# WEB APPENDIX FOR "ECOLOGY, TRADE AND STATES IN PRE-COLONIAL AFRICA" (NOT FOR PUBLICATION)

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## 1. MODEL

An ethnic group exists on a unit interval, stretching from $0$ to $1$. The natural ruler of the ethnic group lives at point $0$. He chooses $S \in [0, 1]$, the fraction of the ethnic group's territory to bring under his direct jurisdiction. That is, he will choose the level of state centralization. He will do this in order to tax the inhabitants in their trading activities. I will show that greater gains from trade will lead him to centralize a larger fraction of the group's territory.

The territory is inhabited by a continuum of agents of mass $1$. They are spread uniformly over the interval. Each of these agents chooses between one of two activities: farming and trading. The returns from farming are normalized to $1$. Farming cannot be taxed. Trading, if successful, gives a return of $\theta > 1$. Trading can be taxed, and so an agent who lives within the centralized state pays a tax rate of $\tau \in [0, 1]$ on trade income. $\tau$ is chosen by the ruler. Agents who live outside the state pay no tax.

In addition to being taxable, trading is also costly. If the agent chooses trading, it entails a cost of $q$. This could represent, for example, the cost of avoiding theft or resolving disputes. The net income from trade is, then, $(1 - \tau)\theta - q$. Agents will engage in trade if $(1 - \tau)\theta - q \geq 1$.

As the ruler expands the size of the state, he provides public goods to his subjects that lower $q$. These could include dispute-resolution services or physical protection. In particular, if the ruler spends $p$ units of revenue per unit of territory on public goods, the cost of trade is $q = \frac{1}{\gamma p}$. Here, $\gamma$ is a parameter that captures the effectiveness of public goods. Agents outside the state receive no public goods. For them, $q$ is infinite, and no trade is possible.

The ruler is self-interested, and maximizes his net revenues. If he brings a piece of territory under his jurisdiction, he will ensure that $p$ and $\tau$ are set such that all of the subjects choose trade, rather than agriculture. Otherwise, he cannot collect any taxes from them. He must select $p$ and $\tau$ such that $(1-\tau)\theta - q \geq 1$. In addition to expenditures on public goods, $pS$, the ruler must pay a cost to extend his authority over space. This takes the form $cS^2$. $c > 0$ is a parameter that captures the costs of projecting power. If the ruler controls a territory of length $S$, and all of the inhabitants engage in trade rather

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than agriculture, his net revenue will be $(\theta\tau - p)S - cS^2$. Given a state of size $S$, the ruler maximizes:

$$V^R(S) = \max_{\tau,p}(\theta\tau - p)S - cS^2 \tag{1}$$

$$s.t.(1-\tau)\theta - \frac{1}{\gamma p} \geq 1 \tag{2}$$

Because net revenue is obviously increasing in $\tau$ and decreasing in $p$, the constraint in (2) will bind. The ruler will be compelled to choose $\tau$ and $p$ such that $\tau = 1 - \frac{1+\gamma p}{\theta\gamma p}$. When this is substituted into (1), the ruler's problem can be solved from its first order conditions. At an interior solution, these give the ruler's optimal $p$ and $\tau$:

$$p^* = \sqrt{\frac{1}{\gamma}}$$
$$\tau^* = \frac{\theta - 1}{\theta} - \frac{1}{\theta\sqrt{\gamma}}$$

If $\theta\tau^* \leq p^*$, then $\gamma$ and $\theta$ are such that no territory can be administered profitably. For a given $S$, the ruler will choose to set $\tau = p = 0$ in order to minimize his losses. The ruler's net revenue, conditional on $S$, can now be written as:

$$V^R(S) = \max\left\{\left(\theta - 2\sqrt{\frac{1}{\gamma}} - 1\right)S - cS^2, -cS^2\right\}$$

If the ruler maximizes this with respect to $S$, the degree of state centralization that maximizes the ruler's self interest is:

$$S^* = \min\left\{1, \max\left\{\frac{1}{2c}\left(\theta - 2\sqrt{\frac{1}{\gamma}} - 1\right), 0\right\}\right\} \tag{3}$$

Define $\theta^L$ as the value of $\theta$ that solves $\theta\tau^* = p^*$. This is the minimum $\theta$ for which any state centralization is profitable. Below this threshold, the ruler does not bring any of the ethnic group's territory under his control. Similarly, define $\theta^H$ as the level of $\theta$ for which $S^* = 1$. For this level of $\theta$ and above, the ruler centralizes the entire territory. If $\theta \in (\theta^L, \theta^H)$, three results hold that highlight mechanisms by which ecologically-determined gains from trade spurred state centralization in pre-colonial Africa:

(1) $\frac{\partial S^*}{\partial \theta} > 0$. Greater gains from trade will directly increase the profitability of state centralization.
(2) $\frac{\partial S^*}{\partial c} < 0$. If greater access to trade makes it cheaper to project authority over space, centralization will increase.
(3) $\frac{\partial S^*}{\partial \gamma} > 0$. If access to trade makes the ruler more effective at providing public goods, state centralization becomes more profitable.

## 2. ADDITIONAL RESULTS MENTIONED IN THE TEXT BUT NOT REPORTED

I present a condensed version of the results from Bates (1983) in Table A1. I report coefficients on the full set of controls in Table A2.

## 3. ADDITIONAL FIGURES MENTIONED IN THE TEXT BUT NOT REPORTED

Vegetation types from White (1983) are mapped in Figure 1. The bimodal distribution of ecological diversity is presented in Figure 2. Ecological diversity is mapped for the artificial countries in Figure 3.

## 4. ROBUSTNESS CHECKS MENTIONED IN THE TEXT BUT NOT REPORTED

4.1. **Validity of the state centralization measure.** For nearly thirty variables from the SCCS that capture ordinal measures of various aspects of state strength, I regress the variable on my measure of state centralization and report the results in Table A3.

4.2. **Validity of the estimation.** In Table A6, I re-estimate the main results using a generalized ordered probit model (Maddala, 1986), in which the coefficients on the latent variables are allowed to vary across the cutoff points of the latent variable. I show in Table A6 that excluding the date of observation or controls that could be interpreted as proxies for trade barely affects the results.

In Table A7, I drop influential observations from the sample. I estimate the main results by OLS with the full set of controls. I then compute the leverage and dfbeta (for ecological diversity) statistics for each observation. In Table A7, I drop all observations with leverage greater than $2(df + 2)/N$. I remove any observations with absolute dfbeta greater than $2/\sqrt{N}$. I drop each of the "South African bantu," "Ethiopia/horn," 'Moslem sudan" and "Indian Ocean" in turn. I also show in this table that the results are not driven by the presence of non-agricultural societies, animal husbandry, or the desert fringe in the data.

## 5. ADDITIONAL MECHANISMS MENTIONED IN THE TEXT BUT NOT REPORTED

I show the correlation of several measures of trade from the SCCS with several measures of states from the SCCS in Table A9. I show that no one form of trade better predicts state centralization in Table A10. I show that local and long distance trade are strongly correlated, but that long distance performs better when both are included in Table A11.

## 6. OTHER ITEMS MENTIONED IN THE TEXT BUT NOT REPORTED

I show summary statistics by colonial power and by country within the British empire in Table A12. I give the full definitions of the controls of interest in Table A13. I give matches between the Ethnographic Atlas and map names from Murdock (1959) in Table

A14. I give matches between place names from Sundström (1974) and real places in Table A15.

## 7. Robustness checks in the global sample

Robustness checks are reported in Tables W1 through WA7 that mirror the robustness checks carried out in the sub-Saharan sample.

## References

Bates, R. (1983). *Essays on the political economy of rural Africa.* University of California Press.

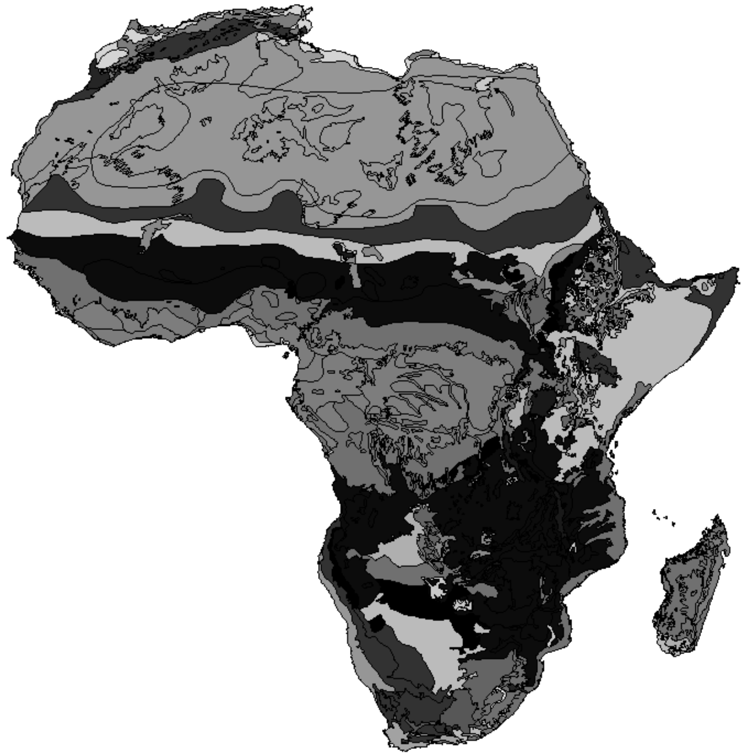
Maddala, G. (1986). *Limited-dependent and qualitative variables in econometrics.* Cambridge University Press.

Murdock, G. (1959). *Africa: Its Peoples and Their Culture History.* Nueva York.

Sundström, L. (1974). *The exchange economy of pre-colonial tropical Africa.* C. Hurst & Co. Publishers.

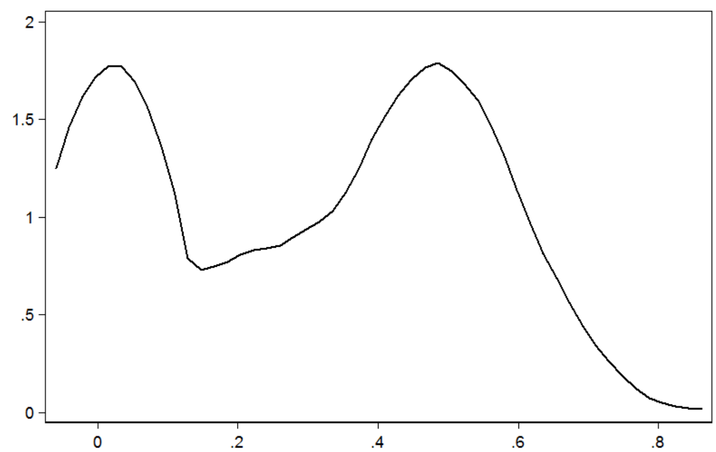
White, F. (1983). The vegetation of Africa: a descriptive memoir to accompany the UNESCO/AETFAT/UNSO vegetation map of Africa. *Natural resources research,* 20:1–356.

FIGURE 1. White's Vegetation Map



*Notes:* Each shade of grey represents a different major vegetation class in White (1983).

FIGURE 2. Kernel density of ecological diversity




*Notes:* This figure depicts the kernel density of ecological diversity in the estimation sample.

FIGURE 3. Ecological diversity: Artificial countries

*Notes:* Darker areas are more diverse.

Table A1. Bates' evidence

| | (1) | (2) | (3) |
|---|---|---|---|
| | Abuts ecological divide | Diversified area | No ecological variation |
| | | *Political structure* | |
| Kinship | 12% | 17% | 40% |
| Chiefs | 38% | 50% | 20% |
| Central monarch | 50% | 33% | 40% |
| N | 8 | 6 | 20 |
| | | *Central bureaucracy* | |
| Absent | 25% | 40% | 67% |
| Present | 75% | 60% | 33% |
| N | 8 | 5 | 18 |
| | | *National army* | |
| Absent | 38% | 40% | 50% |
| Present | 62% | 60% | 50% |
| N | 8 | 5 | 20 |
| | | *Army commanded at* | |
| Local level | 62% | 40% | 50% |
| Regional level | 0% | 20% | 10% |
| National level | 38% | 40% | 40% |
| N | 8 | 5 | 20 |

Adapted from Bates (1983), p. 43.

Table A2. Coefficients on the other controls in the main results

| | (1) | | (2) | |
|---|---|---|---|---|
| | *State centralization* | | | |
| Ecological diversity | 0.794*** | (0.266) | 0.484** | (0.207) |
| Ag. constraints | | | -0.056 | (0.059) |
| Elevation | | | 0.000 | (0.000) |
| Malaria | | | -0.158 | (0.340) |
| Precipitation | | | -0.000 | (0.000) |
| Temperature | | | -0.000 | (0.000) |
| Crop: None | | | -1.620** | (0.787) |
| Crop: Trees | | | 0.134 | (0.392) |
| Crop: Roots/tubers | | | 0.316* | (0.181) |
| Ruggedness | | | 0.000 | (0.000) |
| ln(Area) | | | 0.155** | (0.074) |
| Dist. coast | | | 0.018 | (0.026) |
| Dist. L. Victoria | | | 0.000*** | (0.000) |
| Dist. Atlantic ST | | | -0.000 | (0.000) |
| Dist. Indian ST | | | -0.000 | (0.000) |
| Date observed | | | -0.003 | (0.002) |
| Major river | | | 0.218 | (0.172) |
| Observations | 440 | | 440 | |

*** p<0.01, ** p<0.05, * p<0.1. Regressions estimated by ordered probit. Standard errors in parentheses clustered by region.

Table A3. Alternative measures of states from the SCCS are strongly correlated with state centralization

| Dependent variable | (1) Coef | (2) s.e. | (3) N |
|---|---|---|---|
| v81: Political autonomy | 0.485 | 0.082 | 182 |
| v82: Trend in political autonomy | 0.395 | 0.069 | 182 |
| v84: Higher political organization | 0.400 | 0.071 | 181 |
| v85: Executive | 0.801 | 0.086 | 181 |
| v89: Judiciary | 0.261 | 0.022 | 181 |
| v90: Police | 0.889 | 0.080 | 178 |
| v91: Administrative hierarchy | 0.943 | 0.071 | 181 |
| v700: State punishes crimes against persons | 0.185 | 0.033 | 91 |
| v701: Full-time bureaucrats | 0.242 | 0.026 | 91 |
| v702: Part of kingdom | 0.136 | 0.029 | 86 |
| v756: Political role specialization | 1.220 | 0.167 | 89 |
| v759: Leaders' perceived power | 0.432 | 0.069 | 89 |
| v760: Leaders' perceived capriciousness | 0.240 | 0.097 | 66 |
| v761: Leaders' unchecked power | 0.385 | 0.076 | 85 |
| v762: Inability to remove leaders | 0.420 | 0.100 | 77 |
| v763: Leaders' independence | 0.426 | 0.070 | 86 |
| v764: Leaders' control of decisions | 0.584 | 0.136 | 87 |
| v776: Formal sanctions and enforcement | 0.412 | 0.068 | 89 |
| v777: Enforcement specialists | 0.461 | 0.076 | 88 |
| v779: Loyalty to the wider society | 0.228 | 0.104 | 83 |
| v784: Taxation | 0.536 | 0.069 | 84 |
| v785: Rareness of political fission | 0.154 | 0.102 | 64 |
| v1132: Political integration | 1.185 | 0.070 | 118 |
| v1134: Despotism in dispute resolution | 0.132 | 0.023 | 104 |
| v1135: Jurisdictional perquisites | 0.172 | 0.067 | 34 |
| v1736: Tribute, Taxation, Expropriation | 0.961 | 0.152 | 77 |
| v1740: Levels of political hierarchy | 1.600 | 0.196 | 100 |
| v1741: Overarching jurisdiction | 0.331 | 0.070 | 94 |
| v1742: Selection of lower officials | 0.524 | 0.061 | 95 |

Each row reports the estimated coefficient and standard error when the listed variable in the SCCS is regressed on state centralization and a constant (not reported). All results are significant at conventional levels. I have reversed the signs for variables 756, 759, 760, 761, 762, 763, 764, 765, 776, 777, 779, and 784, so that higher values correspond to greater state strength. I have re-labeled these variables to capture the positive re-coding, and have re-labeled some other variables so that their meaning is clearer. I have removed the "missing" values 0 and 8 from variable 1132, and converted variable 89 into a binary ``judiciary present'' measure, since the categories of judiciary were not clearly ordered.

Table A4. The main result holds with alternative measures of states and diversity

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| | *Any cent.* | *State centralization* | | | | | |
| Ecological diversity | 0.220* | | | | | | |
| | (0.121) | | | | | | |
| Dist. ecological boundary | | -0.315*** | | | | | |
| | | (0.076) | | | | | |
| Ecological polarization | | | 0.243* | | | | |
| | | | (0.129) | | | | |
| Any diversity | | | | 0.239** | | | |
| | | | | (0.115) | | | |
| Ecological diversity (Simpler classes) | | | | | 0.585** | | |
| | | | | | (0.275) | | |
| Ecological diversity (High density areas) | | | | | | 0.410** | |
| | | | | | | (0.187) | |
| Eco. Div. (FAO) | | | | | | | 0.910*** |
| | | | | | | | (0.220) |
| Other controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 440 | 440 | 440 | 440 | 440 | 440 | 440 |

*** p<0.01, ** p<0.05, * p<0.1. Regressions estimated by ordered probit with coefficients reported. Standard errors in parentheses clustered by region. Other controls are log area, major river, agricultural constraints, distance to coast, elevation, malaria, precipitation, ruggedness, temperature, distance to Lake Victoria, distance from the Atlantic and Indian Ocean slave trades, and dummies for crop type, unless otherwise specified.

Table A5. The main result is robust to unobserved heterogeneity

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | *Including area shares* | *Latitude longitude cubic* | *Conley's OLS* | *Including neighbors' X* | *Interactions with de-meaned controls* |
| | *State centralization* | | | | |
| Ecological diversity | 0.522** | 0.498*** | 0.345* | 0.354** | 0.584*** |
| | (0.232) | (0.192) | (0.201) | (0.156) | (0.216) |
| Other controls | Yes | Yes | Yes | Yes | Yes |
| Observations | 440 | 440 | 440 | 440 | 440 |
| | (6) | (7) | (8) | (9) | (10) |
| | *Altonji-Elder-Taber Statistic* | *Ethno. region F.E.* | *UN region F.E.* | *Country F.E.* | *Lang. family F.E.* |
| | *State centralization* | | | | |
| Ecological diversity | | 0.535** | 0.635** | 0.619** | 0.744*** |
| | | (0.256) | (0.273) | (0.265) | (0.254) |
| Altonji-Elder-Taber Statistic | 2.71 | | | | |
| Other controls | No | No | No | No | No |
| Observations | 440 | 440 | 440 | 440 | 437 |

*** p<0.01, ** p<0.05, * p<0.1. Regressions estimated by ordered probit with coefficients reported, unless otherwise indicated. Standard errors in parentheses clustered by region. Other controls are log area, major river, agricultural constraints, distance to coast, elevation, malaria, precipitation, ruggedness, temperature, distance to Lake Victoria, distance from the Atlantic and Indian Ocean slave trades, and dummies for crop type, unless otherwise specified.

Table A6. The main results hold using alternative estimators

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | *Generalized ordered probit* | *Drop distance from coast* | *Drop distance from lake Victoria* | *Drop distance from Atlantic Slave Trade* | *Drop distance from Indian Ocean Slave Trade* | *No date control* |
| | *State centralization* | | | | | |
| Ecological diversity | | 0.460** | 0.422** | 0.473** | 0.454** | 0.481** |
| | | (0.194) | (0.215) | (0.207) | (0.212) | (0.212) |
| Equation 1 | 0.850** | | | | | |
| | (0.414) | | | | | |
| Equation 2 | 0.486* | | | | | |
| | (0.272) | | | | | |
| Equation 3 | 0.645 | | | | | |
| | (0.493) | | | | | |
| Equation 4 | -21.761*** | | | | | |
| | (0.797) | | | | | |
| Other controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 440 | 440 | 440 | 440 | 440 | 440 |

*** p<0.01, ** p<0.05, * p<0.1. Regressions estimated by ordered probit with coefficients reported, unless otherwise indicated. Standard errors in parentheses clustered by region. Other controls are log area, major river, agricultural constraints, distance to coast, elevation, malaria, precipitation, ruggedness, temperature, distance to Lake Victoria, distance from the Atlantic and Indian Ocean slave trades, and dummies for crop type, unless otherwise specified.

Table A7. The main results are robust to discarding outliers and various sub-samples

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Dropped | *High leverage* | *High dfbeta* | *South African Bantu* | *Ethiopia and Horn* | *Moslem Sudan* | *Indian Ocean* |
| | | | *State centralization* | | | |
| Ecological diversity | 0.457* | 0.589** | 0.489** | 0.468** | 0.475** | 0.552*** |
| | (0.270) | (0.293) | (0.206) | (0.229) | (0.226) | (0.189) |
| Other controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 411 | 410 | 421 | 400 | 417 | 435 |
| | (7) | (8) | (9) | (10) | (11) | |
| Dropped | *Not mostly agric.* | *Non-agric.* | *Mostly husbandry* | *Mostly desert* | *Any desert* | |
| | | | *State centralization* | | | |
| Ecological diversity | 0.379* | 0.527*** | 0.438* | 0.435** | 0.473** | |
| | (0.210) | (0.199) | (0.230) | (0.217) | (0.212) | |
| Other controls | Yes | Yes | Yes | Yes | Yes | |
| Observations | 378 | 429 | 402 | 437 | 432 | |

*** p<0.01, ** p<0.05, * p<0.1. Regressions estimated by ordered probit with coefficients reported, unless otherwise indicated. Standard errors in parentheses clustered by region. Other controls are log area, major river, agricultural constraints, distance to coast, elevation, malaria, precipitation, ruggedness, temperature, distance to Lake Victoria, distance from the Atlantic and Indian Ocean slave trades, and dummies for crop type, unless otherwise specified.

Table A8. The Ricardian interpretation is consistent with the histories of six influential states

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Name | Cent. | dfbeta | Name | Cent. | dfbeta |
| | Songhai | 3 | 0.194 | Suku | 3 | 0.108 |
| | Lozi | 3 | 0.173 | Ababda | 1 | 0.103 |
| | Bijogo | 1 | 0.166 | Luba | 3 | 0.103 |
| | Chiga | 0 | 0.145 | Giriama | 3 | 0.102 |
| | Yoruba | 3 | 0.129 | Bunda | 2 | 0.096 |
| | Bagirmi | 3 | 0.128 | Kunama | 0 | 0.096 |
| | Toro | 3 | 0.128 | Baya | 0 | 0.094 |
| | Laketonga | 0 | 0.127 | Fang | 0 | 0.094 |
| | Sherbro | 2 | 0.126 | Rundi | 3 | 0.093 |
| | (7) | (8) | (9) | (10) | (11) | (12) |
| | Yoruba | Songhai | Toro | Suku | Luba | Lozi |
| Participated in trade? | Yes | Yes | Yes | Yes | Yes | Yes |
| Trade a source of wealth? | Yes | Yes | Yes | Unclear | Yes | Yes |
| Trade a source of state power? | Yes | Yes | Yes | Yes | Yes | Yes |
| No capture of trading regions? | Yes | Yes | No | Yes | No | Yes |

These summarize the results of the case studies described in the text.

Table A9. Mechanisms: Trade and states are strongly correlated in the SCCS

| | (1)<br>v1: Trade for food | (2)<br>v2: Food trade intermediation | (3)<br>v93: Political power via commerce | (4)<br>v732: Importance of trade in subsistence | (5)<br>v1007: Trade and markets | (6)<br>v1733: Exchange within community | (7)<br>v1734: Exchange beyond community |
|---|---|---|---|---|---|---|---|
| v81: Political autonomy | | | ** | | ** | | |
| v82: Trend in political autonomy | *** | *** | *** | ** | | | ** |
| v84: Higher political organization | ** | * | *** | | | | |
| v85: Executive | *** | * | *** | ** | ** | | * |
| v89: Judiciary | *** | *** | *** | ** | ** | | * |
| v90: Police | *** | *** | *** | ** | ** | * | ** |
| v91: Administrative hierarchy | *** | ** | *** | ** | *** | | |
| v700: State punishes crimes against persons | ** | *** | *** | ** | | | |
| v701: Full-time bureaucrats | *** | ** | *** | | | | |
| v702: Part of kingdom | | | | | *** | | |
| v756: Political role specialization | ** | | | * | | | |
| v759: Leaders' perceived power | ** | | | | | | ** |
| v760: Leaders' perceived capriciousness | ** | | | * | | * | |
| v761: Leaders' unchecked power | ** | | | | | | |
| v762: Inability to remove leaders | ** | | | | | * | * |
| v763: Leaders' independence | | | * | ** | | | * |
| v764: Leaders' control of decisions | | | | | | | ** |
| v776: Formal sanctions and enforcement | *** | | | * | | | ** |
| v777: Enforcement specialists | | | | | | * | |
| v779: Loyalty to the wider society | | | | ** | | | |
| v784: Taxation | ** | | ** | ** | | | |
| v785: Rareness of political fission | | | | | | | |
| v1132: Political integration | *** | ** | *** | ** | | | |
| v1134: Despotism in dispute resolution | | | | | * | | |
| v1135: Jurisdictional perquisites | | | | | | | |
| v1736: Tribute, Taxation, Expropriation | *** | ** | * | ** | *** | | |
| v1740: Levels of political hierarchy | *** | ** | *** | ** | ** | * | * |
| v1741: Overarching jurisdiction | *** | * | ** | | *** | ** | * |
| v1742: Selection of lower officials | *** | | | *** | ** | * | |

*** p<0.01, ** p<0.05, * p<0.1. Each row reports the significance of the estimated coefficient the listed "state" variable in the SCCS is regressed on the listed "trade" variable and a constant (not reported). I have reversed the signs for variables 756, 759, 760, 761, 762, 763, 764, 765, 776, 777, 779, and 784, so that higher values correspond to greater state strength. I have re-labeled these variables to capture the positive re-coding, and have re-labeled some other variables so that their meaning is clearer. I have removed the missing values 0 and 8 from variable 1132, and converted variable 89 into a binary ``judiciary present'' measure, since the categories of judiciary were not clearly ordered. I have also reversed the sign for variable 732 so that higher values correspond to greater trade. I have converted variable 93 into a binary ``power depends on commerce'' measure if v93 (the most important source of political power) is either 2 (tribute or taxes), 7 (foreign commerce), or 8 (capitalistic enterprises).

Table A10. No one type of trade best predicts states in the SCCS

| Dependent variable | (1) Coef | (2) s.e. | (3) N |
|---|---|---|---|
| v1: Trade for food | 0.324 | 0.071 | 181 |
| v2: Food trade intermediation | 0.289 | 0.087 | 123 |
| v93: Political power via commerce | 0.064 | 0.018 | 181 |
| v732: Importance of trade in subsistence | 0.154 | 0.056 | 92 |
| v1007: Trade and markets | 0.382 | 0.104 | 52 |
| v1733: Exchange within community | 0.200 | 0.096 | 95 |
| v1734: Exchange beyond community | 0.098 | 0.079 | 98 |

Each row reports the estimated coefficient and standard error when the listed variable in the SCCS is regressed on state centralization and a constant (not reported). I have reversed the sign for variable 732 so that higher values correspond to greater trade. I have converted variable 93 into a binary ``power depends on commerce'' measure if v93 (the most important source of political power) is either 2 (tribute or taxes), 7 (foreign commerce), or 8 (capitalistic enterprises).

Table A11. Long distance trade survives in a horse race with local trade

| | (1) | (2) |
|---|---|---|
| | *Ecological diversity* | *State centralization* |
| Ecological diversity | | 0.056 |
| | | (0.306) |
| Dist. ecological divide | -0.284*** | -0.300*** |
| | (0.016) | (0.115) |
| | | |
| Other controls | No | Yes |
| Observations | 440 | 440 |

*** p<0.01, ** p<0.05, * p<0.1. Regressions estimated by ordered probit with coefficients reported, unless otherwise indicated. Standard errors in parentheses clustered by region. Other controls are log area, major river, agricultural constraints, distance to coast, elevation, malaria, precipitation, ruggedness, temperature, distance to Lake Victoria, distance from the Atlantic and Indian Ocean slave trades, and dummies for crop type, unless otherwise specified.

Table A12. Outcomes differ across colonial powers, and within the British empire

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Colonial Power | Ecological diversity | | State centralization | | |
| | Mean | s.d. | Mean | s.d. | N |
| Belgium | 0.26 | 0.24 | 1.08 | 0.92 | 50 |
| Britain | 0.31 | 0.23 | 1.13 | 0.93 | 202 |
| Ethiopia | 0.38 | 0.25 | 1.00 | 0.89 | 6 |
| France | 0.22 | 0.21 | 1.00 | 0.88 | 108 |
| None | 0.46 | 0.19 | 1.55 | 0.92 | 38 |
| Portugal | 0.24 | 0.21 | 1.10 | 0.72 | 20 |
| South Africa | 0.46 | 0.17 | 1.67 | 1.15 | 12 |
| Spain | 0.12 | 0.16 | 2.50 | 2.12 | 2 |

| | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|
| Country | Ecological diversity | | State centralization | | |
| | Mean | s.d. | Mean | s.d. | N |
| Botswana | 0.57 | 0.09 | 1.00 | 1.41 | 2 |
| Egypt | 0.00 | | 1.00 | | 1 |
| Ghana | 0.15 | 0.22 | 0.94 | 1.00 | 18 |
| Kenya | 0.42 | 0.18 | 0.95 | 0.76 | 20 |
| Malawi | 0.42 | 0.04 | 1.50 | 0.71 | 2 |
| Nigeria | 0.16 | 0.21 | 1.02 | 0.93 | 60 |
| Sierra Leone | 0.39 | 0.25 | 1.67 | 0.58 | 3 |
| Somalia | 0.55 | 0.05 | 1.00 | 1.41 | 2 |
| Sudan | 0.42 | 0.18 | 0.87 | 0.76 | 31 |
| Swaziland | 0.45 | | 3.00 | | 1 |
| Tanzania | 0.44 | 0.18 | 1.25 | 0.94 | 36 |
| Uganda | 0.41 | 0.16 | 1.47 | 1.06 | 15 |
| Zambia | 0.25 | 0.22 | 1.64 | 0.92 | 11 |
| Zimbabwe | 0.19 | 0.27 | 2.50 | 0.71 | 2 |

Table A13. Detailed definitions of the control variables

| | |
|---|---|
| *Major river* | This is a dummy that equals one if the Benue, Blue Nile, Chire, Congo, Lualaba, Lukaga, Niger, Nile, Orange, Ubangi, White Nile, or Zambezi Rivers intersect the ethnic group's territory. |
| *Ag. constraints* | This is an index of combined climate, soil and terrain slope constrains on rain-fed agriculture, taken from the FAO-GAEZ project (see Fischer et al. (2001)). I interpret it as an inverse measure of land quality. |
| *Dist. coast* | This is average distance from each point in the ethnic group territory to the nearest point on the coast, in decimal degrees, calculated in ArcMap. |
| *Elevation* | This is average elevation in meters. |
| *Malaria* | This is average climatic suitability for malaria transmission, computed by Adjuik et al. (1998). |
| *Precipitation* | This is average annual precipitation (mm). Because some societies are too small for a raster point to fall within their territory, I impute missing data using the nearest raster point. I treat 55537 is as an error code and drop these points. |
| *Ruggedness* | This is a measure of terrain ruggedness used by Nunn and Puga (2009). It computes the average absolute difference in elevation between a grid cell and that of its neighbors. |
| *Temperature* | This is the accumulated temperature on days with mean daily temperature above 0 degrees celsius, computed using monthly data from 1961 to 2000 collected by the Climate Research Unit (CRU) of the University of East Anglia. I treat 55537 is as an error code and drop these points. I impute missing values using the nearest raster point. |
| *Dist. L. Victoria* | I compute the distance between each ethnic group's centroid and that of Lake Victoria using the globdist function in Stata. |
| *Date observed* | This is the rough date at which the information on the society was recorded, according to the *Ethnographic Atlas* . Dates of observation are missing for the Bomvana and Betsileo. I recode the Bomvana to 1850, to match the date of observation for the other Xhosa. I recode the Betsileo to 1900, the modal date for the other Malagasy societies in the data. |
| *Dist. Atlantic ST* | This is the minimum distance between the ethnic group's centroid and the nearest major source of new world demand for slaves (Virginia, Havana, Haiti, Kingston, Dominica, Martinique, Guyana, Salvador, or Rio), computed using the globdist function in Stata. The choice of ports here follows Nunn (2008). |
| *Dist. Indian ST* | This is, similarly, the distance to the nearest of Mauritius and Muscat. |
| *ln(Area)* | This is in decimal degrees, computed using the Murdock (1959) map. |
| *Crop type* | I construct dummy variables out of the major crop types recorded in the *Ethnographic Atlas.* I treat these as exogenous characteristics determined by the natural environment. |

Table A14. Matches from Atlas

| Name in map | Name in atlas | Match type |
|---|---|---|
| JERAWA, CHAWAI (SW) | CHAWAI | Alternative Spelling |
| BAKO | SHANGAMA | Alternate Subgroup |
| AVIKAM | ALAGYA | Alternate Subgroup |
| GURENSI | NANKANSE | Alternate Subgroup |
| BAKO | UBAMER | Alternate Subgroup |
| KATAB | KAGORO | Alternate Subgroup |
| LUNGU | MAMBWE | Alternative Name |
| JANJERO | JIMMA | Alternative Name |
| BARI | KAKWA | Alternative Name |
| KEMANT | FALASHA | Alternative Name |
| NYAKYUSA | NGONDE | Alternative Name |
| RIF | RIFFIANS | Alternative Name |
| BRONG | ABRON | Alternative Name |
| KINDIGA | HATSA | Alternative Name |
| SOKOTO | BOROROFUL | Alternative Name |
| SAGARA | KAGURU | Alternative Name |
| NYASA | LAKETONGA | Alternative Name |
| GRUNSHI | AWUNA | Alternative Name |
| LESE | MBUTI | Alternative Name |
| RESHIAT | GALAB | Alternative Name |
| GURO | TURA | Alternative Name |
| BANZA | MBANDJA | Alternative Spelling |
| XOSA | XHOSA | Alternative Spelling |
| BUSANSI | BISA | Alternative Spelling |
| KARAMOJONG | KARAMOJON | Alternative Spelling |
| NGURU | NGULU | Alternative Spelling |
| KURAMA, GURE (NE) | KURAMA | Alternative Spelling |
| GYRIAMA | GIRIAMA | Alternative Spelling |
| CHAGA | CHAGGA | Alternative Spelling |
| SHAWIA | SHAWIYA | Alternative Spelling |
| KIPSIGI | KIPSIGIS | Alternative Spelling |
| BAKAKARI | DAKAKARI | Alternative Spelling |
| FUNGON | FUNGOM | Alternative Spelling |
| FIA | BAFIA | Alternative Spelling |
| ZUANDE, BATU (E) | ZUANDE | Alternative Spelling |
| HLENGWE | LENGE | Alternative Spelling |
| BIRIFON | BIRIFOR | Alternative Spelling |
| AMER | BENIAMER | Alternative Spelling |
| KONA | HONA | Alternative Spelling |
| ZENEGA | ZENAGA | Alternative Spelling |
| KURAMA, GURE (NE) | GURE | Alternative Spelling |
| NGUMBE | NGUMBI | Alternative Spelling |
| SABEI | SAPEI | Alternative Spelling |
| BIRA | PLAINSBIR | Alternative Spelling |
| TONGA | PL TONGA | Alternative Spelling |
| SIWA | SIWANS | Alternative Spelling |
| FOUTADJALON | FUTAJALON | Alternative Spelling |
| LAKA (ADAMAWA | LAKA | Alternative Spelling |
| LI | BALI | Alternative Spelling |
| MBESA | BOMBESA | Alternative Spelling |
| ANYANG | BANYANG | Alternative Spelling |

| | | |
|---|---|---|
| BASA | BASAKOMO | Alternative Spelling |
| MUM | BAMUM | Alternative Spelling |
| AULLIMINDEN | AULLIMIND | Alternative Spelling |
| SINZA | ZINZA | Alternative Spelling |
| SUK | HILLSUK | Alternative Spelling |
| SALA | SARA | Alternative Spelling |
| NEN | BANEN | Alternative Spelling |
| SUK | PLAINSSUK | Alternative Spelling |
| NKOLE | NYANKOLE | Alternative Spelling |
| TALODI | MORO | Location |
| GURENSI | KUSASI | Location |
| KELA | LALIA | Location |
| OMETO | BADITU | Location |
| TOPOTHA | BODI | Location |
| KEREWE | KARA | Location |
| KAFA | SHAKO | Location |
| KANURI | WODAABE | Location |
| NAMSHI | DJAFUN | Location |
| KOALIB | MESAKIN | Location |
| KOALIB | NYARO | Location |
| TALODI | TIRA | Location |
| TUMTUM | KORONGO | Location |
| BORAN | BURJI | Location |
| TAGALI | OTORO | Location |
| WABA | ISALA | Location |
| NANDI | TIRIKI | Location |
| AFUSARE | ANAGUTA | Location |
| NYIMA | TULLISHI | Location |
| BIRIFON | LOWIILI | Location |
| MIJERTEIN | SOMALI | Subgroup |
| KAMBATA | SIDAMO | Subgroup |
| NGWATO | TSWANA | Subgroup |
| KARANGA | SHONA | Subgroup |
| TENDA | BASSARI | Supergroup |
| KONSO | TSAMAI | Supergroup |
| KONSO | ARBORE | Supergroup |
| HAUSA | KANAWA | Supergroup |
| OMETO | MALE | Supergroup |
| LUO | VUGUSU | Supergroup |
| OMETO | DORSE | Supergroup |
| GRUNSHI | KASENA | Supergroup |
| OMETO | BASKETO | Supergroup |
| IBO | AFIKPO | Supergroup |
| TENDA | CONIAGUI | Supergroup |
| HAUSA | ZAZZAGAWA | Supergroup |
| XOSA | BOMVANA | Supergroup |
| SENGA | NGONI | Supergroup |
| MOSSI | YATENGA | Supergroup |
| MAO | ANFILLO | Supergroup |
| OMETO | DIME | Supergroup |
| OMETO | HAMMAR | Supergroup |
| IBIBIO | EFIK | Supergroup |
| OMETO | BANNA | Supergroup |

| GURENSI | TALLENSI | Supergroup |
|---|---|---|

Table A15. Matches to Sundstrom

| Location | Name in map | Lat. | Lon. | Resource |
|---|---|---|---|---|
| Air | | 18.28 | 8.00 | Iron |
| Akpa- fu | | 7.26 | 0.49 | Iron |
| Alur (Okebo) | Alur | 2.52 | 31.22 | Iron |
| Babua (Bonyoro and Ganyoro) | Babwa | 2.49 | 25.34 | Iron |
| Balandougou | | 12.90 | -8.88 | Iron |
| Bambouk | Malinke | 11.87 | -10.65 | Iron |
| Bamungu | | . | . | Iron |
| Banamba area | | 13.55 | -7.45 | Iron |
| Banjelli | Basari | 9.20 | 0.79 | Iron |
| Bassari | Basari | 9.20 | 0.79 | Iron |
| Baule | Baule | 7.29 | -4.79 | Iron |
| Bida | | 9.08 | 6.02 | Iron |
| Birgo | | 12.66 | -12.29 | Iron |
| Boubou | | 13.37 | -1.80 | Iron |
| Buberuka | | -1.49 | -29.84 | Iron |
| Budu | Budu | 2.12 | 28.12 | Iron |
| Chagga | Chaga | -3.21 | 37.45 | Iron |
| Chokwe | Chokwe | -9.66 | 20.32 | Iron |
| Dagari | Dagari | 10.77 | -2.56 | Iron |
| Dakwa | | -17.72 | 18.17 | Iron |
| Daura | | 13.04 | 8.32 | Iron |
| Dentila | | 13.50 | 9.92 | Iron |
| Duru | Duru | 8.10 | 14.13 | Iron |
| Ekpe | | 5.75 | 8.50 | Iron |
| Follona | | . | . | Iron |
| Gantsa | | . | . | Iron |
| Golungo Alto | | -9.13 | 14.77 | Iron |
| Gurgara | | | | Iron |
| Hoggar | | 23.29 | 5.53 | Iron |
| Ifoghas | | 19.12 | 1.75 | Iron |
| Iru | | 6.43 | 3.42 | Iron |
| Jifa | | . | . | Iron |
| Jur | Jur | 8.08 | 28.04 | Iron |
| Kanioka | | -4.87 | -21.65 | Iron |
| Kano | | 12.00 | 8.52 | Iron |
| Kete | | . | . | Iron |
| Kissenje | | . | . | Iron |
| Kuriga | | . | . | Iron |
| Kwanyama | Ambo | -17.59 | 16.04 | Iron |
| Kwoteru | | . | . | Iron |
| Longo in Sindja | | . | . | Iron |
| Ma- kandiambougou | | 12.62 | -7.94 | Iron |
| Mandara | Mandara | 11.45 | 14.19 | Iron |
| Mao | Mao | 9.03 | 34.78 | Iron |
| Misumba | | -4.27 | -21.95 | Iron |
| Mofu | | 10.58 | 14.33 | Iron |
| Moussodougou | | 10.83 | -4.95 | Iron |
| Naparba | | . | . | Iron |
| Ndjembo | | . | . | Iron |
| Ndulo | | . | . | Iron |
| Ngapu | | 5.77 | 20.68 | Iron |

| | | | | |
|---|---|---|---|---|
| Ngbandi | Ngbandi | 3.77 | 21.83 | Iron |
| Ngele | | 5.33 | 39.58 | Iron |
| Nugar | | 10.00 | -18.58 | Iron |
| Nyaneka (Mbi) | Nyaneka | -15.55 | 13.96 | Iron |
| Osaka | | . | . | Iron |
| Oule | | . | . | Iron |
| Oyo | | 7.85 | 3.93 | Iron |
| Pegue | Dogon | 14.44 | -3.22 | Iron |
| Pianga | | -4.48 | -21.60 | Iron |
| Sambabougou | | 14.58 | 8.17 | Iron |
| San-Trokofi | | 7.20 | 0.50 | Iron |
| Sappo Sap | | . | . | Iron |
| Senufo of Kanedougou | Senufo | 9.25 | -5.61 | Iron |
| Shimba | | -4.28 | 20.42 | Iron |
| Sokoto | Sokoto | 12.78 | 4.42 | Iron |
| Sundi | Sundi | -4.49 | 13.99 | Iron |
| Teke (N'galiema) | Teke | -2.88 | 15.46 | Iron |
| Totela | Totela | -16.35 | 24.53 | Iron |
| Toto | | . | . | Iron |
| Vili | Vili | -4.66 | 12.06 | Iron |
| Yaka | Yaka | -6.26 | 17.15 | Iron |
| Yakoma | Yakoma | 4.30 | 21.78 | Iron |
| Yanzi (Nguli) | Yanzi | -3.98 | 18.10 | Iron |
| Yende | | 8.88 | -10.17 | Iron |
| Zanfara | | 11.75 | 5.02 | Iron |
| Zaouar | | 20.45 | 16.52 | Iron |
| Zargu | | . | . | Iron |
| Zigueri | | . | . | Iron |
| Abimi | | . | . | Salines |
| Accany | | . | . | SeaSalt |
| Accra | | 5.55 | -0.20 | SeaSalt |
| Adamawa | Adamawa | 7.56 | 13.18 | VegetableSalt |
| Alima | | -1.59 | 16.62 | VegetableSalt |
| Alur | Alur | 2.52 | 31.22 | Salines |
| Amadror | | 24.83 | 6.42 | RockSalt |
| Ambriz | | -7.85 | 13.12 | SeaSalt |
| Andulo | | -11.48 | 15.83 | Natron |
| Aquamboe | | 5.42 | -1.32 | SeaSalt |
| Ardra | | 6.65 | 2.15 | SeaSalt |
| Arguin | | 20.60 | -16.45 | SeaSalt |
| Assinie | Assini | 5.18 | -2.87 | SeaSalt |
| Attaka | | . | . | VegetableSalt |
| Awei | | 2.00 | 32.78 | Salines |
| Azara | | 5.48 | 7.15 | Salines |
| Babua | | 0.15 | 10.13 | VegetableSalt |
| Bachama | Bachama | 9.47 | 11.99 | VegetableSalt |
| Baga | Baga | 10.38 | -14.25 | SeaSalt |
| Bagrimi | Bagirmi | 11.30 | 16.41 | VegetableSalt |
| Banda | Banda | 6.72 | 22.16 | VegetableSalt |
| Banyang | Anyang | 5.77 | 9.47 | VegetableSalt |
| Bari | Bari | 4.74 | 31.73 | Salines |
| Baya | Baya | 5.58 | 15.78 | Salines |
| Baya | Baya | 5.58 | 15.78 | Animal |

| | | | | |
|---|---|---|---|---|
| Baya | Baya | 5.58 | 15.78 | VegetableSalt |
| Bemba | Bemba | -10.67 | 31.34 | Salines |
| Bena Lulua | Lulua | -5.94 | 22.35 | VegetableSalt |
| Benguella | | -12.55 | 13.42 | SeaSalt |
| Benin | Edo | 6.32 | 5.80 | SeaSalt |
| Benin | Edo | 6.32 | 5.80 | VegetableSalt |
| Bilma | | 18.68 | 12.92 | Salines |
| Bishi | | 10.25 | 10.10 | Salines |
| Biskra | | 34.85 | 5.73 | RockSalt |
| Bolobo | | -2.17 | 16.23 | VegetableSalt |
| Bomanda | | 7.22 | 8.05 | VegetableSalt |
| Bomokandi | | 3.65 | 26.13 | VegetableSalt |
| Bondjo | Bondjo | 2.52 | 18.02 | VegetableSalt |
| Bongo | Bongo | 6.84 | 28.69 | VegetableSalt |
| Bonny | | 4.43 | 7.17 | SeaSalt |
| Borgu | | 9.35 | 2.62 | Salines |
| Bornu | | 11.50 | 13.00 | VegetableSalt |
| Bouavere | | . | . | VegetableSalt |
| Boubou | | 13.37 | -1.80 | VegetableSalt |
| Brass | | 4.32 | 6.24 | SeaSalt |
| Budu | Budu | 2.12 | 28.12 | Salines |
| Buduma | Buduma | 13.53 | 14.42 | VegetableSalt |
| Buduma | Buduma | 13.53 | 14.42 | VegetableSalt |
| Bunda | Bunda | -5.08 | 19.62 | VegetableSalt |
| Bungu | | 7.75 | 33.00 | Salines |
| Busa | Busa | 10.52 | 4.20 | Salines |
| Bussamai | | 8.37 | -9.18 | VegetableSalt |
| Calabar | | 4.95 | 8.33 | SeaSalt |
| Cape Corso | | 5.10 | -1.25 | SeaSalt |
| Cape Lahou | | 5.13 | -5.02 | SeaSalt |
| Cape Lope | | -0.63 | 8.65 | SeaSalt |
| Cape Mesurado | | 6.31 | -10.81 | SeaSalt |
| Cape Mount | | 7.17 | -11.00 | SeaSalt |
| Cape Mount | | 7.17 | -11.00 | VegetableSalt |
| Cape Verdes | | 15.11 | -23.62 | SeaSalt |
| Chad | | 13.00 | 14.00 | Natron |
| Chad | | 13.00 | 14.00 | VegetableSalt |
| Chokwe | Chokwe | -9.66 | 20.32 | VegetableSalt |
| Commenda | | -32.90 | 17.98 | SeaSalt |
| Daboya | | 14.07 | -0.90 | Salines |
| Dagera | Kanuri | 12.05 | 12.75 | VegetableSalt |
| Dimi | | -1.15 | 15.85 | RockSalt |
| Dirki | | 19.00 | 12.90 | Salines |
| Djenne | | 13.90 | -4.55 | VegetableSalt |
| Dombu | | 7.32 | -11.27 | Salines |
| Duma | Duma | -1.87 | 13.16 | VegetableSalt |
| Ekoi | Ekoi | 5.62 | 8.81 | Salines |
| Elmina | | 5.08 | -1.35 | SeaSalt |
| Etosha | | -18.95 | 15.90 | Salines |
| Ewe | Ewe | 6.61 | 0.85 | VegetableSalt |
| Facki | | . | . | Salines |
| Fang | Fang | 1.73 | 11.75 | VegetableSalt |
| Fernan Vaz | | -1.57 | 9.25 | VegetableSalt |

| | | | | |
|---|---|---|---|---|
| Fetu | | 5.08 | -1.35 | SeaSalt |
| Fez | | 34.03 | -5.00 | RockSalt |
| Fezzan | Fezzan | 26.21 | 15.13 | Salines |
| Fogha | | 31.77 | 14.05 | Salines |
| Fooli | | . | . | Salines |
| Gagu | Gagu | 6.41 | -5.66 | VegetableSalt |
| Gandiole (Aoulil) | | 15.79 | -16.53 | SeaSalt |
| Gannawari | | . | . | VegetableSalt |
| Gesera | | -8.00 | 35.00 | VegetableSalt |
| Gold Coast | | 5.10 | -1.25 | SeaSalt |
| Gold Coast | | 5.10 | -1.25 | VegetableSalt |
| Gonsalves | | . | . | SeaSalt |
| Goree | | 14.67 | -17.40 | SeaSalt |
| Gurio | | . | . | Salines |
| Guro | Guro | 7.36 | -6.02 | VegetableSalt |
| Gurunsi | Gurensi | 10.82 | -0.44 | VegetableSalt |
| Habe | | 11.87 | -3.13 | VegetableSalt |
| Hausa | Hausa | 12.37 | 7.15 | VegetableSalt |
| Hima | | 0.29 | 30.18 | Salines |
| Hoggar | | 23.29 | 5.53 | RockSalt |
| Huana | | . | . | VegetableSalt |
| Hunde | Hunde | -1.03 | 28.62 | VegetableSalt |
| Idjil | | 22.63 | -12.55 | RockSalt |
| Ijaw | Ijaw | 4.81 | 6.28 | VegetableSalt |
| Imbangala | | -3.24 | 17.37 | RockSalt |
| Irangi | | -0.35 | 39.48 | VegetableSalt |
| Jekri | Itsekiri | 5.59 | 5.49 | VegetableSalt |
| Joal | | 14.17 | -16.83 | SeaSalt |
| Kagoro | Kagoro | 14.14 | -8.74 | VegetableSalt |
| Kakonto | | -13.02 | 24.68 | Salines |
| Kanem | Kanembu | 13.99 | 14.43 | VegetableSalt |
| Kanga Bonu | Guro | 7.36 | -6.02 | VegetableSalt |
| Kango | | 0.15 | 10.13 | VegetableSalt |
| Kanyenne | | 9.37 | -6.63 | Salines |
| Kasai | | -10.96 | 19.32 | VegetableSalt |
| Kasuku | | -2.95 | 25.95 | VegetableSalt |
| Katab | Katab | 9.76 | 8.32 | VegetableSalt |
| Katwe | | 0.30 | 32.58 | Salines |
| Kavirondo | | 1.13 | 34.55 | Salines |
| Keaka | Ekoi | 5.62 | 8.81 | Salines |
| Keana | | 8.53 | 8.30 | Salines |
| Kela | Kela | -1.98 | 23.71 | VegetableSalt |
| Kete | | . | . | VegetableSalt |
| Khassonke | Kasonke | 14.32 | -10.66 | VegetableSalt |
| Kibila | | -6.45 | 24.58 | VegetableSalt |
| Kibiro | | 1.68 | 31.25 | Salines |
| Kikuyu | Kikuyu | -0.85 | 36.99 | Natron |
| Kita | | 13.05 | -9.48 | RockSalt |
| Kita | | 13.05 | -9.48 | VegetableSalt |
| Kivu | | -2.50 | 28.00 | VegetableSalt |
| Kongo | Kongo | -6.62 | 14.62 | SeaSalt |
| Kongo | Kongo | -6.62 | 14.62 | VegetableSalt |
| Konkomba | Konkomba | 9.84 | 0.57 | VegetableSalt |

| | | | | |
|---|---|---|---|---|
| Kotoko | Kotoko | 11.70 | 15.15 | Animal |
| Kotoko | Kotoko | 11.70 | 15.15 | VegetableSalt |
| Kpelle | Kpelle | 7.43 | -9.11 | VegetableSalt |
| Kuba | Kuba | -4.69 | 21.88 | VegetableSalt |
| Kuku | Kuku | 3.93 | 31.54 | Animal |
| Kuku | Kuku | 3.93 | 31.54 | VegetableSalt |
| Kunene | | -17.26 | 11.75 | RockSalt |
| Kwango | | -3.24 | 17.37 | Salines |
| Lake Albert | | 1.68 | 30.92 | Salines |
| Lake Edward | | -0.33 | 29.60 | Salines |
| Lake Kioga | | 1.50 | 33.00 | Salines |
| Lake Kivu | | -2.00 | 29.00 | Salines |
| Lake Nyiri | | -2.00 | 36.87 | Natron |
| Lake Rukwa | | -8.00 | 32.42 | Salines |
| Lala | Lala | -13.59 | 30.28 | VegetableSalt |
| Lamba | Lamba | -12.75 | 27.91 | Salines |
| Latuka | Lotuko | 4.52 | 32.71 | Animal |
| Lendu | Lendu | 1.92 | 30.52 | VegetableSalt |
| Lese | Lese | 1.98 | 29.17 | VegetableSalt |
| Liberia | | 6.32 | -10.80 | SeaSalt |
| Liberia | | 6.32 | -10.80 | VegetableSalt |
| Little Popo | | 6.23 | 1.60 | SeaSalt |
| Loanda | | -8.84 | 13.23 | RockSalt |
| Loango | | -2.27 | 9.58 | SeaSalt |
| Lobi | Lobi | 10.01 | -3.34 | VegetableSalt |
| Logu | | 3.83 | 31.60 | VegetableSalt |
| Lomami | | -6.13 | 24.48 | VegetableSalt |
| Lomela | | -3.52 | 23.60 | Salines |
| Lomela | | -3.52 | 23.60 | VegetableSalt |
| Lualaba | | 2.15 | 22.48 | Salines |
| Lualaba | | 2.15 | 22.48 | VegetableSalt |
| Luanda River | | -8.84 | 13.23 | Salines |
| Lufubu | | -9.90 | 28.78 | Salines |
| Lugowa | | -2.50 | 28.87 | Salines |
| Luigila | | . | . | VegetableSalt |
| Lukenie | | 3.47 | 22.45 | VegetableSalt |
| Lulua | Lulua | -5.94 | 22.35 | Salines |
| Lumbo | Lumbo | -2.51 | 10.90 | SeaSalt |
| Lunda | Lunda | -8.57 | 22.58 | Salines |
| Lunda | Lunda | -8.57 | 22.58 | VegetableSalt |
| Lupolo | Lupolo | -10.33 | 15.14 | VegetableSalt |
| Luvira | | -11.00 | 33.75 | Salines |
| Majumba | | . | . | SeaSalt |
| Malagarasi | | -5.20 | 29.78 | Salines |
| Malinke | Malinke | 11.87 | -10.65 | VegetableSalt |
| Mamfe | | 5.77 | 9.28 | Salines |
| Mandja | Mandja | 5.96 | 18.32 | VegetableSalt |
| Manga | Manga | 13.41 | 11.35 | Salines |
| Manga | Manga | 13.41 | 11.35 | Natron |
| Mano | | 6.92 | -11.51 | VegetableSalt |
| Mao | Mao | 9.03 | 34.78 | Salines |
| Mao | Mao | 9.03 | 34.78 | Animal |
| Marra Mountains | | 12.95 | 24.27 | Salines |

| | | | | |
|---|---|---|---|---|
| Marungu | | -3.73 | 30.80 | Salines |
| Masai | Masai | -2.92 | 36.42 | Natron |
| Mbala | Mbala | -4.82 | 18.21 | Salines |
| Mbala | Mbala | -4.82 | 18.21 | VegetableSalt |
| Mbere | Mbere | 7.12 | 15.86 | VegetableSalt |
| Mbi | | . | . | VegetableSalt |
| Mfini | | . | . | VegetableSalt |
| Miltou | | 17.40 | 10.23 | VegetableSalt |
| Moashia | | . | . | Salines |
| Moroa | | 9.73 | 8.40 | VegetableSalt |
| Munio | | . | . | Natron |
| Munza | | -8.65 | 15.40 | Salines |
| Murzuk | | 25.90 | 13.90 | Natron |
| Musgu | Musgu | 10.99 | 15.31 | VegetableSalt |
| Mweru | | -9.17 | 28.50 | Salines |
| Nankanse | Gurensi | 10.82 | -0.44 | VegetableSalt |
| Ndiki | Fia | 4.82 | 11.33 | VegetableSalt |
| Ngala | Ngala | 1.27 | 18.86 | VegetableSalt |
| Nganza | | -5.16 | 18.96 | Salines |
| Ngbetu | Mangbetu | 3.40 | 27.80 | VegetableSalt |
| Ngelima | | 1.55 | 25.33 | VegetableSalt |
| Ngigmi | | 14.25 | 13.11 | Salines |
| Ngimi | | . | . | VegetableSalt |
| Ngongo | Ngongo | -5.33 | 18.39 | VegetableSalt |
| Nkutshu | | -2.70 | 23.20 | VegetableSalt |
| North African Sebkras | | 22.27 | -11.43 | Salines |
| Northern Liberia | | 8.00 | -10.00 | VegetableSalt |
| Nouakchott | | 18.10 | -15.95 | SeaSalt |
| Nuba | | 12.00 | 30.75 | Salines |
| Nyamwezi | Nyamwezi | -5.07 | 32.81 | Salines |
| Nyangwe | | -4.22 | 26.18 | Salines |
| Ouidah | | 6.37 | 2.08 | SeaSalt |
| Popoie | | . | . | VegetableSalt |
| Porto da Salines | | . | . | SeaSalt |
| Porto Novo | | 6.50 | 2.61 | SeaSalt |
| Quissama | | -9.98 | 14.48 | RockSalt |
| Rega | Rega | -2.93 | 27.73 | VegetableSalt |
| Rivers Mano and Mahfa | | 6.92 | -11.51 | SeaSalt |
| Ruanda | Ruanda | -1.93 | 29.94 | VegetableSalt |
| Rundi | Rundi | -3.28 | 30.09 | VegetableSalt |
| Rusugi | | -7.80 | 35.60 | Salines |
| Rutshuru | | -1.18 | 29.45 | Salines |
| Ruwenzori | | 0.39 | 29.87 | Salines |
| Sakata | Sakata | -2.84 | 17.78 | VegetableSalt |
| Samba | | -8.88 | 13.20 | Salines |
| Sankuru | | -4.28 | 20.42 | Salines |
| Sankuru | | -4.28 | 20.42 | VegetableSalt |
| Sarua | | 10.50 | 17.00 | VegetableSalt |
| Sebe | | . | . | Salines |
| Semliki | | 1.22 | 30.50 | Salines |
| Senegal Mouth | | 15.79 | -16.53 | SeaSalt |
| Sengere | | -1.80 | 17.50 | VegetableSalt |
| Shari | | 12.91 | 14.57 | Animal |

| | | | | |
|---|---|---|---|---|
| Shari | | 12.91 | 14.57 | VegetableSalt |
| Sierra Leone | | 8.48 | -13.23 | VegetableSalt |
| Sierra Leono | | 8.48 | -13.23 | SeaSalt |
| Soko | Soko | 1.45 | 23.68 | VegetableSalt |
| Soko | Soko | 1.45 | 23.68 | VegetableSalt |
| Songe | Songe | -5.40 | 25.42 | VegetableSalt |
| Songo Meno | Songomeno | -3.73 | 22.69 | VegetableSalt |
| Taodeni-Tegazza | | 23.60 | -5.00 | RockSalt |
| Teda | Teda | 21.74 | 16.33 | VegetableSalt |
| Tetela | Tetela | -3.68 | 24.46 | VegetableSalt |
| Tigidda | | 17.52 | 6.78 | Salines |
| Timbuctoo | | 16.78 | -3.01 | VegetableSalt |
| Tofoke | | 0.52 | 25.20 | VegetableSalt |
| Toma | Toma | 8.20 | -9.37 | VegetableSalt |
| Tuburi | Tuburi | 10.31 | 15.09 | Animal |
| Tumba | | -0.83 | 18.00 | VegetableSalt |
| Tumbwe | | -6.02 | 29.13 | VegetableSalt |
| Ubangi | | -0.50 | 17.70 | VegetableSalt |
| Uelle | | 4.15 | 22.43 | VegetableSalt |
| Upper Likwala | | -1.00 | 17.00 | Salines |
| Vili | Vili | -4.66 | 12.06 | SeaSalt |
| Vinza | | -5.00 | 31.00 | Salines |
| Volta | | 5.77 | 0.68 | SeaSalt |
| Wadi | | 30.43 | -30.27 | Salines |
| Wadi l'Natrum | | 30.42 | 30.33 | Natron |
| Waja | | 12.28 | 39.60 | Natron |
| Wasau | | . | . | RockSalt |
| Yaka | Yaka | -6.26 | 17.15 | VegetableSalt |
| Yanzi | Yanzi | -3.98 | 18.10 | VegetableSalt |
| Yaunde | | 3.87 | 11.52 | VegetableSalt |
| Yoruba | Yoruba | 8.32 | 4.11 | VegetableSalt |
| Zaberma | Zerma | 13.58 | 2.72 | Natron |
| Zande | Azande | 4.58 | 26.45 | Salines |
| Zande | Azande | 4.58 | 26.45 | VegetableSalt |

Table W1. Summary Statistics

| | (1) Mean | (2) s.d. | (3) Min | (4) Max | (5) N |
|---|---|---|---|---|---|
| State centralization | 0.90 | 1.05 | 0 | 4 | 1,077 |
| Ecological diversity (FAO classes) | 0.42 | 0.25 | 0 | 0.84 | 1,077 |
| | | | | | |
| Land quality | 1.29 | 0.90 | -4.0e-07 | 3.98 | 1,077 |
| Date observed | 1,900 | 103 | -800 | 1,965 | 1,077 |
| Precipitation | 1,236 | 836 | 12.6 | 6,164 | 1,077 |
| Temperature | 7,119 | 2,834 | 35.5 | 10,830 | 1,077 |
| Absolute latitude | 21.1 | 17.4 | 0.017 | 78.1 | 1,077 |
| Pct. malarial | 0.17 | 0.20 | 0 | 0.69 | 1,077 |
| Dist. to coast | 4.32 | 3.88 | 0 | 15.4 | 1,077 |
| Elevation | 167 | 9.68 | 141 | 230 | 1,077 |
| Major river | 0.30 | 0.46 | 0 | 1 | 1,077 |
| Ruggedness | 120,983 | 134,492 | 137 | 977,941 | 1,077 |
| Crop: None | 0.22 | 0.42 | 0 | 1 | 1,077 |
| Crop: Non-food | 0.0019 | 0.043 | 0 | 1 | 1,077 |
| Crop: Vegetables | 0.0028 | 0.053 | 0 | 1 | 1,077 |
| Crop: Trees | 0.056 | 0.23 | 0 | 1 | 1,077 |
| Crop: Roots/tubers | 0.19 | 0.39 | 0 | 1 | 1,077 |
| Log Area | 0.45 | 1.77 | -5.41 | 7.19 | 1,077 |

Table W3. The instrumental variables results do not hold in the global sample

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | *OLS: Baseline* | | *IV* | |
| | *State centralization* | | | |
| Ecological diversity | 0.275** | 0.275** | 0.060 | 0.060 |
| | (0.125) | (0.125) | (0.908) | (0.908) |
| Other controls | Yes | Yes | Yes | Yes |
| Observations | 863 | 1,077 | 863 | 1,077 |
| F-statistic | | | 9.945 | 9.945 |
| | (5) | (6) | (7) | (8) |
| | *OLS: Reduced form* | | *OLS: First Stage* | |
| | *State centralization* | | *Ecological diversity* | |
| Log rainfall range | 0.001 | 0.001 | 0.021*** | 0.021*** |
| | (0.019) | (0.019) | (0.007) | (0.007) |
| Other controls | Yes | Yes | Yes | Yes |
| Observations | 863 | 1,077 | 863 | 1,077 |

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses clustered by region. Other controls are log area, land quality, distance from coast, elevation, malaria, rainfall, temperature, date, crop dummies, major river, ruggedness and absolute latitude. The excluded instrument is the log rainfall range. In columns 3, 5, and 7, missing values of the log rainfall range are recoded to zero. In columns 2, 4, 6, and 8, these observations are excluded.

Table W4. The Ricardian interpretation better explains the main result than six alternatives

| | (1) | (2) | (3) |
|---|---|---|---|
| | *Drop Area Q1* | *Drop Area Q5* | *Drop Area Q1 and Q5* |
| | *State centralization* | | |
| Ecological diversity | 0.610*** | 0.734*** | 0.993*** |
| | (0.206) | (0.181) | (0.236) |
| Other controls | Yes | Yes | Yes |
| Observations | 861 | 862 | 646 |
| | (4) | (5) | (6) |
| | *State centralization* | | |
| Ecological diversity | 0.332 | 0.344* | 0.459** |
| | (0.208) | (0.185) | (0.190) |
| Ag. Constraints Range | 0.092* | | |
| | (0.048) | | |
| Pop. density | | 0.002*** | |
| | | (0.001) | |
| Subsistence diversity | | | -1.545*** |
| | | | (0.385) |
| Other controls | Yes | Yes | Yes |
| Observations | 1,077 | 1,074 | 1,077 |

*** p<0.01, ** p<0.05, * p<0.1. Regressions estimated by ordered probit unless otherwise indicated. Standard errors in parentheses clustered by region unless otherwise indicated. Other controls are log area, land quality, distance from coast, elevation, malaria, rainfall, temperature, date, crop dummies, major river, ruggedness and absolute latitude unless otherwise indicated.

Table W5. Trade supports class stratification and local democracy, and no one type of trade matters most

| | (1) | (2) | (3) | (4) | (4) |
|---|---|---|---|---|---|
| | *Local state* | *Class Stratification* | *Headman is appointed (ordered logit)* | *High gods* | *Headman is democratic* |
| Ecological diversity | -0.197 | 0.542* | -0.343 | -0.332 | 0.492** |
| | (0.208) | (0.282) | (1.011) | (0.345) | (0.228) |
| Other controls | Yes | Yes | Yes | Yes | |
| Observations | 1,076 | 981 | 823 | 687 | 823 |
| | (6) | (7) | (8) | | |
| | | | *State centralization* | | |
| % dep. on fishing | -0.047 | | | | |
| | (0.055) | | | | |
| Iron production | | 1.129*** | | | |
| | | (0.221) | | | |
| Gold production | | | 0.319** | | |
| | | | (0.134) | | |
| Other controls | Yes | Yes | Yes | | |
| Observations | 1,077 | 884 | 884 | | |

*** p<0.01, ** p<0.05, * p<0.1. Regressions estimated by ordered probit unless otherwise indicated. Standard errors in parentheses clustered by region unless otherwise indicated. Other controls are log area, land quality, distance from coast, elevation, malaria, rainfall, temperature, date, crop dummies, major river, ruggedness and absolute latitude unless otherwise indicated.

Table WA4. The main result holds with alternative measures of states and some alternative measures of diversity

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | *Any cent.* | *Cent. > 1* | *State centralization* | | |
| Ecological diversity | 0.191** | 0.139** | | | |
| | (0.088) | (0.064) | | | |
| Ecological polarization | | | 0.241 | | |
| | | | (0.147) | | |
| Any diversity | | | | -0.013 | |
| | | | | (0.188) | |
| Ecological diversity (Hist. pop den.>1 per skm) | | | | | 0.426** |
| | | | | | (0.204) |
| Other controls | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,075 | 1,075 | 1,077 | 1,077 | 796 |

*** p<0.01, ** p<0.05, * p<0.1. Regressions estimated by ordered probit unless otherwise indicated. Standard errors in parentheses clustered by region unless otherwise indicated. Other controls are log area, land quality, distance from coast, elevation, malaria, rainfall, temperature, date, crop dummies, major river, ruggedness and absolute latitude unless otherwise indicated. Two observations are lost in columns (1) and (2) because non-food crops are a perfect predictor.

Table WA5. The main result is robust to some checks for unobserved heterogeneity

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | *Including area shares* | *Latitude longitude cubic* | *Conley's OLS* | *Including neighbors' X* | *Interactions with de-meaned controls* |
| | | | *State centralization* | | |
| Ecological diversity | -0.216 | 0.459** | 0.276** | 0.439** | 0.499*** |
| | (0.258) | (0.194) | (0.133) | (0.179) | (0.173) |
| Other controls | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,077 | 1,077 | 1,077 | 1,077 | 1,077 |
| | (6) | (7) | (8) | (9) | (10) |
| | *Altonji-Elder-Taber Statistic* | *Ethno. region F.E.* | *Broader ethno. region F.E.* | *Country F.E.* | *Lang. family F.E.* |
| | | | *State centralization* | | |
| Ecological diversity | | 0.407*** | 0.743*** | 0.592*** | 0.630*** |
| | | (0.137) | (0.135) | (0.165) | (0.145) |
| Altonji-Elder-Taber Statistic | 2.396 | | | | |
| Other controls | Yes | No | No | No | No |
| Observations | | 1,077 | 1,077 | 1,077 | 1,031 |

*** p<0.01, ** p<0.05, * p<0.1. Regressions estimated by ordered probit unless otherwise indicated. Standard errors in parentheses clustered by region unless otherwise indicated. Other controls are log area, land quality, distance from coast, elevation, malaria, rainfall, temperature, date, crop dummies, major river, ruggedness and absolute latitude unless otherwise indicated.

Table WA6. The main results hold using alternative estimators

| | (1) | (2) | (3) |
|---|---|---|---|
| | *Generalized ordered probit* | *No "trade" controls* | *No date control* |
| | *State centralization* | | |
| Ecological diversity | | 0.457** | 0.453** |
| | | (0.187) | (0.183) |
| Equation 1 | 0.485** | | |
| | (0.212) | | |
| Equation 2 | 0.626** | | |
| | (0.258) | | |
| Equation 3 | 0.405* | | |
| | (0.245) | | |
| Equation 4 | -0.551 | | |
| | (1.069) | | |
| Other controls | Yes | Yes | Yes |
| Observations | 1,077 | 1,077 | 1,077 |

*** p<0.01, ** p<0.05, * p<0.1. Regressions estimated by ordered probit unless otherwise indicated. Standard errors in parentheses clustered by region unless otherwise indicated. Other controls are log area, land quality, distance from coast, elevation, malaria, rainfall, temperature, date, crop dummies, major river, ruggedness and absolute latitude unless otherwise indicated.

Table WA7. The main results are robust to discarding outliers and various sub-samples

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Dropped | *High leverage* | *High dfbeta* | *Not mostly agric.* | *Non-agric.* |
| | | *State centralization* | | |
| Ecological diversity | 0.473** | 0.375* | 0.565*** | 0.552*** |
| | (0.189) | (0.198) | (0.213) | (0.207) |
| Other controls | Yes | Yes | Yes | Yes |
| Observations | 1,051 | 1,010 | 656 | 833 |
| | (5) | (6) | (7) | (8) |
| Dropped | *Mostly husbandry* | *Mostly desert* | *Any desert* | *High ag. constr.* |
| | | *State centralization* | | |
| Ecological diversity | 0.601*** | 0.484** | 0.697*** | 0.562*** |
| | (0.187) | (0.212) | (0.198) | (0.182) |
| Other controls | Yes | Yes | Yes | Yes |
| Observations | 1,002 | 956 | 709 | 969 |

*** p<0.01, ** p<0.05, * p<0.1. Regressions estimated by ordered probit unless otherwise indicated. Standard errors in parentheses clustered by region unless otherwise indicated. Other controls are log area, land quality, distance from coast, elevation, malaria, rainfall, temperature, date, crop dummies, major river, ruggedness and absolute latitude unless otherwise indicated.