Geography, Transparency and Institutions

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Outline of our research project

Our main thesis:

Geographical conditions/technology

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→ Information, storage, control (irrigation, transportation)

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→ Information, storage, control (irrigation, transportation)

→ Appropriability (the ability of the state to obtain revenue from its subjects)

→ State Institutions (property rights, hierarchy, capacity)

Today's presentation

A model offering an explanation for the effect of transparency on:

- State capacity/scale

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A model offering an explanation for the effect of transparency on:

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- Property rights (of farmers over land)

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A model offering an explanation for the effect of transparency on:

- State capacity/scale
- Property rights (of farmers over land)
- State concentration (center vs. periphery)

Plan for the Presentation

1. A principal-agent model explaining regional differences in scale and institutions
2. Application of the model to explain institutional differences between ancient Egypt and Mesopotamia
3. Related literature

Motivation

Acemoglu and Robinson (2012), following North (1981), argue that the greatest detriment to economic prosperity is the presence of extractive institutions that compromise property rights.

Motivation

However, Ancient Egypt had a prosperous civilization, built the great pyramids, and was stable over several millennia despite an extractive government and despite the lack of property rights of farmers over the land they cultivated.

Contribution

- A theory that offers an explanation for the success of some nations in the preindustrial world and the failure of others.

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- A theory that offers an explanation for the success of some nations in the preindustrial world and the failure of others.
- Unlike Acemoglu and Robinson (2012), who argue that institutions are by and large determined by the vagaries of human history, we propose a mechanism that explains how differences in institutions are the result of differences in geography and technology.

Contribution

- Our basic argument is that the distinguishing factor between the institutions of earlier states was the government's ability to appropriate revenue from the farming sector, and that this ability was determined by the transparency of production (among other factors), which, in turn, is affected by geographical and technological conditions.

Contribution

modern phenomena

- Inertia of institutions

→ deep rooted factors that account for the current variation in the wealth of nations

Contribution

modern phenomena

- Our transparency theory formalizes a key scholarly argument that attributes the unprecedented increase in the relative scale of government in the past century to a decline in the cost of collecting taxes.

Contribution

modern phenomena

→ The shift away from self-employment in agriculture into production by hired labor transformed the capacity to tax.

→ It was accompanied by a paper trail that rendered private production much more transparent to the modern state and facilitated income taxation.

Contribution

modern phenomena

→ An analogy between the long-term effects of the Agricultural Revolution in antiquity and the modern Industrial Revolution.

Our Theory

We argue that environmental differences

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→ Differences in the transparency of the production process

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→ Differences in the transparency of the production process

→ Differences in the tax technology

Our Theory

We argue that environmental differences

→ Differences in the transparency of the production process

→ Differences in the tax technology

→ Differences in the scale of the state, state concentration, and in related social institutions

Explaining regional differences: a principal-agent model

- Principal – the government
- Agents – the subjects/farmers

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Key assumption

- The degree of transparency varies across regions

Explaining regional differences: a principal-agent model

We study the impact of transparency on two standard elements in the (implicit) contract:

- “Stick” – threat of dismissal
- “Carrot” – share of output

Explaining regional differences: a principal-agent model

We study the impact of transparency on two standard elements in the (implicit) contract:

- "Stick" – threat of dismissal
- "Carrot" – share of output

and the implications to state intuitions:

scale, concentration, and land ownership

Model

The principal-agent problem

The principal designs the contract to maximize its expected income

Agents are risk neutral and choose their effort level to maximize their expected welfare

Output (per agent):

$$Y = \begin{cases} H & \text{if } e = h \text{ and } \theta = G \\ L & \text{otherwise} \end{cases}$$

$e \in \{h, l\}$ - effort

$\theta \in \{G, B\}$ - state of nature

$p \in (0, 1)$ - the probability that $\theta = G$

Information

$\sigma \in \{g, b\}$ - a public signal about the state of nature

Signal accuracy $q \geq 1/2$

$$q = \Pr(g|G) = \Pr(b|B)$$

$$1 - q = \Pr(g|B) = \Pr(b|G)$$

σ is observed after effort decision

Interpretation of the signal

a. Observation of output in other plots provides information about the state of nature at a specific plot depending on the correlation across plots.

Interpretation of the signal

b. An observable signal, such as the ‘Nilometer’ that measures the amount of water in the Nile.

The cost of maintaining the agent

$m > 0$ if effort is low $(e = l)$

$m + \gamma$ if effort is high $(e = h)$

$\gamma > 0$ is the cost of high effort

Assumptions:

$L \geq m + \gamma$

(low output is larger than the maintenance cost)

$p(H - L) > \gamma$

(effort is efficient)

Agent's Income and Utility

I - agent's expected income

$U = I - (m + \gamma)$ - agent's periodic utility when exerting effort

δ - the agent's discount factor

δV - the value of the agent's employment in the next period

$zero$ - agent's value of unemployment

Incentive scheme - the carrot:

The principal pays the agent:

an added bonus $a \geq 0$ if output is high $(Y = H)$

a basic wage $\omega \geq m + \gamma$ regardless of output

Incentive scheme - the stick:

$d \in \{0,1\}$ - the probability the agent is dismissed if:

$$Y = L \text{ and } \sigma = g$$

(otherwise the agent is retained)

x - the cost of replacing the agent

In the paper's appendix we show that the qualitative results hold:

1. if $d \in [0,1]$
2. if dismissal could depend on past output and signals

→ Two types of contracts are possible:

$d = 0$ *"Pure Carrot"*

and

$d = 1$ *"Stick and Carrot"*

The optimization implies that $\omega = m + \gamma$

→ An employment contract is fully described by a and d

(a carrot and a stick)

We assume that:

$$x > \frac{\delta p \gamma}{(1 - \delta/2)(1 - p)} > \frac{\delta p \gamma}{1 - p}$$

→ dismissing the agent when $\sigma = b$ is dominated by never dismissing

The value of employment (The Bellman equation)

$$V = pa + \Pr(retained) \cdot \delta V$$

$\rightarrow$

$$V = \frac{pa}{1 - \delta \Pr(retained)}$$

The principal's objective function - OF:

$$\pi = \max_{a \geq 0, d \in \{0,1\}} p(H-L) + L - (m+\gamma) - pa - (1-p)(1-q)dx$$

subject to the agent's incentive compatibility constraint - IC:

$$p(a+\delta V) + (1-p)[q + (1-q)(1-d)]\delta V + \omega - (m+\gamma)$$

$$\geq p(q(1-d) + (1-q))\delta V + (1-p)[(q + (1-q)(1-d)]\delta V$$

$$+\omega - m$$

Rewrite the agent's IC:

$$pa + pqd\delta V \geq \gamma$$

Intuition:

The return to effort: the expected rise in income, $pa,$ and the increase in the probability to maintain the job $pqd,$ multiplied by its value, $\delta V,$ is larger than the cost of effort.

Solution

The IC is binding (the contract is designed by the principal)

$$a = \frac{\gamma}{p} - qd\delta V$$

Stick & Carrot: $(d = 1)$

$$V_s = \frac{\gamma}{1 - \delta(p + q - 2pq)} > 0$$

Pure Carrot: $(d = 0)$

$$V_c = \frac{\gamma}{1 - \delta}$$

(We find a as a function of V from the IC and replace in the value function)

The two contracts:

"Pure Carrot"

$$d_c = 0, \quad a_c = \frac{\gamma}{p}$$

or

"Stick & Carrot"

$$d_s = 1, \qquad a_s = \frac{\gamma}{p} - q\delta V$$

$$= \frac{\gamma}{p} - \frac{q\delta\gamma}{1 - \delta(p + q - 2pq)}$$

By replacing a from the IC in the OF, if:

$$q < \hat{q}$$

→ *Pure Carrot*

Otherwise

→ *Stick & Carrot*

The threshold $\hat{q}$ is given by:

$$\frac{\hat{q}}{(1-\hat{q})} = \frac{(1-p)x}{p\delta\gamma}[1-\delta(p+\hat{q}-2p\hat{q})].$$

- This quadratic equation has one root strictly inside the unit interval $0 < \hat{q} < 1$
- For $x > \frac{\delta p\gamma}{(1-\delta/2)(1-p)}$: $\hat{q} > 1/2$

→ For some set of parameters the 'pure carrot' contract is optimal

Intuition: a principal relying on a “stick” to incentivise the agent has to incur the cost of dismissal x with probability:

$$(1-p)(1-q)$$

→ The expected cost of using the “stick”:

$$(1-p)(1-q)x$$

is decreasing with the quality of information q

Property rights and transparency

We interpret the “pure carrot” contract as a regime in which farmers pay taxes but are de-facto owners of the land they cultivate

→ Greater productive opacity leads to property rights

Expected Income - *Pure Carrot*

The expected income of the agent

$$I_c = m + 2\gamma$$

The expected income of the principal

$$\pi_c = p(H - L) + L - (m + 2\gamma)$$

Efficient outcome:

$$I_c + \pi_c = p(H - L) + L$$

Expected Income - *Stick & Carrot*

The expected income of the Agent

$$I_s = m + 2\gamma - \frac{pq\delta\gamma}{1 - \delta(p + q - 2pq)}$$

is decreasing with q

The intuition for the decline of I with q above $\hat{q}$:

Holding constant the bonus, a, a higher q implies a lower probability of dismissal, increasing the value of employment. Therefore, as q increases a has to decline to hold the incentive constraint binding.

Expected Income - *Stick & Carrot*

The expected income of the principal

$$\pi_s = p(H-L) + L - (m + 2\gamma) + \frac{pq\delta\gamma}{1-\delta(p+q-2pq)} - (1-p)(1-q)x$$

is increasing with q

Expected Income - *Stick & Carrot*

inefficient outcome:

$$I_s + \pi_s = p(H - L) + L - (1 - p)(1 - q)x$$

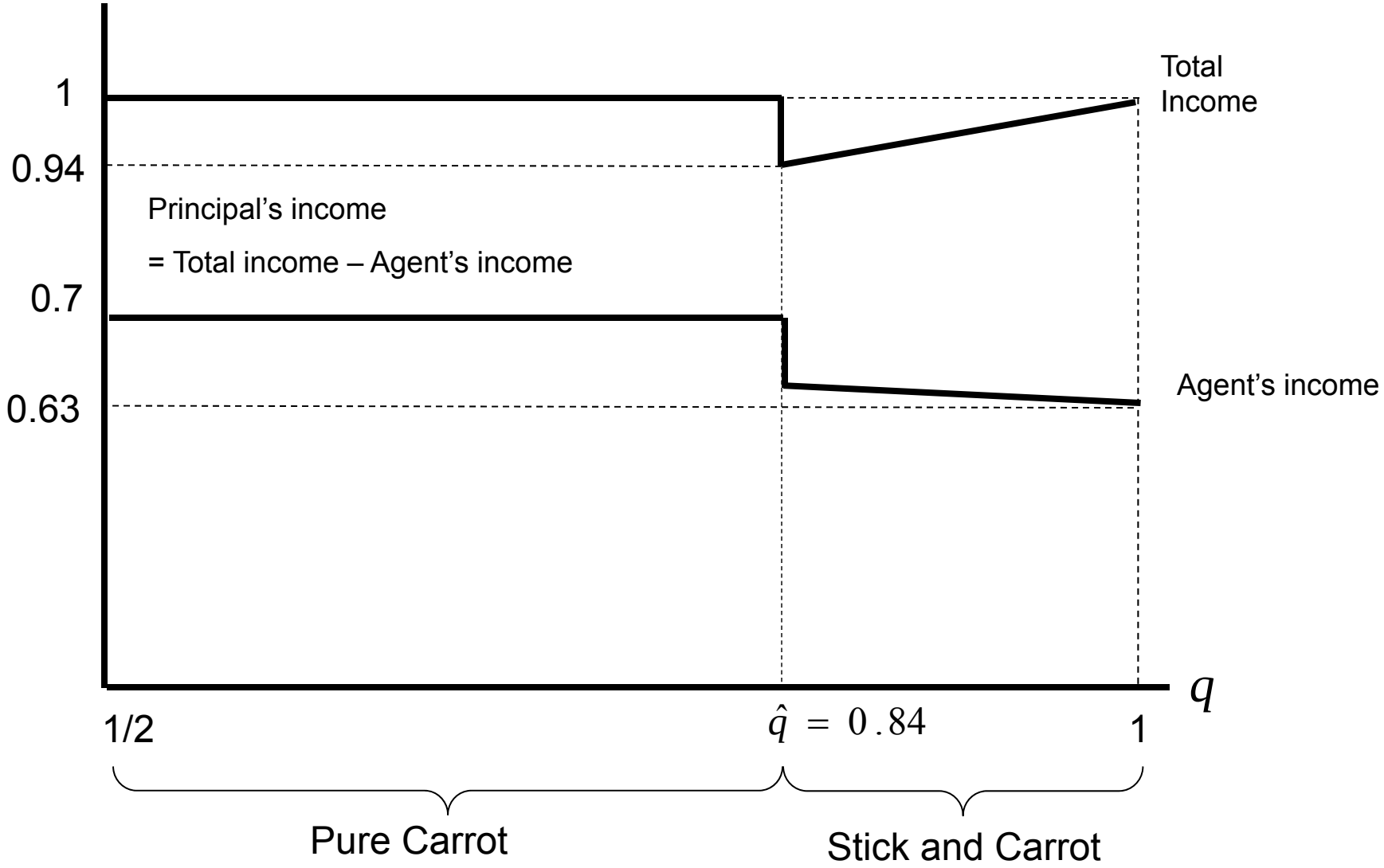
inefficiency declines with q

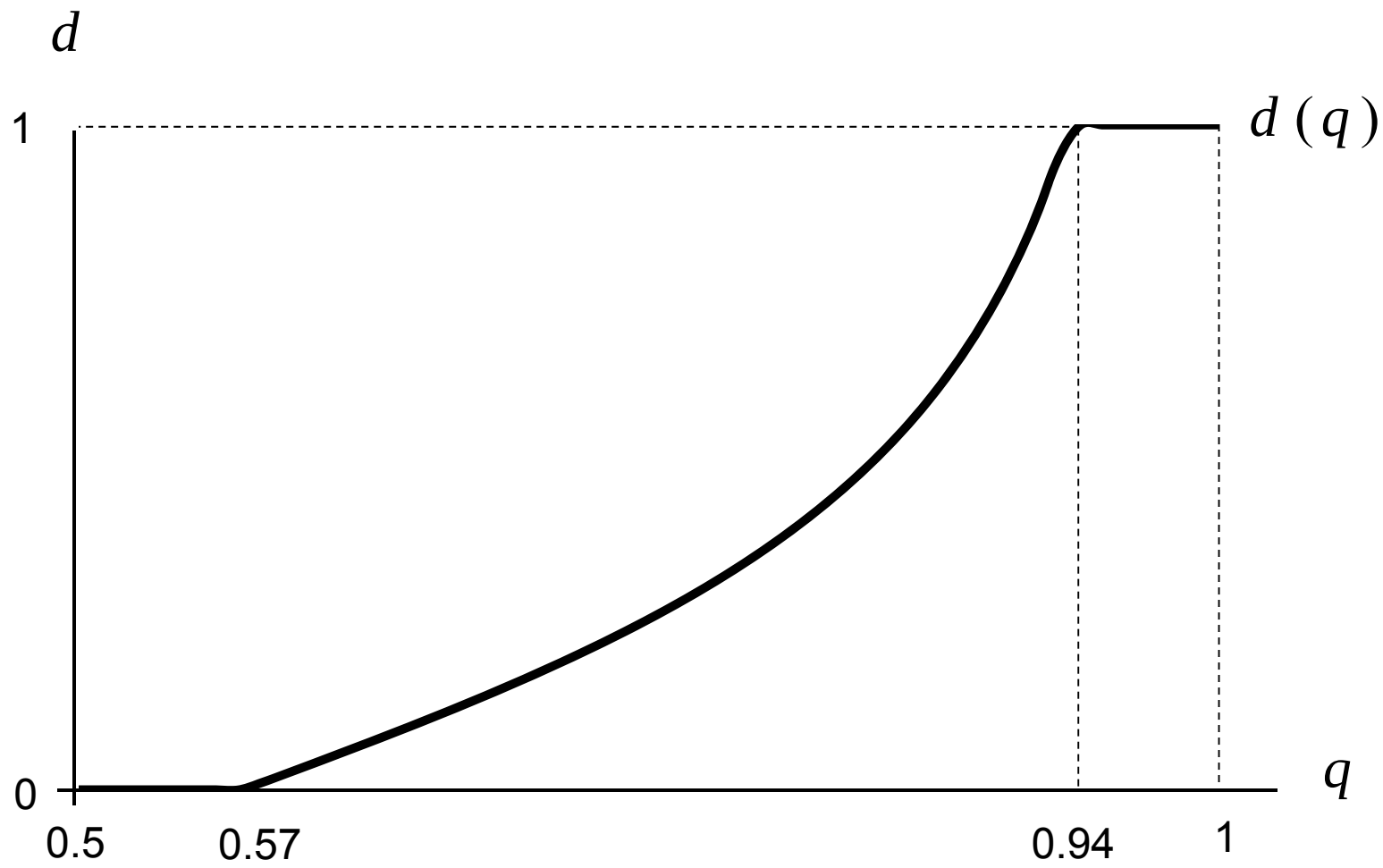
An Illustrative Calibration

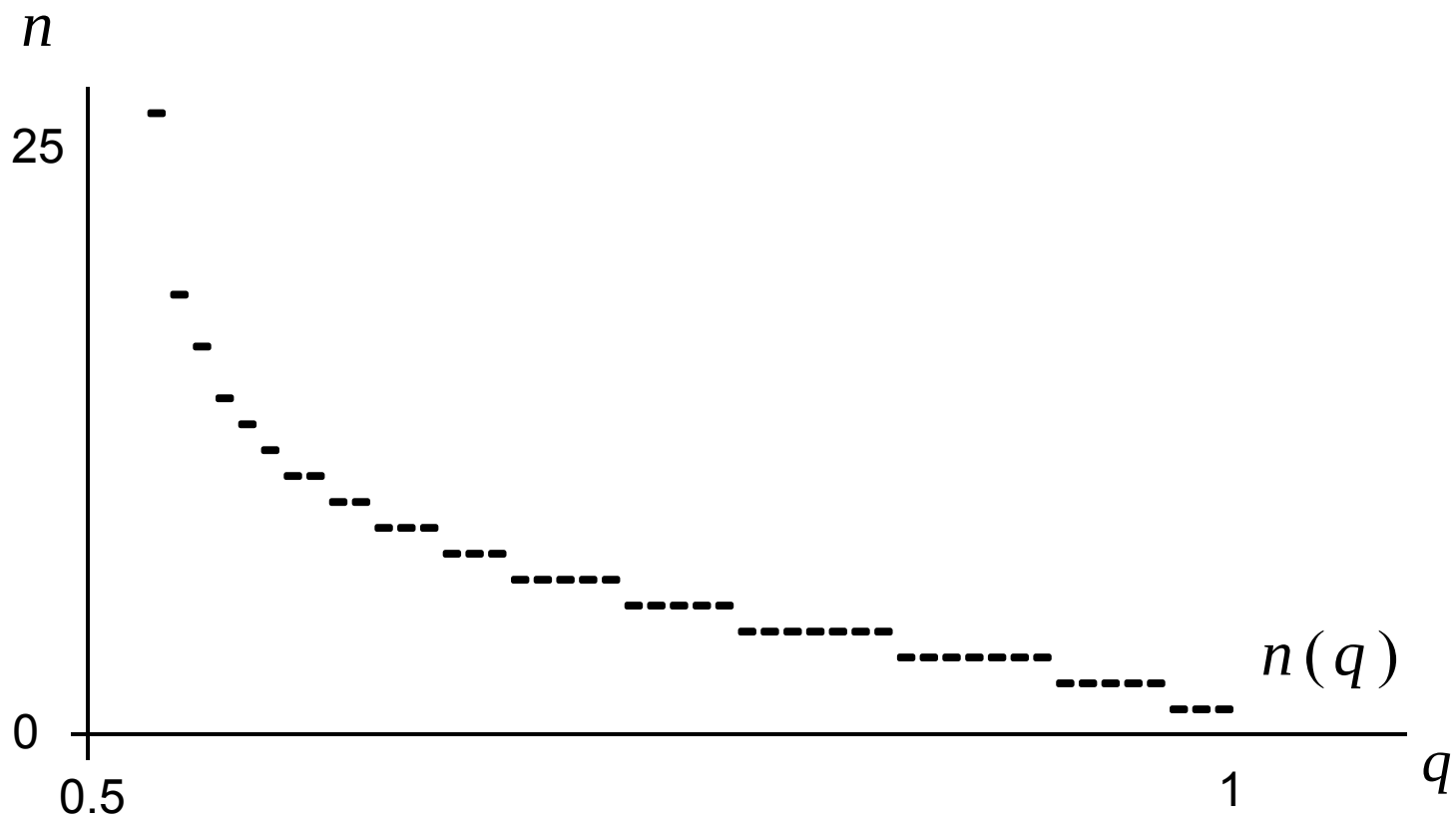
$E(Y) = pH + (1-p)L = 1$ (representing about 1.5 tons of net grain)

$H = 1.1, L = 0.6$ and $p = 0.8$, (a bad harvest occurs about every five years)

$x = 2, m = 0.5, \gamma = 0.1$ and $\delta = 0.8$.


1
0.94
0.7
0.63
Total
Income
Principal's income
= Total income – Agent's income
Agent's income
q
1/2
$\hat{q} = 0.84$
1
Pure Carrot
Stick and Carrot


d
1
d (q)
0
q
0.5
0.57
0.94
1


n
25
0
0.5
1
q
n(q)

Extension: State Concentration

A key aspect of state government is the multi-tiered hierarchy of control

- Our model can be interpreted as a series of principal-agent interactions at the different tiers of the hierarchy – each tier like the one we analyze
- Differences in transparency across the tiers could determine the size of the state and concentration

Extension: State Concentration

Two main cases:

1. Local farming is transparent to both local officials and the state

- "stick & carrot" farming contract and "stick & carrot" contract to local officials
- peripheral centers are *weak*

Extension: State Concentration

Two main cases:

2. Local farming is transparent to local officials *but not* to the state

- "stick & carrot" farming contract and "pure carrot" contract to local officials
- peripheral centers are *strong*

Comment

- Our results are robust to sheltering or misreporting output instead of moral hazard problems related to exerting effort (Appendix B)

Part 4. Application:
Mesopotamia and Ancient Egypt

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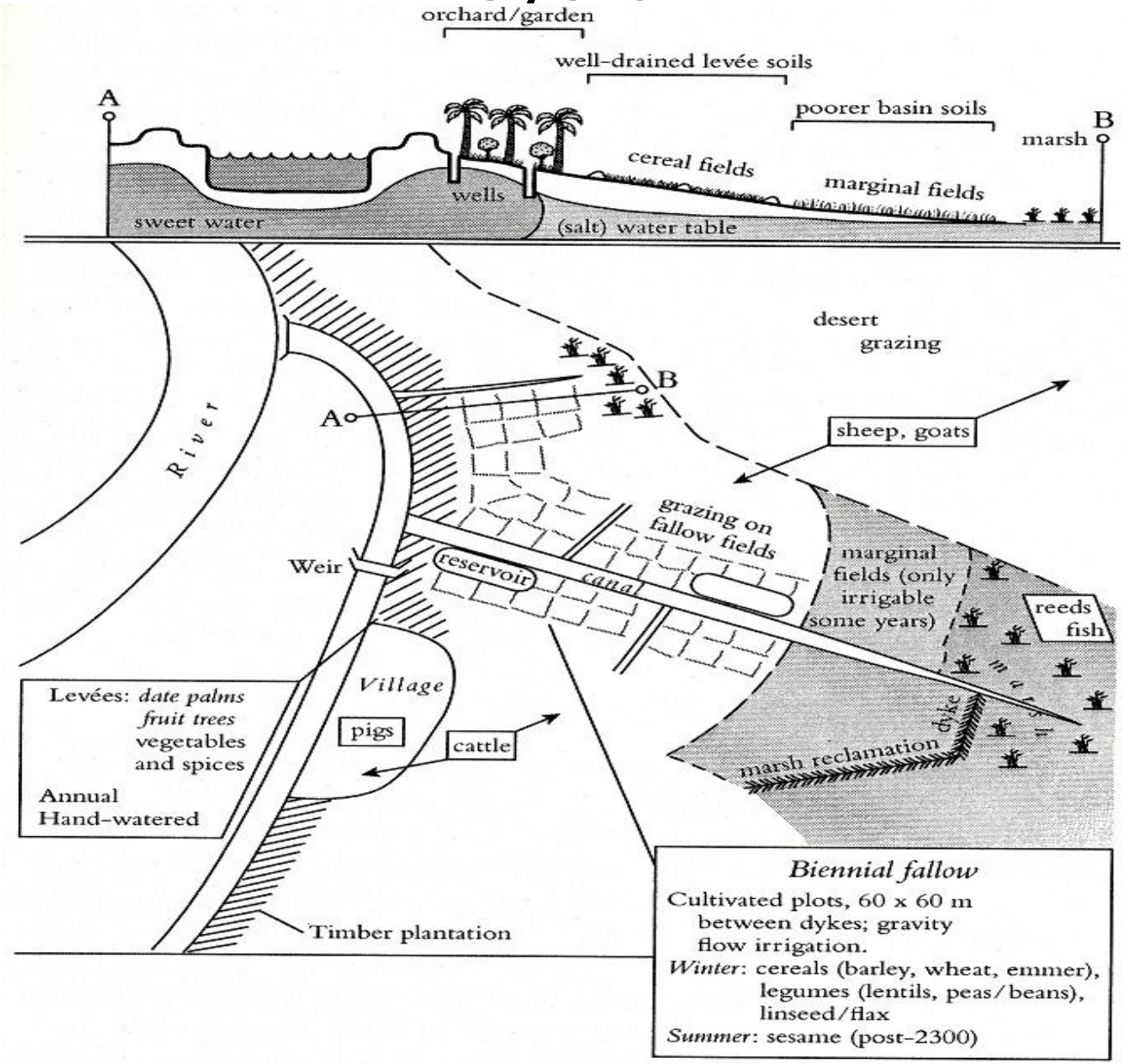
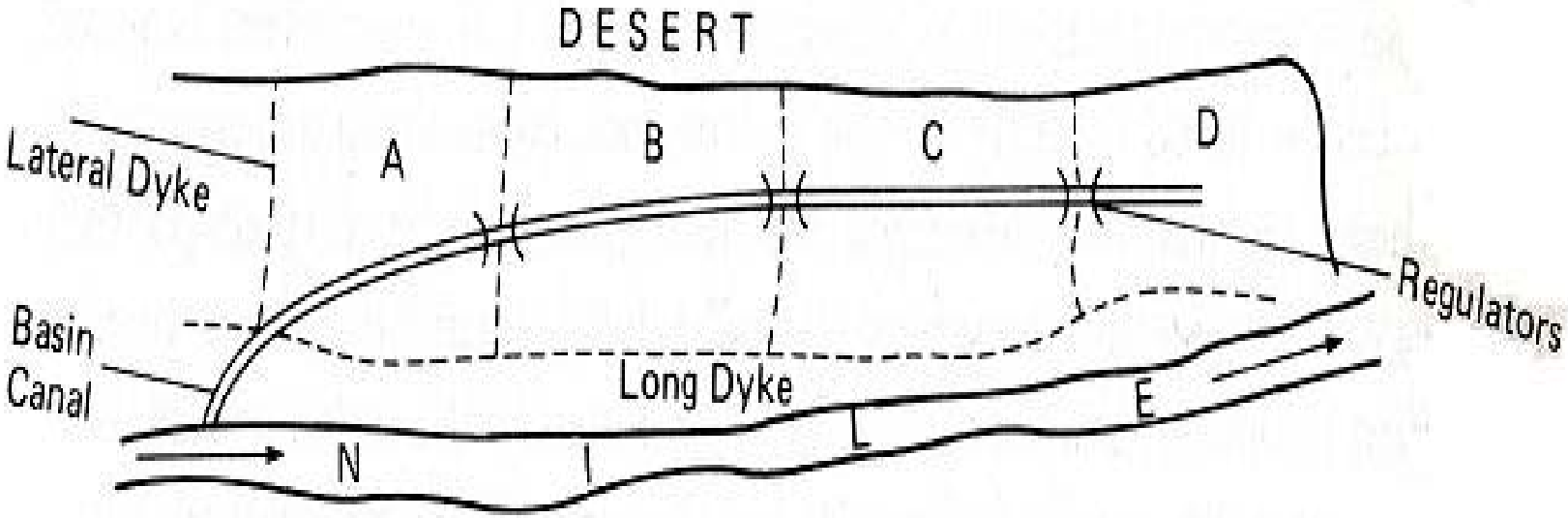
- This expressed disapproval of Pharaonic land tenure institutions, where farmers were serfs who tilled land that they did not own
- In ancient Israel and Upper Mesopotamia, owner-operated farming was common and sometimes the norm
- Land tenure in Southern (lower) Mesopotamia was more like in Egypt

Mesopotamia – typical irrigation system



Egypt – typical irrigation system



Nilometer

- The Nilometer: indicator for the inundation height of the Nile

Nilometer

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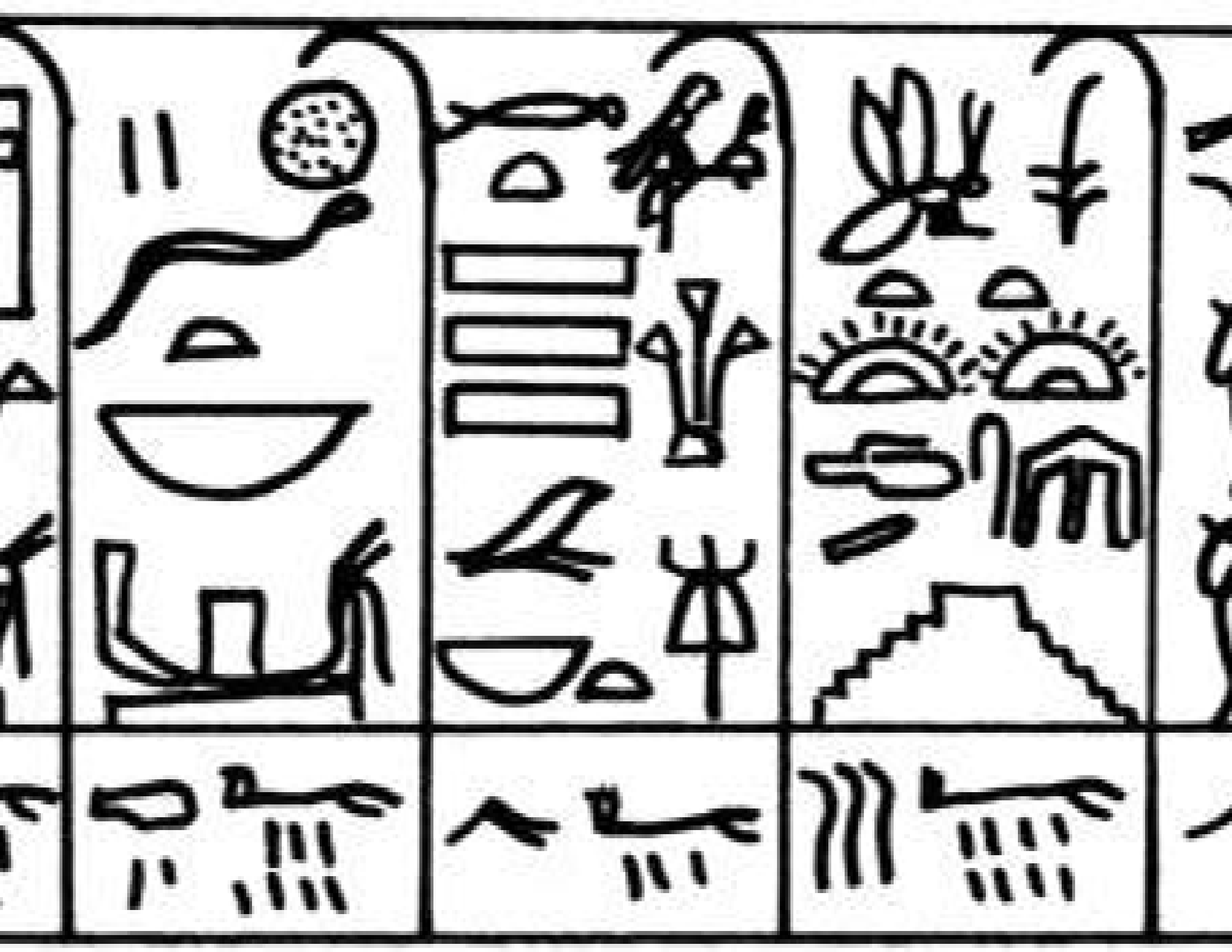
- Cooper (1976:366): “On the basis of the Nile flood recorded by the Nilometer, the government knew in advance what revenue to anticipate.”



Application:
Ancient Egypt and Mesopotamia

Land ownership

Our theory can explain why:

- Egyptian farmers were tenant-serfs, without title to the land that they cultivated
- Much of the land in Upper Mesopotamia was cultivated by its direct owners

  (Records for private real estate transaction and loan contracts, that would be typically secured by land, are abundant in ancient Mesopotamia and hardly exist in ancient Egypt)

State Concentration

Our theory can explain why:

- The local nobles and the regional governors in Egypt were agents of the Pharaoh, subject to dismissal
- The cities in Egypt were administrative centers
- The cities in Mesopotamia retained much power, controlled by the local elite

Legal Disputes

Our theory can explain why legal disputes were resolved:

- in Egypt by local noblemen without legal codes
- in Mesopotamia by court process, guided by law codes issued by the state

State Capacity

Our theory can explain why the central state in Egypt:

- rose much faster than in Mesopotamia
- was much more stable
- could siphon off a greater share of the country's produce

  (This enabled the construction of the great pyramids in the mid-third millennium)

Are Kings Gods?

Our theory can explain why:

- The Pharaohs were considered as incarnations of the gods
- The kings of Mesopotamia (with a single exception in early Akkad) were only considered as envoys of the gods

Related literature

- Wittfogel (1957) - hydraulic theory
- Adams (1981) - precautionary storage
- Mann (1986) – “Social cage” adopting Carneiro’s (1970) theory of “environmental circumscription”
- Tilly (1975) - warfare theory
- Dal Bó, Hernández and Mazzuca (2015) – “The Paradox of Civilization:” circumscription matters because: “prosperity attracts predation, and higher insecurity discourages the investments that create prosperity.”
- Mayshar, Moav, Neeman and Pascali (2015) – Cereals vs roots & tubers

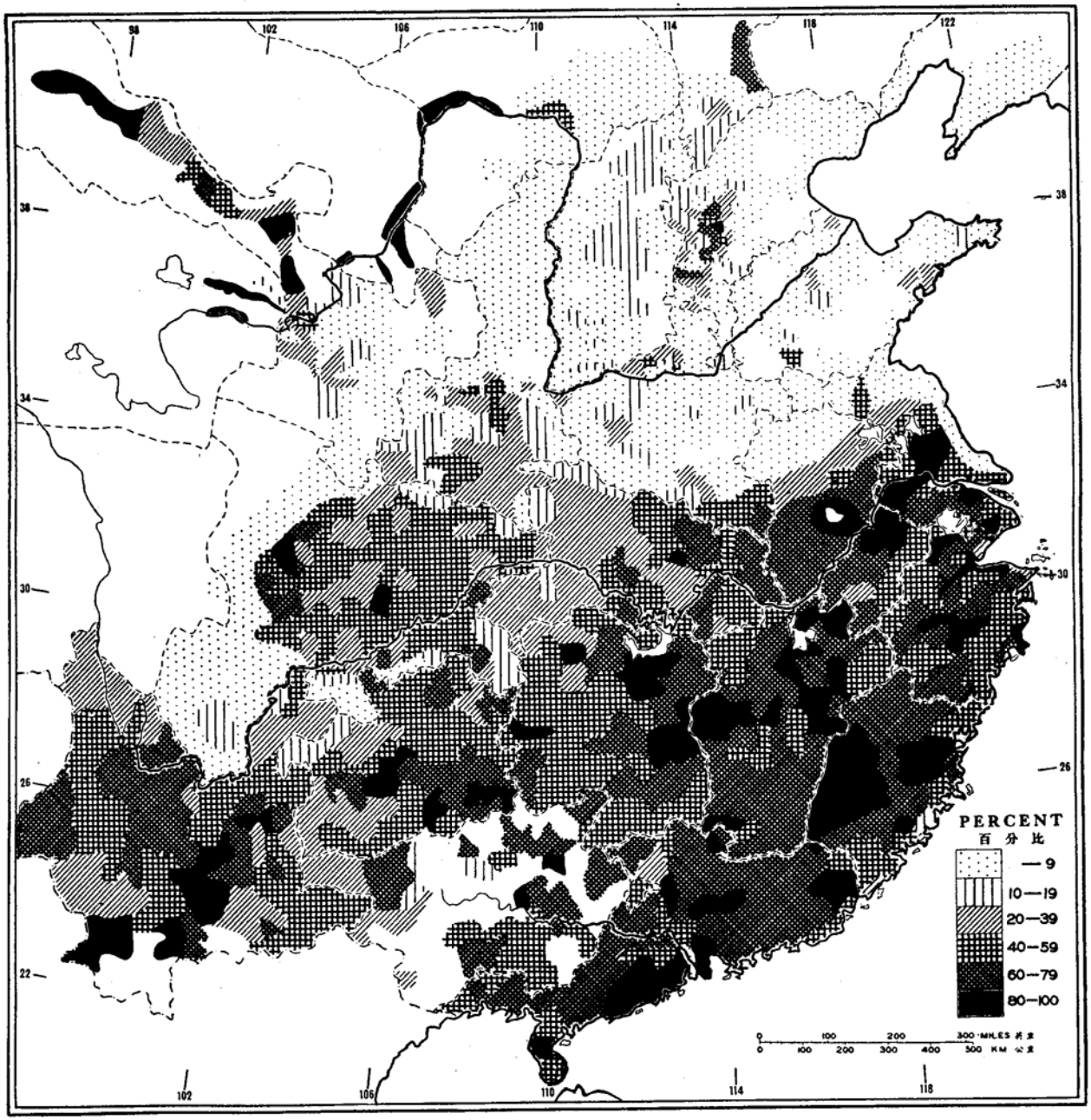
Related literature - evidence

- Billman (2002) - an early irrigation system in 400 BCE-800 CE in Peru created an opportunity for leaders “to control land and the flow of water” thus enabling them “to finance the creation of centralized, hierarchical political organizations”

Land Tenure
Evidence from China

John Lossing Buck *Land Utilization in China* (University of Chicago Press, 1937)

A survey of 16,786 farms and 38,256 farm families in the Chinese farm economy

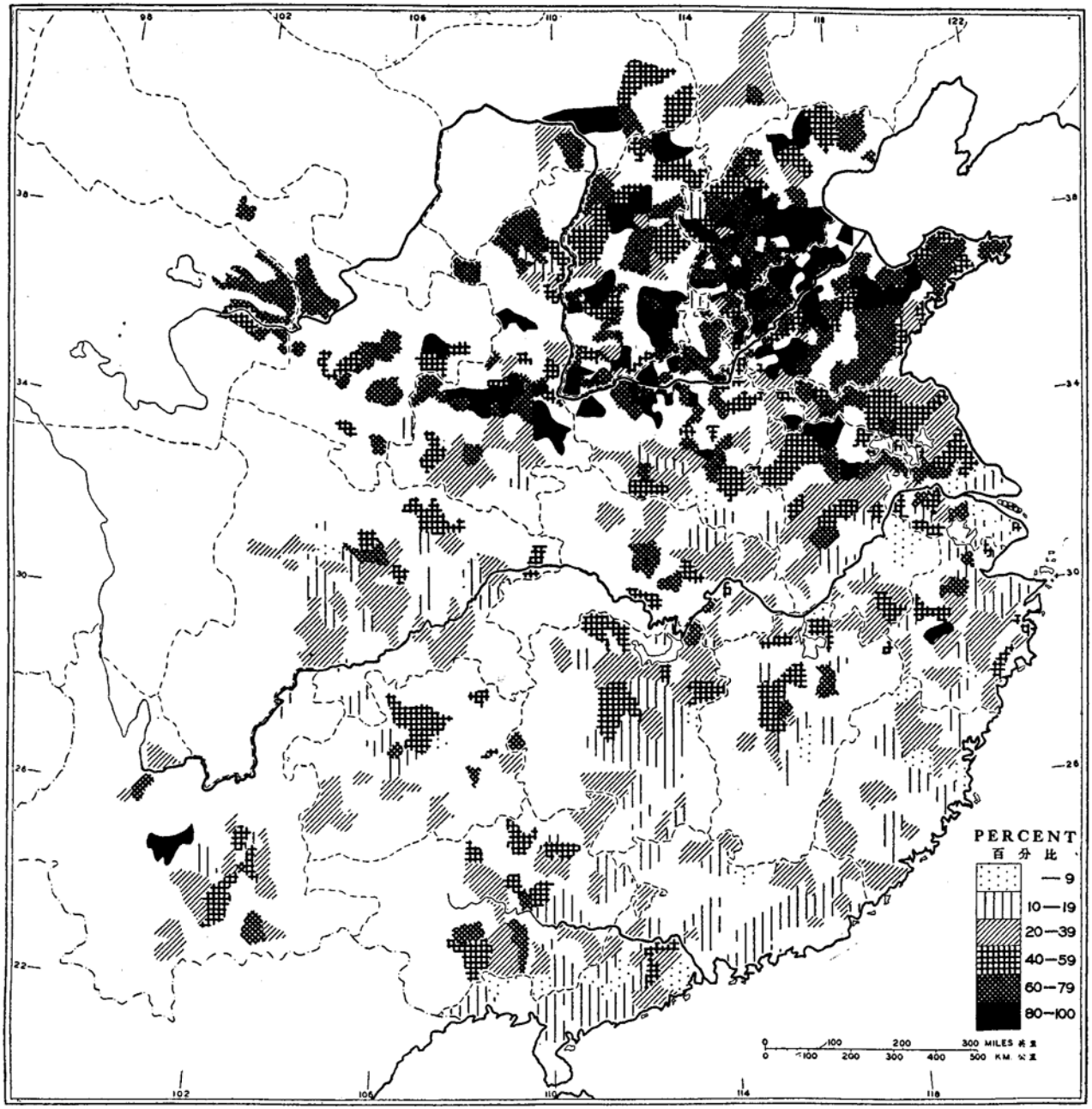


MAP 4. PERCENTAGE OF THE CULTIVATED LAND WHICH IS IRRIGATED

Rice is the main irrigated crop. Many places in the Rice Region have no

第四圖 耕地內灌溉面積之百分比

稻係主要灌溉作物. 在水稻地帶內, 若干地方, 除水稻外, 並無其他灌溉作物, 故其稻田面積之百分比, 卽等於灌溉面積之百分比. 小麥地帶, 因水



MAP 6. PERCENTAGE OF FARMERS WHO ARE OWNERS

第六圖 自耕農之百分比

中國農民，管有自耕之田地者，佔百分之五四．小麥地帶，四分之三以

Cereals, Appropriability and Hierarchy

Joram Mayshar	Hebrew University of Jerusalem
Omer Moav	University of Warwick & IDC
Zvika Neeman	Tel-Aviv University
Luigi Pascali	UPF & University of Warwick

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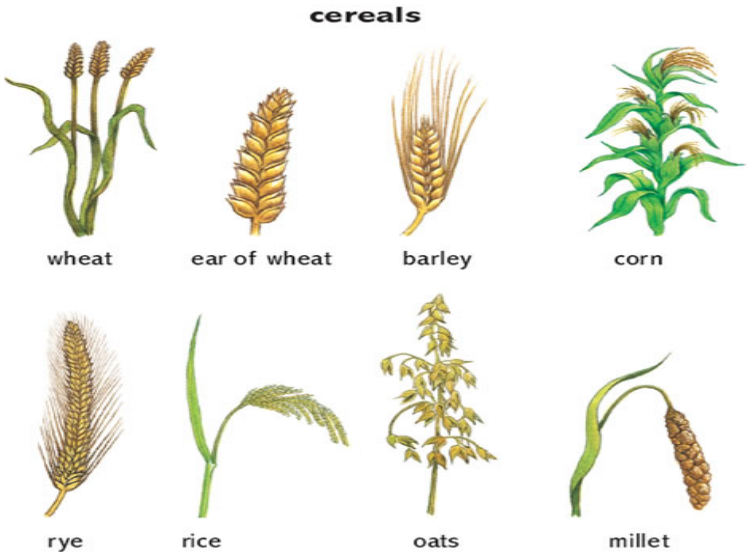

This stuff, not this

The emergence of hierarchy

Following the Neolithic Revolution some regions of the world developed complex hierarchies, leading to city-states and the great civilizations of antiquity

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- How did farming trigger this change?

The emergence of hierarchy

Following the Neolithic Revolution some regions of the world developed complex hierarchies, leading to city-states and the great civilizations of antiquity

- How did farming trigger this change?
- Why did some regions remain with only simple hierarchy, in spite of adopting farming?

Existing literature

- Neolithic Revolution →

  Increased productivity →

  Food surplus → (various mechanisms)

  Hierarchy (an elite that did not produce food) →

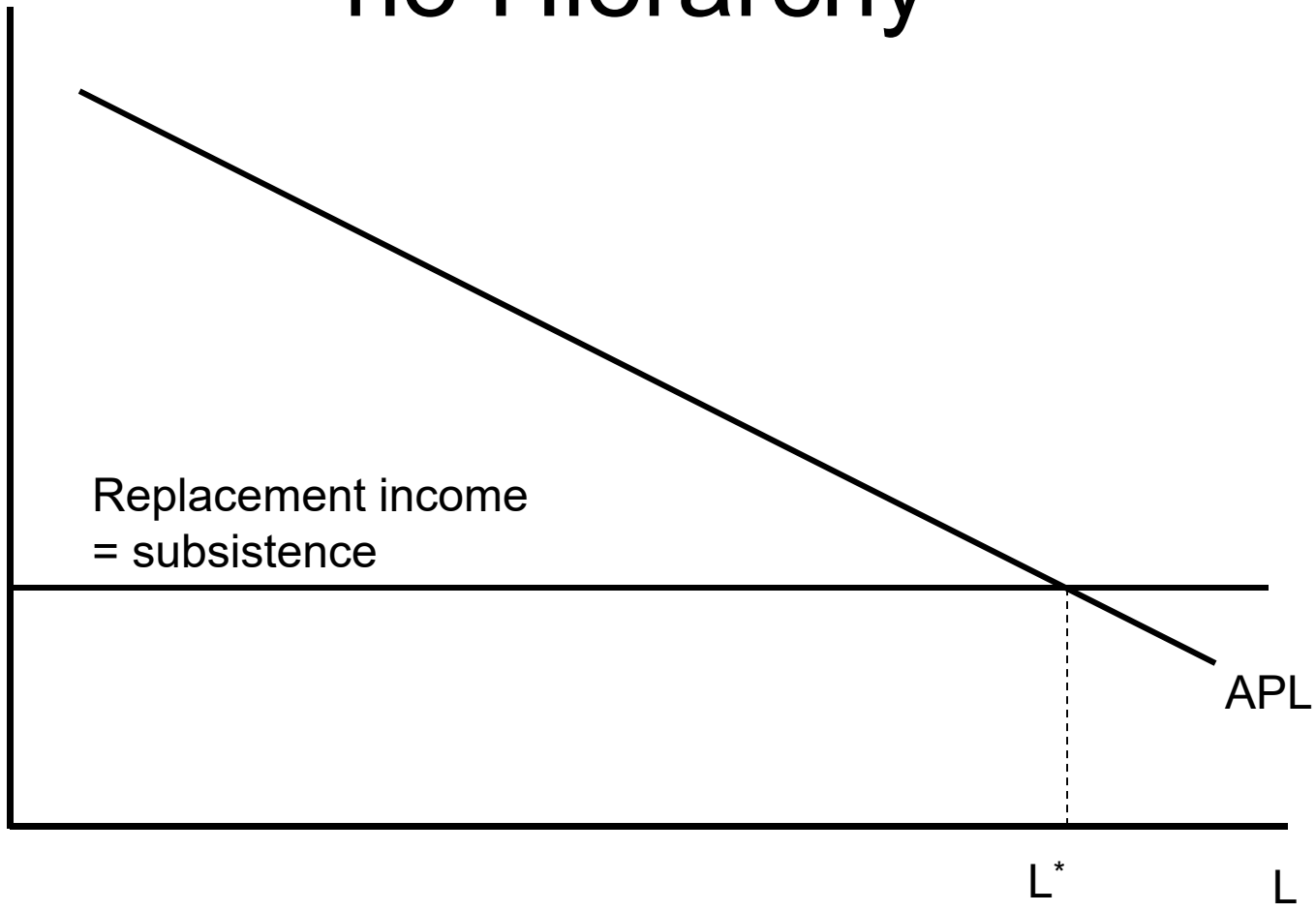
  The emergence of the state

Existing literature

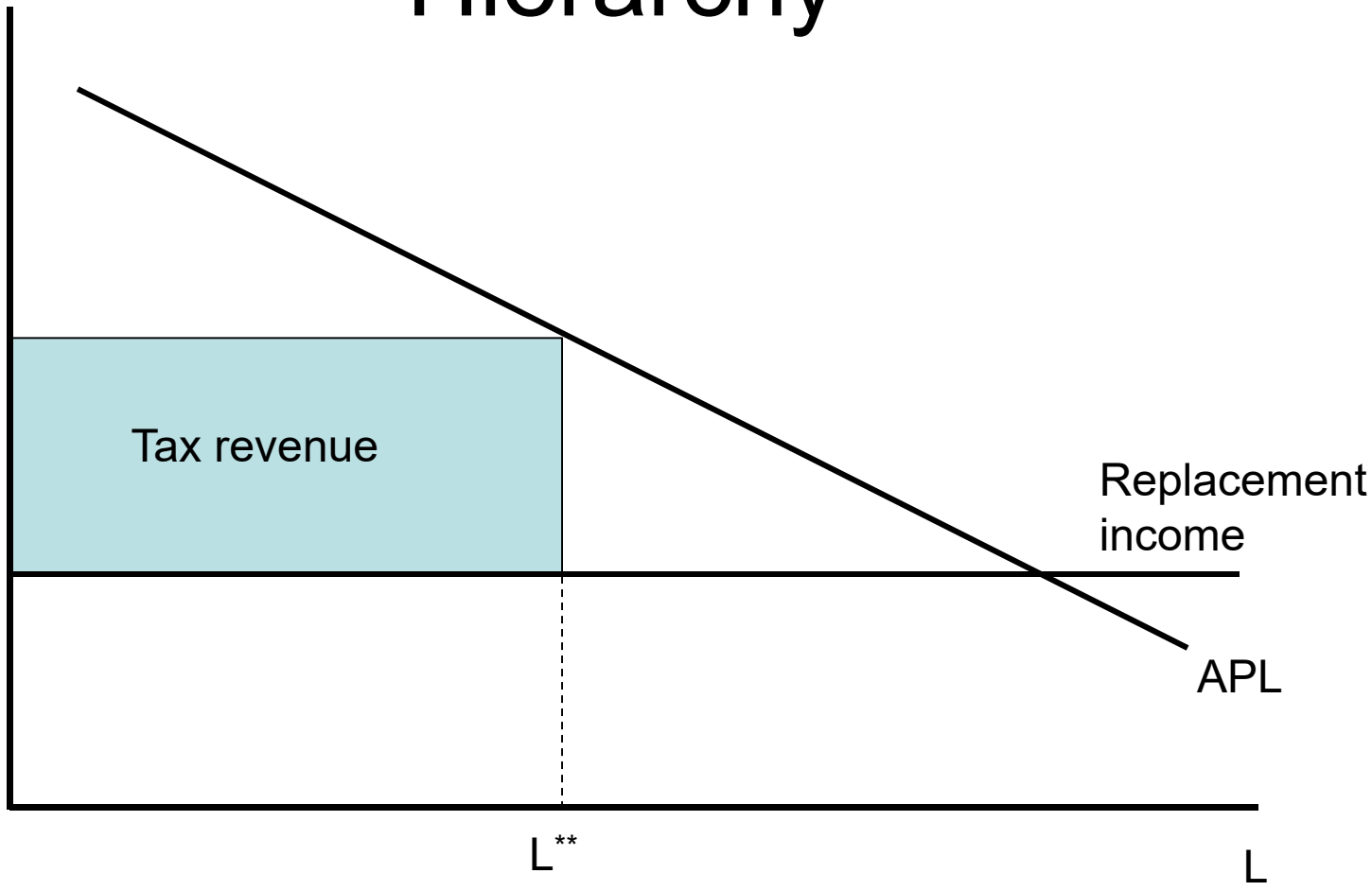
- Neolithic Revolution →
  Increased productivity →
  Food surplus → (various mechanisms)
  Hierarchy (an elite that did not produce food) →
  The emergence of the state

- Differences between regions in productivity →
  differences in surplus →
  differences in social institutions

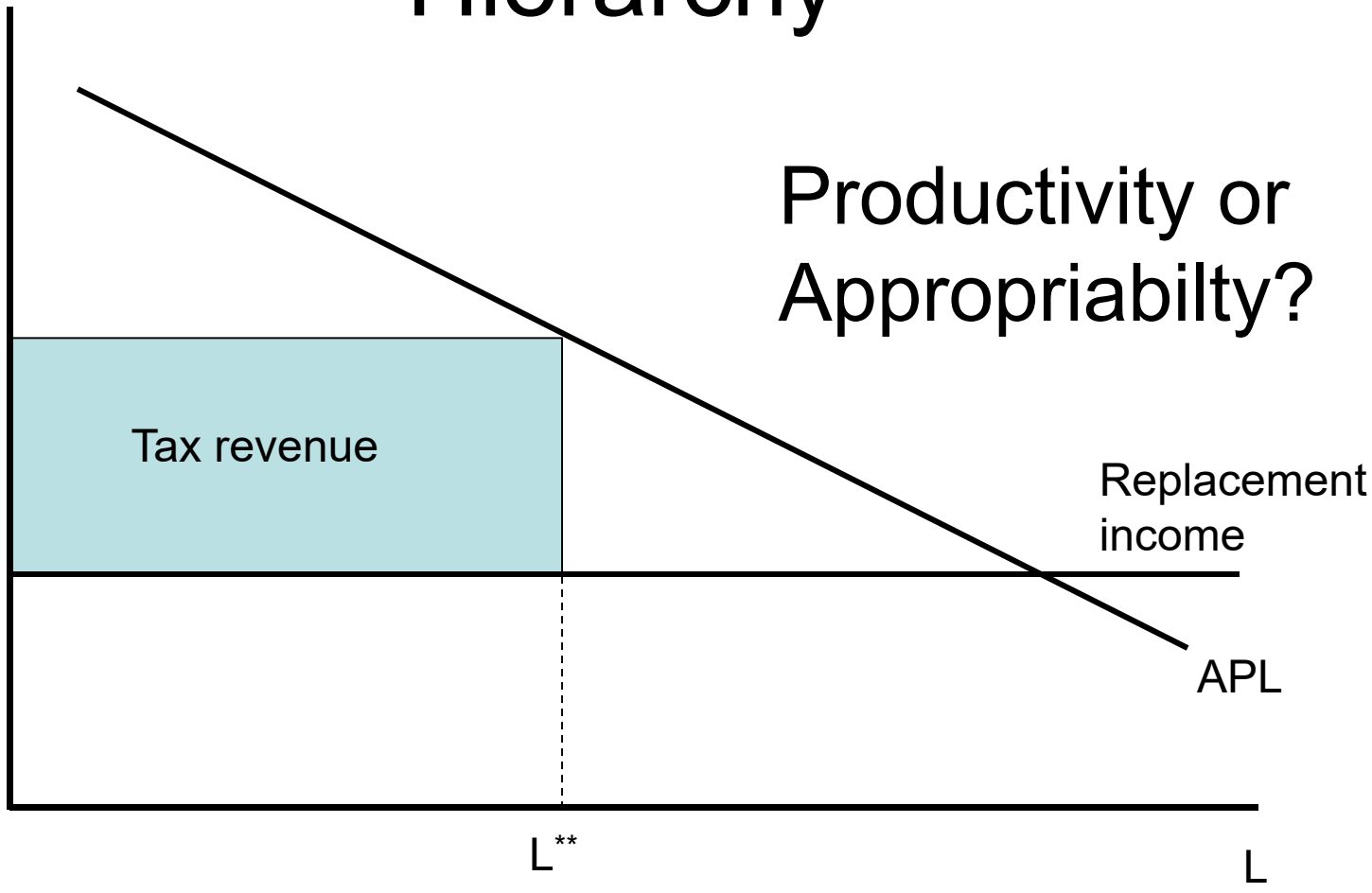
Equilibrium with no Surplus and no Hierarchy



Equilibrium with Surplus and Hierarchy



Equilibrium with Surplus and Hierarchy



Our explanation

- Neolithic Revolution →

  Increased appropriability →

  Hierarch and Surplus

Our explanation

- Neolithic Revolution →

  Increased appropriability →

  Hierarchy and Surplus

- Differences between regions in land suitability for cereals vs. roots/tubers →

  Differences in appropriability →

  Differences in hierarchical complexity

Our explanation

- Appropriability generates the demand for the state and it allows its existence
  - →Encourages robbery and creates a demand for protection
  - →Facilitated the finance of the elite and the provision of protection

- There is a positive correlation between agricultural surplus and hierarchy, but surplus is an outcome of hierarchy rather than its cause.

Our contribution and critique

Our contribution and critique

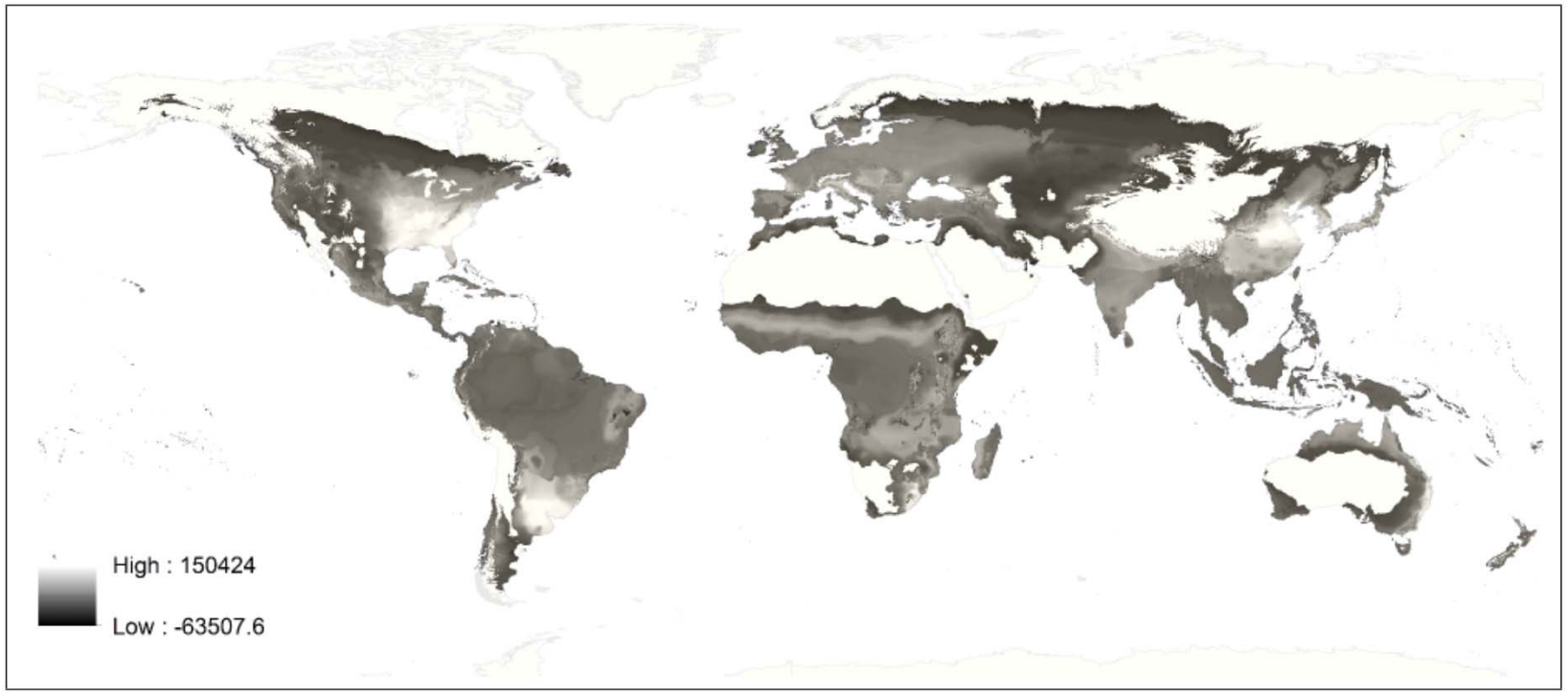
Our contribution and critique

- Surplus is unlikely to emerge following the very slow transition to farming

(Population size adjusts to prevent the creation of surplus following the slow rise in productivity, as predicted by Malthus and supported empirically by Ashraf-Galor, 2011, and others)

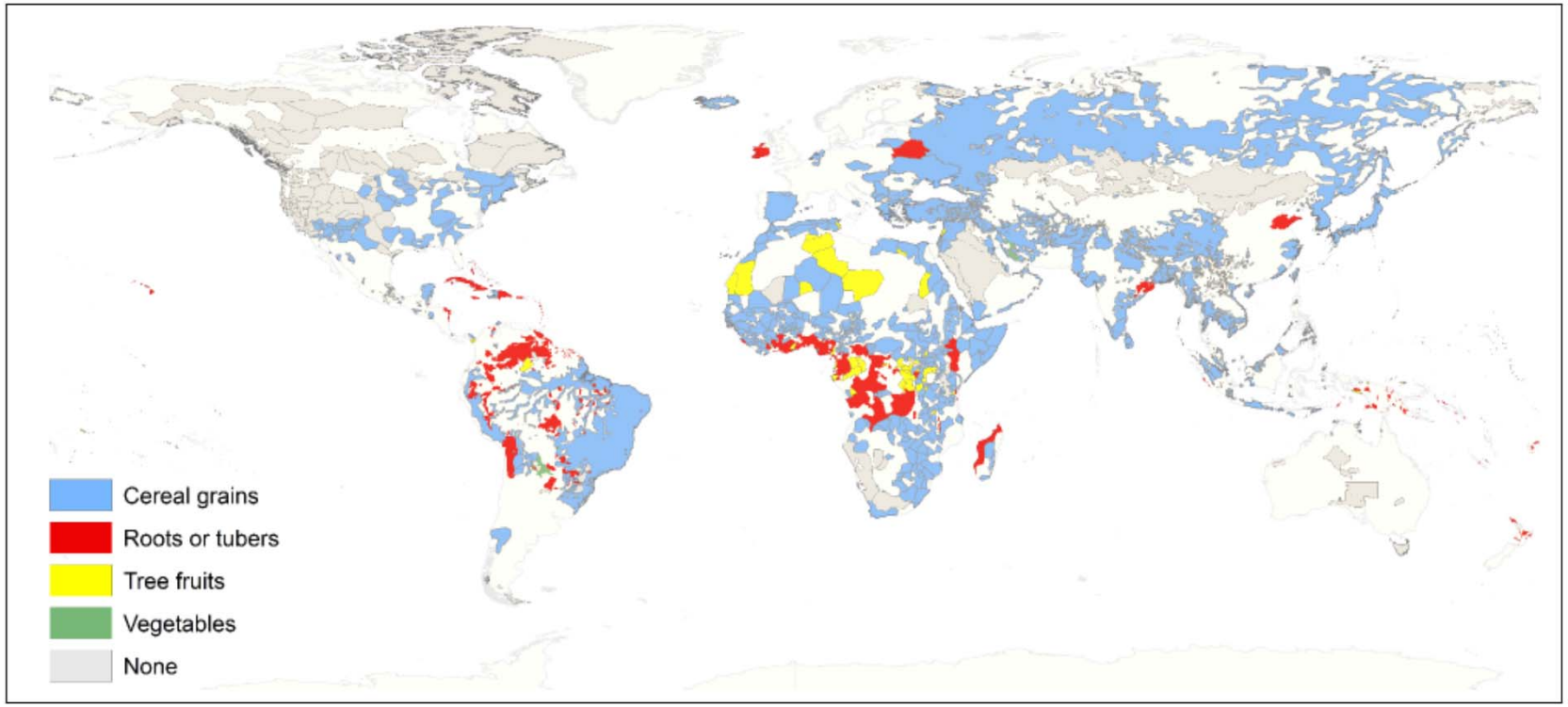
Crop yields, agriculture and main crop

Figure 7: Difference in potential yields (calories per hectare) of cereals versus roots and tubers.



Crop yields, agriculture and main crop

Figure 5: Major crop in pre-colonial societies



Crop yields, agriculture and main crop

Table 2: Potential Crop Yields, Choice of Crops and Reliance on Agriculture

	Dependent variable is:					
	Major crop is cereal grains (dummy)			Reliance on agriculture		
	(1)	(2)	(3)	(4)	(5)	(6)
CALORIC DIFF	0.205***	0.210***	0.253***	0.0812***	-0.0978***	-0.0464***
(CER - TUB)	(0.0168)	(0.0310)	(0.0329)	(0.00945)	(0.0134)	(0.0136)
MAX CALORIES		-0.00664	-0.137***		0.230***	0.128***
(ALL CROPS)		(0.0338)	(0.0386)		(0.0153)	(0.0178)
CONTINENT FE	NO	NO	YES	NO	NO	YES
r2	0.132	0.132	0.359	0.0733	0.235	0.387
N	982	982	982	1063	1063	1063

The table reports cross-sectional OLS estimates and the unit of observation is the society in Murdock's Ethnoatlas. The dependent variable is either a dummy that identifies societies that cultivate cereal grains as main crop (columns 1-3) or the reliance of the these societies on agriculture (columns 4-6). CALORIC DIFF (CER-TUB) is the standardized difference between the maximum potential calorie yield per hectare that can be obtained from cereals versus the one that can be obtained from either roots or tubers. MAX CALORIES (ALL CROPS) is the standardized maximum potential calorie yield per hectare that can be obtained from cultivating the most productive crop among cereal grains, roots and tubers. Societies that live on lands that are suitable for neither cereals nor roots and tubers are excluded from the sample. Robust standard errors in parentheses *** significant at less than 1 percent; ** significant at 5 percent; * significant at 10 percent

Cereals, surplus and hierarchy

2SLS estimates

2nd stage:

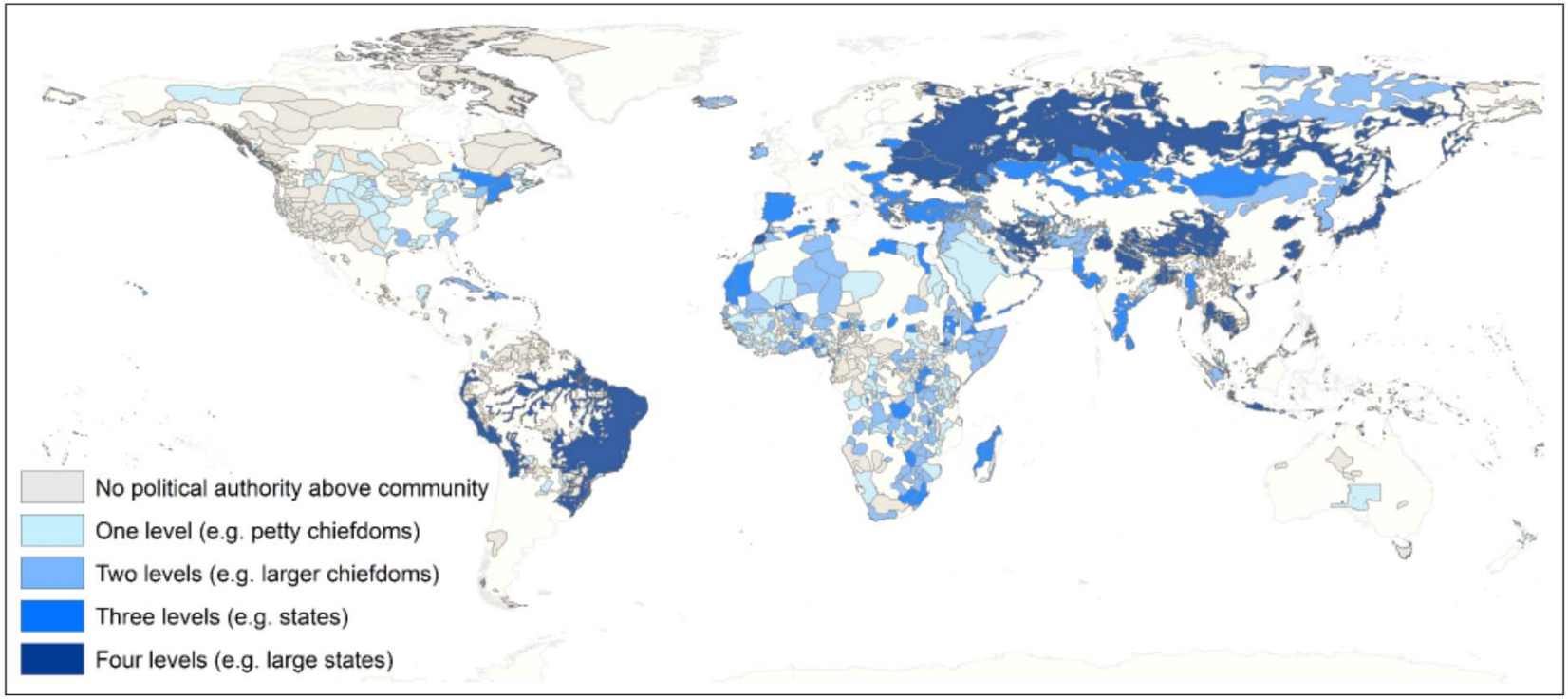
$Hierarchy_i / Surplus_i = \alpha\ I(Main\ Crop=Cereals_i) + X'\beta + \varepsilon$

1st stage:

$I(Main\ Crop=Cereals_i) = \gamma_0(YieldCereals_i - YieldTubers_i) + X'\beta + \varepsilon$

Cereals, surplus and hierarchy

Figure 4: Jurisdictional hierarchy beyond the local community in pre-colonial societies



Cereals, surplus and hierarchy

Table 3: Cereals, Surplus and Hierarchy - Reduced Form

	Dependent variable is:					
	Jurisdictional Hierarchy Beyond Local Community			Existence of farming surplus		
	(1)	(2)	(3)	(4)	(5)	(6)
CALORIC DIFF	0.244***	0.179**	0.274***	0.141***	0.241***	0.202***
(CER - TUB)	(0.0394)	(0.0732)	(0.0758)	(0.0319)	(0.0681)	(0.0742)
MAX CALORIES		0.0825	-0.188**		-0.132	-0.0985
(ALL CROPS)		(0.0713)	(0.0886)		(0.0870)	(0.0985)
CONTINENT FE	NO	NO	YES	NO	NO	YES
r2	0.0416	0.0429	0.249	0.0757	0.0911	0.157
N	952	952	952	140	140	140

The table reports cross-sectional OLS estimates and the unit of observation is the society in Murdock's Ethnoatlas. The dependent variable is either a dummy that identifies societies that produce a farming surplus or Murdock's (1967) index of jurisdictional hierarchy beyond the local community and it takes the following values: 1 (no political authority beyond community), 2 (petty chiefdoms), 3 (larger chiefdoms), 4 (states), 5 (large states). CALORIC DIFF (CER-TUB) is the standardized difference between the maximum potential calorie yield per hectare that can be obtained from cereals versus the one that can be obtained from either roots or tubers. MAX CALORIES (ALL CROPS) is the standardized maximum potential calorie yield per hectare that can be obtained from cultivating the most productive crop among cereal grains, roots and tubers. Societies that live on lands that are suitable for neither cereals nor roots and tubers are excluded from the sample. Robust standard errors in parentheses *** significant at less than 1 percent; ** significant at 5 percent; * significant at 10 percent

Cereals and hierarchy

Table 4: Cereals and Hierarchy - OLS and 2SLS

	Dependent variable: Jurisdictional Hierarchy Beyond Local Community							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	2SLS	2SLS	2SLS	OLS	2SLS	2SLS	2SLS
MAIN CROP:	0.707***	1.170***	0.863**	1.040***	0.304***	0.892***	1.064***	0.993***
CEREALS	(0.0630)	(0.195)	(0.364)	(0.245)	(0.0762)	(0.261)	(0.332)	(0.277)
MAX CALORIES			0.0811				-0.0368	
(ALL CROPS)			(0.0714)				(0.0564)	
DEPENDENCE ON				0.334				-0.419
AGRICULTURE				(0.298)				(0.644)
CONTINENT FE	NO	NO	NO	NO	YES	YES	YES	YES
N	952	952	952	952	952	952	952	952
F excl instrum.		145.6	42.53	63.39		95.00	58.58	22.37
A-R Test (p-val)		0.000	0.0147	0.000		0.000	0.000	0.000

The table reports cross-sectional OLS and 2SLS estimates and the unit of observation is the society in Murdock's Ethnoatlas. The dependent variable is Murdock's (1967) index of jurisdictional hierarchy beyond the local community and it takes the following values: 1 (no political authority beyond community), 2 (petty chiefdoms), 3 (larger chiefdoms), 4 (states), 5 (large states). The main regressor is a dummy that identifies society in which the major crop is a cereal grain. MAX CALORIES (ALL CROPS) is the standardized maximum potential calorie yield per hectare that can be obtained from cultivating the most productive crop among cereal grains, roots and tubers. DEPENDENCE ON AGRICULTURE is the percentage calorie dependence on agriculture for subsistence. Societies that live on lands that are suitable for neither cereals nor roots and tubers are excluded from the sample. "A-R Test" is the Anderson-Rubin test: the null hypothesis that the endogenous regressor is equal to zero. Robust standard errors in parentheses *** significant at less than 1 percent; ** significant at 5 percent; * significant at 10 percent

Cereals and hierarchy

Panel estimates

$$Hierarchy_{c,t} = \alpha\,(YieldsCereals_{c,t} - YieldsTubers_{c,t}) + \eta_c + \eta_t + X'\beta_t + \varepsilon_{c,t}$$

Note:

-Hierarchy: (=0: Tribe; =0.75: Chiefdom; =1: State)

-Variation in $YieldsCereals_{c,t}$ and $YieldsTubers_{c,t}$ over time are generated by the Columbian exchange.

- Years 1500-1600 are excluded from the regression.

Cereals and hierarchy

Table 6: Cereals and Hierarchy - Panel Regressions

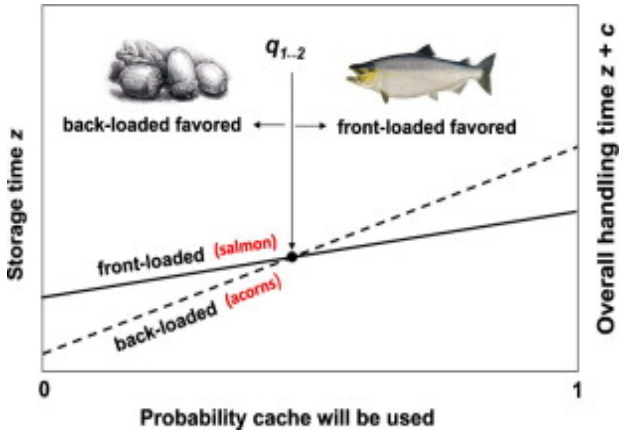
	Dep. Variable: Hierarchy Index						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CALORIC DIFF	0.189***	0.272***	0.282***	0.240***	0.255***	0.261***	0.197**
(CER - TUB)	(0.0683)	(0.0834)	(0.0760)	(0.0857)	(0.0889)	(0.0839)	(0.0795)
MAX CALORIES		-0.163	-0.193	-0.152	-0.115	-0.148	-0.165
(ALL CROPS)		(0.141)	(0.131)	(0.139)	(0.142)	(0.138)	(0.123)
Controls (x Year FE):							
Precipitation	NO	NO	YES	NO	NO	NO	NO
Temperature	NO	NO	NO	YES	NO	NO	NO
Elevation	NO	NO	NO	NO	YES	NO	NO
Ruggedness	NO	NO	NO	NO	NO	YES	NO
Abs Latitude	NO	NO	NO	NO	NO	NO	YES
COUNTRY FE	YES	YES	YES	YES	YES	YES	YES
TIME FE	YES	YES	YES	YES	YES	YES	YES
r2	0.680	0.682	0.716	0.684	0.681	0.686	0.705
N	2869	2869	2850	2812	2755	2869	2869

The table reports panel OLS estimates and the unit of observation is the territory delimited by modern-country borders every 50 years. The dependent variable is an hierarchy index: it equals 0 if there is not a government above tribal level, 0.75 if the political organization can be at best described as a paramount chiefdom and 1 otherwise. CALORIC DIFF (CER-TUB) is the standardized difference between the maximum potential calorie yield per hectare that can be obtained from cereals versus the one that can be obtained from either roots or tubers. MAX CALORIES (ALL CROPS) is the standardized maximum potential calorie yield per hectare that can be obtained from cultivating the most productive crop among cereal grains, roots and tubers. Robust standard errors in parentheses *** significant at less than 1 percent; ** significant at 5 percent; * significant at 10 percent

Supportive evidence: productivity vs appropriability

Native Americans in California (Tushingham and Bettinger 2013)

- Despite the fact that salmon is a better source of nutrition, earlier foragers preferred to rely on acorns
- Unlike salmon, gathering and storage of acorns involves little effort but its subsequent preparation for consumption is costly
- The rapid transition to salmon intensification was possible after a sedentary community was large enough and storage facilities where constructed



→

(1) selection of food sources is affected by their appropriability

(2) appropriable food and complex hierarchy are correlated

Supportive evidence: appropriability and stationary bandits

Mining in the DRC
De la Sierra (2013)

- A rise in the price of Coltan — produced from a relatively bulky and hence transparent ore — led to the monopolization of violence
- An increase in the price of gold, which is easier to conceal and is hence less transparent, did not

→ it isn't productivity/surplus that explains the emergence of hierarchy – it is appropriability

Supportive evidence: appropriability and stationary bandits

Sulphur mines and the mafia
Buonanno et al. (2012)

- Buonanno et al. support the hypothesis that the mafia in Sicily emerged after the collapse of the Bourbon Kingdom.

- A vacuum of power made it easy for a new hierarchy to emerge, disproportionally more where the local product was more appropriable: the mines and in particular the sulphur mines.

→ it isn't productivity/surplus that explains the emergence of hierarchy – it is appropriability

Conclusions

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- The existing literature abstracts from the role of appropriabililty in explaining differences in state capacity, concentration, and institutions
- We argue that geographical differences affect the degree of transparency and thereby state's capacity, concentration and institutions