# Celestial Enlightenment:
# Eclipses, Curiosity and Economic Development among Pre-Modern Ethnic Groups

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- Growth determinants in Unified growth theory:
  - Human capital,
  - Technological change.
- Limited evidence in the long run.
  - Voigtländer and Squicciarini (2015), Mokyr (2018), Özak (2018), Chen et al. (2020)
  - Many papers document persistence but not a direct effect.
- Side quest on deeply-rooted determinants of growth:
  - Geographical factors, caloric avalability and agriculture, climatic variability.

# This Paper

**Underlying research question**

Was human capital related to economic growth in Malthusian times?

**Main idea**

Curiosity is a natural predecessor to human capital.
It motivates thinking, improving:

- Human capital,
- Technology

$\implies$ Positive effect on economic growth.

**Contributions**

More curious societies developed more.
Curiosity emerges as a predecesor of human capital.
It also impacts technology.

- Circumvents data limitations.
- Curiosity: precursor of human capital.
  - Smith (1821, p. 22): "[w]onder [...] is the first principle which prompts mankind to the study [...]".
  - Mokyr (p. 15-16, 2004) sustains a similar idea.
- Explaining rare phenomena: intellectual endeavour (Ludwig et al. (2007)).
- More rare phenomena $\rightarrow$ Comparative advantage in thinking.
- Examples:
  - Japanese people and earthquakes (Ludwig et al. (2007)).
  - Maya people and solar eclipses (Dvorak (2017)).

- We exploit eclipse frequency to explain economic prosperity.
- Solar eclipses are impressive even today, and more so during the past.
  - Day turns into night, temperature drops, animals change behaviour, winds change direction.
- For pre-modern groups: increase the demand for explanations:
  - Smith (1821, p. 21): "renders them [people...] more desirous to know".
  - Iwaniszewski (2014) and Barale (2014).
  - Boerner et al. (2019,2021): solar eclipses $\rightarrow$ scientific curiosity.
    - Focus on medieval Europe.

# Competing Natural Events

- Alternative curiosity-catching phenomena have problems:
  - Cause massive destruction: retard growth.
    - Volcano eruptions, earthquakes, floods and tsunamis.
  - Are less impressive, harder to notice and more common:
    - Lunar and partial eclipses.
  - Affect the whole Earth:
    - Supernovae, comets.

- However, solar eclipses:
  - Do not destroy physical nor human capital.
  - Impressive effects: obscurity, wind, temperature.
  - Narrow area of effect: provides local variation.

- If eclipses influence curiosity and the latter (partly) determines human capital:
  - More economic development,
  - More human capital,
  - Better technology,
  - More curiosity.
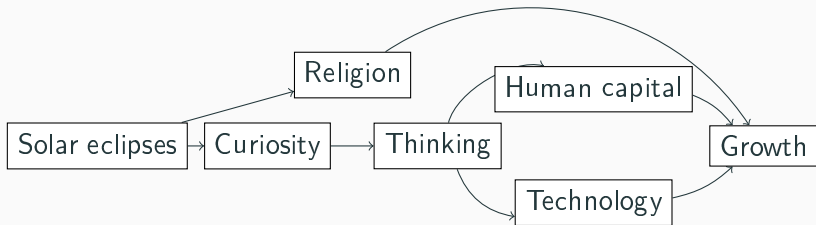
- Multiple databases:
    - Ethnographic Atlas: `ethnic groups` (Waho, Maidu, Ngäbe),
    - Seshat: `polities` (Kediri Kingdom, Susa I, Han Empire),
    - Michalopoulos and Xue (2021): folk tales, linked to EA,
    - Ashraf and Galor (2011): countries,
    - Wikidata: `people`

- **Growth proxies**: Population density, settlement patterns, social complexity.
- **Human capital**: Strategy games, writing, eclipse understanding, calendars, importance of thinking, text complexity, geometry.
- **Technology**: Tasks, technology, money, infrastructure.
- **Curiosity**: Eclipse and curiosity importance, scientific occupations.

# Data: Total Solar Eclipses

- Intersect eclipse paths with ethnic homelands.

- Time frame: 2000BCE to 1500CE.

- Count the number of total solar eclipses visible from ethnic homelands.
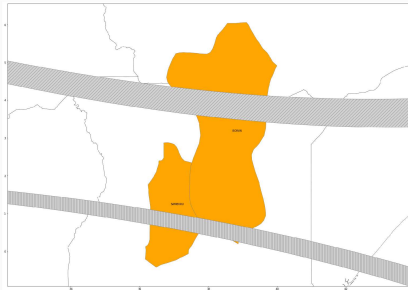
# Empirical Strategy

- Differet strategies depending on the data:
  - Simples cross-section,

  $$Y_i = f(\alpha_1 E_i + \gamma_1 I_i + \delta_i + \varepsilon_i)$$

  - Panel data regression (Seshat)

  $$Y_{i,t} = \sum_{k=0}^{1} \beta_{t-k}^{E} E_{i,t-k} + \sum_{k=0}^{1} \beta_{t-k}^{V} V_{i,t-k} +$$
  $$\sum_{y \neq Y \in \mathcal{Y}} \beta^y y_{i,t-1} + \beta^A A_{i,t} + \sum_{y \in \mathcal{Y}} \gamma^y y_{-i,t} + \delta_i + \kappa_t + \epsilon_{i,t}.$$

  - Panel data regresion (Ashraf and Galor, 2011)

  $$Y_{i,t} = f\left(\beta^E E_{i,t} + \beta^V V_{i,t} + \delta_i + \kappa_t + \epsilon_{i,t}\right).$$

Solar eclipses → Curiosity → Thinking → { Human capital, Technology } → Growth; Solar eclipses → Religion → Growth

| | Ethnographic Atlas | | | | | | Seshat | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Population Density | | | Settlement Patterns | | | Population Density | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Solar ec. (log) | 0.217 | 0.618 | 0.682 | −0.292 | 0.578 | 0.678 | 0.049 | 0.164 |
| | (0.147) | (0.231)*** | (0.194)*** | (0.166)* | (0.143)*** | (0.123)*** | (0.076) | (0.089)* |
| | | | | | | | [0.065] | [0.090]* |
| Dist. volc. (log-km) | | −0.110 | −0.084 | | −0.062 | −0.074 | | |
| | | (0.056)** | (0.061) | | (0.059) | (0.060) | | |
| Dist. fault (log-km) | | 0.127 | 0.130 | | −0.040 | −0.064 | | |
| | | (0.033)*** | (0.039)*** | | (0.019)** | (0.031)** | | |
| Volc. eruptions (log) | | | | | | | 0.028 | 0.357 |
| | | | | | | | (0.249) | (0.503) |
| | | | | | | | [0.212] | [0.438] |
| Fixed effects | Continent | Continent | Continent | Continent | Continent | Continent | Polity | Polity |
| Time Fixed Effects | No | No | No | No | No | No | Yes | Yes |
| Geography | No | Yes | Yes | No | Yes | Yes | No | No |
| Ethnic | No | No | Yes | No | No | Yes | No | No |
| Controls Seshat | No | No | No | No | No | No | Yes | Yes |
| $R^2$/Pseudo-$R^2$ | 0.074 | 0.158 | 0.198 | 0.067 | 0.147 | 0.196 | 0.980 | 0.844 |
| Observations | 568 | 466 | 466 | 1133 | 932 | 932 | 334 | 475 |

[1] Continent fixed effects: indicators for Asia, Europe, Africa, North America, South America and Oceania. Geographic controls: average temperature, precipitation and cloud coverage; distance to the coast, to waterways, to the closest volcano and fault line and terrestrial distance to Addis Ababa; terrain ruggedness, elevation; malaria prevalence; soil potential caloric yield; absolute latitude, south indicator, major habitat type indicator and homeland size decile indicators. Ethnic controls: major crop type indicator. Controls Seshat: past and distance-weighted values for population density, administrative levels, hierarchical complexity, writing and text types, geometrical measurements, the use of calendars and money and inrastructure types. Additional controls for area and past values of eclipses and volcano eruptions. Regressions using the Seshat present the standard errors clustered at the polity level in brackets and accounting for time and spatial autocorrelation (1000 years and 5000 km) in square brackets.
[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

# Results: Population density and settlement patterns

| | Ethnographic Atlas | | | | | | Seshat | |
|---|---|---|---|---|---|---|---|---|
| | Population Density | | | Settlement Patterns | | | Population Density | |
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| | | | | | | | [0.065] | [0.090]* |
| Dist. volc. (log-km) | | −0.110 | −0.084 | | −0.062 | −0.074 | | |
| | | (0.056)** | (0.061) | | (0.059) | (0.060) | | |
| Dist. fault (log-km) | | 0.127 | 0.130 | | −0.040 | −0.064 | | |
| | | (0.033)*** | (0.039)*** | | (0.019)** | (0.031)** | | |
| Volc. eruptions (log) | | | | | | | 0.028 | 0.357 |
| | | | | | | | (0.249) | (0.503) |
| | | | | | | | [0.212] | [0.438] |
| Fixed effects | Continent | Continent | Continent | Continent | Continent | Continent | Polity | Polity |
| Time Fixed Effects | No | No | No | No | No | No | Yes | Yes |
| Geography | No | Yes | Yes | No | Yes | Yes | No | No |
| Ethnic | No | No | Yes | No | No | Yes | No | No |
| Controls Seshat | No | No | No | No | No | No | Yes | Yes |
| $R^2$/Pseudo-$R^2$ | 0.074 | 0.158 | 0.198 | 0.067 | 0.147 | 0.196 | 0.980 | 0.844 |
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[1] Continent fixed effects: indicators for Asia, Europe, Africa, North America, South America and Oceania. Geographic controls: average temperature, precipitation and cloud coverage; distance to the coast, to waterways, to the closest volcano and fault line and terrestrial distance to Addis Ababa; terrain ruggedness; elevation; malaria prevalence; soil potential caloric yield; absolute latitude, south indicator, major habitat type indicator and homeland size decile indicators. Ethnic controls: major crop type indicator. Controls Seshat: past and distance-weighted values for population density, administrative levels, hierarchical complexity, writing and text types, geometrical measurements, the use of calendars and money and inastructure types. Additional controls for area and past values of eclipses and volcano eruptions. Regressions using the Seshat present the standard errors clustered at the polity level in brackets and accounting for time and spatial autocorrelation (1000 years and 5000 km) in square brackets.
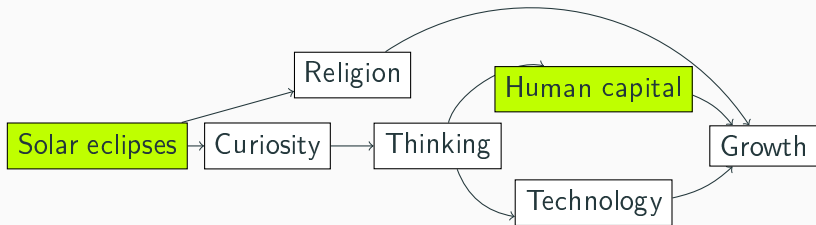
[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

# Results: Social complexity

| | Ethnographic Atlas | | | Seshat | | | |
|---|---|---|---|---|---|---|---|
| | Juris. Hier. | Class Strat. | Pol. Int. | Adm. Levels | | Juris. Hier. | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Solar ec. (log) | 0.537 | 0.566 | 0.542 | 0.035 | 0.357 | 0.056 | 0.264 |
| | (0.146)*** | (0.191)*** | (0.236)** | (0.036) | (0.110)*** | (0.037) | (0.072)*** |
| | | | | [0.033] | [0.101]*** | [0.033]* | [0.075]*** |
| Dist. volc. (log-km) | 0.059 | −0.120 | 0.116 | | | | |
| | (0.056) | (0.052)** | (0.060)* | | | | |
| Dist. fault (log-km) | −0.008 | −0.006 | −0.018 | | | | |
| | (0.047) | (0.048) | (0.092) | | | | |
| Volc. eruptions (log) | | | | 0.115 | 0.494 | 0.081 | 0.355 |
| | | | | (0.304) | (0.273)* | (0.200) | (0.210)* |
| | | | | [0.274] | [0.196]** | [0.187] | [0.156]** |
| Fixed effects | Continent | Continent | Continent | Polity | Polity | Polity | Polity |
| Time Fixed Effects | No | No | No | Yes | Yes | Yes | Yes |
| Geography | Yes | Yes | Yes | No | No | No | No |
| Ethnic | Yes | Yes | Yes | No | No | No | No |
| Controls Seshat | No | No | No | Yes | Yes | Yes | Yes |
| $R^2$/Pseudo-$R^2$ | 0.236 | 0.160 | 0.223 | 0.992 | 0.858 | 0.989 | 0.872 |
| Observations | 933 | 846 | 265 | 334 | 478 | 334 | 478 |

[1] Continent fixed effects: indicators for Asia, Europe, Africa, North America, South America and Oceania. Geographic controls: average temperature, precipitation and cloud coverage; distance to the coast, to waterways, to the closest volcano and fault line and terrestrial distance to Addis Ababa; terrain ruggedness; elevation; malaria prevalence; soil potential caloric yield; absolute latitude, south indicator, major habitat type indicator and homeland size decile indicators. Ethnic controls: major crop type indicator. Controls Seshat: past and distance-weighted values for population density, administrative levels, hierarchical complexity, writing and text types, geometrical measurements, the use of calendars and money and infrastructure types. Additional controls for area and past values of eclipses and volcano eruptions. Regressions using the Seshat present the standard errors clustered at the polity level in brackets and accounting for time and spatial autocorrelation (1000 years and 5000 km) in square brackets.
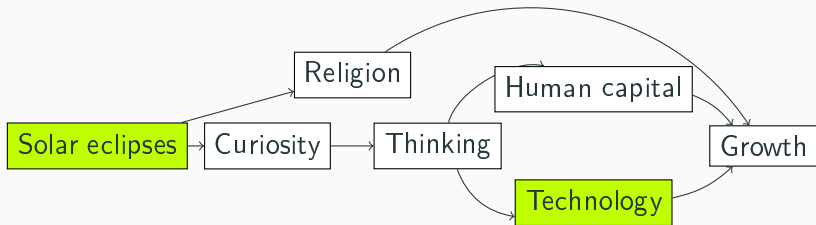
[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

| | Ethnographic Atlas | | Folklore | | | Seshat | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Strat. Games | Writing | Ec. Exp. | Cal. Rel. | Think Rel. | Writing | Texts | Calendar | Geom. Meas. |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Solar ec. (log) | 0.219 | 0.396 | 0.301 | 0.331 | 0.244 | 0.013 | 0.028 | 0.030 | 0.020 |
| | (0.065)*** | (0.137)*** | (0.126)** | (0.090)*** | (0.082)*** | (0.029) | (0.010)*** | (0.018) | (0.007)** |
| | | | | | | [0.026] | [0.011]** | [0.017]* | [0.008]** |
| Dist. volc. (log-km) | −0.000 | 0.044 | −0.034 | −0.101 | −0.031 | | | | |
| | (0.022) | (0.044) | (0.056) | (0.034)*** | (0.031) | | | | |
| Dist. fault (log-km) | −0.002 | −0.001 | 0.166 | 0.069 | 0.135 | | | | |
| | (0.014) | (0.046) | (0.061)*** | (0.041)* | (0.039)*** | | | | |
| Volc. eruptions (log) | | | | | | −0.098 | −0.041 | −0.024 | 0.147 |
| | | | | | | (0.081) | (0.027) | (0.043) | (0.073)* |
| | | | | | | [0.071] | [0.023]* | [0.038] | [0.060]** |
| Fixed effects | Continent | Continent | Continent | Continent | Continent | Polity | Polity | Polity | Polity |
| Time Fixed Effects | No | No | No | No | No | Yes | Yes | Yes | Yes |
| Geography | Yes | Yes | Yes | Yes | Yes | No | No | No | No |
| Ethnic | Yes | Yes | Yes | Yes | Yes | No | No | No | No |
| Controls Seshat | No | No | No | No | No | Yes | Yes | Yes | Yes |
| $R^2$/Pseudo-$R^2$ | 0.654 | 0.527 | 0.090 | 0.102 | 0.100 | 0.915 | 0.931 | 0.923 | 0.920 |
| Observations | 346 | 122 | 918 | 918 | 918 | 478 | 478 | 478 | 442 |

[1] Continent fixed effects: indicators for Asia, Europe, Africa, North America, South America and Oceania. Geographic controls: average temperature, precipitation and cloud coverage; distance to the coast, to waterways, to the closest volcano and fault line and terrestrial distance to Addis Ababa; terrain ruggedness, elevation; malaria prevalence; soil potential caloric yield; absolute latitude, south indicator, major habitat type indicator and homeland size decile indicators. Ethnic controls: major crop type indicator. Controls Seshat: past and distance-weighted values for population density, administrative levels, hierarchical complexity, writing and text types, geometrical measurements, the use of calendars and money and infrastructure types. Additional controls for area and past values of eclipses and volcano eruptions. Regressions using the Seshat present the standard errors clustered at the polity level in brackets and accounting for time and spatial autocorrelation (1000 years and 5000 km) in square brackets.
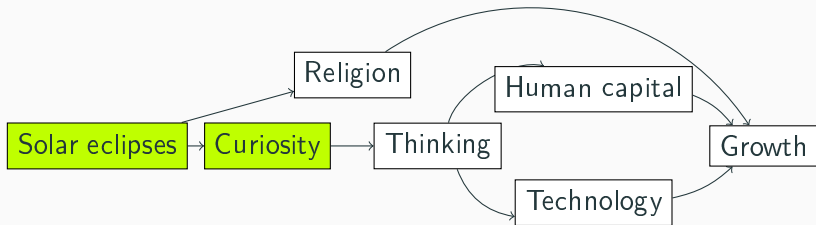
[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

| | Ethnographic Atlas | | Seshat | | Ashraf and Galor, 2011 | | | | |
| | Tasks | Tech. | Money | Infra. | Tech. Index | Non-agri. Tech. Index | Comm. Tech. | Ind. Tech | Trans. Tech. |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Solar ec. (log) | 0.078 | 0.072 | 0.195 | 0.051 | 0.125 | 0.162 | 0.683 | 0.879 | 0.047 |
| | (0.040)** | (0.037)* | (0.079)** | (0.011)*** | (0.034)*** | (0.041)*** | (0.132)*** | (0.360)** | (0.041) |
| | | | [0.069]** | [0.011]*** | | | | | |
| Dist. volc. (log-km) | −0.015 | −0.009 | | | | | | | |
| | (0.012) | (0.019) | | | | | | | |
| Dist. fault (log-km) | −0.016 | 0.008 | | | | | | | |
| | (0.007)** | (0.018) | | | | | | | |
| Volc. eruptions (log) | | | −0.832 | 0.058 | −0.087 | −0.110 | −0.320 | −0.631 | −0.111 |
| | | | (0.512) | (0.046) | (0.019)*** | (0.024)*** | (0.082)*** | (0.194)*** | (0.028)*** |
| | | | [0.469]* | [0.039] | | | | | |
| Fixed effects | Continent | Continent | Polity | Polity | Country | Country | Country | Country | Country |
| Time Fixed Effects | No | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Geography | Yes | Yes | No | No | No | No | No | No | No |
| Ethnic | Yes | Yes | No | No | No | No | No | No | No |
| Controls Seshat | No | No | Yes | Yes | No | No | No | No | No |
| $R^2$/Pseudo-$R^2$ | 0.098 | 0.646 | 0.894 | 0.884 | | | | | |
| Observations | 738 | 112 | 478 | 478 | 292 | 292 | 292 | 292 | 292 |

[1] Continent fixed effects: indicators for Asia, Europe, Africa, North America, South America and Oceania. Geographic controls: average temperature, precipitation and cloud coverage; distance to the coast, to waterways, to the closest volcano and fault line and terrestrial distance to Addis Ababa; terrain ruggedness, elevation; malaria prevalence; soil potential caloric yield; absolute latitude, south indicator, major habitat type indicator and homeland size decile indicators. Ethnic controls: major crop type indicator. Controls Seshat: past and distance-weighted values for population density, administrative levels, hierarchical complexity, writing and text types, geometrical measurements, the use of calendars and money and infrastructure types. Additional controls for area and past values of eclipses and volcano eruptions. Regressions using the Seshat present the standard errors clustered at the polity level in brackets and accounting for time and spatial autocorrelation (1000 years and 5000 km) in square brackets.

[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

# Results: Curiosity

| | Folklore | | Wikidata | |
| --- | --- | --- | --- | --- |
| | Eclipse Rel. | Curious Rel. | Scientific occ. | |
| | (1) | (2) | (3) | (4) |
| Solar ec. (log) | 0.384 | 0.342 | | |
| | $(0.072)^{***}$ | $(0.142)^{**}$ | | |
| Dist. volc. (log-km) | $-0.029$ | 0.008 | | |
| | (0.026) | (0.040) | | |
| Dist. fault (log-km) | 0.041 | 0.167 | | |
| | (0.041) | $(0.070)^{**}$ | | |
| Solar ec. (0/1) | | | 0.036 | 0.024 |
| | | | $(0.019)^{*}$ | $(0.012)^{**}$ |
| Volc. eruptions (0/1) | | | 0.057 | 0.010 |
| | | | (0.120) | (0.068) |
| Fixed effects | Continent | Continent | City | City |
| Time Fixed Effects | No | No | Yes | Yes |
| Geography | Yes | Yes | No | No |
| Ethnic | Yes | Yes | No | No |
| Weights | No | No | Sample | Population |
| $R^2$/Pseudo-$R^2$ | 0.081 | 0.153 | 0.471 | 0.319 |
| Observations | 918 | 918 | 129010 | 129010 |

[1] Continent fixed effects: indicators for Asia, Europe, Africa, North America, South America and Oceania. Geographic controls: average temperature, precipitation and cloud coverage; distance to the coast, to waterways, to the closest volcano and fault line and terrestrial distance to Addis Ababa; terrain ruggedness, elevation; malaria prevalence; soil potential caloric yield; absolute latitude, south indicator, major habitat type indicator and homeland size decile indicators. Ethnic controls: major crop type indicator.

[2] $^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.

**Figure 1:** Solar eclipses and curiosity.
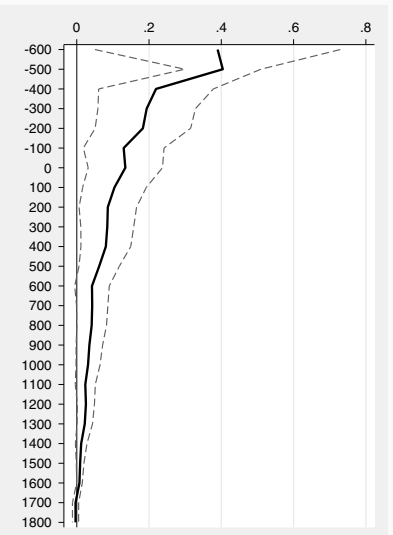
## Robustness

- The results are generally robust to:
  - Using lunar eclipses
  - Simultaneous introduction of solar and lunar eclipses.
  - Replacing distance to fault lines with mentions of earthquakes in folk tales.
  - Dividing the sample avobe and below average (human capital outcomes).
  - In regressions using the Ethnographic Atlas:
    - Dropping top and bottom 5% larger groups.
    - Using k-means.
    - Controlling for area.
    - Running quantile regressions.
    - Dropping one ethnic group at a time.
    - Dropping one continent at a time.

- Rule out that results are due to luck.
  - Placebo regressions.
  - Concepts unrelated to growth, social complexity, etc.
    - Meteorological phenomena, inanimated objects, colours.
    - Caveats: some colours can reflect interest in the sky.
    - Red sunsets, blue sky, black if interested in the night sky.

## Results: Placebo regressions

| | Folklore | | | | | |
| | Meteorology | | Inanimate | | Colours | |
| | Clouds (1) | Lightning (2) | Rock (3) | Sand (4) | White (5) | Purple (6) |
|---|---|---|---|---|---|---|
| Solar ec. (log) | −0.254 | 0.379 | −0.045 | 0.026 | 0.202 | 0.064 |
| | (0.194) | (0.122)*** | (0.133) | (0.170) | (0.180) | (0.105) |
| Fixed effects | Continent | Continent | Continent | Continent | Continent | Continent |
| Geography | Yes | Yes | Yes | Yes | Yes | Yes |
| Ethnic | Yes | Yes | Yes | Yes | Yes | Yes |
| Pseudo-$R^2$ | 0.199 | 0.122 | 0.088 | 0.250 | 0.207 | 0.132 |
| Observations | 918 | 918 | 918 | 918 | 918 | 918 |

[1] Continent fixed effects: indicators for Asia, Europe, Africa, North America, South America and Oceania. Geographic controls: average temperature, precipitation and cloud coverage; distance to the coast, to waterways, to the closest volcano and fault line and terrestrial distance to Addis Ababa; terrain ruggedness, elevation; malaria prevalence; soil potential caloric yield; absolute latitude, south indicator, major habitat type indicator and homeland size decile indicators. Ethnic controls: major crop type indicator.

[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

- Frequent eclipses $\rightarrow$ emergence of religious-political leaders.
- Religion may interact with development.
  - Provide cohesion, facilitate large works (Norenzayan (2013)).
  - Negative impact of religion on growth (Squicciarini (2020)).
  - Mitigation:
    - Investigate the relationship between eclipses and religion.
    - In general, no effect.
- Leaders can rationalise events $\rightarrow$ reduce thinking.
  - Moreso for destructive events: demand for soothing.
  - Mitigation:
    - Separate regressions for ethnicities with and without leaders.
    - Eclipses increase thinking and curiosity, regardless of leaders.
    - Earthquakes only when leaders are absent.

# Results: Religion I

| | Ethnographic Atlas | Folklore | | | Wikidata | |
|---|---|---|---|---|---|---|
| | High gods | Religious rel. | Religion rel. | Pray rel. | Religious occ. | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Solar ec. (log) | 0.643 | 0.331 | −0.385 | 0.218 | | |
| | (0.152)*** | (0.326) | (0.276) | (0.337) | | |
| Solar ec. (0/1) | | | | | 0.008 | 0.004 |
| | | | | | (0.013) | (0.010) |
| Fixed effects | Continent | Continent | Continent | Continent | City | City |
| Time Fixed Effects | No | No | No | No | Yes | Yes |
| Geography | Yes | Yes | Yes | Yes | No | No |
| Ethnic | Yes | Yes | Yes | Yes | No | No |
| Weights | No | No | No | No | Sample | Population |
| Pseudo-$R^2$ | 0.265 | 0.623 | . | 0.294 | 0.444 | 0.385 |
| Observations | 599 | 918 | 918 | 918 | 129010 | 129010 |

[1] Continent fixed effects: indicators for Asia, Europe, Africa, North America, South America and Oceania. Geographic controls: average temperature, precipitation and cloud coverage; distance to the coast, to waterways, to the closest volcano and fault line and terrestrial distance to Addis Ababa; terrain ruggedness, elevation; malaria prevalence; soil potential caloric yield; absolute latitude, south indicator, major habitat type indicator and homeland size decile indicators. Ethnic controls: major crop type indicator.

[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

# Results: Religion II

| | Folklore | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | No Shaman | | No Healer | | Shaman | | Healer | |
| | Think rel. | Curious rel. | Think rel. | Curiosity rel. | Think rel. | Curiosity rel. | Think rel. | Curious rel. |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Solar ec. (log) | 0.408 | 0.846 | 0.490 | 0.817 | 0.211 | 0.197 | 0.247 | 0.214 |
| | (0.127)*** | (0.303)*** | (0.162)*** | (0.391)** | (0.104)** | (0.133) | (0.097)** | (0.118)* |
| Earthquake rel. | 0.183 | −0.155 | 0.177 | 0.030 | −0.115 | −0.469 | −0.128 | −0.450 |
| | (0.101)* | (0.244) | (0.106)* | (0.242) | (0.051)** | (0.114)*** | (0.048)*** | (0.125)*** |
| Fixed effects | Continent | Continent | Continent | Continent | Continent | Continent | Continent | Continent |
| Geography | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Ethnic | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$/Pseudo-$R^2$ | 0.084 | 0.174 | 0.057 | 0.144 | 0.145 | 0.187 | 0.155 | 0.175 |
| Observations | 508 | 508 | 444 | 444 | 410 | 410 | 474 | 474 |

[1] Continent fixed effects: indicators for Asia, Europe, Africa, North America, South America and Oceania. Geographic controls: average temperature, precipitation and cloud coverage; distance to the coast, to waterways, to the closest volcano and fault line and terrestrial distance to Addis Ababa; terrain ruggedness, elevation; malaria prevalence; soil potential caloric yield; absolute latitude, south indicator, major habitat type indicator and homeland size decile indicators. Ethnic controls: major crop type indicator.

[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

- Pre-modern ethnic groups represent the distant past:
  - Traditional socieities,
  - Farmers, foragers, hunter-gatherers,
  - Lived undisturbed, isolated on the same place for centuries.
    - Rapa Nui (Easter Island), Cherokee, Ithu (Australia), etc.
- Abundant anthropologic information about them.
  - Social organisation, activities, marriage customs, etc.

**Figure 2:** Number of total solar eclipses (log) at the ethnic level.
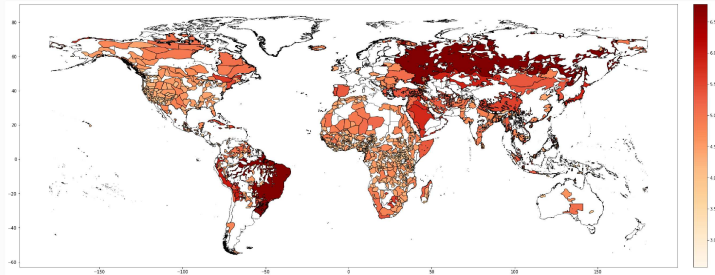
- Focuses on all societies that have inhabited certain well-delimited areas.
- It can seen as a panel.
- Manually computed the extent of each society for different periods of time.
- Heavy focus on military aspects.
- Main concern:
  - The original authors of the database interpolated data.

**Figure 3:** Seshat database.
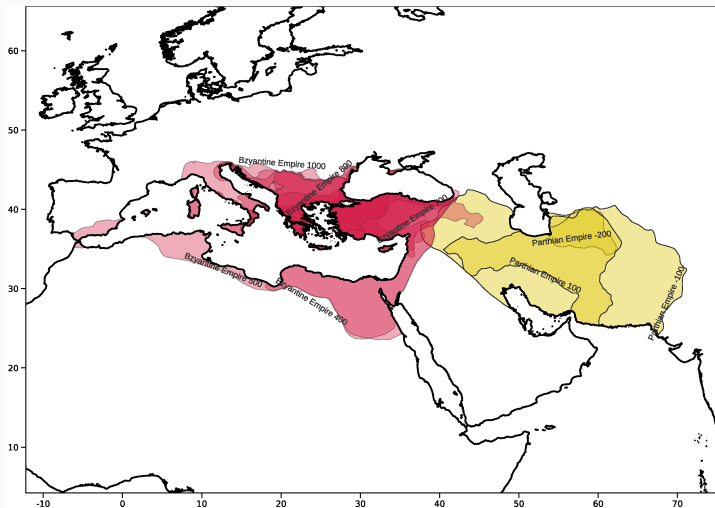
- Use data from people listed on Wikipedia.
  - Birthdate,
  - Birthplace,
  - Occupation.

- born between -500 and 1800.

- Estimate the effect of having seen a total solar eclipse between the ages 5 and 15

- on the probability of becoming a scientist.

$$Y_{i,t,c} = \beta Ec_{i,t,c} + \gamma_c + \theta_t + \epsilon_{i,t,c}$$