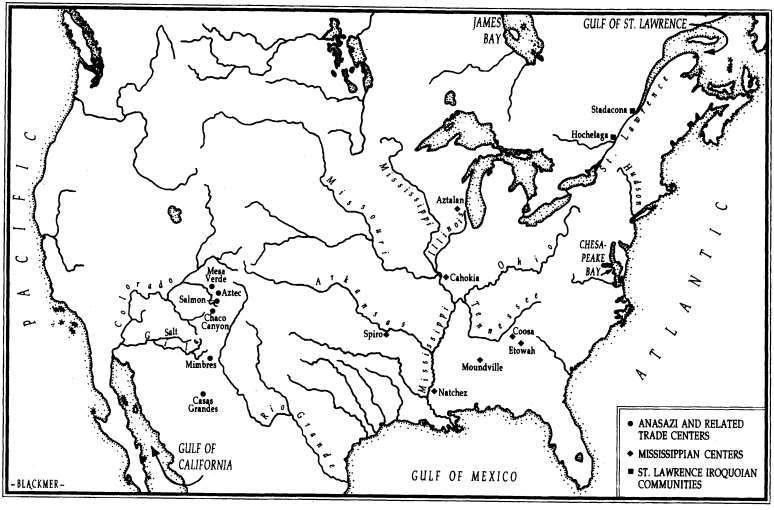
Putting American Economic Growth in Perspective

Rank	Country	GDP per capita (2010 US dollars)
180	Democratic Republic of Congo	171
179	Liberia	239
178	Sierra Leone	311
145	Kenya	912
	United States, 1710	**952**
144	Nicaragua	972
118	Indonesia	2,329
	United States, 1840	**2,336**
117	Paraguay	2,337
84	Namibia	4,543
	United States, 1880	**4,585**
83	Azerbaijan	4,807
52	St. Kitts and Nevis	10,315
	United States, 1929	**10,640**
51	Lithuania	11,172
37	Oman	18,013
	United States, 1945	**18,079**
36	Czech Republic	18,557
10	Austria	45,989
9	**United States**	**46,381**
8	United Arab Emirates	46,857
7	Netherlands	48,223
6	Ireland	51,356
5	Denmark	56,115
4	Switzerland	67,560
3	Qatar	68,872
2	Norway	79,085
1	Luxembourg	104,512

International Monetary Fund, World Economic Outlook Database, April 2010

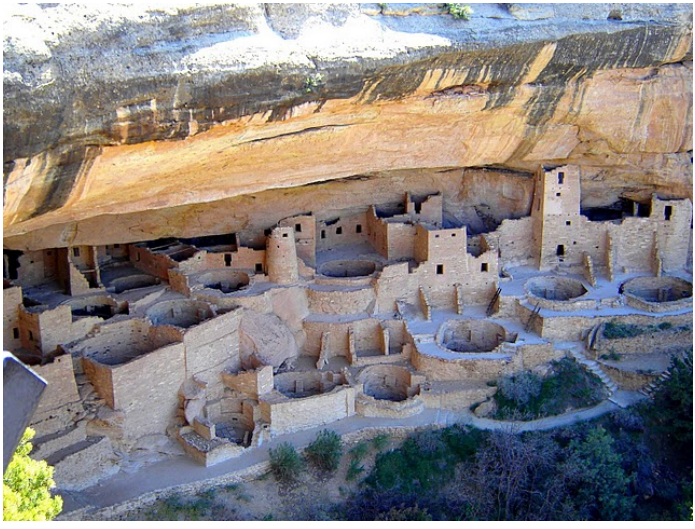
The Precolonial Economy

Selected Native American centers in North America, ca. 1250.



From "The Indians' Old World" by Neil Salisbury, William and Mary Quarterly, Vol. 53, No. 3, 1996

The Precolonial Economy



Anasazi (circa 1200 AD) ruins in Mesa Verde National Park

The Precolonial Economy

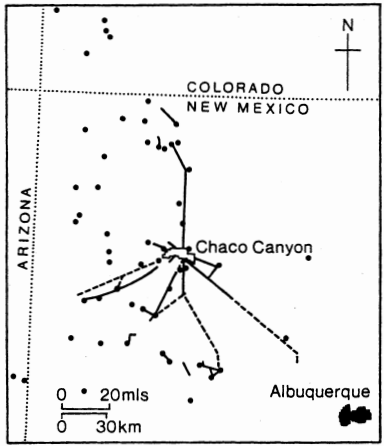
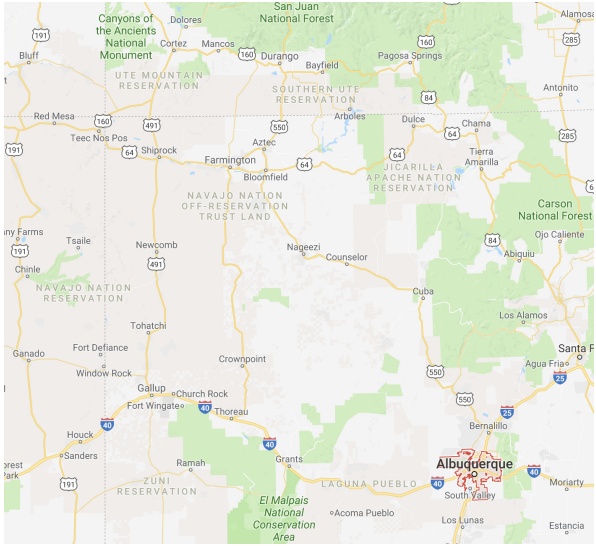


FIGURE V.

Chaco Canyon exchange system. Dots indicate sites of town and village outliers. Solid lines show roads documented by ground surveys; dashed lines are roads documented by aerial surveys. From *Ancient North America* by Brian M. Fagan, copyright © 1995 Thames and Hudson. Reprinted by permission of the publisher.

The Precolonial Economy



The Precolonial Economy

Historical city populations in North America and Europe

City	Time Period	Population
Cahokia (Mississippian)	12th century	20,000
Chaco Canyon (Anasazi)	12th century	15,000
London	1100	25,000
Paris	1150	50,000
Rome	1100	35,000

Chandler, Tertius, Four Thousand Years of Urban Growth, 1987.

The Precolonial Economy

- How do we know about these economies?
- We certainly don't have the equivalent of modern economic indicators
- Instead, we need to rely on archeological evidence
- What can we learn about economic activity from archeological evidence?
- More than you might think

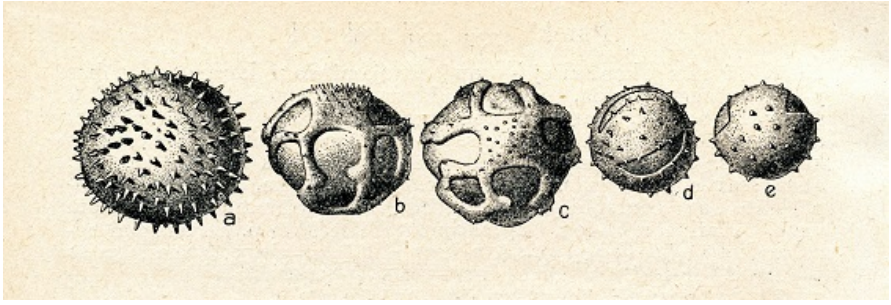
The Precolonial Economy

- Let's look at an example of what we've learned about the Anasazi with a recent paper by Axtell et al.
- Axtell et al. are going to combine a bunch of cool archeological data with economic theory to model Anasazi population growth and collapse
- The data come from a range of interesting techniques
- The theory comes from varied basic Econ 303-style constrained optimization
- First, the data

Axtell et al.

Dendroclimatology

Axtell et al.



Palynology

Axtell et al.

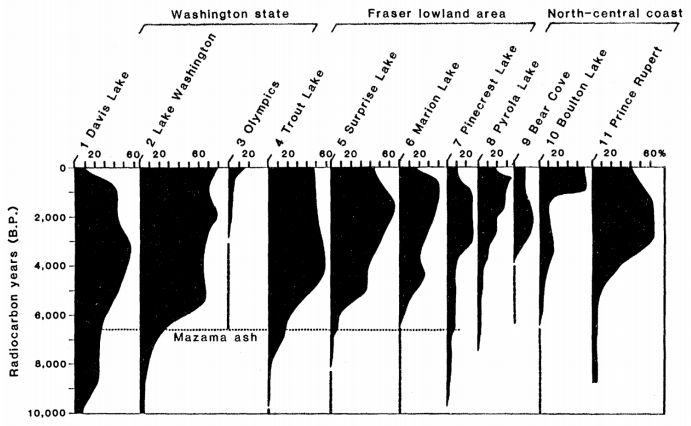


Fig. 2. Relative frequency (percent) curves for cedar-type pollen from 11 radiocarbon-dated lake or bog cores. Curves are smoothed to show only the main patterns and ages are interpolated between radiocarbon dates. Mazama tephra, 6600 years old, is shown for those sites where it occurs. Data sources for curves are Trout Lake (*23*), Boulton Lake (*24*), Pyrola Lake (*25*), Davis Lake (*17*), Lake Washington (*16*), Olympic Peninsula (*12*), Surprise and Marion Lakes (*13*), Pinecrest Lake (*26*), Bear Cove (*15*), and Prince Rupert (*27*).

From Hebda and Mathewes (1984)

Axtell et al.

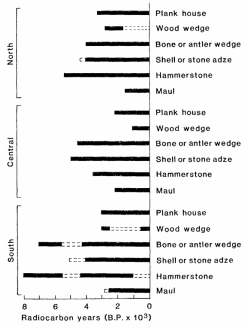


Fig. 3. Ranges of artifacts are approximate because of the difficulty of associating artifacts with radiocarbon-dated materials and the irregular preservation of wood, bone, and antler. Data sources: north coast including Queen Charlotte Islands (*28*, *29*) and adjacent mainland (*20*, *30*), central coast of British Columbia (*18*, *31–34*), south coast including Fraser Lowland and Gulf of Georgia (*19*, *35–39*), Vancouver Island (*40–42*), Olympic Peninsula, and Puget Sound (*43–46*).

From Hebda and Mathewes (1984)

Axtell et al.

- Geology, archeology, palynology and dendroclimatology all give Axtell et al. a pretty good sense of low and high frequency changes in environmental conditions
- The idea is to use these data to fit a model of the Anasazi society
- From archeological sites, we have a sense of where and when the Anasazi lived
- Axtell et al. want to model migration, farming and family formation decisions as a function of environmental conditions
- Then you can estimate the model to try to match the observed spatial and temporal distribution of the Anasazi

Table 1. Household (agent) attributes

1. Five surface rooms or one pithouse is considered to represent a single household.
2. Each household that is both matrilineal and matrilocal consists of 5 individuals. Only female marriage and residence location are tracked, although males are included in maize-consumption calculations.
3. Each household consumes 160 kg of maize per year per individual.
4. Each household can store a maximum of 2 years' total corn consumption (1,600 kg), i.e., if at harvest 800 kg of corn remains in storage and additional 800 kg can be added to that from the current crop.
5. Households use only 64% of the total potential maize yield. (The unutilized production is attributed to fallow, loss to rodents, insects, and mildew, and seed for the next planting.)

Table 2. Household (agent) rules

1. A household fissions when a daughter reaches the age of 15.
2. A household moves when the amount of grain in storage in April plus the current year's expected yield (based on last year's harvest total) falls below the amount necessary to sustain the household through the coming year.
   - A. Identification of agricultural location:
     The location must be currently unfarmed and uninhabited.
     The location must have potential maize production sufficient for a minimum harvest of 160 kg per person per year (22). Future maize production is estimated from that of neighboring sites.
     If multiple sites satisfy these criteria the location closest to the current residence is selected.
     If no site meets the criteria the household leaves the valley.
   - B. Identification of a residential location:
     - i. The residence must be within 1 km of the agricultural plot.
     - ii. The residential location must be unfarmed (although it may be inhabited, i.e., multihousehold sites permitted).
     - iii. The residence must be in a less productive zone than the agricultural land identified in A.

     If multiple sites satisfy these above criteria the location closest to the water resources is selected.
     If no site meets these criteria they are relaxed in order of iii then i.

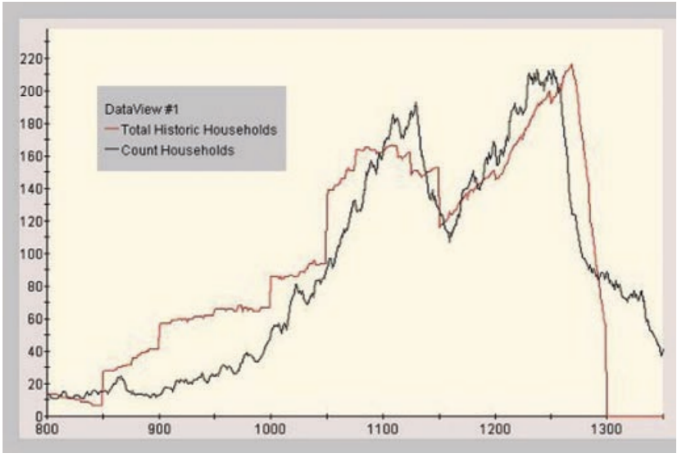


Fig. 2. Best single run of the model according to the L^1 norm. Other best runs based on other norms yield very similar trajectories. The average run, produced by averaging over 15 distinct runs, looks quite similar to this one as well.

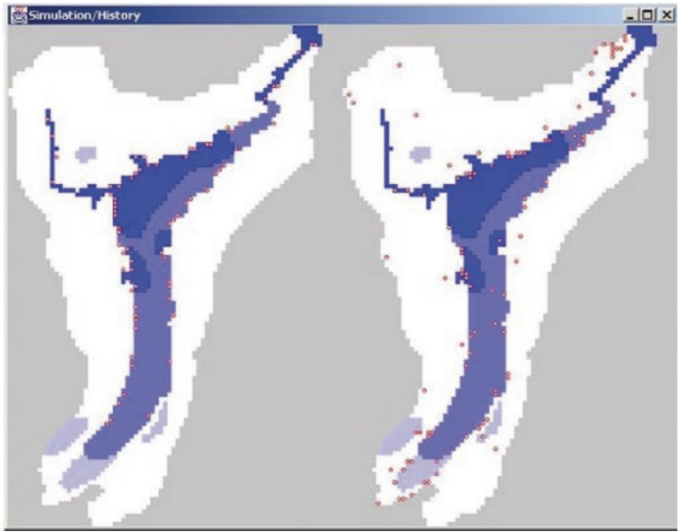


Fig. 3. Simulated and historical settlement patterns, in red, for Long House Valley in A.D. 1125; North is to the top of the page.

The Precolonial Economy

- What about understanding more complex dimensions of the economy?
- The climate data may not be as relevant here but there are other things to look at
- Let's take a quick look at the evidence used in a paper by Maggiano et al. on a Mayan society from 500 AD
- Archeology tells us that this site, Xcambó, was a center for salt production but then shifted to a more administrative role as a commercial port
- Maggiano et al. want to know how daily occupations of Xcambó inhabitants changed

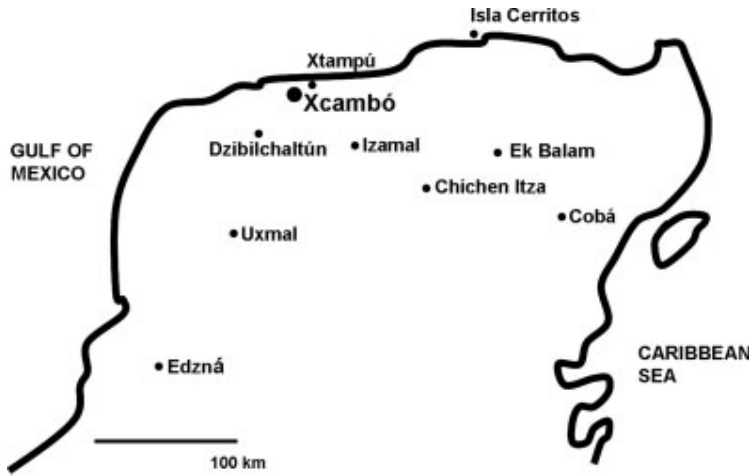


Fig. 1. Map of Yucatan.

Maggiano et al.

- Maggiano et al. are going to make a couple of hypotheses about the impact of switching from salt production to commercial port
- First, male occupations should switch from harsh labor to administrative employment requiring less physical demand and reduced mobility
- Second, female occupations would not change significantly as it was primarily males involved in salt production
- How do you find evidence to test these changes?

Maggiano et al.

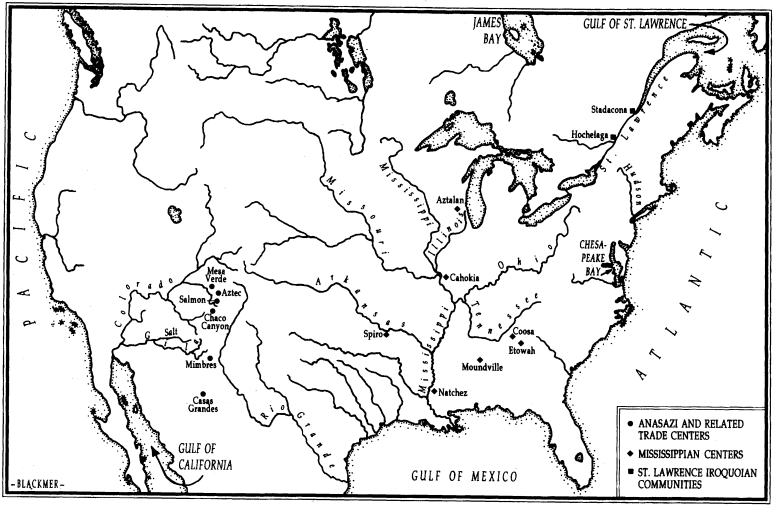
TABLE 1. Humeral robusticity (CA[a] and Zp[b]) by side and sex

		Males						Females						Sex. dif.[c]	
			Right		Left				Right		Left				
	Group	*n*	Mean	SD	Mean	SD	Side dif.[d]	*n*	Mean	SD	Mean	SD	Side dif.[d]	Rt.	Lt.
CA	EC	6	355.1	39.3	342.7	31.0	4.3%	7	235.5	38.9	238.3	36.8	4.5%	50.8%***	43.8%***
	LC	24	314.0	36.6	303.5[e]	37.4	4.8%*	14	254.0	33.1	254.5	36.3	4.4%	23.8%***	19.3%***
Zp	EC	6	60.3	8.5	55.4	7.5	9.1%*	4	32.2	1.9	33.8	3.2	7.1%	87.3%***	63.9%***
	LC	15	50.5[e]	7.0	46.7[e]	6.9	9.2%***	8	35.3	4.6	35.4	5.9	6.5%	42.3%***	31.9%***

EC = Early Classic; LC = Late Classic.
Levels of significance: $*P \leq 0.05$, $***P \leq 0.001$.
[a] Standardized by body weight.
[b] Standardized by body weight and bone length × 1000.
[c] Percent sexual dimorphism between male and female values = 100 × (male mean – female mean)/female mean; independent samples *t*-test.
[d] Percent asymmetry between right and left side values = 100 × (maximum – minimum)/minimum; *t*-test for paired variables.
[e] Statistically significant difference between EC and LC mean; tested by independent samples *t*-test; significance level: $P \leq 0.05$.

The Precolonial Economy

Selected Native American centers in North America, ca. 1250.



From "The Indians' Old World" by Neil Salisbury, William and Mary Quarterly, Vol. 53, No. 3, 1996

Why Do We Speak English?

- Europeans didn't arrive to an empty continent
- Relatively large population centers existed
- Economies had evolved to include complex political structures, agriculture, division of labor, trade over long distances, etc.
- So why are we an English speaking country today?

Why Do We Speak English?

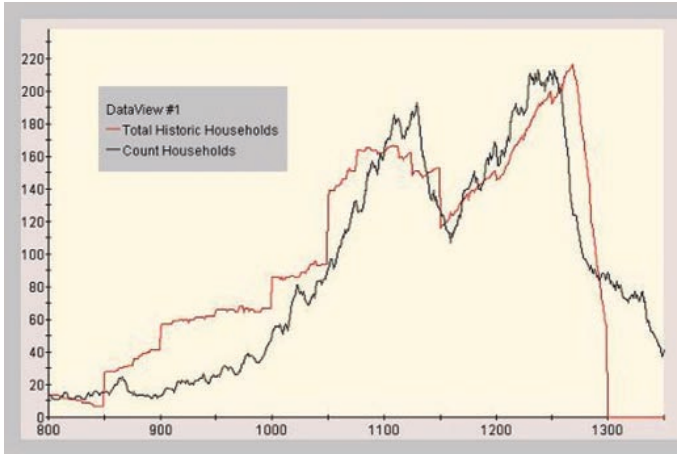
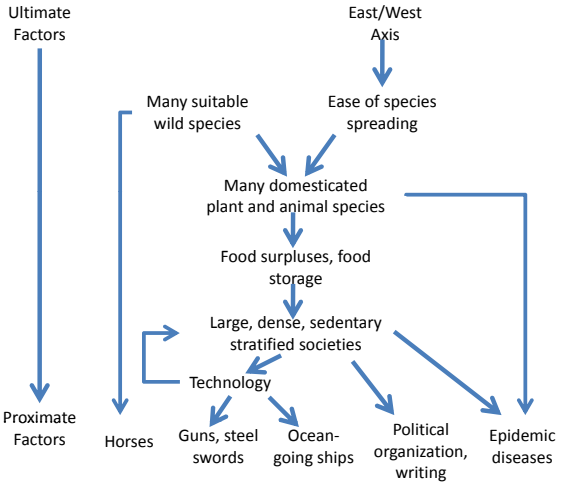


Fig. 2. Best single run of the model according to the L^1 norm. Other best runs based on other norms yield very similar trajectories. The average run, produced by averaging over 15 distinct runs, looks quite similar to this one as well.

Why Do We Speak English?

- Salisbury and Axtell touch on this, emphasizing ecological crises
- This is essentially an argument about a Malthusian trap of the sort we have discussed
- But Europe had similar issues of a Malthusian trap and many Native American societies had not run into dire ecological crises
- What differences led to Europeans being able to take control of North America? Let's take a quick look at one theory from Jared Diamond

Guns, Germs, and Steel



Guns, Germs, and Steel

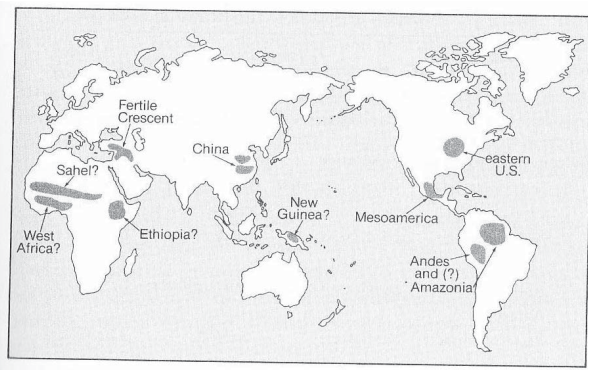


Figure 5.1. Centers of origin of food production. A question mark indicates some uncertainty whether the rise of food production at that center was really uninfluenced by the spread of food production from other centers, or (in the case of New Guinea) what the earliest crops were.

From Jared Diamond, "Guns, Germs, and Steel", 1997

Guns, Germs, and Steel

Mammalian Candidates for Domestication

	Eurasia	Sub-Saharan Africa	The Americas	Australia
Candidates	72	51	24	1
Domesticated species	13	0	1	0
Percentage of candidates domesticated	18%	0%	4%	0%

Candidate is defined as a species of terrestrial, herbivorous or omnivorous, wild mammal weighing over 100 pounds.

The Major Five

Domesticated animal	Location of wild ancestor
Sheep	West and Central Asia
Goat	West Asia
Cow	Eurasia and North Africa
Pig	Eurasia and North Africa
Horse	Russia

The Minor Nine

Domesticated animal	Location of wild ancestor
Arabian camel	Arabia
Bactrian camel	Central Asia
Llama and alpaca	Andes
Donkey	North Africa (maybe Southwest Asia)
Reindeer	Eurasia
Water buffalo	Southeast Asia
Yak	Himalayas
Bali cattle	Southeast Asia
Mithan	India

Guns, Germs, and Steel

Virginia H.B. 2689

Guns, Germs, and Steel

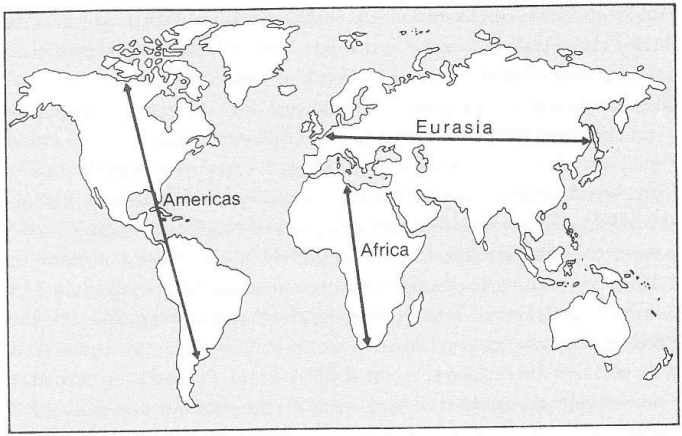


Figure 10.1. Major axes of the continents.

From Jared Diamond, "Guns, Germs, and Steel", 1997

Guns, Germs, and Steel

Guns, Germs, and Steel

Summary

Temperature (° F)	Max	Average	Min	Sum
Max Temperature	80	70	62	-
Avg Temperature	70	54	39	-
Min Temperature	55	44	28	-
Precipitation (Inches)	Max	Average	Min	Sum
Precipitation	0	0	0	0
Dew Point (° F)	Max	Average	Min	Sum
Dew Point	63	31	3	-

October 2017, Albequerque

Summary

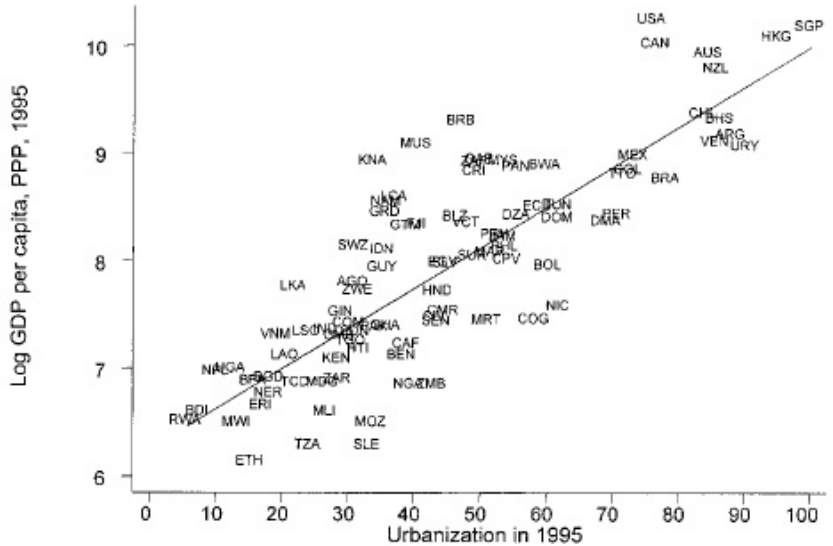
Temperature (° F)	Max	Average	Min	Sum
Max Temperature	89	78	71	-
Avg Temperature	71	62	52	-
Min Temperature	41	37	30	-
Precipitation (Inches)	Max	Average	Min	Sum
Precipitation	1.72	0.15	0	3.71
Dew Point (° F)	Max	Average	Min	Sum
Dew Point	73	50	18	-

October 2017, St. Louis

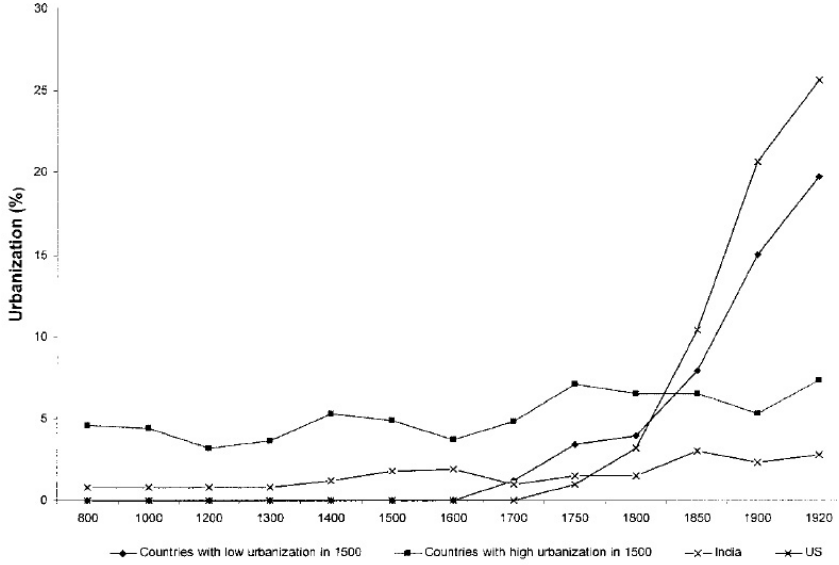
The Arrival of Europeans

- Let's look at a case where there was a clash of societies
- In particular, we'll look at "The Slaughter of the Bison and Reversal of Fortunes on the Great Plains" by Feir, Gillezeau and Jones
- It's a case where actions of the European settlers dramatically altered the Native American economy with long run effects
- First things first, what do we mean by reversal of fortunes?

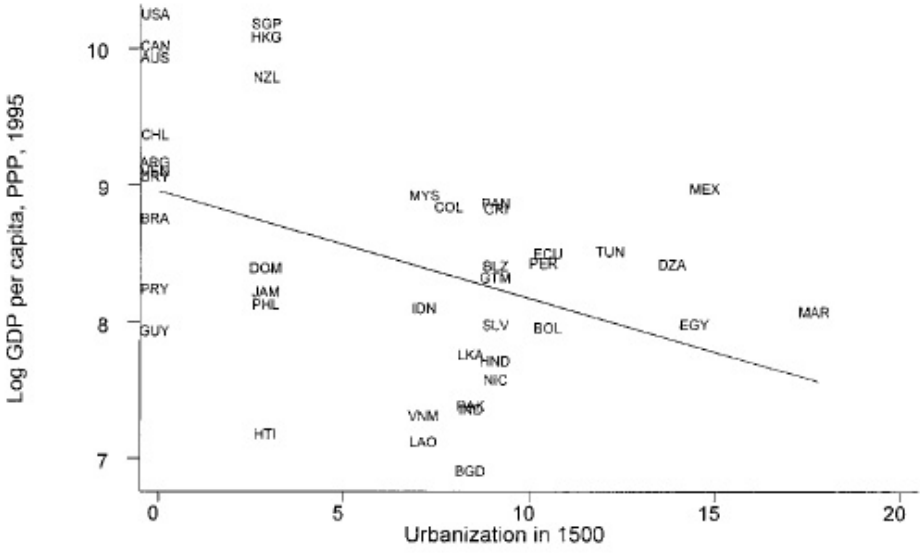
Reversal of Fortunes



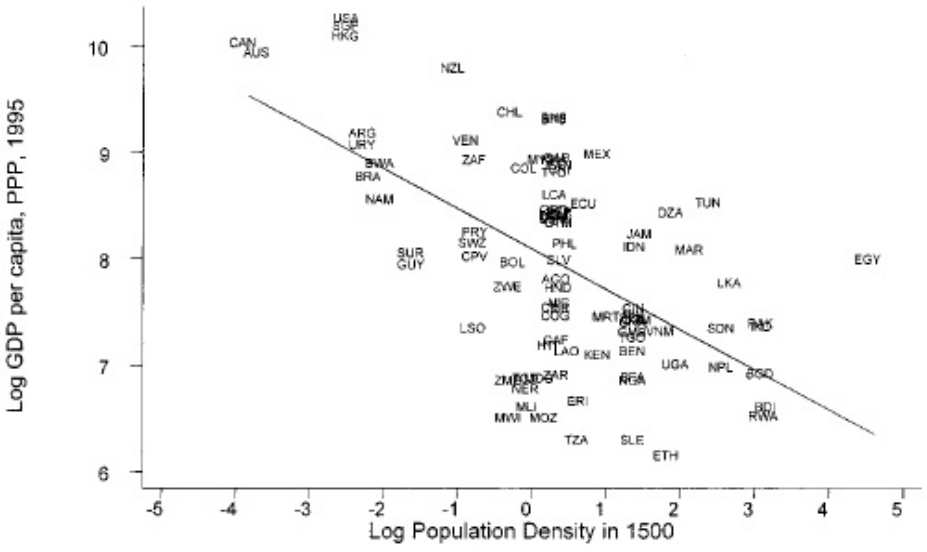
Reversal of Fortunes



Reversal of Fortunes



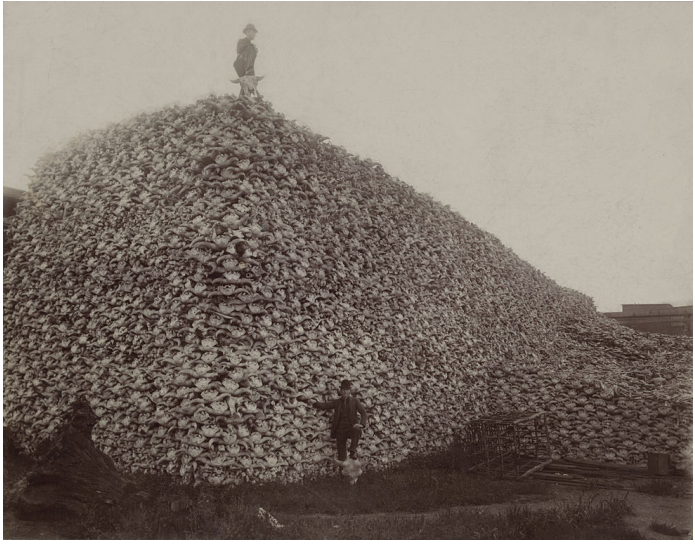
Reversal of Fortunes



Reversal of Fortunes

- The Acemoglu, Johnson and Robinson story of societies clashing is a bit different than Diamond
- Recall Diamond's story: guns, germs and steel make the difference but those come from favorable geography and natural endowments long ago
- Acemoglu, Johnson and Robinson are going to think in terms of institutions: whether colonizers imposed extractive or growth-producing institutions dictates future economic growth
- We'll think about both of these stories (and others) with the slaughter of the bison

Back to Bison

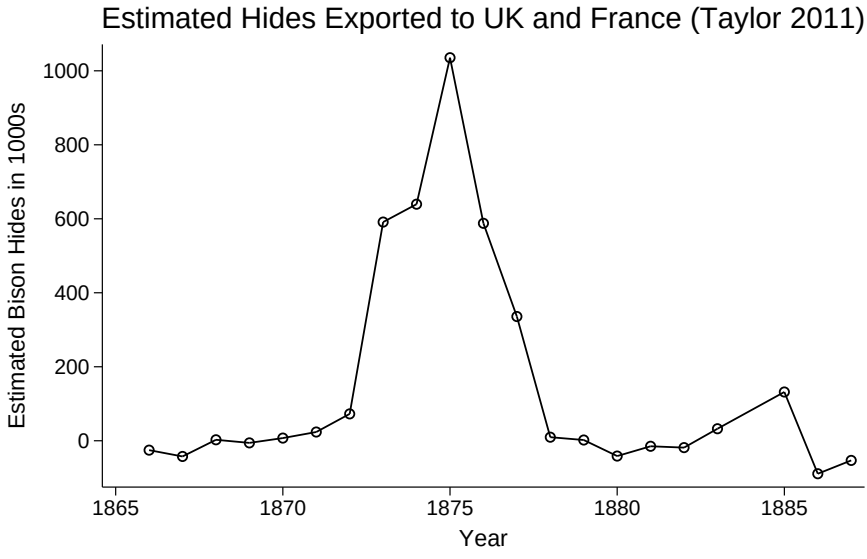


The Slaughter of the Bison

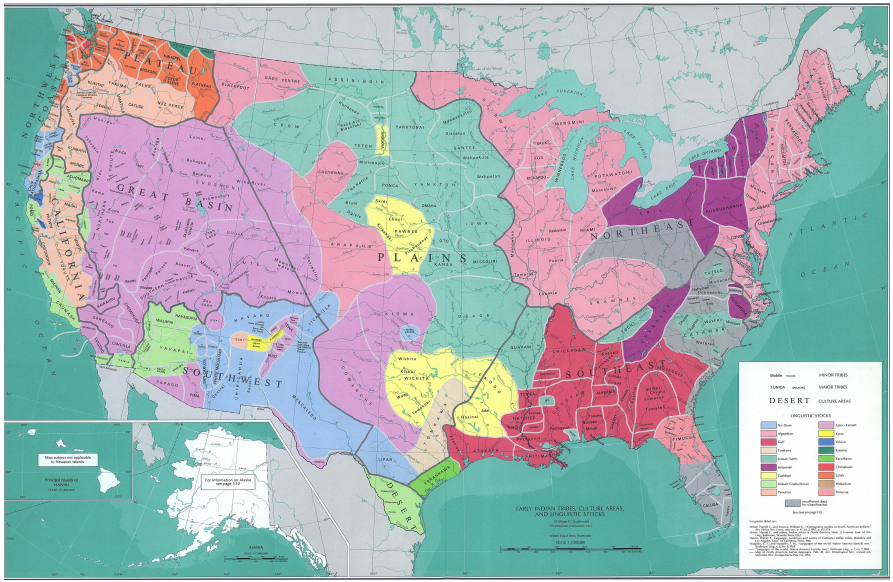
- The basic idea of the paper is to see how the loss of the bison impacted the standard of living of bison-dependent societies in the short run and the long run
- Key to the paper is that the decline of the bison was both slow and rapid
- In some regions, the bison decline was gradual, beginning with the introduction of the horse and European settlers
- In other regions, the decline was rapid, occurring in roughly a decade

The Slaughter of the Bison

The Slaughter of the Bison



The Slaughter of the Bison



The Slaughter of the Bison

- Given the bison map and the ancestral territories map, you can determine which societies were hit by the slow or rapid decline of the bison
- The next task is to find measures of relevant outcomes
- This is not as simple as you'd think, both because of time periods and unique problems of studying Native Americans
- Ultimately, several different outcome measures are used including heights, occupational data, and nighttime light data

The Slaughter of the Bison

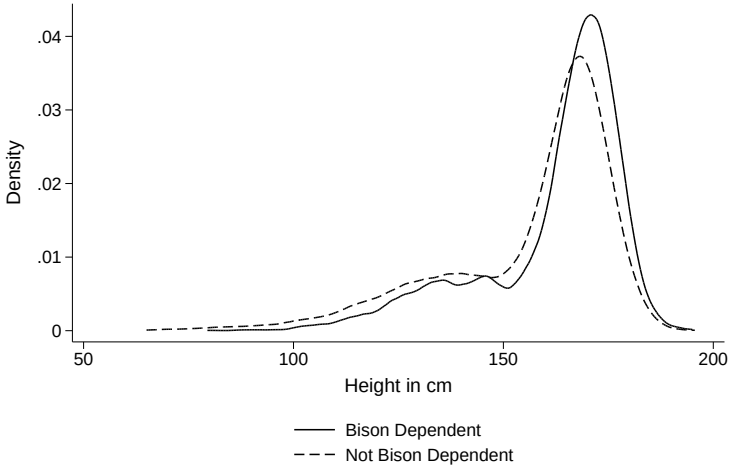


Figure A3: This figure plots the density of standing height from Franz Boas' sample 1890 to 1901. N=9,075. Societies are classified as bison-reliant when more than 60% of their ancestral territory was covered by the historic bison range and non-bison-reliant if it was less than this. A similar pattern is visible if a threshold of 80% or 40% is used.

The Slaughter of the Bison

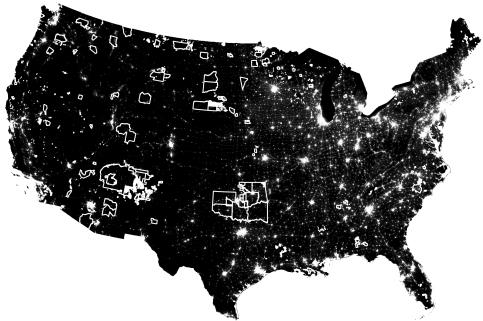


Figure 3: The distribution of nighttime lights in 2000 overlaid with Native American homelands or reservation boundaries in 2013.

The Slaughter of the Bison

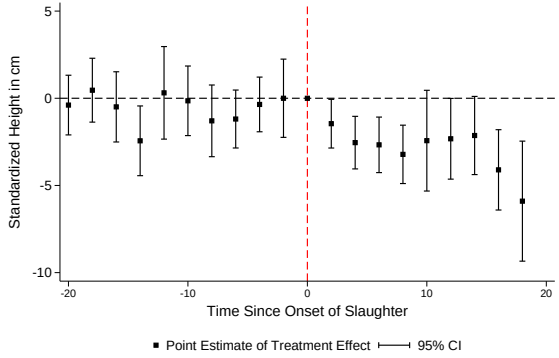
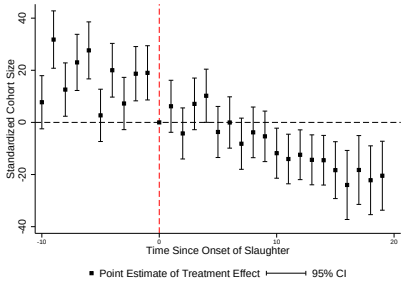
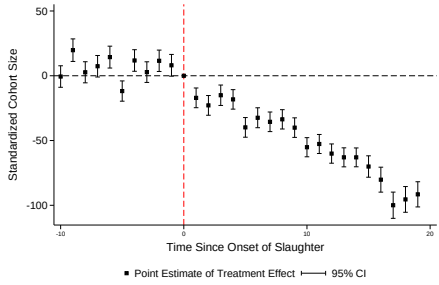


Figure 4: Coefficients on indicators for each two-year of birth before and after the slaughter interacted with whether the tribe obtained most of its calories from bison at least during part of the year. The dependent variable is height in cm and conditions on age fixed effects, a dummy for "full blood", the tribe being located in Canada, whether a railway entered the traditional territory of the tribe and the number of years since your year of birth the railway had been present, and for whether the respondent had been born during a period of war. Data is from Franz Boas' 1889 to 1903 sample, N=7,321 (males).

The Slaughter of the Bison



(a) Full sample



(b) Bison-reliant: gradual vs. rapid

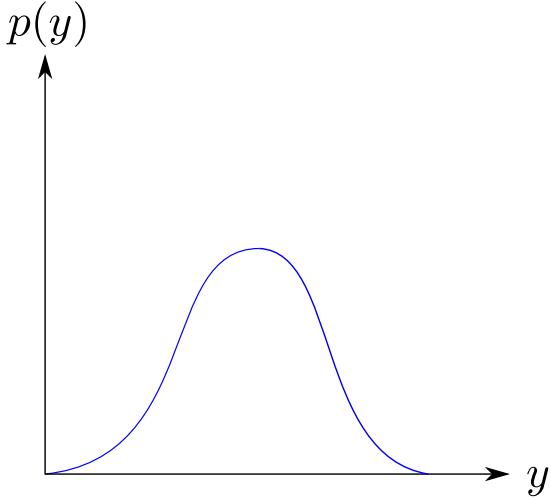
Figure 5: Coefficients on indicators for each two-year of birth before and after the slaughter interacted with whether the tribe obtained most of its calories from bison at least during part of the year. The dependent variable is the weighted number of people observed in that cohort and conditions on age fixed effects. Data is from the IPUMS 1900 and 1910 Census Over-sample. Given that some tribe-birth year combinations have no observations, we impute a population size of zero.

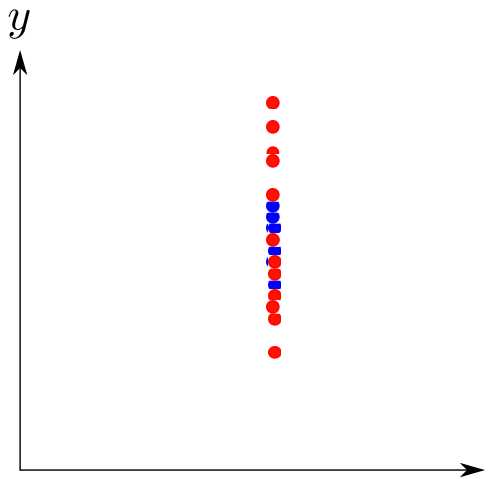
Bison and Econometrics

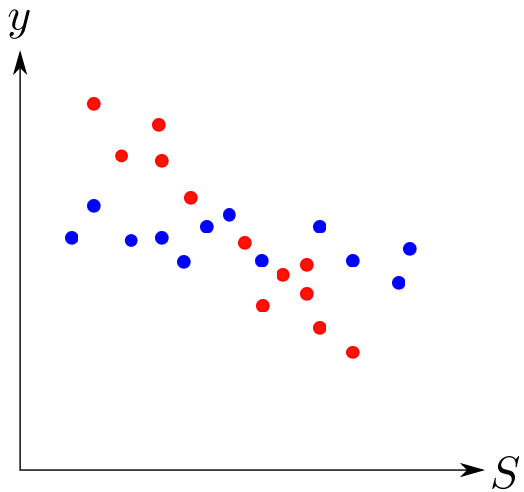
- Before we turn to the regression tables themselves, a quick econometrics primer/refresher
- We'll start with thinking about just the relationship between the share of bison lost (S_i) and income per capita (y_i):

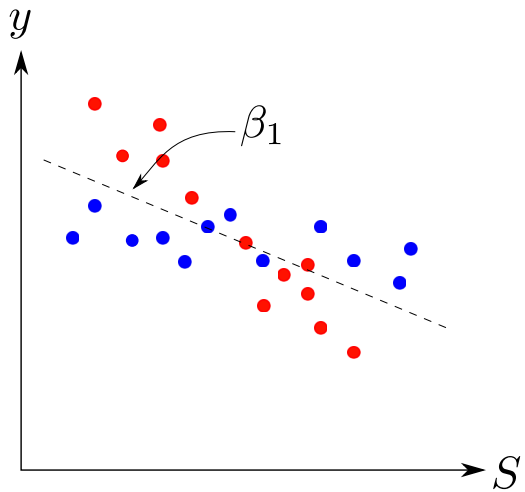
$$y_i = \beta_0 + \beta_1 S_i$$

- How do we interpret this equation and what do we expect in terms of signs of the coefficients?


$p(y)$
y


y


y
S

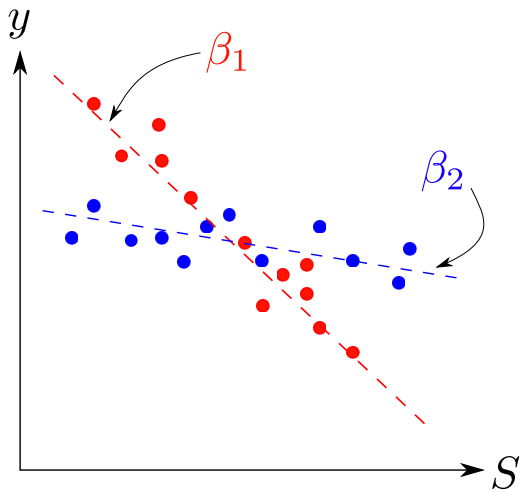

y
β_1
S

Bison and Econometrics

- But Feir, Gillezeau and Jones argue that the relationship should be different for those that lost bison early versus those that lost them late
- So let's model those as separate variables, S^{early} and S^{late}:

$$y_i = \beta_0 + \beta_1 S_i^{\text{late}} + \beta_2 S_i^{\text{early}}$$

- Now the impact of bison loss can differ by whether it was early or late


y
β_1
β_2
S

Bison and Econometrics

- But another part of the story is that the impact of the bison slaughter should depend on whether you were developing other skills, i.e. agriculture
- So we could include a measure for calories from agriculture, AG_i:

$$y_i = \beta_0 + \beta_1 S_i^{\text{late}} + \beta_2 S_i^{\text{early}} + \beta_3 AG_i$$

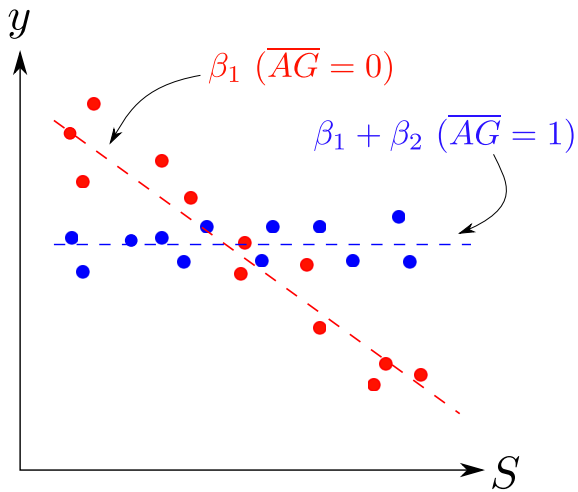
- Does this do what we want?
- Nope.

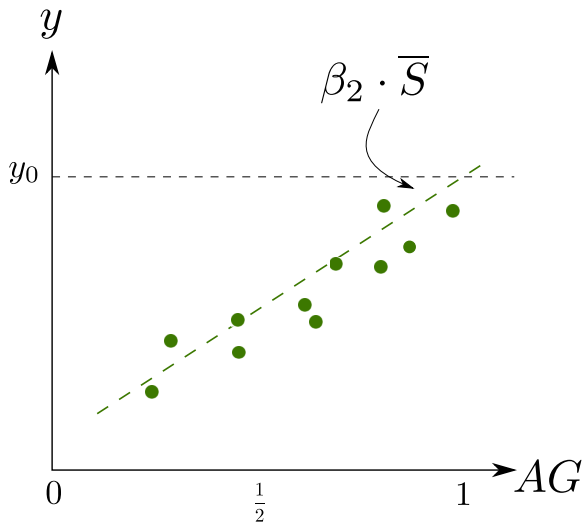
Bison and Econometrics

- What we need is what we call an *interaction term*
- We need the relationship between S and y (the slope coefficient) to depend on AG
- To get that, we can include a term that has S multipled by AG (note that I'm going to simplify things by only looking at late bison loss):

$$y_i = \beta_0 + \beta_1 S_i + \beta_2 S_i \cdot AG_i$$

- Now the slope coefficient related to S is equal to $\beta_1 + \beta_2 S_i$
- How can we think about this graphically?


y
β_1 $(\overline{AG} = 0)$
$\beta_1 + \beta_2$ $(\overline{AG} = 1)$
S


y
$\beta_2 \cdot \overline{S}$
y_0
AG
0
$\frac{1}{2}$
1

The Slaughter of the Bison

Table 4: Correlation between Standardized Occupational Rank and Tribe Historic bison-reliance in 1910 and 1930

	1910	1930	1910	1930
	Full Sample		Only Bison-reliant	
Share lost as of 1870	0.0431	0.126		
	(0.191)	(0.118)		
Share lost as of 1889	-0.582	-0.474	-0.604	-0.720
	(0.211)	(0.155)	(0.201)	(0.164)
Age	0.111	0.0726	0.100	0.100
	(0.026)	(0.031)	(0.046)	(0.052)
Age-Squared	-0.001	-0.001	-0.001	-0.001
	(0.000)	(0.000)	(0.001)	(0.001)
Constant	-2.234	-1.195	-1.825	-1.962
	(0.418)	(0.628)	(0.920)	(1.121)
Observations	463	620	225	296
Adjusted R^2	0.067	0.086	0.038	0.125

The Slaughter of the Bison

Table 5: Correlation between the Share of Bison Covering Traditional Territory and Income Per Capita by Reservation in 2000

	(1)	(2)	(3)	(4)	(5)
Original Share	-2588.3				
	(823.913)				
Share lost as of 1870		-1632.6		-2015.0	
		(894.083)		(892.423)	
Share lost as of 1889			-3918.5	-4380.3	-2556.2
			(590.392)	(671.006)	(616.157)
Constant	11074.9	10553.0	10355.2	11038.3	9213.4
	(618.927)	(599.328)	(441.578)	(624.817)	(500.193)
Observations	197	197	197	197	72
Adjusted R^2	0.053	0.014	0.037	0.060	0.045

Notes: Clustered standard errors at the tribe level in parentheses. The last column only includes tribes for whom at least 60% of their original territory was covered by bison.

The Slaughter of the Bison

Table 13: Correlation between Share of Bison Covering Traditional Territory and Income Per Capita Adjusted for Experience with Agriculture

	(1)	(2)	(3)
Share lost as of 1870	-3884.2	-2294.6	-1098.5
	(1494.426)	(1210.170)	(1217.349)
Share lost as of 1870 X AG Cal	941.4	26.41	-341.3
	(344.777)	(341.150)	(394.416)
Share lost as of 1889	-2998.7	-4370.0	-4866.3
	(1390.663)	(1499.165)	(1580.858)
Share lost as of 1889 X AG Cal	1490.4	2836.9	4290.2
	(922.949)	(1129.248)	(1345.322)
Cultural Controls	X	X	X
Soil Quality Controls	X	X	X
Colonial Controls		X	X
Contemporary Controls			X
Observations	197	197	197
Adjusted R^2	0.113	0.292	0.420

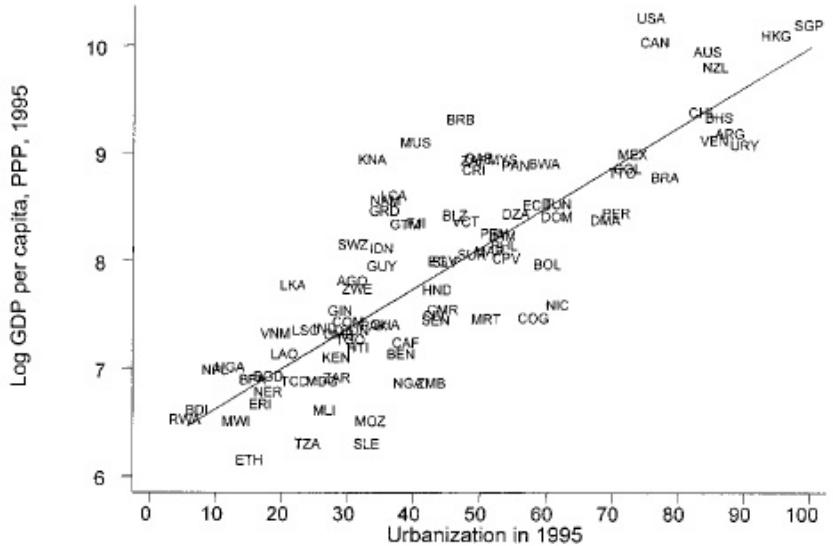
Notes: Clustered standard errors at the tribe level in parentheses. "Cultural controls" include calories from agriculture, historic centralization, measures of nomadism, jurisdictional hierarchy, wealth distinctions, log ruggedness and population in 1600. "Colonial controls" include being involved in an Indian war, a measure of forced coexistence, and distance displaced from traditional territory. "Contemporary controls" include nearby income per capita, log distance to the nearest city, presence of a casino. "Soil Quality controls" include share of reservation land without constraints from excess salts, nutrient availability, nutrient retention, rooting conditions, oxygen availability, toxicity, and workability.

The Slaughter of the Bison

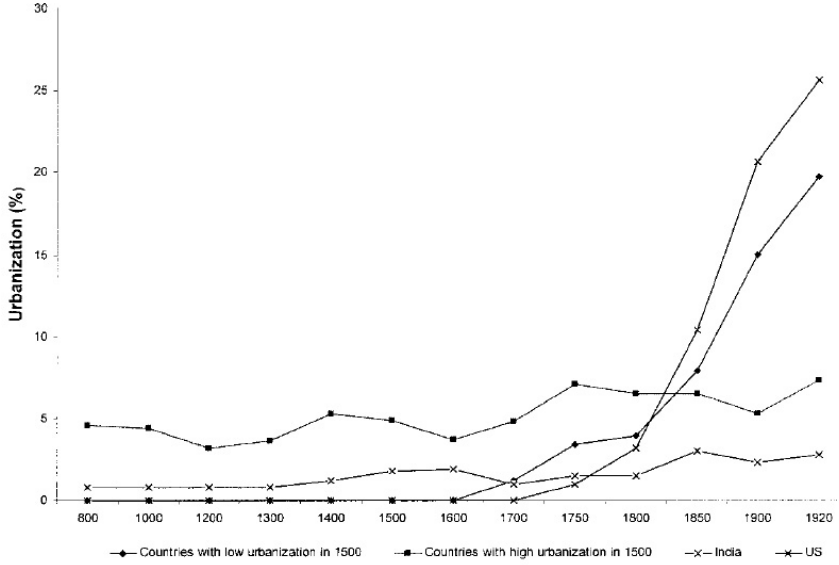
- The short run negative effects seem quite plausible
- But why the medium and long run effects?
- Why would subsequent generations still suffer from the slaughter of the bison?
- Two interesting mechanism are raised by Feir, Gillezeau and Jones
  - The transferability of human capital
  - Constraints on mobility from federal policies
- To think about these mechanisms, let's start with a couple polls:

https://pollev.com/jmparman

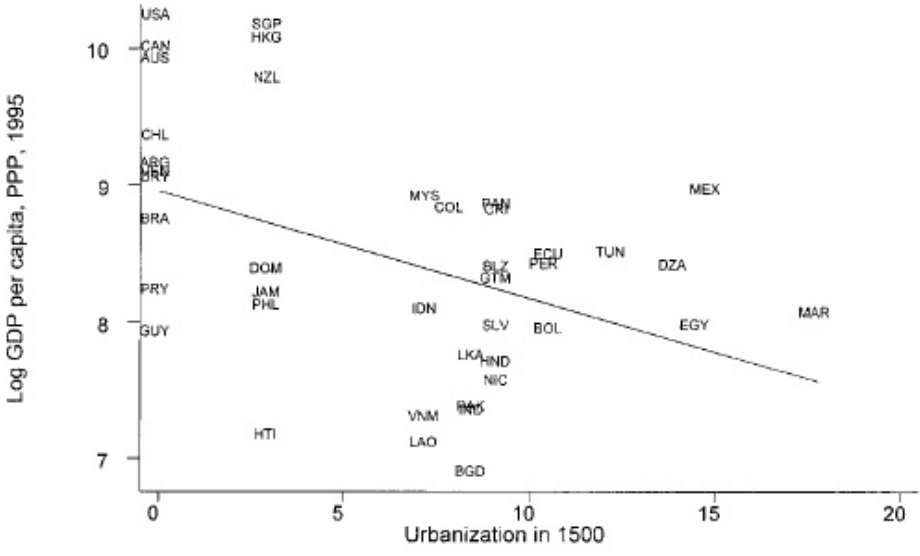
Returning to the Reversal of Fortunes



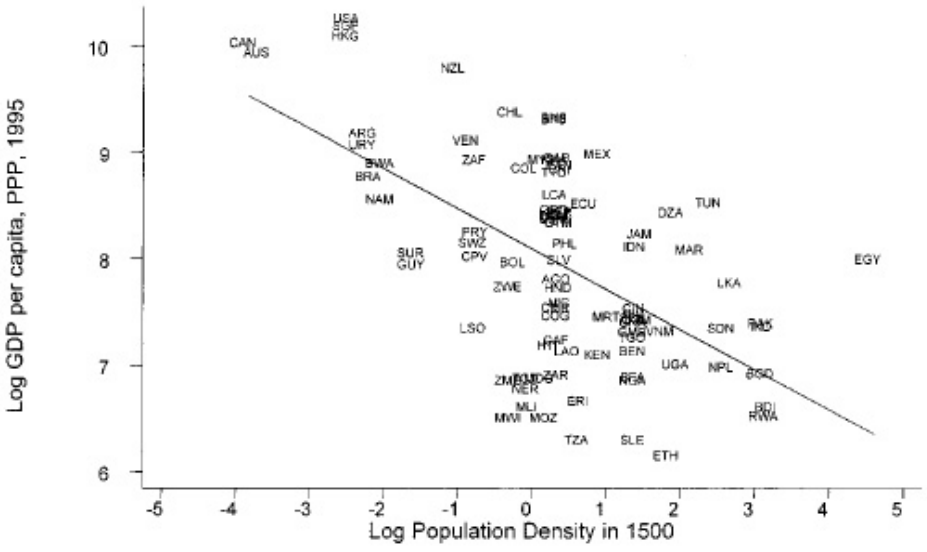
Returning to the Reversal of Fortunes



Returning to the Reversal of Fortunes



Returning to the Reversal of Fortunes



Announcements

- This week will be all about Native American economies
- Readings:
  - For this week: Feir, Gillezeau, and Jones (2017) "The Slaughter of the North American Bison and Reversal of Fortunes on the Great Plains"
  - For next week: Sawers (1992) "The Navigation Acts Revisited"
- Study guide questions are up on Blackboard
- Never too early to start on the first referee report

Announcements

- Sorry for having to cancel Thursday's class and office hours, tough to lecture without a voice
- Today we'll cover the bison paper
- Then we'll be moving on to the Colonial economy, the reading for that will be Sawers (1992) "The Navigation Acts Revisited"
- Make certain you are working on your first referee report, email me or stop by office hours with any questions