The Diffusion of Development

Enrico Spolaore
Tufts University
and NBER

Romain Wacziarg
Stanford University,
NBER and CEPR

March 5, 2006

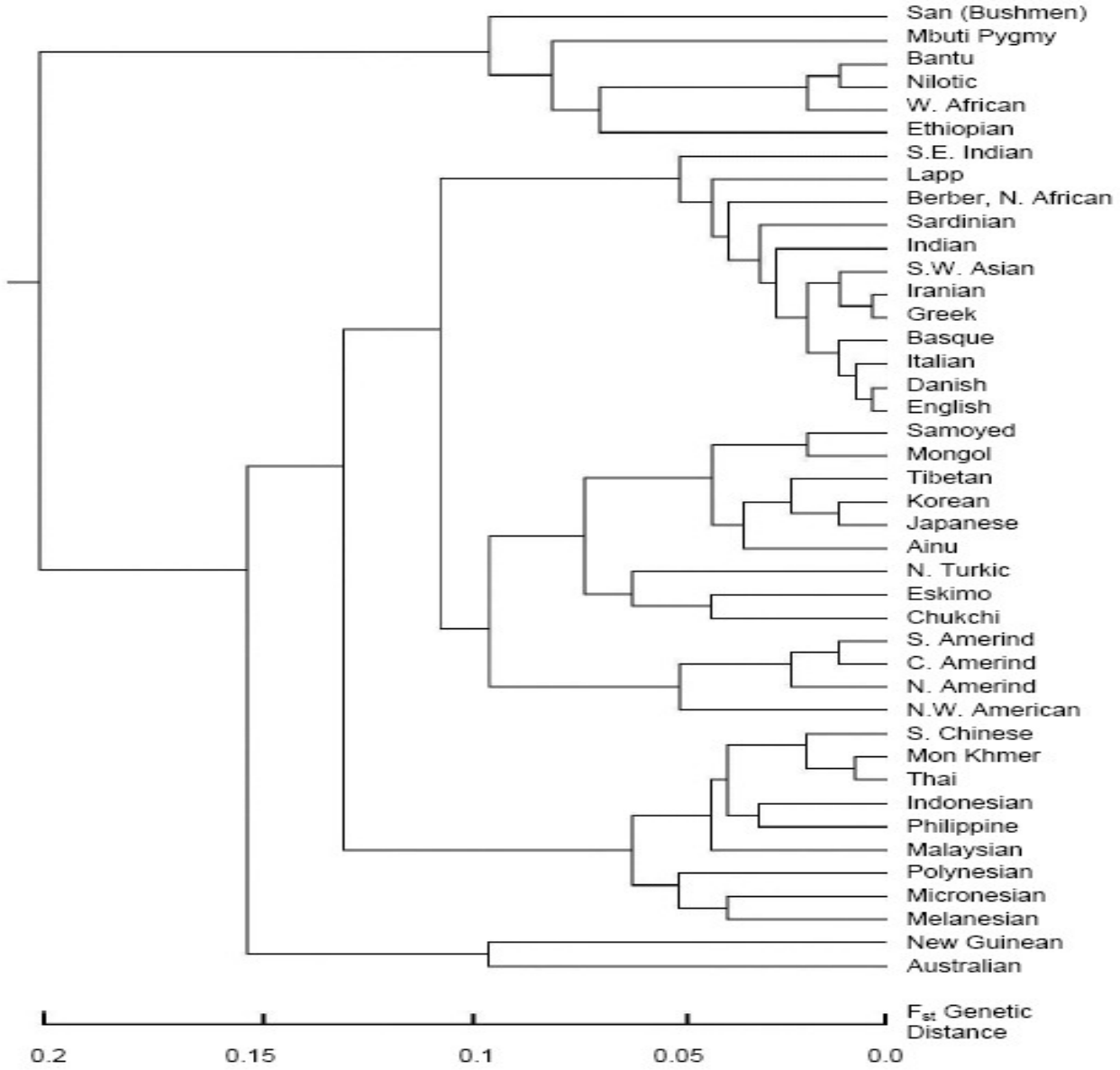
Barriers to Diffusion

- Why don't laggards adopt all the features that allow the rich countries to be rich?
  - The answer has to do with barriers to the long term diffusion of development.
- The goal of this paper is to assess the *barriers* to the diffusion of development over the very long run.
- We are not so much concerned with the determinants of development, as with barriers that prevent these determinants, whatever they are, from diffusing across time/space.

Distance Measures

- We examine two classes of determinants of income differences:
  - Geography-based measures of distance: greater circle distance, latitudinal distance, contiguity, climatic differences…
  - Measures of distance in human characteristics: genealogical distance, linguistic distance, common history variables…
- The main contribution of the paper is to highlight the importance of differences in vertically transmitted characteristics (VTCs).
- VTCs include (but may not be limited to) cultural features such as language, norms, values…
- Differences in VTCs are measured primarily by genetic distance.

Phylogenetic Tree of Human Populations

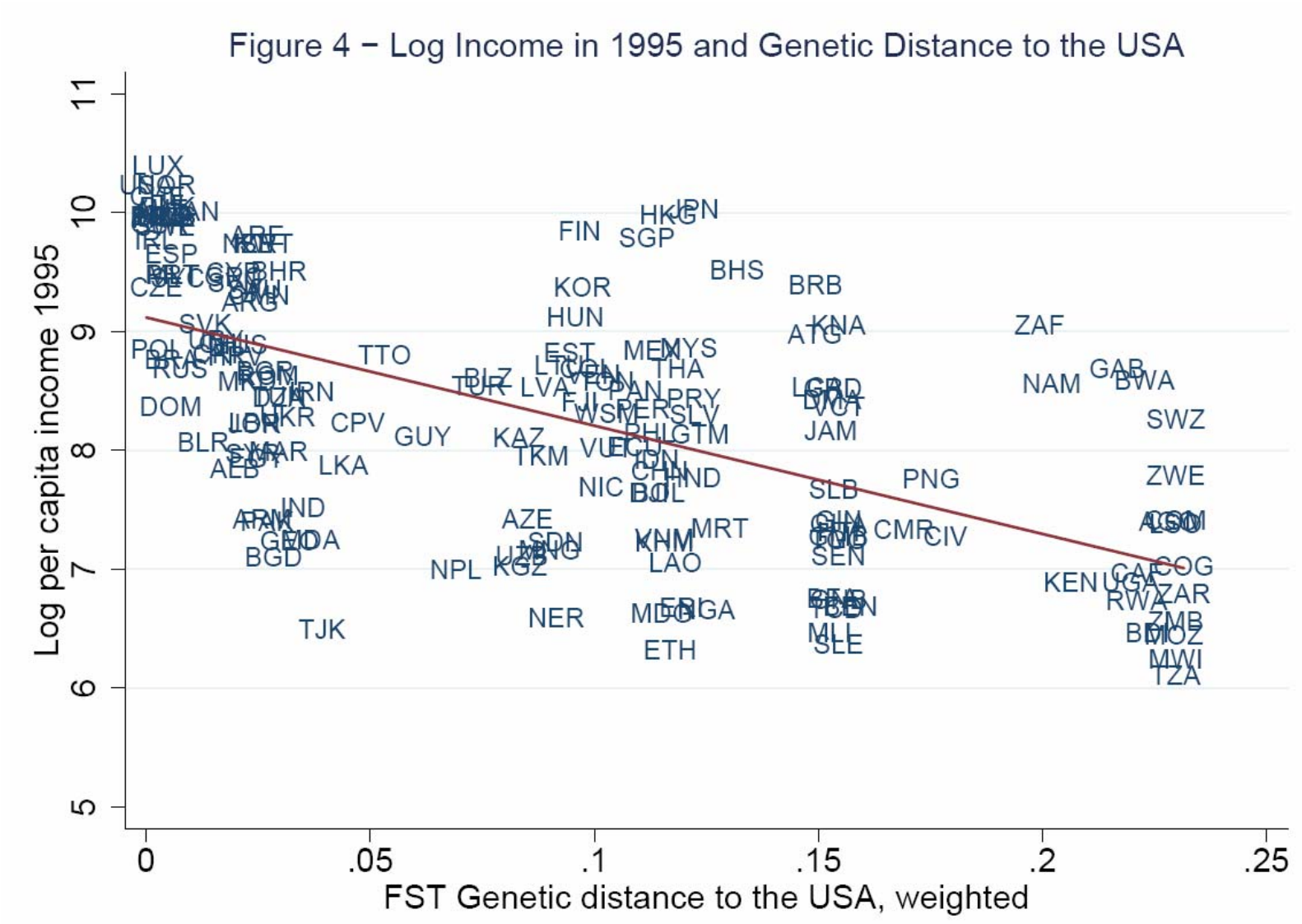


Source: Cavalli-Sforza et al., 1994

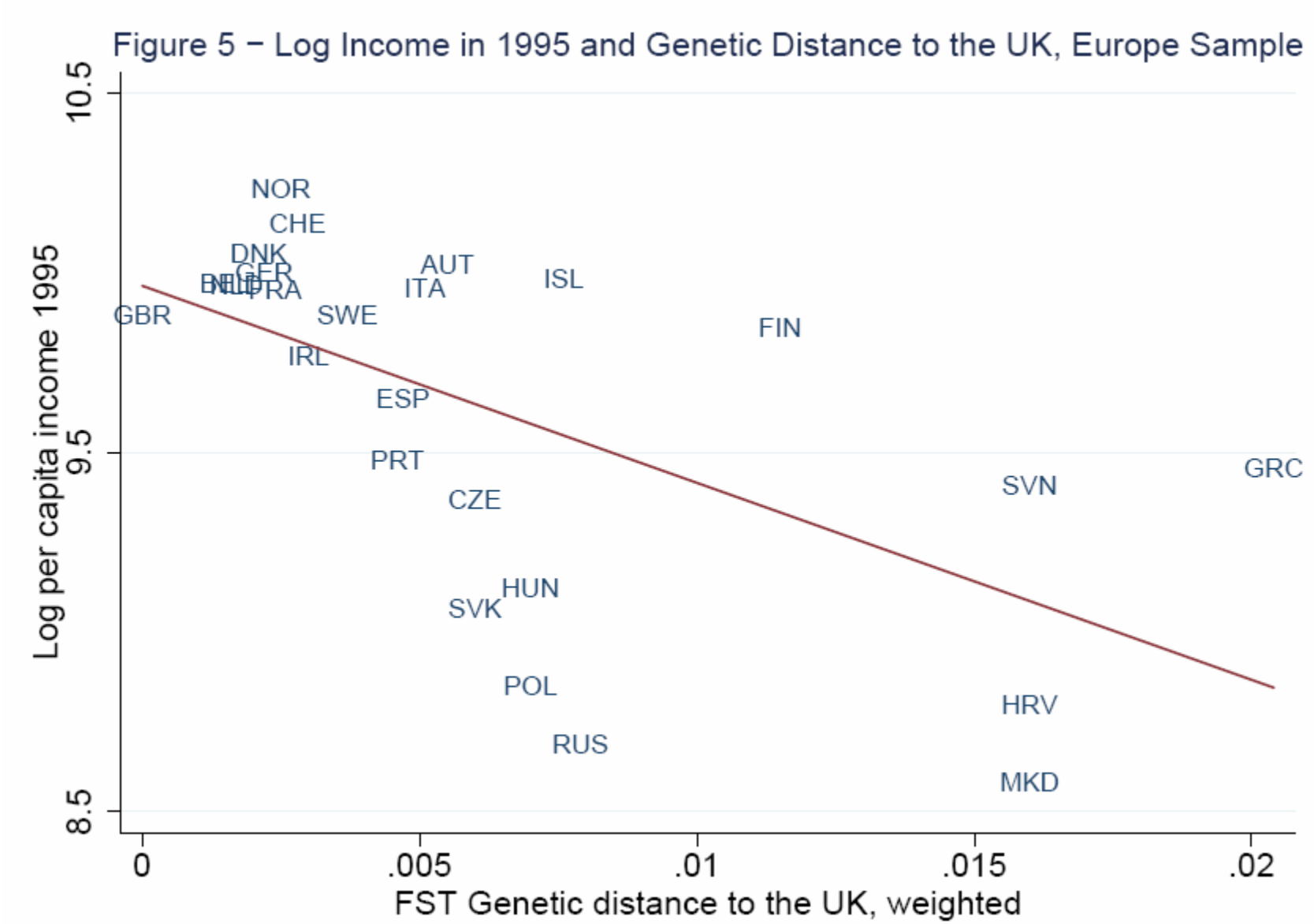
Main Findings

- There is a statistically and economically significant correlation between measures of genetic distance and differences in income per capita.
  - Even when controlling for various measures of geographical isolation, and other cultural, climatic and historical difference measures.
- The results are reinforced when we focus on the distance relative to the technological frontier.
- They hold not only for contemporary worldwide income differences, but also:
  - For income differences measured since 1500,
  - For income differences within Europe.
- The time path of the effect since 1500 is consistent with the "barriers" interpretation

Genetic Distance and Income Distance (World)



Genetic Distance and Income Distance (Europe)



Outline

1. General taxonomy of the effects of genetic distance
2. Genetic distance data and first-pass empirical results
3. Empirical methodology (bilateral approach)
4. Empirical results (bilateral approach)
5. Concluding comments

General taxonomy of the effects of VTCs (II)

	Direct Effect (D)	Barrier Effect (B)
Genetic Transmission (GT)	Galor and Moav, 2002	Guiso et al., 2005 Caselli and Coleman, 2002
Cultural Transmission (CT)	Tabellini, 2005 Max Weber… Extension to our model	Our baseline model

Genetic Distance Data

- Data from Cavalli-Sforza et al. (1994)
- We focus on 42 populations, based on 120 alleles, matched to 167 countries (today and in 1492)
- These populations are representative of subpopulations characterized by a high level of genetic similarity. However, measures of bilateral distance among these subpopulations are available only regionally. We also use the regional data for Europe.
- Maximal genetic distance is between Mbuti Pygmies and Papua New-Guineans: $F_{ST} = 0.4573$,
- Minimal genetic distance is between the Danish and the English: $F_{ST} = 0.0021$.
- Mean genetic distance among the 861 available pairs is 0.1338.

Table 1 – Simple Correlations among Distance Measures

	Geodesic distance	Diff. in absolute latitudes	Diff. in absolute latitudes	F_{ST} Gen. Dist.	F_{ST} Gen. Dist., 1500	Nei Gen. Dist.	Abs. log income diff. 1995	Abs. log income diff. 1500[a]
Difference in absolute latitudes	0.331	1						
Difference in absolute longitudes	0.843	0.060	1					
F_{ST} Genetic Distance	0.354	0.138	0.205	1				
F_{ST} Genetic Distance, 1500 match	0.478	0.166	0.305	0.658	1			
Nei Genetic Distance	0.318	0.154	0.171	0.929	0.606	1		
Abs. log income difference, 1995	0.015	0.104	-0.048	0.141	0.226	0.177	1	
Abs. log income difference, 1500[a]	0.159	0.155	0.069	-0.096	0.196	-0.086	-0.051	1
Abs. log income difference, 1700[b]	0.141	0.249	0.131	0.000	0.072	0.076	0.503	0.060

(number of observations: 13861 except [a]: 325 and [b]: 1431)

Table 3 - Baseline regressions
(Common-country fixed effects estimates, dependent variable: absolute value of income differences, 1995)

	(1)	(2)	(3)	(4)	(5)	(6)
	FST Gen. Dist.	**FST Gen Dist, relative to US**	**Nei Gen. Dist.**	**Weighted FST Gen. Dist.**	**Weighted FST Gen. Dist., relative to US**	**Weighted regression**
Fst Genetic Distance	2.388					2.529
	(0.102)**					(0.095)**
Fst genetic distance,		3.125				
relative to the USA		(0.123)**				
Nei Genetic Distance			14.893			
			(0.569)**			
Weighted Fst Genetic				2.731		
Distance				(0.110)**		
Relative Fst genetic distance					4.473	
to the USA, weighted					(0.134)**	
Observations	13861	13861	13861	13041	13041	13861
(# countries)	(167)	(167)	(167)	(162)	(162)	(167)
Adjusted R-squared	0.76	0.76	0.76	0.77	0.78	0.74
Standardized Beta (%)	21.77%	22.38%	24.05%	23.48%	30.49%	23.06%

Robust standard errors in parentheses; * significant at 10%; ** significant at 5%

Table 4 - Controlling for Geographic Distance (common-country fixed effects)
Dependent variable: absolute value of log income differences, 1995

	(1)	(2)	(3)	(4)
	Distance Metrics	**Add micro-geography controls**	**More micro-geography controls**	**Continent dummies**
Fst genetic distance, relative to the USA	**2.817 (0.129)****	**2.738 (0.127)****	**4.313 (0.367)****	**1.880 (0.127)****
Absolute difference in latitudes	0.012 (0.048)	-0.024 (0.048)	0.404 (0.156)**	-0.302 (0.053)**
Absolute difference in longitudes	-0.130 (0.027)**	-0.130 (0.027)**	-0.215 (0.108)**	-0.007 (0.027)
Geodesic Distance (1000s of km)	0.028 (0.003)**	0.025 (0.003)**	0.031 (0.015)**	0.002 (0.004)
1 for contiguity		-0.456 (0.056)**	-0.440 (0.110)**	-0.292 (0.052)**
=1 if either country is an island		0.214 (0.040)**	0.192 (0.295)	0.233 (0.040)**
=1 if either country is landlocked		0.400 (0.046)**	0.278 (0.135)**	0.392 (0.044)**
Dummy=1 if pair shares at least one sea or ocean		0.043 (0.027)	0.100 (0.061)*	-0.007 (0.026)
Absolute value of difference in average elevation			0.093 (0.061)	
Measure of indirect trade costs, CIF/FOB-1, 1980-2005 avg.			0.329 (0.104)**	
Observations # of countries	13861 (167)	13861 (167)	1932 (134)	13861 (167)
Adjusted R-squared	0.76	0.77	0.81	0.78
Standardized Beta (%)	20.03%	19.47%	31.73%	13.46%

Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; includes all controls

Table 5 - The Endogeneity of Genetic Distance and the Diamond Gap (common-country fixed effects)
Dependent variable: absolute value of log income differences, 1995 (columns 1-3) or 1500 (column 4)

	(1)	(2)	(3)	(4)
	Without New World	**IV with 1500 GD**	**Diamond Gap, w/o New World**	**Income 1500, Diamond Gap**
Fst genetic distance relative to the USA	**2.387 (0.195)****	**3.882 (0.254)****	**1.813 (0.202)****	
Fst genetic distance relative to the English, 1500 match				**1.935 (0.268)****
Absolute difference in latitudes	0.402 (0.113)**	-0.140 (0.053)**	0.470 (0.112)**	0.352 (0.092)**
Absolute difference in longitudes	-0.484 (0.096)**	-0.117 (0.027)**	0.015 (0.095)	0.075 (0.038)**
Geodesic Distance (1000s of km)	0.056 (0.011)**	0.022 (0.003)**	-0.025 (0.012)**	-0.024 (0.009)**
1 for contiguity	-0.354 (0.062)**	-0.418 (0.057)**	-0.370 (0.060)**	-0.061 (0.045)
=1 if either country is an island	0.206 (0.120)*	0.226 (0.041)**	0.250 (0.119)**	0.022 (0.085)
=1 if either country is landlocked	0.298 (0.052)**	0.395 (0.046)**	0.294 (0.051)**	-0.030 (0.054)
Dummy=1 if pair shares at least one sea or ocean	-0.036 (0.050)	0.041 (0.027)	-0.049 (0.050)	-0.031 (0.032)
Diamond Gap			0.431 (0.029)**	0.183 (0.031)**
Observations (# countries)	7626 (124)	13861 (167)	7626 (124)	325 (26)
Adjusted R-squared	0.75	-	0.76	0.83
Standardized Beta (%)	17.34%	27.81%	13.17%	42.30%

Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; includes all controls

Table 7 - Controlling for common history and cultural distance (common-country fixed effects) – Plurality measures of cultural distance. Dependent variable: absolute value difference in log income per capita, 1995.

	(1)	(2)	(3)	(4)	(5)
	Colonial history controls	**Linguistic distance, plurality**	**% cognate, plurality**	**Religious similarity, plurality**	**Religious + Linguistics, plurality**
Fst genetic distance relative to the USA	**3.343 (0.152)****	**3.299 (0.152)****	**3.062 (0.215)****	**3.252 (0.153)****	**3.259 (0.152)****
1 if countries were or are the same country	-0.240 (0.075)**	-0.233 (0.076)**	-0.050 (0.083)	-0.203 (0.076)**	-0.204 (0.076)**
1 for pairs ever in colonial relationship	0.109 (0.080)	0.123 (0.080)	0.030 (0.096)	0.135 (0.079)*	0.132 (0.079)*
1 for common colonizer post 1945	-0.146 (0.032)**	-0.145 (0.032)**	0.047 (0.070)	-0.120 (0.032)**	-0.121 (0.032)**
1 for pairs currently in colonial relationship	-0.840 (0.400)**	-0.802 (0.364)**	-0.852 (0.284)**	-0.725 (0.312)**	-0.731 (0.318)**
Linguistic Distance Index		0.113 (0.065)*			-0.020 (0.067)
Religious Distance Index, dominant religions				0.296 (0.028)**	0.298 (0.029)**
Lexicostatistical % cognate measure			-0.269 (0.051)**		
Observations (# countries)	10011 (142)	10011 (142)	2556 (72)	10011 (142)	10011 (142)
Adjusted R-squared	0.77	0.77	0.80	0.77	0.77
Standardized Beta (%)	24.63%	24.31%	22.78%	23.96%	24.01%

Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; additional geographical controls included

Historical Variation in the Effect

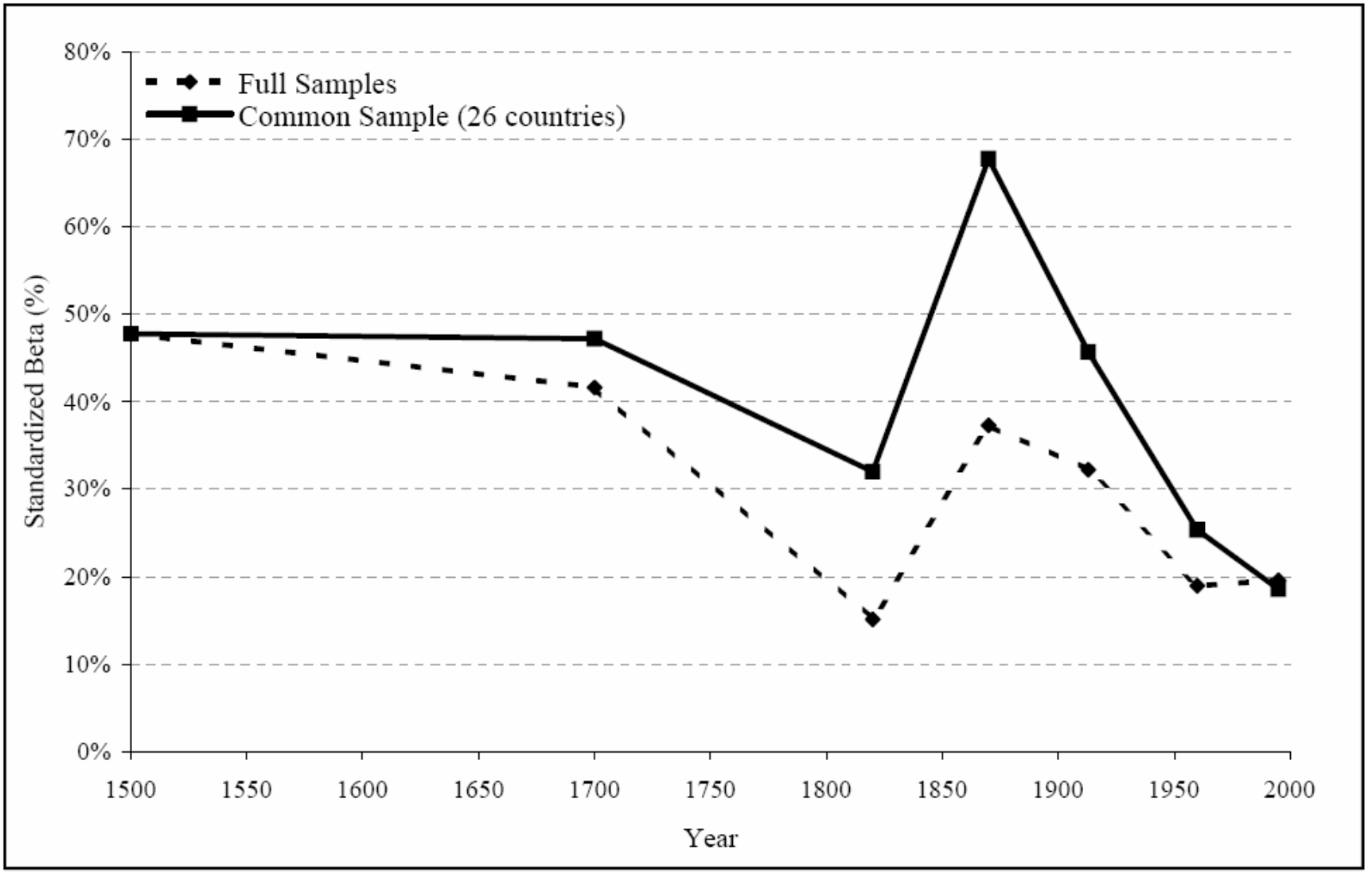


Table 9 - Regressions for the European Sample (common country fixed-effects)
Dependent variable: Absolute value log income difference, 1995 (except column 6, 1870)

	(1)	(2)	(3)	(4)	(5)	(6)
	No controls	**Geographic distance controls**	**More micro-geography controls**	**Cultural distance controls**	**% cognate control**	**1870 Income data**
Genetic Distance	**38.055**	**27.780**	**24.540**	**26.893**	**19.306**	**88.920**
relative to the English	**(6.556)****	**(7.219)****	**(10.394)****	**(8.006)****	**(6.448)****	**(20.488)****
Absolute value difference			0.078			
in average elevation			(0.165)			
(CIF imports/FOB exports)-			0.684			
1, 1980-2005 average, DOTS			(0.158)**			
Linguistic Distance Index,				0.892		
plurality languages				(0.329)**		
Religious Distance Index,				-0.036		
dominant religions				(0.079)		
% cognate,					-1.073	
plurality languages					(0.135)**	
Observations	296	296	156	249	188	153
(# countries)	(25)	(25)	(25)	(23)	(20)	(18)
Adjusted R-squared	0.78	0.79	0.75	0.79	0.87	0.85
Standardized beta	44.44%	32.44%	32.01%	32.65%	23.69%	132.29%

Robust standard errors in parentheses; * significant at 10%; ** significant at 5%
All regressions except column 1 include full set of baseline geographic distance controls (coefficients not reported)

Conclusion: Main results

1. Differences in income per capita across countries are positively correlated with measures of genetic distance between populations.
2. The effect of genetic distance - an overall measure of differences in vertically transmitted characteristics across generations - holds even when a large set of geographical and other variables are controlled for.
3. The patterns of relationships between income differences and measures of genetic and geographical distances hold also for 1500 and 1700, and within Europe.
4. The same patterns hold when examining the relationship between income differences and the relative distance to the technological and institutional frontier.

Conclusion: Interpretation

- The diffusion of technology, institutions and norms of behavior conducive to higher incomes is affected by differences in *vertically transmitted characteristics* associated with genealogical relatedness.
- We view VTCs as primarily *cultural.*
- Populations that are genealogically far apart are more likely to differ in those characteristics, and hence less likely to adopt each other's innovations over time.
- The evidence is consistent with a barrier effect, though we cannot rule out direct effects operating simultaneously.
- Remaining questions concern the microeconomic mechanism that accounts for the barrier effect: difficulties in communicating, lack of shared norms of behavior, lack of shared values, lack of trust, etc…