

Why Do Some Countries Produce So Much More Output per Worker than Others?

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Motivation & background: result from level accounting

- Differences among countries can be attributed to differences in human capital, physical capital, and productivity.

	K/L	H/L	Productivity	Y/L
Niger	1 *	1 *	1	= 1
US	1.5 *	3.1 *	7.7	= 35

- Assume $\alpha=1/3$,
$$y_i = \left(\frac{K_i}{Y_i}\right)^{\alpha/(1-\alpha)} h_i A_i$$

PRODUCTIVITY CALCULATIONS: RATIOS TO U. S. VALUES

Country	Y/L	Contribution from		
		$(K/Y)^{\alpha/(1-\alpha)}$	H/L	A
United States	1.000	1.000	1.000	1.000
Canada	0.941	1.002	0.908	1.034
Italy	0.834	1.063	0.650	1.207
West Germany	0.818	1.118	0.802	0.912
France	0.818	1.091	0.666	1.126
United Kingdom	0.727	0.891	0.808	1.011
Hong Kong	0.608	0.741	0.735	1.115
Singapore	0.606	1.031	0.545	1.078
Japan	0.587	1.119	0.797	0.658
Mexico	0.433	0.868	0.538	0.926
Argentina	0.418	0.953	0.676	0.648
U.S.S.R.	0.417	1.231	0.724	0.468
India	0.086	0.709	0.454	0.267
China	0.060	0.891	0.632	0.106
Kenya	0.056	0.747	0.457	0.165
Zaire	0.033	0.499	0.408	0.160
Average, 127 countries:	0.296	0.853	0.565	0.516
Standard deviation:	0.268	0.234	0.168	0.325
Correlation with Y/L (logs)	1.000	0.624	0.798	0.889
Correlation with A (logs)	0.889	0.248	0.522	1.000

Motivation & background:

Why use level instead of growth rate

- levels capture the differences in long-run economic performance that are most directly relevant to welfare as measured by the consumption of goods and services
- the relatively low correlation of growth rates across decades, which suggests that differences in growth rates across countries may be mostly Transitory (*Easterly, Kremer, Summers, 1993*)
- All countries will grow at a common rate in the long run: technology transfer keeps countries from drifting indefinitely far from each other (*Barro Sala-i-martin, 1995*)

Motivation & background:

Proximate Versus Fundamental Causes

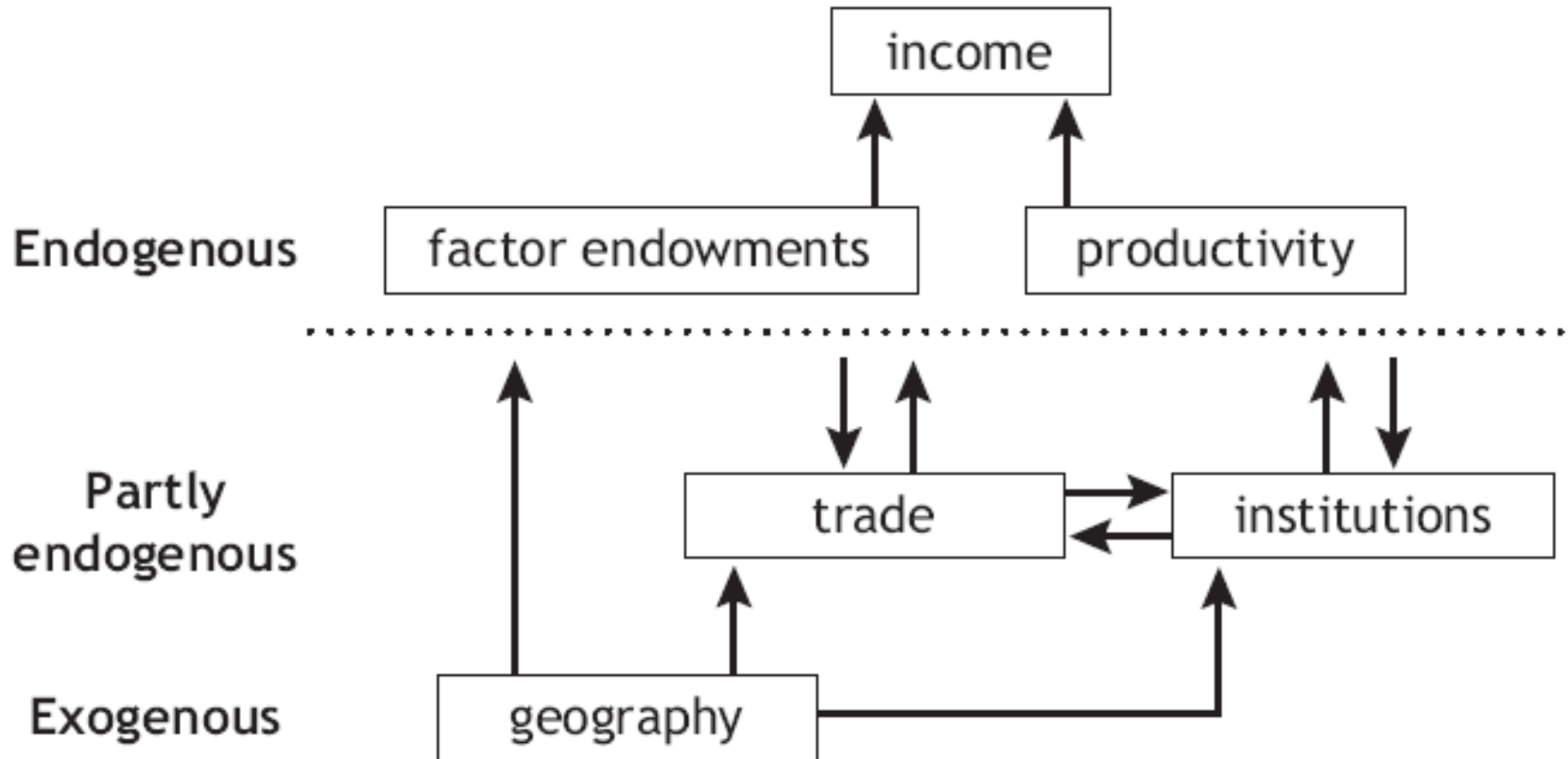
- “...*the factors we have listed (innovation, economies of scale, education, capital accumulation etc.) are not causes of growth; they are growth.*” (North and Thomas, 1973, p. 2, italics in original).
- Why do countries differ so much in capital and productivity?

Motivation & background:

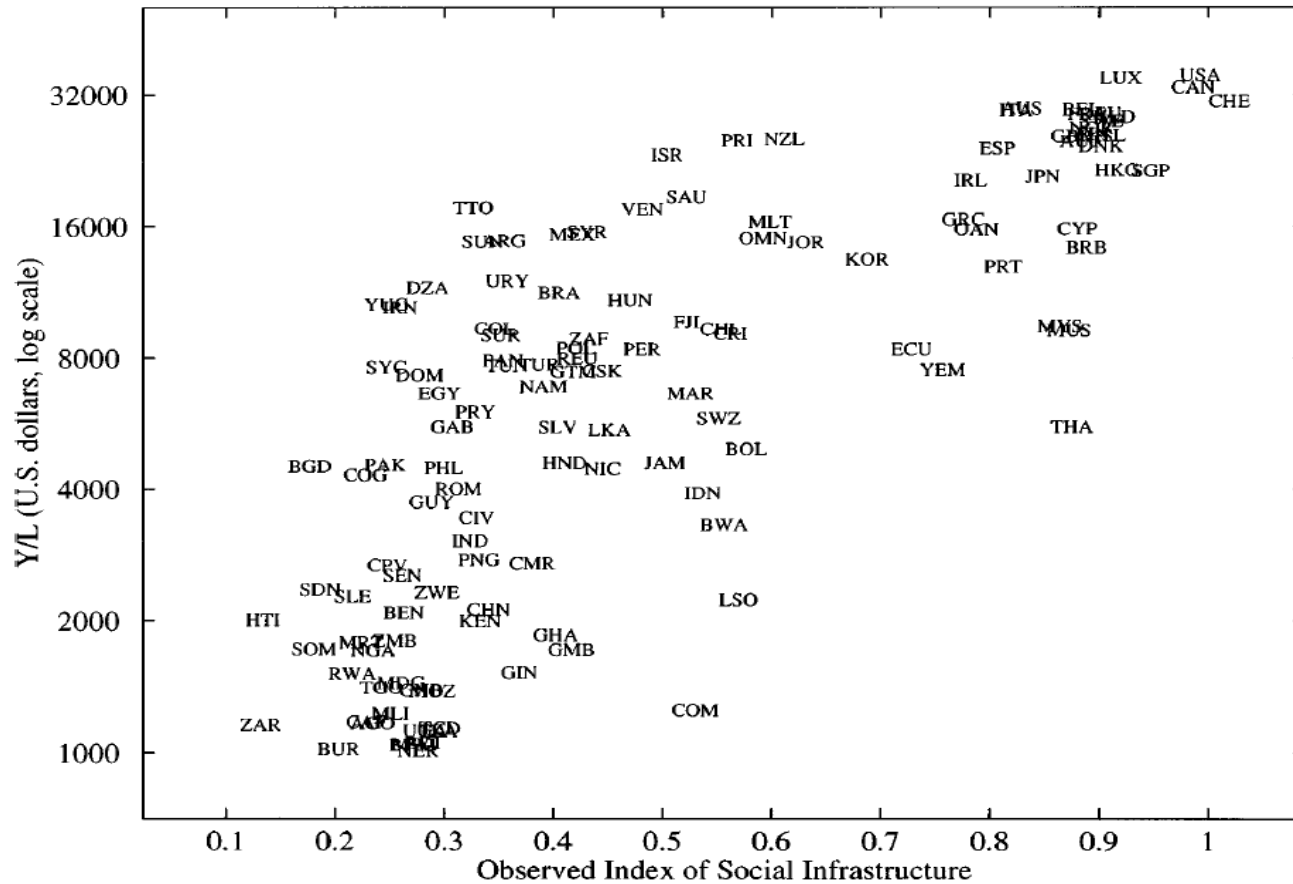
The importance of social infrastructures

- **Productive activities are vulnerable to diversions:**
 1. Thievery, squatting, and Mafia protection are diversion by private agents
 2. Expropriation, confiscatory taxation, and corruption are public diversion
- **Social control of diversion has two benefits:**
 1. in a society free of diversion, productive units are rewarded by the full amount of their production
 2. where social control of diversion is effective, individual units do not need to invest resources in avoiding diversion.
- **A government supports productive activity by deterring private diversion and by refraining from diverting itself.**

Basic framework: all of growth economics on one page



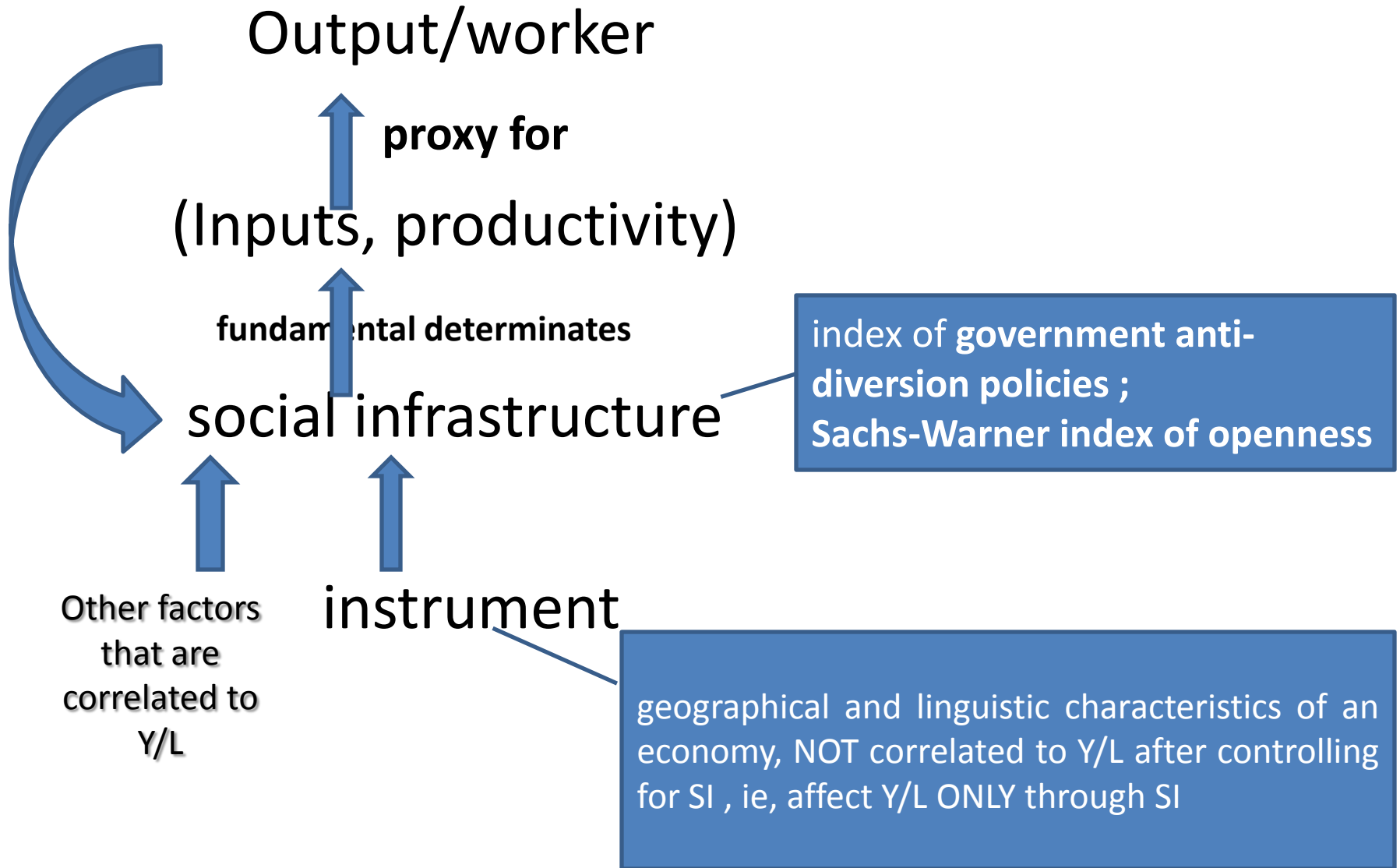
Basic framework : addressing endogeneity



Two sources of endogeneity

1. Feedback from Y/L to social infrastructure
2. Same factor affect Y/L and SI in the same direction

Basic framework



DATA:

Measurement of social infrastructure

Combining two indexes

1. index of **government anti-diversion policies** (GADP) created from data assembled by a firm that specializes in providing assessments of risk to international investors, Political Risk Services.
average of: (i) law and order, (ii) bureaucratic quality, (iii) corruption, (iv) risk of expropriation, and (v) government repudiation of contracts. Measured on a $[0,1]$ scale.
1. **Sachs-Warner index** measures the fraction of years during the period 1950 to 1994 that the economy has been open to trade and is measured on a $[0,1]$ scale.

DATA:

Potential measurement error

- Example: the experts at Political Risk Services who constructed the components of the GADP index were swayed in part by knowledge of income levels.
- Example: poor countries may have limited ability to collect taxes and may therefore be forced to interfere with international trade.
- **In both cases, we will have POSITIVE measurement error**

DATA:

Selection of Instruments

- **Main specification:**

1. distance from the equator
2. the extent to which the primary languages of Western are spoken as first languages today
3. That of English as separate instrument

- **Alternative specification:**

Ethno-linguistic fractionalization, religious affiliation, $\log(\text{population})$, $\log(\text{C-H density})$, capitalist system indicator, continent dummies

Model and results

Structural equations

$$\log Y/L = \alpha + \beta S + \epsilon, \quad \text{True SI}$$

$$S = \tilde{S} - v, \quad \text{Measurement error, } \text{corr}(v, \epsilon) > 0$$



$$\log Y/L = \alpha + \beta \tilde{S} + \epsilon - \beta v,$$

$$S = \gamma + \delta \log Y/L + X\theta + \eta.$$

x: instrument, validity means $\text{corr}(x, \epsilon) = 0$;
 η : other factors and $\text{corr}(\eta, \epsilon) > 0$

Model and results:

Reduced form equation for \tilde{S}

$$\tilde{S} = \frac{\gamma + \delta\alpha + \delta\epsilon + X\theta + \eta}{1 - \delta\beta} + \nu.$$

- + simultaneity : $\text{beta}(SI)_{OLS} > \text{beta}(SI)_{IV}$,
SI underestimated, so COEFFICIENT Overestimated
- + measurement error: $\text{beta}(SI)_{OLS} < \text{beta}(SI)_{IV}$,
SI overestimated, so COEFFICIENT Underestimated
- Net effect: ambiguous
- Measurement errors turns out to matter more for this model as shown in IV vs OLS regressions above.

Model and Result:

IV vs OLS regression and instrument validity

TABLE II
BASIC RESULTS FOR OUTPUT PER WORKER
 $\log Y/L = \alpha + \beta \hat{S} + \bar{\epsilon}$

Specification	Social infrastructure	OverID test ρ -value test result	Coeff test ρ -value test result	$\hat{\sigma}_{\bar{\epsilon}}$
1. Main specification	5.1432 (.508)	.256 Accept	.812 Accept	.840
<i>Alternative specifications to check robustness</i>				
2. Instruments: Distance, Frankel-Romer	4.998 (.567)	.208 Accept	.155 Accept	.821
3. No imputed data 79 countries	5.323 (.607)	.243 Accept	.905 Accept	.889
4. OLS	3.289 (.212)	—	.002 Reject	.700

The coefficient on Social infrastructure reflects the change in log output per worker associated with a one-unit increase in measured social infrastructure. For example, the coefficient of 5.14 means that a difference of .01 in our measure of social infrastructure is associated with a 5.14 percent difference in output per worker. Standard errors are computed using a bootstrap method, as described in the text. The main specification uses distance from the equator, the Frankel-Romer instrument, the fraction of the population speaking English at birth, and the fraction of the population speaking a Western European language at birth as instruments. The OverID test column reports the result of testing the overidentifying restrictions, and the Coeff test reports the result of testing for the equality of the coefficients on the *GADP* policy index variable and the openness variable. The standard deviation of log *Y/L* is 1.078.

- **Suppose no true simultaneity problem**

$$\text{plim} \left(\frac{\hat{\beta}_{OLS}}{\hat{\beta}_{IV}} \right)^{1/2} = \frac{\sigma_S}{\sigma_{\hat{S}}}.$$

Gives higher bound on $r_{\hat{S},S} = 0.8$

- On the other hand, **if we do have simultaneity**, from data we know that the lower bound of $r_{\hat{S},S} = 0.707$

We can apply the ratio $r_{\hat{S},S}$ to get a reasonable estimate of the range of variation of true social infrastructure.

$r_{\hat{S},S} = .707$ suggests that differences in social infrastructure can account for a 25.2-fold difference in output per worker across countries.

If $r_{\hat{S},S} = .800$, differences in social infrastructure imply a 38.4-fold difference in output per worker across countries

This did good job in explaining large productivity gap of the world

Model and results:

Reduced form regressions

TABLE III
REDUCED-FORM REGRESSIONS

Regressors	Dependent variables	
	Social infrastructure	Log (output per worker)
Distance from the equator, (0,1) scale	0.708 (.110)	3.668 (.337)
Log of Frankel-Romer predicted trade share	0.058 (.031)	0.185 (.081)
Fraction of population speaking English	0.118 (.076)	0.190 (.298)
Fraction of population speaking a European language	0.130 (.050)	0.995 (.181)
R^2	.41	.60

N = 127. Standard errors are computed using a bootstrap method, as described in the text. A constant term is included but not reported.

Model and results:

RESULTS FOR $\log K/Y$, $\log H/L$, and $\log A$

$$\text{Component} = \alpha + \beta \tilde{S} + \tilde{\epsilon}$$

Dependent variable

	$\frac{\alpha}{1 - \alpha} \log K/Y$	$\log H/L$	$\log A$
Social infrastructure	1.052 (.164)	1.343 (.171)	2.746 (.336)
OverID test (p)	.784	.034	.151
Test result	Accept	Reject	Accept
$\hat{\sigma}_{\tilde{\epsilon}}$	.310	.243	.596
$\hat{\sigma}_{\text{Depvar}}$	.320	.290	.727

Model and results:

Powerful in explaining variations in input,
productivity, and output

TABLE V
FACTORS OF VARIATION: MAXIMUM/MINIMUM

	Y/L	$(K/Y)^{\alpha/(1-\alpha)}$	H/L	A
Observed factor of variation	35.1	4.5	3.1	19.9
Ratio, 5 richest to 5 poorest countries	31.7	1.8	2.2	8.3
Predicted variation, only measurement error	38.4	2.1	2.6	7.0
Predicted variation, assuming $r_{\tilde{S},S}^2 = .5$	25.2	1.9	2.3	5.6

The first two rows report actual factors of variation in the data, first for the separate components and then for the geometric average of the five richest and five poorest countries (sorted according to Y/L). The last two rows report predicted factors of variation based on the estimated range of variation of true social infrastructure. Specifically, these last two rows report $\exp(r\hat{\beta}_{IV}(\tilde{S}_{\max} - \tilde{S}_{\min}))$, first with $r = .800$ and second with $r^2 = .5$.

Robustness: test for alternative model

TABLE VI
ROBUSTNESS RESULTS
 $\log Y/L = \alpha + \beta \tilde{S} + \lambda \text{ Added Variable} + \tilde{\epsilon}$

Specification	Social infrastructure	Additional variable	OverID test p -value test result	$\hat{\sigma}_{\tilde{\epsilon}}$
1. $\tilde{S} = GADP$	5.410 (.394)	...	.006 Reject	.769
2. $\tilde{S} = \text{years open}$	4.442 (.871)	...	.131 Accept	1.126
3. Distance from equator	5.079 (2.61)	0.062 (2.062)	.129 Accept	.835
4. Ethnolinguistic fractionalization (N = 113)	5.006 (.745)	-0.223 (.386)	.212 Accept	.816
5. Religious affiliation (N = 121)	4.980 (.670)	See Note	.478 Accept	.771
6. Log (population)	5.173 (.513)	0.047 (.060)	.412 Accept	.845
7. Log (C-H density)	5.195 (.539)	-0.546 (1.11)	.272 Accept	.850
8. Capitalist system indicator variable	6.354 (1.14)	-1.057 (.432)	.828 Accept	.899
9. Instruments: main set plus continent dummies	4.929 (.388)	...	.026 Reject	.812

other literatures

- Acemoglu, Robinson, Johnson, 2001:
(potential) settler mortality \Rightarrow settlements \Rightarrow Early institutions
 \Rightarrow current institutions \Rightarrow current Performance
- Mauro 1995:
Ethno-linguistic fractionalization \Rightarrow bureaucratic efficiency &
political stability \Rightarrow investment/gdp

Critiques: on measurement of institutions

GADP is by construction: *outcomes, not some permanent characteristics that North refers to as institutions (constraints on government)* (Glaser, etc, 2004)

- a good dictator “chose” to respect property right VS a government “has to” respect that under institutional constraints
- Eg: expropriation risk of USSR, Iran and Singapore during 1980s is as low as US

Critiques: on selection of instruments

- Geographic and language features are analytically DIRECTLY affecting Y/L other than through institution. (structural change literature)
- On AJR (2001) Settler mortality affect human capital in history and today and thus Y/L (Glaser, etc, 2004)

Critiques: on model specification

- Should include Interaction between institutions and human capital:
democracy works better with well-educated people;
democracy in poor country may even work worse than dictatorship.
- Should model institution nonlinear? Allow for decreasing return to institutions (eg China after 1978, little change in institutions but huge marginal effect)
- Any other idea?