

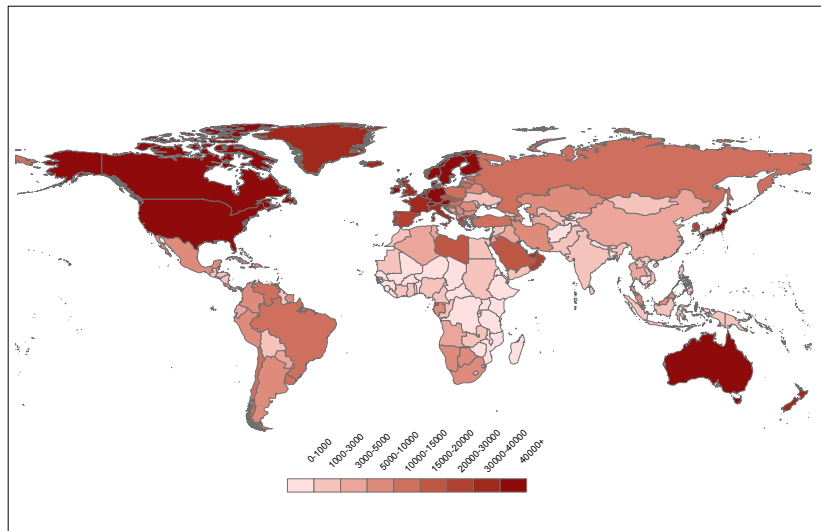
# Deep Roots of Comparative Development

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AEA Continuing Education Program

Lecture III - AEA 2014

## The Origins of Inequality in Income per Capita across the Globe in 2010



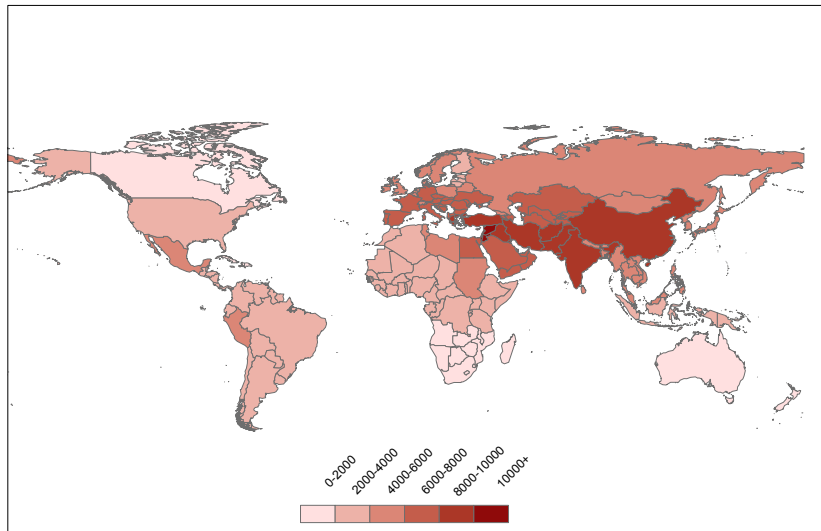
## Deeply-Rooted Factors of Comparative Development

- Persistent effects of:
  - Geographical characteristics:
    - Climate, Soil quality, Latitude, Isolation
  - Biogeographical conditions that triggered the Neolithic Revolution (NR)
    - Domesticable species, Orientation of continents (Diamond, 1997)
  - Migratory distance from the cradle of humankind in East Africa to indigenous settlements across the globe:
    - Variation in genetic diversity across countries (Ashraf-Galor, AER 2013)

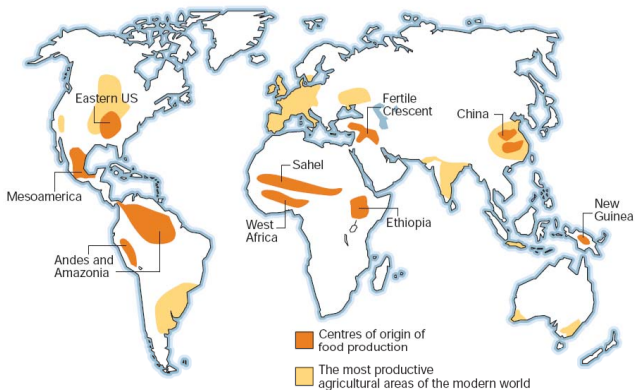
## The Neolithic Origins of Comparative Development – Diamond's Hypothesis

- The transition from hunter-gatherer tribes to agricultural communities:
  - Emergence of non-food-producing class:
    - $\implies$  Knowledge creation (science, technology & written languages)
  - Technological head start and its persistent effect via:
    - Urbanization, nation states, colonization
- Variations in biogeographical characteristics conducive for the NR:
  - $\implies$  Origins of the observed patterns of comparative development

## Variation in the Onset of the Neolithic Revolution



## Independent Origins

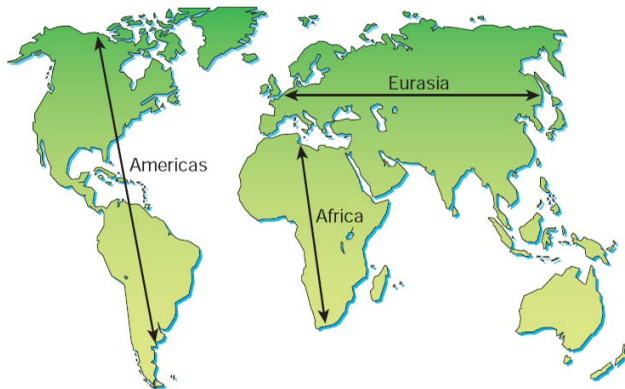


Source: Diamond (Nature 2002)

## Biogeographical Origins of the Onset of the Neolithic Revolution

- Geographical factors that maximized biodiversity (climate, latitude, landmass)
  - Availability of domesticable species of plants and animals
    - $\implies$  Onset of domestication
- Orientation of continents:
  - $\implies$  Diffusion of agricultural practices along similar latitudes

## Orientation of Continents



Source: Diamond (Nature 2002)



# The Diamond Hypothesis

- The domination of Euro-Asia in the pre-colonial era reflects:
  - Larger number of domesticable species of plants and animals
  - East-West orientation
    - $\implies$  Technological head start
- The economic domination of Europeans and their offshoots in the contemporary world reflects:
  - Persistence of head start
    - $\implies$  Guns, Germs and Steel

## Testable Predictions

- Earlier onset of the Neolithic Revolution yields:
  - Over the entire course of development
    - Technological superiority
  - During the Malthusian epoch
    - Higher population density
    - Negligible effect on income per capita
  - Over the contemporary era
    - Higher income per capita (accounting for the time elapsed since the ancestral populations of a country experienced the NR)

## The Neolithic Revolution (NR) &amp; Technological Level: 1000 BCE–2000 CE

	(1)	(2)	(3)	(4)
Dependent Variable: <b>Log Technological Level</b>				
	1000 BCE	1500 CE	2000	2000
Log Years since NR	4.34*** (1.24)	1.05*** (0.07)	-0.12 (0.92)	
Log Years since NR (Ancestry Adjusted)				0.128 (0.08)
Continent Dummies	Yes	Yes	Yes	Yes
Observations	112	143	132	132
R <sup>2</sup>	0.24	0.51	0.48	0.46
Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.				
Source: Ashraf-Galor (AER 2011); Ashraf-Galor (2014)				

# The Neolithic Revolution on Population Density in 1500

	OLS (1)	OLS (2)	OLS (3)	OLS (4)	IV (5)
Dependent Variable: <b>Log Population Density in 1500</b>					
Log years since Neolithic	0.833*** (0.298)	1.025*** (0.233)	1.087*** (0.184)	1.389*** (0.224)	2.077*** (0.391)
Log land productivity		0.641*** (0.059)	0.576*** (0.052)	0.573*** (0.095)	0.571*** (0.082)
Log absolute latitude		-0.353*** (0.104)	-0.314*** (0.103)	-0.278** (0.131)	-0.248** (0.117)
Mean distance to nearest coast or river			-0.392*** (0.142)	0.220 (0.346)	0.250 (0.333)
% land within 100 km of coast or river			0.899*** (0.282)	1.185*** (0.377)	1.350*** (0.380)
Continental dummies	Yes	Yes	Yes	Yes	Yes
Observations	147	147	147	96	96
R <sup>2</sup>	0.40	0.66	0.73	0.73	0.70
First-stage F-statistic					14.65
Overidentification p-value					0.44

Instrumental variables: number of prehistorical domesticable species of plants and animals.

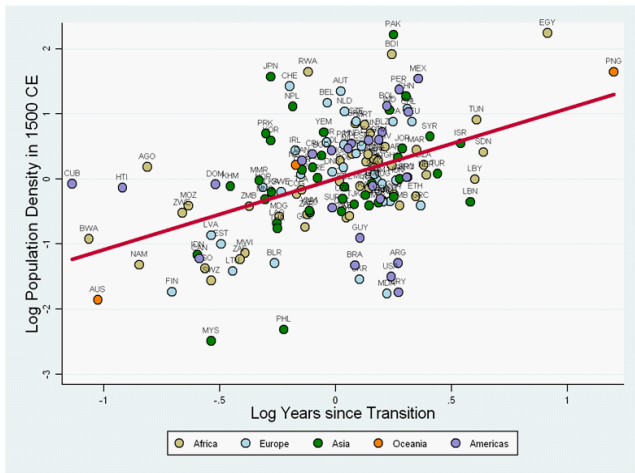
Robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

## The Neolithic Revolution and Income per Capita: 1–1500 CE

	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
	Log Income per Capita			Log Population Density		
	1500	1000	1	1500	1000	1
Log years since Neolithic	0.159 (0.136)	0.073 (0.045)	0.109 (0.072)	1.337*** (0.594)	0.832*** (0.363)	1.006*** (0.483)
Log land productivity	0.041 (0.025)	-0.021 (0.025)	-0.001 (0.027)	0.584*** (0.159)	0.364*** (0.110)	0.681*** (0.255)
Log absolute latitude	-0.041 (0.073)	0.060 (0.147)	-0.175 (0.175)	0.050 (0.463)	-2.140** (0.801)	-2.163** (0.979)
Mean distance to nearest coast or river	0.215 (0.198)	-0.111 (0.138)	0.043 (0.159)	-0.429 (1.237)	-0.237 (0.751)	0.118 (0.883)
% land within 100 km of coast or river	0.124 (0.145)	-0.150 (0.121)	0.042 (0.127)	1.855** (0.820)	1.326** (0.615)	0.228 (0.919)
Continental dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	31	26	29	31	26	29
R <sup>2</sup>	0.66	0.68	0.33	0.88	0.95	0.89

Robust standard errors in parentheses; \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$ .

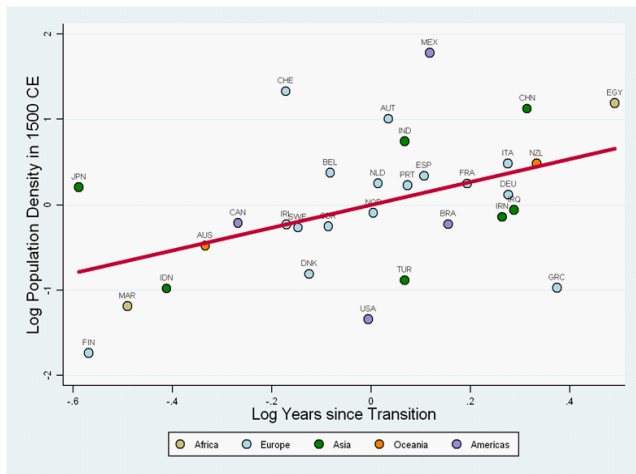
# The Neolithic Revolution and Population Density in 1500



Conditional on land productivity, geographical factors, and continental fixed effects.

Source: Ashraf-Galor (AER 2011)

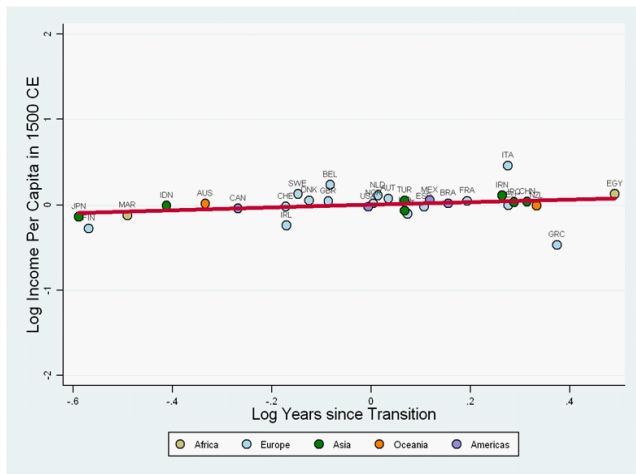
# The Neolithic Revolution and Population Density in 1500 (Income Sample)



Conditional on land productivity, geographical factors, and continental fixed effects.

Source: Ashraf-Galor (AER 2011)

# The Neolithic Revolution and Income per Capita in 1500 CE



Conditional on land productivity, geographical factors, and continental fixed effects.

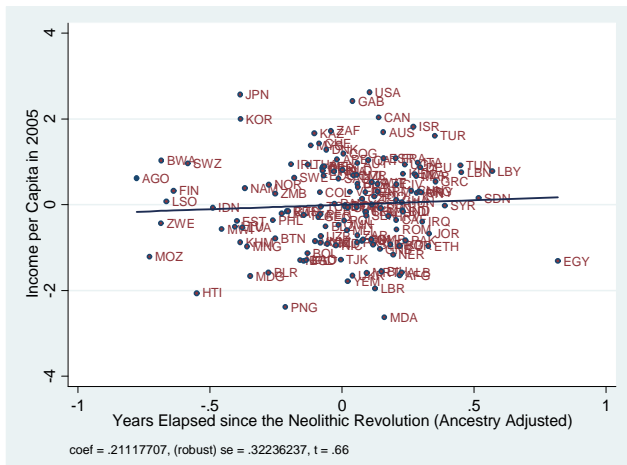
Source: Ashraf-Galor (AER 2011)



# The Neolithic Revolution and Income per Capita in 2005

	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)
<b>Log Income per Capita in 2005</b>				
Log years since Neolithic	0.525* (0.276)	0.010 (0.216)	-0.336 (0.272)	
Log years since Neolithic (ancestry adjusted)				0.211 (0.322)
Log land productivity		-0.379*** (0.080)	-0.515*** (0.077)	-0.494*** (0.078)
Log absolute latitude		0.765*** (0.149)	0.353** (0.138)	0.375*** (0.142)
Mean distance to nearest coast or river		-0.462 (0.302)	-0.465* (0.261)	-0.425 (0.260)
% land within 100 km of coast or river		1.624*** (0.364)	0.686* (0.367)	0.768** (0.361)
Continental dummies	No	No	Yes	Yes
Observations	143	143	143	143
R <sup>2</sup>	0.04	0.47	0.62	0.62
Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.				

# The Neolithic Revolution and Income per Capita in 2005



Conditional on land productivity, geographical factors, and continental fixed effects.

Source: Ashraf-Galor (2014)

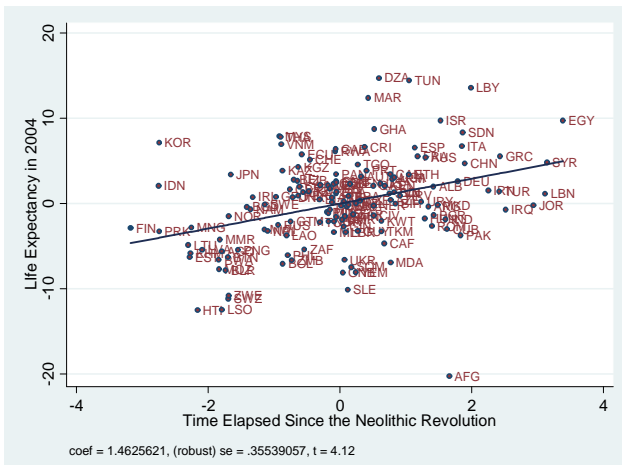
## The Neolithic Origins of Contemporary Variation in Life Expectancy

- The Neolithic Revolution increased the exposure and the vulnerability of humans to infectious diseases via:
  - the rise in population density
  - the domestication of animals
  - the increase in work effort
- Natural selection of individuals who were genetically pre-disposed towards resistance to infectious diseases (Galor-Moav, 2005)
- Variation in the timing of the Neolithic Revolution among the ancestral populations of each county contributed to the variation in life expectancy across countries (Galor-Moav, 2007)

# The Neolithic Origins of Variation in Life Expectancy in 2004

	OLS	OLS	OLS	IV
	(1)	(2)	(3)	(4)
<b>Life Expectancy in 2004</b>				
Log years since Neolithic (ancestry adjusted)	1.559*** (0.461)	1.463*** (0.355)	1.635*** (0.444)	1.909** (0.889)
Log land productivity		-1.386*** (0.350)	-1.636*** (0.444)	-1.371*** (0.519)
Log absolute latitude		0.195*** (0.053)	0.124* (0.068)	0.055 (0.048)
Mean distance to nearest coast or river		-5.030*** (1.084)	-7.130*** (1.937)	-5.121*** (1.668)
Island		9.365*** (1.990)	8.083 (2.723)	9.154*** (2.670)
Continental dummies	Yes	Yes	Yes	Yes
Observations	146	146	96	96
R <sup>2</sup>	0.71	0.80	0.86	
First-stage F-statistic				13.55
Instrumental variable: number of prehistorical domesticable animals.				
Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.				

# The Neolithic Origins of Variation in Life Expectancy in 2004



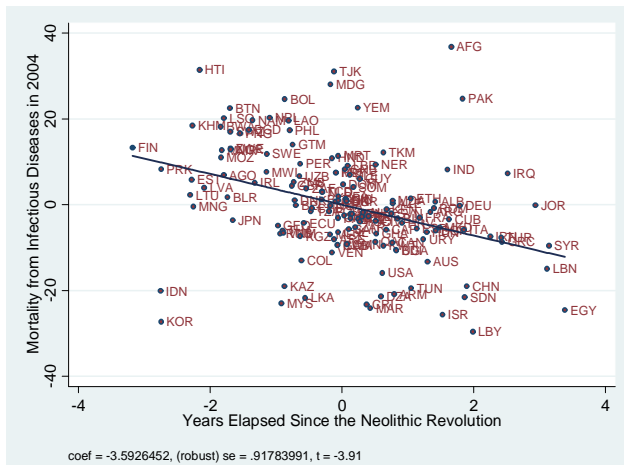
Conditional on land productivity, geographical factors, and continental fixed effects.

Source: Galor-Moav (2007)

## The Neolithic Origins of Mortality from Infectious Diseases in 2004

	OLS	OLS	OLS	IV
	(1)	(2)	(3)	(4)
<b>Years of Life Lost to Infectious Disease 2004</b>				
Log years since Neolithic (ancestry adjusted)	-3.818*** (1.160)	-3.593*** (0.918)	-3.504*** (1.286)	-8.664** (2.918)
Log land productivity		3.000*** (0.899)	2.016*** (1.468)	2.150 (1.572)
Log absolute latitude		-0.571*** (0.124)	-0.407*** (0.164)	-0.380 (0.192)
Mean distance to nearest coast or river		8.026*** (3.032)	10.07*** (4.583)	9.133* (5.514)
Island		-25.39*** (7.977)	-18.24* (10.90)	-28.56** (13.29)
Continental dummies	Yes	Yes	Yes	Yes
Observations	146	146	96	96
R <sup>2</sup>	0.77	0.84	0.87	
First-stage F-statistic				17.59
Instrumental variable: number of prehistorical domesticable animals.				
Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.				

# The Neolithic Origins of Mortality from Infectious Diseases in 2004



Conditional on land productivity, geographical factors, and continental fixed effects.

Source: Galor-Moav (2007)

## Persistence and Reversals in the Role of Geographical Factors

- Dynamics of the geographical patterns of comparative development
  - Reversal in the role of
    - Land Productivity
    - Distance from the equator
  - Persistence in the role of
    - Disease environment
    - Ecological diversity
    - Geographical Isolation
    - Range of land quality
    - Land suitable for large plantations



## Reversal in the Role of Land Productivity & Absolute Latitude

- Land productivity
  - 1-1500 CE
    - Positive association with population density
  - 2000s
    - Negative association with income per capita
- Absolute latitude
  - 1-1500 CE
    - Negative association with population density
  - 2000s
    - Positive association with income per capita

## Reversal in the Role of Land Productivity

	World sample (1)	Non-Colony sample (2)	Ex-Colony sample (3)	World sample (4)	Non-Colony sample (5)	Ex-Colony sample (6)
	Log Population Density			Log Income per Capita		
	1500			2005		
Log years since Neolithic	1.111*** (0.188)	0.769* (0.447)	1.383*** (0.267)			
Log years since Neolithic (ancestry adjusted)				0.211 (0.322)	-0.100 (0.559)	0.083 (0.382)
Log land productivity	0.568*** (0.053)	0.550*** (0.057)	0.585*** (0.115)	-0.494*** (0.078)	-0.518*** 0.087	-0.456*** 0.141
Log absolute latitude	-0.330*** (0.106)	-0.491*** (0.136)	-0.302** (0.123)	0.375*** (0.142)	0.891** (0.432)	0.139 (0.149)
Continental dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	143	68	75	143	68	75
R <sup>2</sup>	0.73	0.72	0.70	0.62	0.64	0.57

Additional Controls: mean distance to nearest coast & river and % land within 100 km of coast & river.

Robust standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

## Origins of the Reversal in the Role of Land Productivity

- The effect is nearly identical in the:
  - World sample
  - Former colonies sample (Acemoglu-Johnson-Robinson, QJE 2002)
  - Non-former colonies sample
  - $\implies$  Reversal in the role of land productivity is largely independent of the forces of colonialism
- Acquired comparative advantage in agriculture & delayed industrial transition

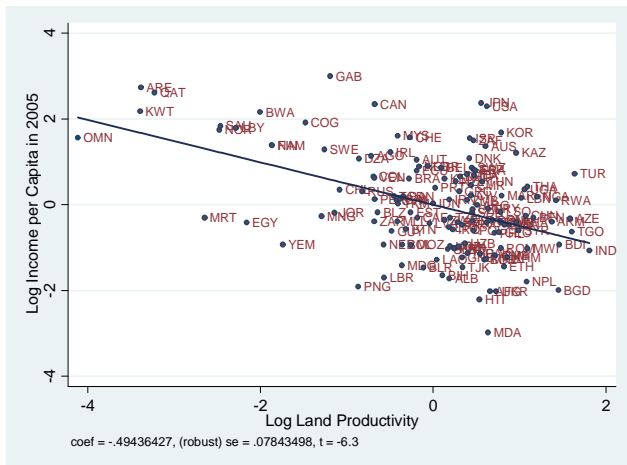
# Land Productivity and Population Density in 1500



Conditional on years since Neolithic transition, geographical factors, and continental fixed effects.

Source: Ashraf-Galor (AER 2011)

# Land Productivity and Income per Capita in 2005



Conditional on years since Neolithic transition, geographical factors, and continental fixed effects.

Source: Ashraf-Galor (AER 2013)

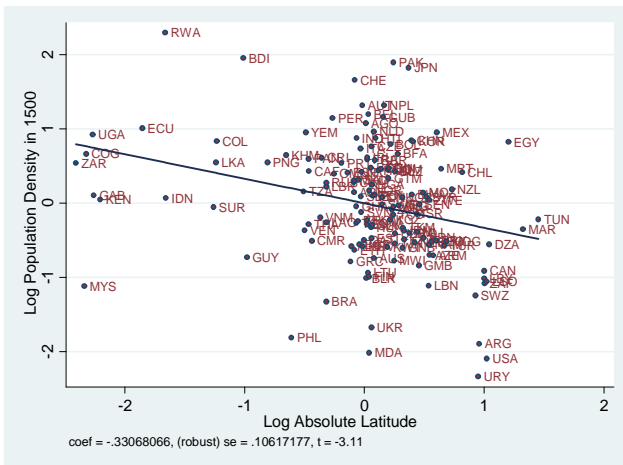
## Reversal in the Role of Distance from the Equator

	World sample (1)	Non-Colony sample (2)	Ex-Colony sample (3)	World sample (4)	Non-Colony sample (5)	Ex-Colony sample (6)
	Log Population Density			Log Income per Capita		
	1500			2005		
Log years since Neolithic	1.111*** (0.188)	0.769* (0.447)	1.383*** (0.267)			
Log years since Neolithic (ancestry adjusted)				0.211 (0.322)	-0.100 (0.559)	0.083 (0.382)
Log land productivity	0.568*** (0.053)	0.550*** (0.057)	0.585*** (0.115)	-0.494*** (0.078)	-0.518*** 0.087	-0.456*** 0.141
Log absolute latitude	-0.330*** (0.106)	-0.491*** (0.136)	-0.302** (0.123)	0.375*** (0.142)	0.891** (0.432)	0.139 (0.149)
Continental dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	143	68	75	143	68	75
R <sup>2</sup>	0.73	0.72	0.70	0.62	0.64	0.57

Additional Controls: mean distance to nearest coast & river and % land within 100 km of coast & river.

Robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

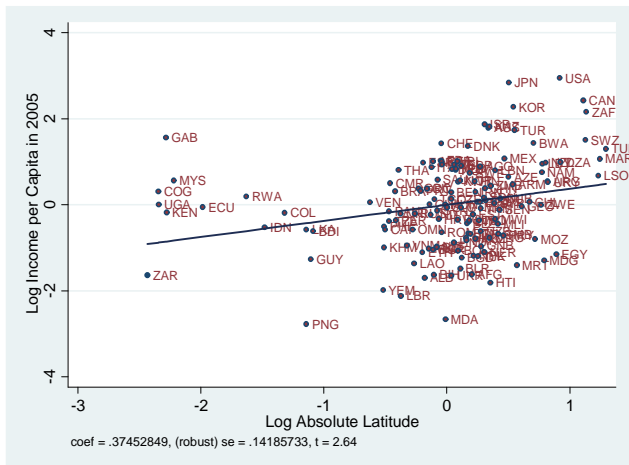
## Distance from the Equator and Population Density in 1500



Conditional on years since Neolithic transition, geographical factors, and continental fixed effects.

Source: Ashraf-Galor (AER 2011)

## Distance from the Equator and Income per Capita in 2005



Conditional on years since Neolithic transition, geographical factors, and continental fixed effects.

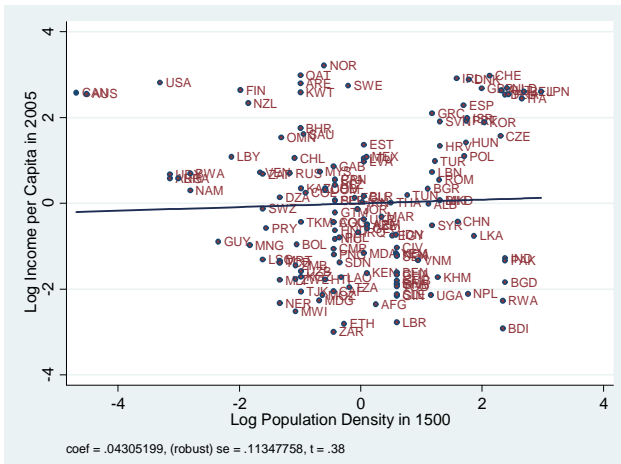
Source: Ashraf-Galor (AER 2013)



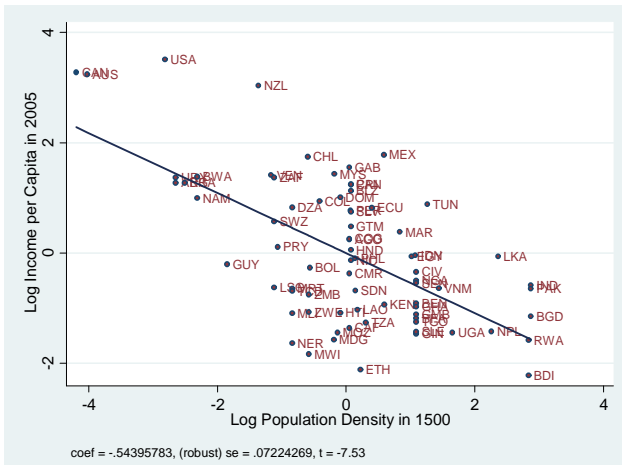
## Origins of the Reversal in the Role of Distance from the Equator

- The effect is qualitatively similar in the:
  - World sample
  - Non-former colonies sample
  - $\implies$  Reversal in the role of distance from the equator is largely independent of the forces of colonialism
- Temperate drift hypothesis: Advanced technologies gradually complemented production in temperate zones

## Population Density in 1500 and Income per Capita in 2005 – World Sample



# Population Density in 1500 & Income per Capita in 2005 – Ex-Colonies Sample



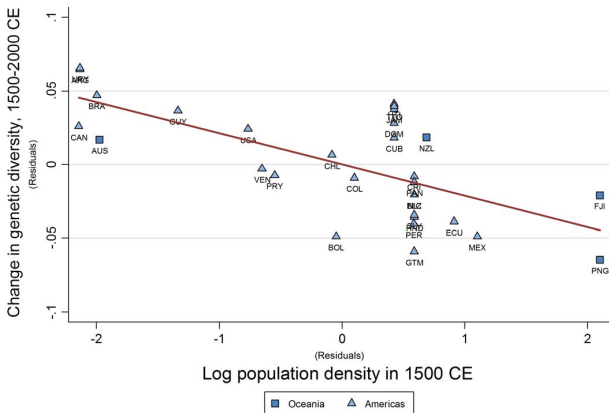
## Reversal of Fortune

- This reversal in the relative performance of countries is:
  - Absent in the world sample
  - Present in the former colonies sample
  - $\implies$  Reversal of Fortune is largely triggered by colonialism (Engerman-Sokoloff, 1997; Acemoglu et al., AER 2001, QJE 2002)

## Origins of Reversal of Fortune among Ex-Colonies

- Persistent effect of institutions implemented by colonial powers (Engerman-Sokoloff, 1997; Acemoglu et al., AER 2001, QJE 2002)
  - Exclusive (growth retarding) institutions imposed in densely populated areas
  - Inclusive (growth enhancing) institutions implemented in sparsely populated areas
- Persistent effect of the human capital and diversity brought by the colonists
  - Larger effect of colonizers in sparsely populated areas (Glaeser et al., JEG 2004; Easterly-Levine, 2012; Ashraf-Galor, 2014)

# Population Density in 1500 & Subsequent Changes in Genetic Diversity



coef = -0.021; (robust) se = 0.003; t = -6.09; n = 30

## Persistent Effects of Some Geographical Factors

- Disease environment
  - Persistent effect on labor productivity & investment in human capital  
(Gallup-Sachs, 2001; Andersen-Dalgaard-Selaya, 2012)
- Geographical isolation
  - Reduced trade and technological diffusion (Gallup-Mellinger-Sachs, 1999)
  - Persistence of culture conducive for innovations (Ashraf-Galor-Ozak, JEEA 2010)

## Persistent Effects of Geographical Factors

- Land suitable for large plantations
  - Inequality:
    - Extractive institutions (Engerman-Sokoloff, 1997)
    - Concentration of landownership:
      - Suboptimal investment in public education (Galor-Moav-Vollrath, RES 2009)
- Soil quality conducive for agriculture
  - Specialization in unskilled-intensive goods
    - Reduces human capital formation & increases fertility & slows the transition to modern growth (Galor-Mountford, RES 2008)



## Persistent Effects of Geographical Factors

- Range of soil quality
  - Emergence of geographical specific human capital  $\implies$  reduced mobility  $\implies$  ethnic fractionalization (Michalopoulos, AER 2012)
    - Persistent effect of ethnic fractionalization (Easterly-Levine, QJE 1997)
- Ecological diversity & storable crops
  - Emergence & persistence of state capacity (Fenske, JEEA 2014; Mayshar-Moav-Neeman, 2013)
- Geographical determinants of body size
  - Determined fertility & income per capita in the Malthusian epoch and the timing of the take-off (Dalgaard-Strulik, 2013)