                                     |                       |                                |                       | - 0.038<br>(0.048)   |
| <i>PDSI</i> (-2)       |                                     |                       |                                |                       | - 0.021<br>(0.048)   |
| <i>PDSI-H</i>          |                                     | - 0.054<br>(0.014)*** | 0.290<br>(0.064)***            | - 0.068<br>(0.050)    |                      |
| Estimation             | OLS                                 | OLS                   | OLS                            | OLS                   | Logit                |
| Within R <sup>2</sup>  | 0.19                                | 0.03                  | 0.14                           | 0.67                  |                      |
| Number of Observations | 9263                                | 4598                  | 456                            | 912                   | 1008                 |
|                        | Panel B. The dependent variable is: |                       |                                |                       |                      |
|                        | <i>Primary-S</i>                    | <i>Democracy</i>      | $\Delta 10$ - <i>Democracy</i> | <i>Culture</i>        | <i>Culture</i>       |
| <i>Democracy</i> (-1)  | 0.016<br>(0.010)*                   |                       |                                |                       |                      |
| <i>Democracy</i> (-2)  | 0.002<br>(0.008)                    |                       |                                |                       |                      |
| <i>Culture</i> (-1)    | - 0.021<br>(0.038)                  |                       |                                |                       |                      |
| <i>Culture</i> (-2)    | 0.056<br>(0.038)                    |                       |                                |                       |                      |
| <i>PDSI</i>            |                                     | - 0.051<br>(0.034)    | - 0.094<br>(0.033)***          | - 0.005<br>(0.003)*   | - 0.005<br>(- 1.67)* |
| <i>PDSI</i> (-1)       | 0.002<br>(0.003)                    |                       |                                |                       |                      |
| <i>PDSI</i> (-2)       | 0.004<br>(0.003)                    |                       |                                |                       |                      |
| <i>PDSI-H</i>          |                                     |                       |                                | 0.248<br>(0.129)*     | 0.248<br>(1.92)*     |
| Estimation             | OLS                                 |                       |                                |                       |                      |
| Within R <sup>2</sup>  | 0.56                                | 0.27                  | 0.14                           | 0.10                  | 0.10                 |
| Number of Observations | 4,357                               | 2242                  | 1976                           | 912                   | 912                  |

- Notes:
1. While columns (1), (2) and (5) 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 columns (2) and (5) of panel A and column (1) of table B, 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 (4) of panel B, which list standard errors clustered at the country level, and those in column (5) 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: |                                |                      |
|                           | <i>Democracy</i>           | $\Delta 10$ - <i>Democracy</i> | <i>Culture</i>       |
| <i>PDSI<sub>Y</sub></i>   | - 0.051<br>(0.025)**       | - 0.125<br>(0.036)***          | - 0.006<br>(0.002)** |
| <i>PDSI-H<sub>Y</sub></i> |                            |                                | 0.324<br>(0.039)***  |
| Estimation                | OLS                        |                                |                      |
| Within R <sup>2</sup>     | 0.28                       | 0.14                           | 0.13                 |
| Number of Observations    | 2242                       | 1976                           | 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<sub>Y</sub>* and *Rainfall<sub>Y</sub>*.

Table V: Decennial Fluctuations in Droughts

|                           | (1)                  | (2)                  | The dependent variable is: |                     | (4)                 |
|---------------------------|----------------------|----------------------|----------------------------|---------------------|---------------------|
|                           | <i>Democracy</i>     | <i>Culture</i>       | <i>Democracy</i>           | <i>Culture</i>      | <i>Culture</i>      |
| <i>PDSI</i>               | - 0.194<br>(0.098)** | - 0.027<br>(0.013)** | - 0.194<br>(0.099)**       | - 0.025<br>(0.013)* | - 0.025<br>(0.013)* |
| <i>PDSI-H</i>             |                      | 0.125<br>(0.094)     |                            | 0.123<br>(0.094)    | 0.123<br>(0.094)    |
| <i>Internal-Conflicts</i> |                      |                      | 0.055<br>(1.596)           | - 0.165<br>(0.192)  | - 0.165<br>(0.192)  |
| Estimation                | OLS                  |                      |                            |                     |                     |
| Within R <sup>2</sup>     | 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)                  | Panel A. The dependent variable is: |                       | (5)                   | (6)                    |
|-----------------------------|-----------------------|----------------------|-------------------------------------|-----------------------|-----------------------|------------------------|
|                             | <i>Democracy</i>      | <i>Culture</i>       | <i>Democracy</i>                    | <i>Culture</i>        | <i>Democracy</i>      | <i>Culture</i>         |
| <i>PDSI</i>                 | - 0.051<br>(0.021)**  | - 0.005<br>(0.002)** | - 0.017<br>(0.022)                  | - 0.005<br>(0.002)**  | - 0.049<br>(0.021)**  | - 0.005<br>(0.002)**   |
| <i>PDSI-H</i>               |                       | 0.248<br>(0.041)***  |                                     | 0.275<br>(0.048)***   |                       | 0.253<br>(0.041)***    |
| <i>Circumscription</i>      |                       |                      |                                     |                       | 0.621<br>(0.070)***   | 0.048<br>(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 <sup>2</sup>       | 0.27                  | 0.10                 | 0.29                                | 0.10                  | 0.30                  | 0.11                   |
| Number of Observations      | 2242                  | 912                  | 2242                                | 912                   | 2242                  | 912                    |
|                             | <i>Democracy</i>      | <i>Culture</i>       | Panel B. The dependent variable is: |                       | <i>Democracy</i>      | <i>Culture</i>         |
|                             | <i>Democracy</i>      | <i>Culture</i>       | <i>Democracy</i>                    | <i>Culture</i>        | <i>Democracy</i>      | <i>Culture</i>         |
| <i>PDSI</i>                 | - 0.004<br>(0.039)    | - 0.007<br>(0.004)*  | - 0.051<br>(0.021)**                | - 0.005<br>(0.002)**  | - 0.051<br>(0.021)**  | - 0.005<br>(0.002)**   |
| <i>PDSI-H</i>               |                       | 0.455<br>(0.067)***  |                                     | 0.247<br>(0.041)***   |                       | 0.246<br>(0.041)***    |
| <i>Irrigated-Land</i>       | - 0.238<br>(0.055)*** | 0.039<br>(0.004)***  |                                     |                       |                       |                        |
| <i>Internal-Conflicts</i>   |                       |                      | 0.094<br>(0.168)                    | - 0.011<br>(0.017)    |                       |                        |
| <i>External-Conflicts</i>   |                       |                      |                                     |                       | 0.286<br>(0.160)*     | 0.023<br>(0.016)       |
| Estimation                  | OLS                   |                      |                                     |                       |                       |                        |
| Within R <sup>2</sup>       | 0.21                  | 0.29                 | 0.27                                | 0.10                  | 0.28                  | 0.10                   |
| Number of Observations      | 826                   | 380                  | 2242                                | 912                   | 2242                  | 912                    |
|                             | <i>Democracy</i>      | <i>Culture</i>       | Panel C. The dependent variable is: |                       | <i>Democracy</i>      | <i>Culture</i>         |
|                             | <i>Democracy</i>      | <i>Culture</i>       | <i>Democracy</i>                    | <i>Culture</i>        | <i>Democracy</i>      | <i>Culture</i>         |
| <i>PDSI</i>                 | - 0.041<br>(0.021)**  | - 0.005<br>(0.002)** | - 0.052<br>(0.021)**                | - 0.005<br>(0.002)**  | - 0.053<br>(0.021)*** | - 0.005<br>(0.002)**   |
| <i>PDSI-H</i>               |                       | 0.252<br>(0.041)***  |                                     | 0.246<br>(0.042)***   |                       | 0.250<br>(0.041)***    |
| <i>Muslim</i>               | 0.020<br>(0.005)***   | - 0.001<br>(0.001)*  |                                     |                       |                       |                        |
| <i>Heterogeneity</i>        |                       |                      | - 1.396<br>(1.063)                  | 0.048<br>(0.131)      |                       |                        |
| <i>Human-Capital</i>        |                       |                      |                                     |                       | - 0.030<br>(0.010)*** | - 0.002<br>(0.001)***  |
| Estimation                  | OLS                   |                      |                                     |                       |                       |                        |
| Within R <sup>2</sup>       | 0.28                  | 0.10                 | 0.28                                | 0.10                  | 0.28                  | 0.10                   |
| Number of Observations      | 2242                  | 912                  | 2242                                | 912                   | 2242                  | 912                    |
|                             | <i>Democracy</i>      | <i>Culture</i>       | Panel D. The dependent variable is: |                       | <i>Democracy</i>      | <i>Culture</i>         |
|                             | <i>Democracy</i>      | <i>Culture</i>       | <i>Democracy</i>                    | <i>Culture</i>        | <i>Democracy</i>      | <i>Culture</i>         |
| <i>PDSI</i>                 | - 0.047<br>(0.021)**  | - 0.005<br>(0.002)** | - 0.052<br>(0.021)**                | - 0.005<br>(0.002)**  | - 0.051<br>(0.021)**  | - 0.005<br>(0.002)**   |
| <i>PDSI-H</i>               |                       | 0.248<br>(0.041)***  |                                     | 0.267<br>(0.041)***   |                       | 0.239<br>(0.041)***    |
| <i>Income</i>               | - 0.487<br>(0.113)*** | - 0.003<br>(0.014)   |                                     |                       |                       |                        |
| <i>Inequality</i>           |                       |                      | - 0.047<br>(0.009)***               | - 0.003<br>(0.001)*** |                       |                        |
| <i>Inflation</i>            |                       |                      |                                     |                       | - 0.0001<br>(0.0001)  | 0.0001<br>(0.00004)*** |
| Estimation                  | OLS                   |                      |                                     |                       |                       |                        |
| Within R <sup>2</sup>       | 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*.