HUMAN CAPITAL, SCHOOLS, AND ECONOMIC GROWTH

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Pareto Lecture

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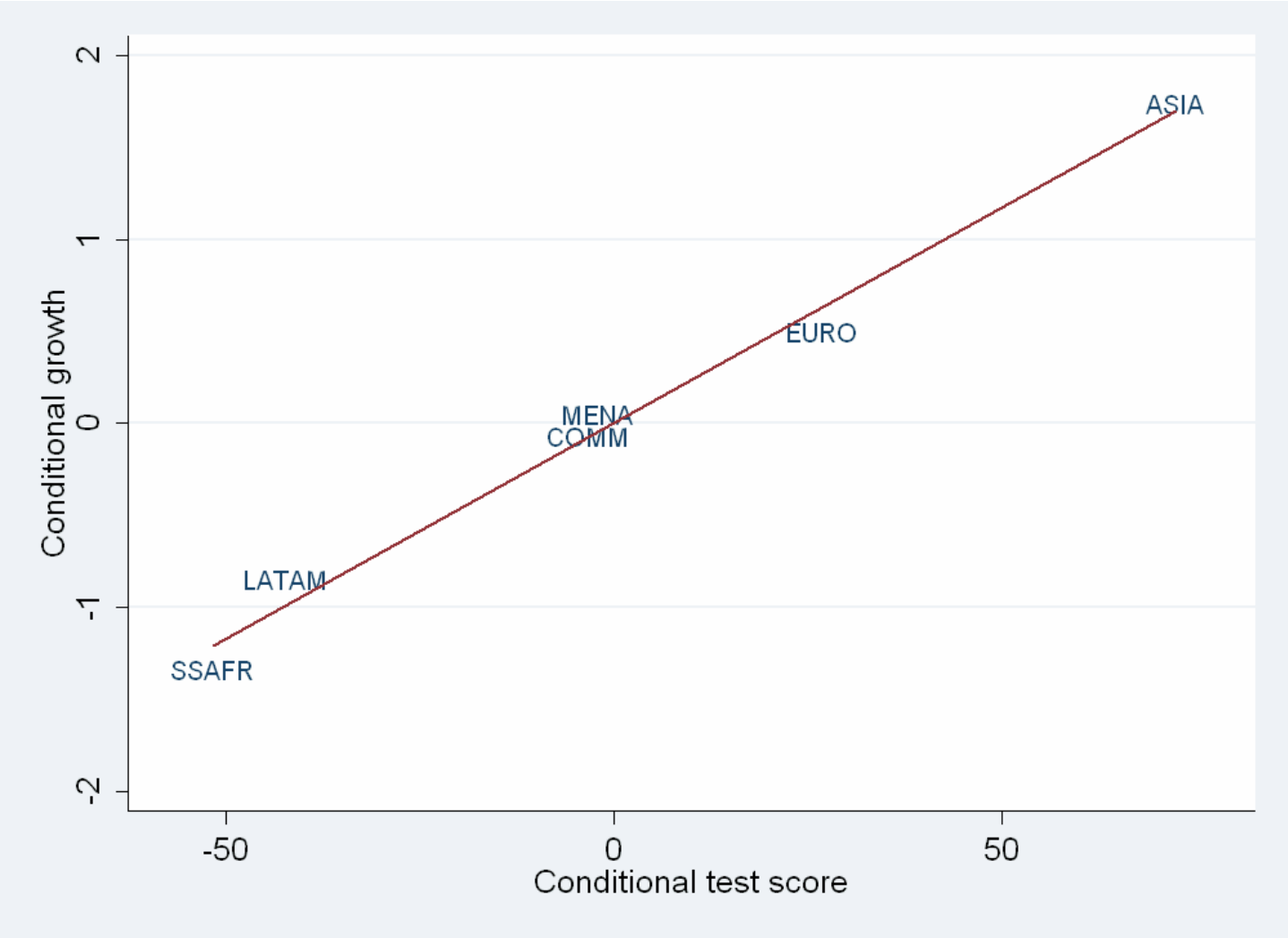
Overview

- The long run importance of human capital
  - Substantial new evidence
  - Quality imperative
  - Magnitudes
- Skepticism about cross-country growth models
  - Specification
  - Causality
  - Form of relationship
- Evidence on Policy Options
  - Integrate new understanding of schools

Latin America Then and Now

	GDP/pop 1960	Years schooling	GDP/pop 2000	Growth 1960-2000	Test score
Asia	1891	4.0	13571	4.5	480
Sub-Saharan Africa	2304	3.3	3792	1.4	360
MENA	2599	2.7	8415	2.7	412
Latin America	**4152**	**4.7**	**8063**	**1.8**	**388**
Europe	7469	7.4	21752	2.9	492
Commonwlth OECD	11252	9.5	26147	2.1	500

Cognitive Skills and Long Run Economic Growth



Education in Growth (Theory)

1. Augmented neoclassical growth theories
   - Mankiw/Romer/Weil (QJE 1992)
2. Theories of endogenous growth
   - Lucas (JMonE 1988); Romer (JPE 1990); Aghion/Howitt (1998)
3. Theories of knowledge diffusion
   - Nelson/Phelps (AER 1966); Benhabib/Spiegel (HbEcoGro 2005)

Empirical Progression – Measure of Human Capital

- Simple cross-country growth regressions
  - Enrollment rates (Barro QJE 1991)
- Wide variety of measurement alternatives
  - School enrollment and attainment (Mankiw/Romer/Weil QJE 1992; Levine/Renelt AER 1992; Barro/Lee JMonE 1993)

→ Jacob Mincer + expediency

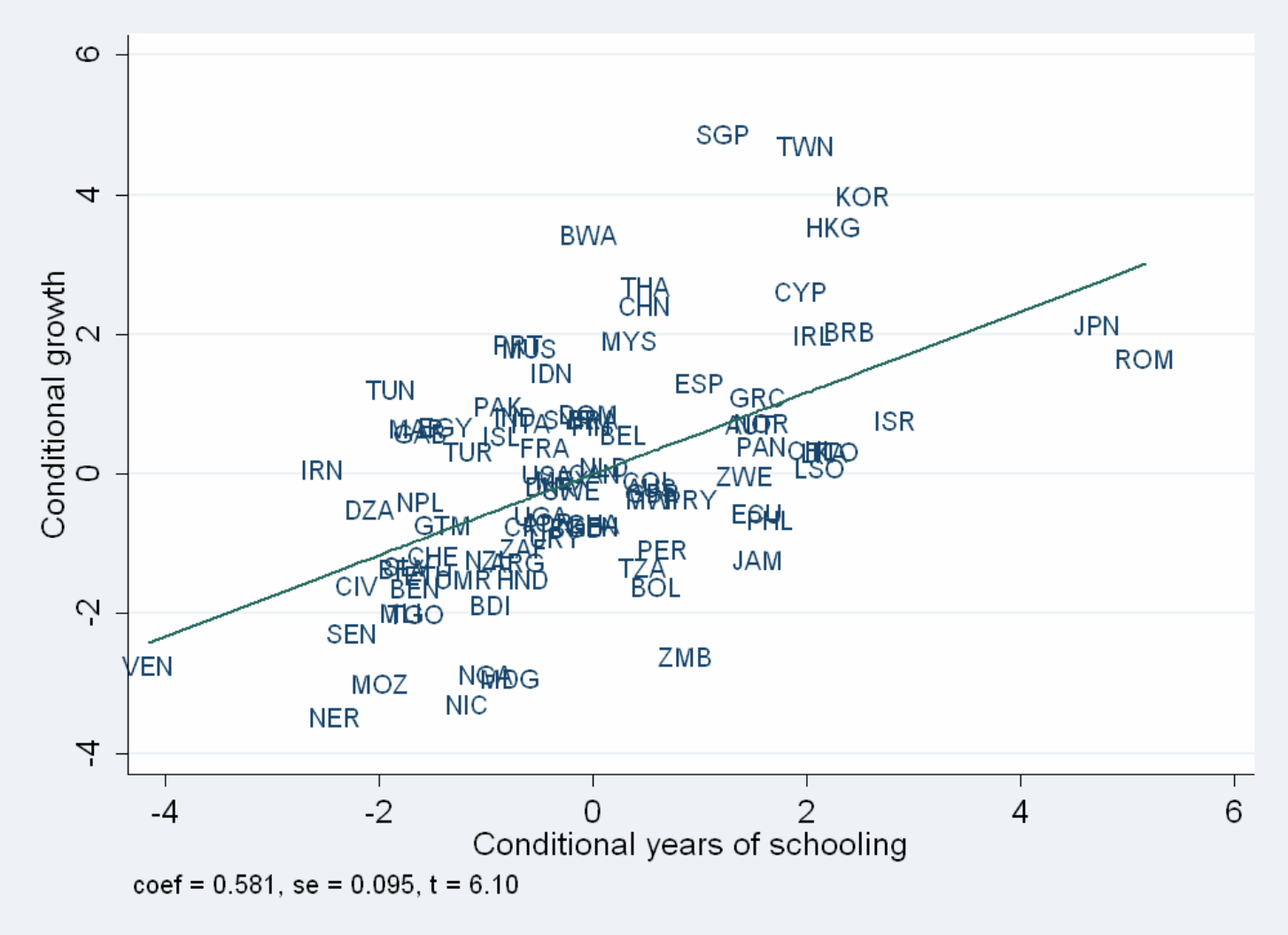
A Simple Growth Model with Cognitive Skills

$$g = \gamma H + \beta X + \varepsilon$$

$$\Downarrow$$

$$g = \gamma S + \beta X + \varepsilon$$

Years of Schooling and Economic Growth



Added-variable plots of a regression of the average annual rate of growth (in percent) of real GDP per capita in 1960-2000 on average years of schooling in 1960 and the initial level of real GDP per capita in 1960.

A Simple Growth Model with Cognitive Skills

$$g = \gamma H + \beta X + \varepsilon$$

$$H = \lambda F + \phi(qS) + \eta A + \alpha Z + \nu$$

Empirical Progression

- Simple cross-country growth regressions
  - Enrollment rates (Barro QJE 1991)
- Wide variety of measurement alternatives
  - School enrollment and attainment (Mankiw/Romer/Weil QJE 1992; Levine/Renelt AER 1992; Barro/Lee JMonE 1993)
- Cognitive skills
  - Hanushek/Kimko (AER 2000); Barro (AER 2001); Woessmann (JESur 2003); Coulombe/Tremblay (TopMac 2006); Ciccone/Papaioannou (RES 2009)
  - Hanushek/Woessmann (JEL 2008, J Econ Growth 2012)

International Student Achievement Tests

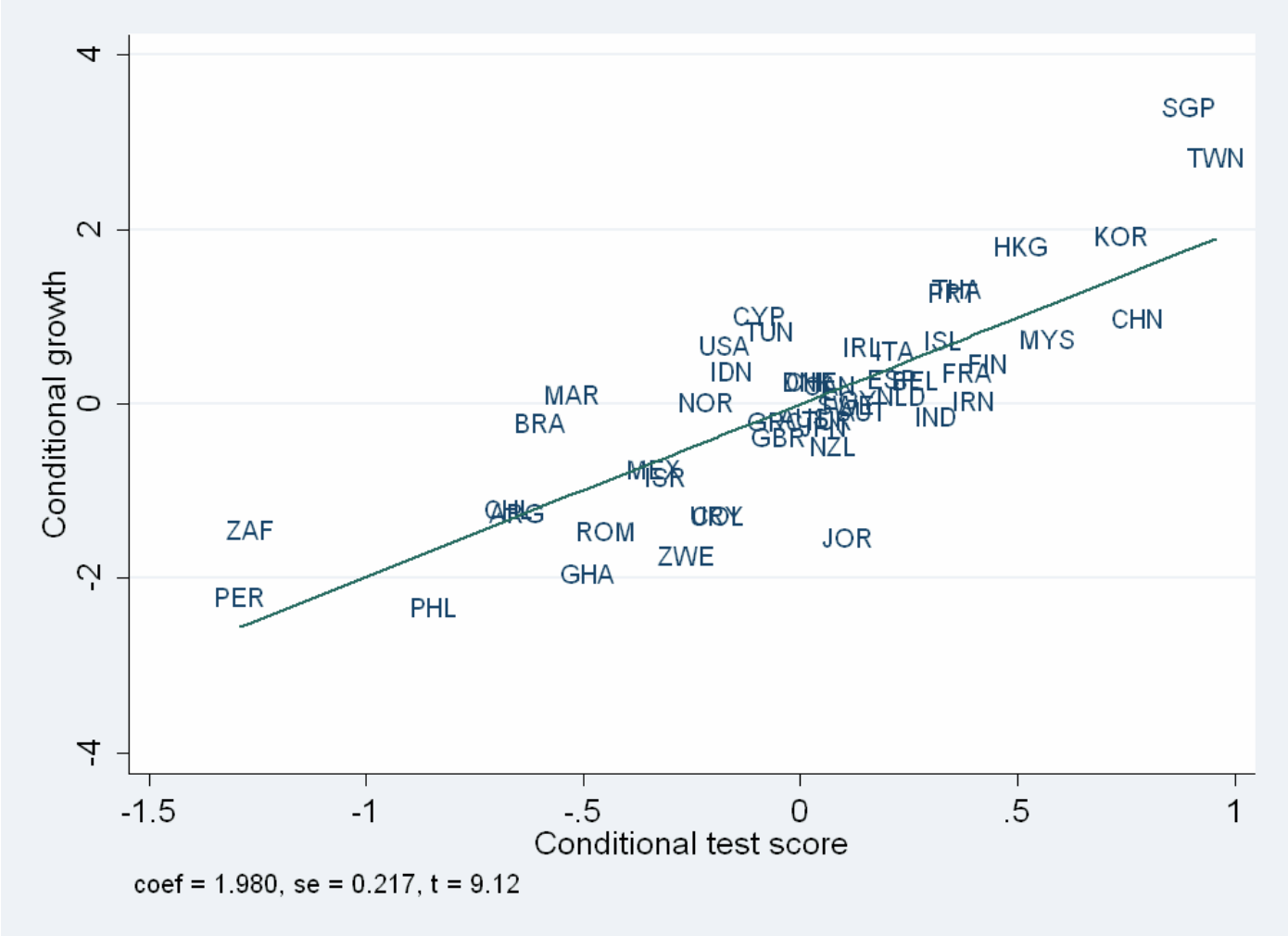
- Measuring knowledge, not sitting in the classroom
- International agencies have conducted many international tests of students' performance in cognitive skills since mid-1960s
  - 12 testing occasions, 36 separate test observations (age levels, subjects)
- Combine into single measure of human capital

Years of Schooling vs. Cognitive Skills in Growth Regressions

	(1)	(2)	(3)
Cognitive skills		2.015	1.980
		(10.68)	*(9.12)*
Years of schooling 1960	0.369		0.026
	(3.23)		*(0.34)*
GDP per capita 1960	-0.379	-0.287	-0.302
	(4.24)	*(9.15)*	*(5.54)*
No. of countries	50	50	50
R^2 (adj.)	0.252	0.733	0.728

Notes: Dependent variable: average annual growth rate in GDP per capita, 1960-2000. Regressions include a constant. Test scores are average of math and science, primary through end of secondary school, all years. *t*-statistics in parentheses.

Cognitive Skills and Economic Growth



Added-variable plots of a regression of the average annual rate of growth (in percent) of real GDP per capita in 1960-2000 on the initial level of real GDP per capita in 1960, average test scores on international student achievement tests, and average years of schooling in 1960.

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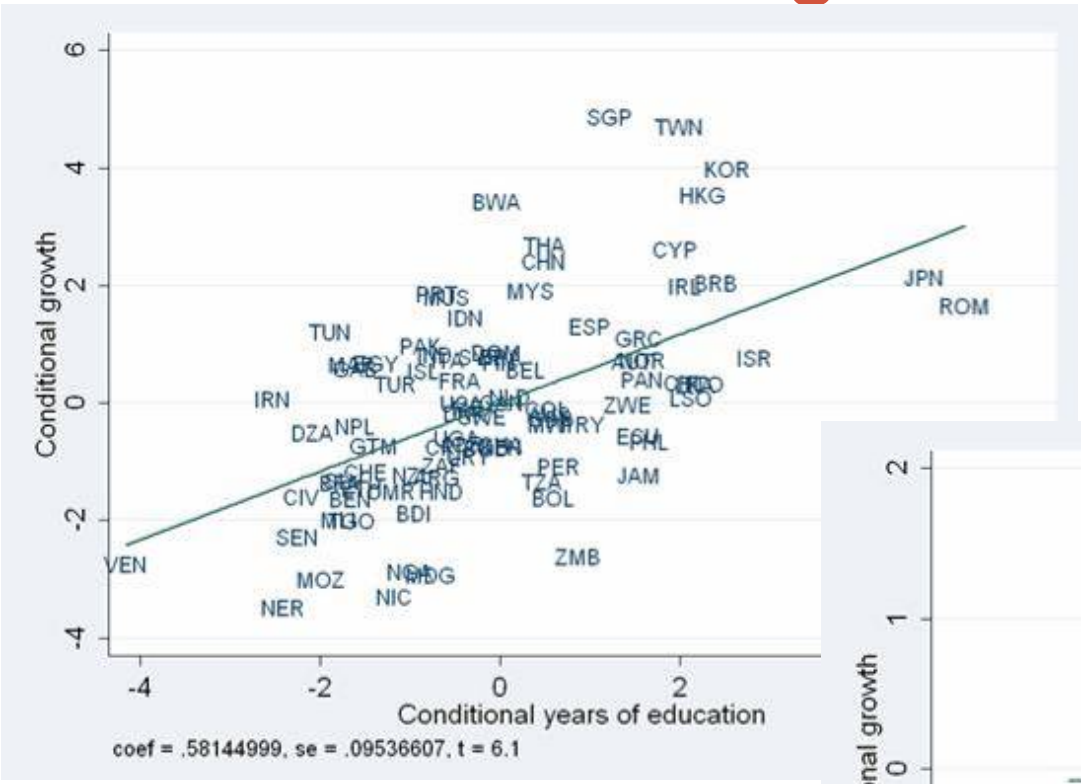
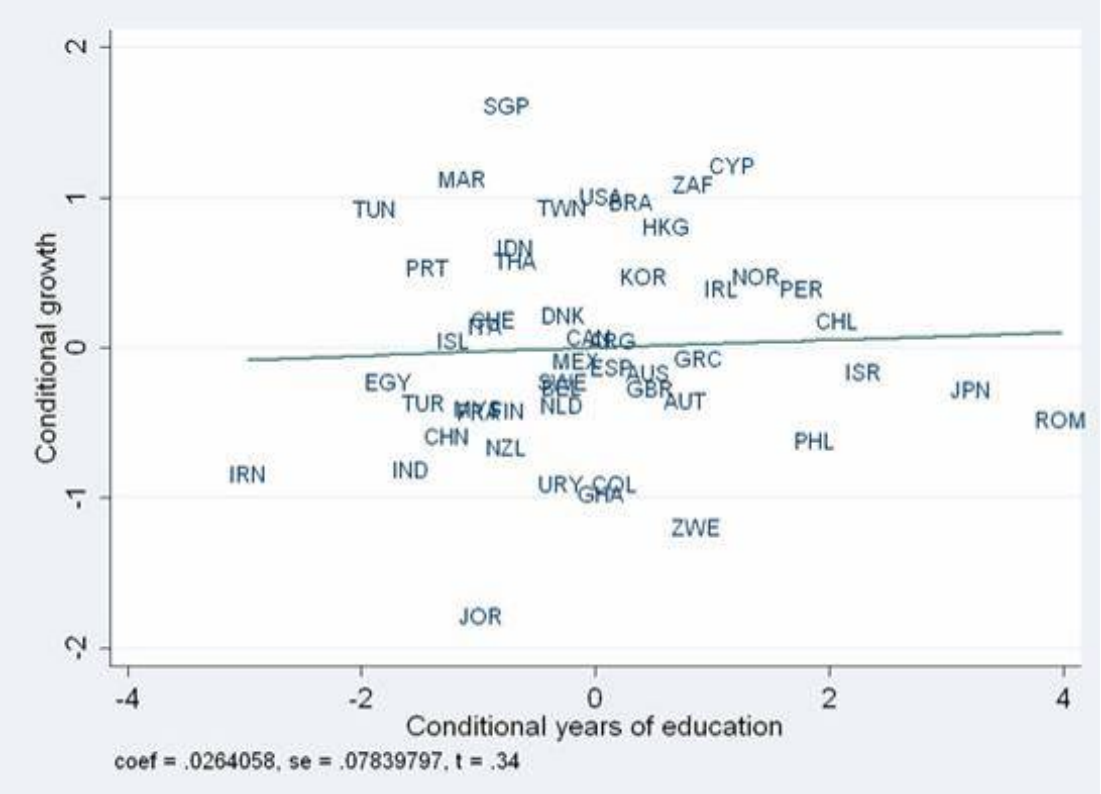
Years of Schooling and Economic Growth

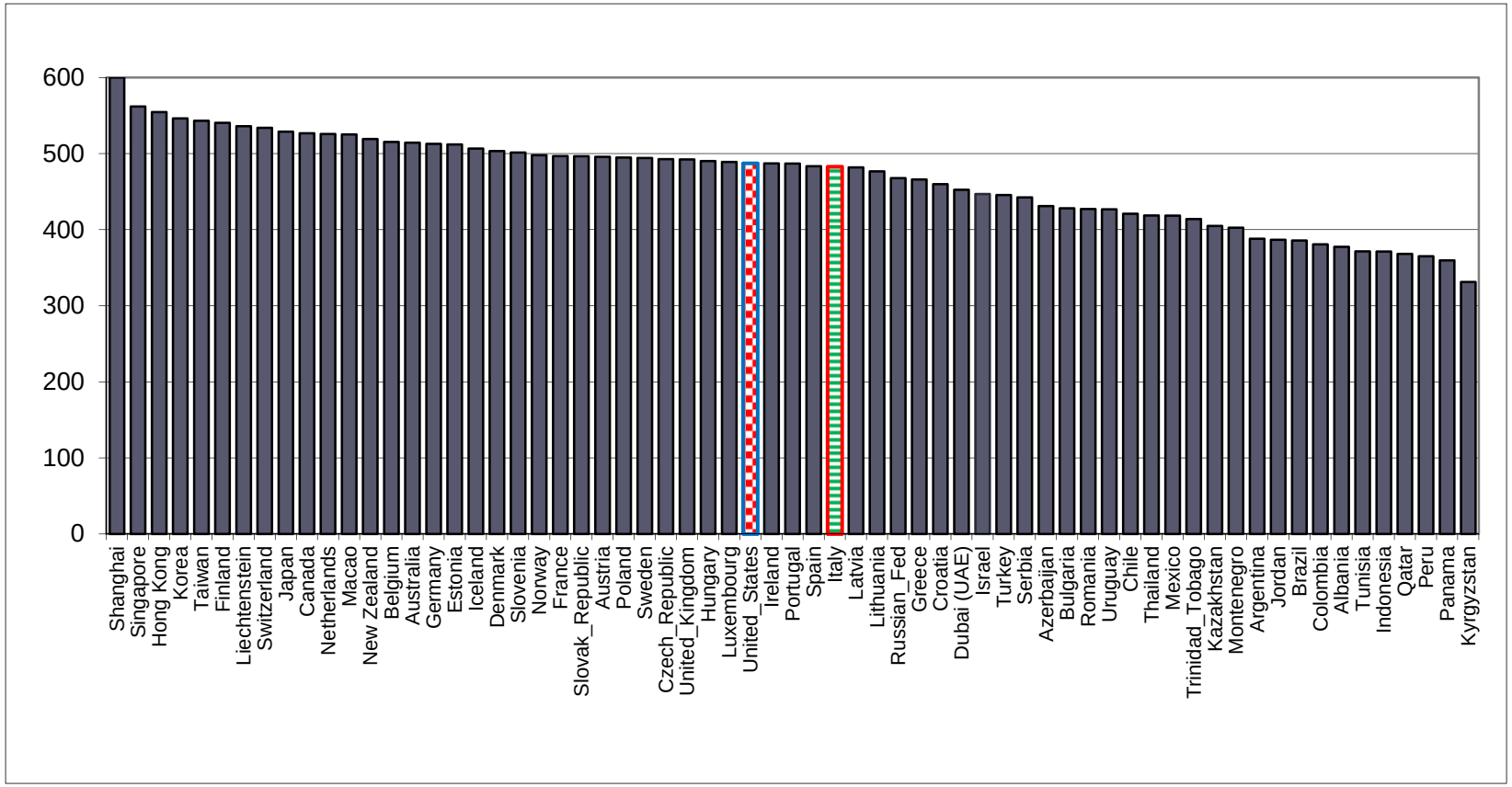


Without quality control

With quality control



PISA Mathematics Achievement, 2009



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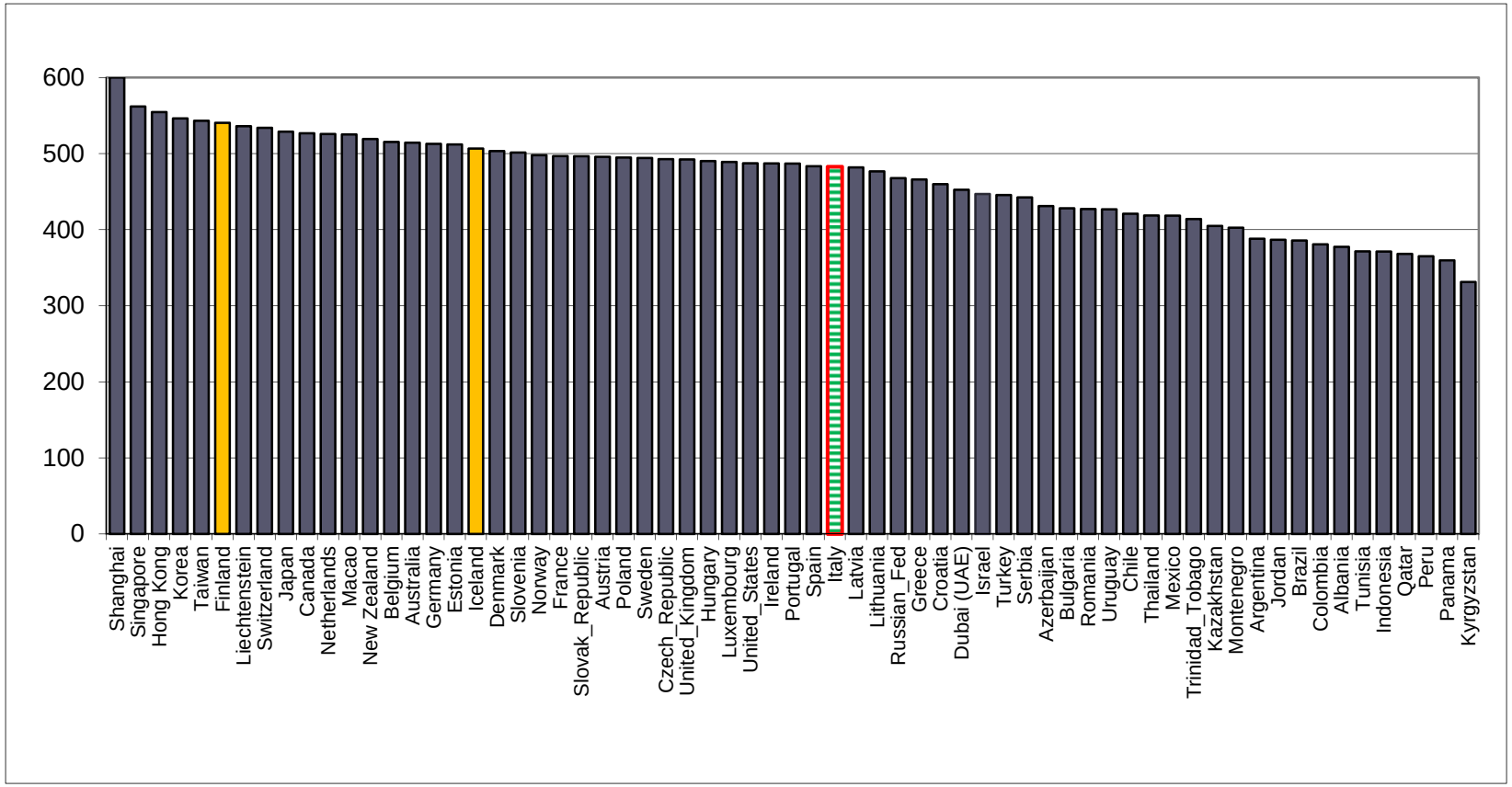
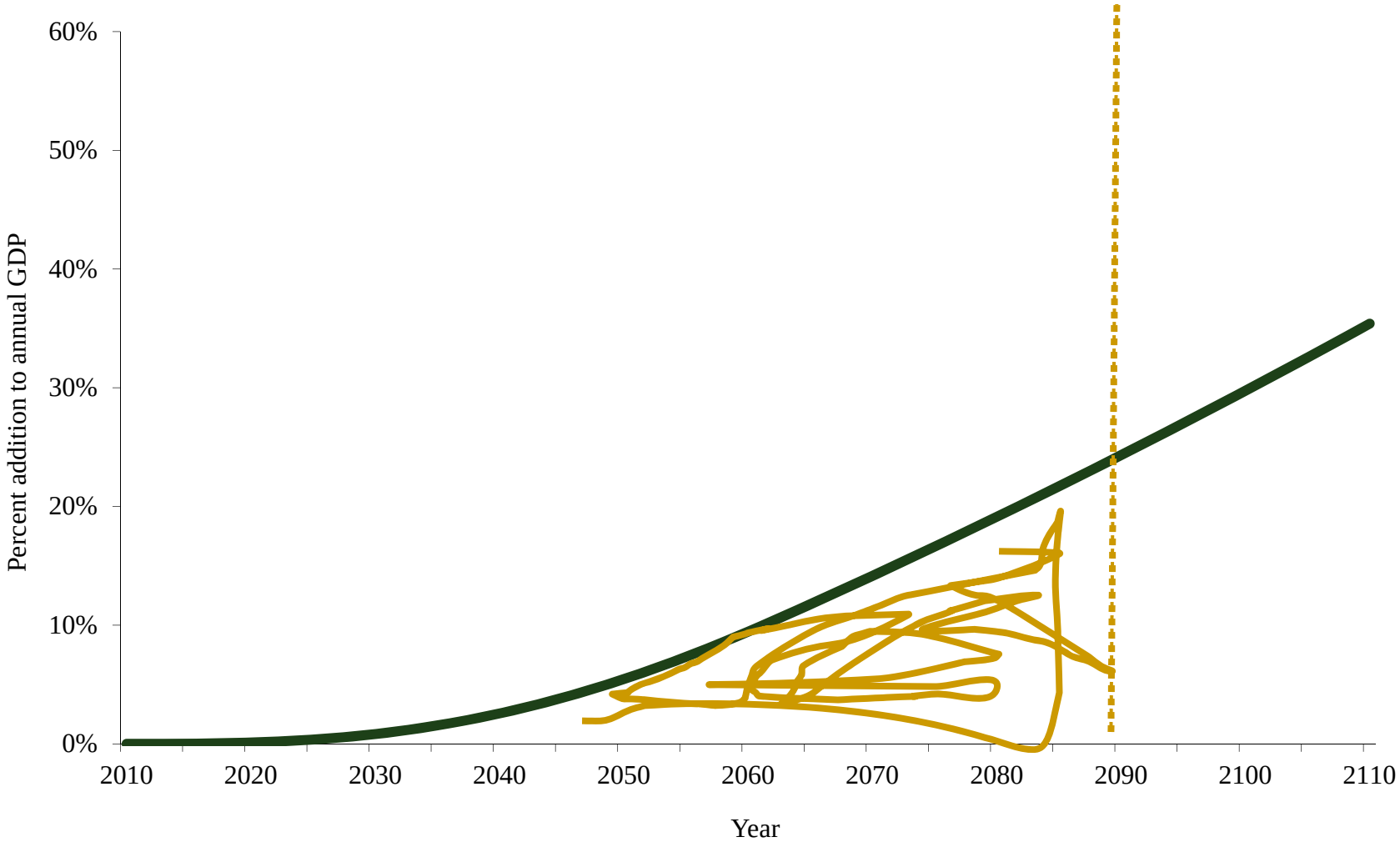


Projecting the Benefits of Reform

- School reform takes time (assumed 20 years)
- Improved schools take time to impact average skills of workers (2.5% replaced each year)
- Growth without improvement at 1.5%
- Present value of reform bonus discounted at 3%
- Calculated for lifetime of person born today

Gains from School Improvement



Economic Value of Improvement (Italy)

	Reaching Iceland	Reaching Finland	Achieving EUROPE 2020
Endogenous Growth			
Present value (billion €)	4126	17291	6886
% discounted GDP	6.2	25.9	10.3

Economic Value of Improvement (Italy)

	Reaching Iceland	Reaching Finland	Achieving EUROPE 2020
Endogenous Growth			
Present value (billion €)	4126	17291	6886
% discounted GDP	6.2	25.9	10.3
Neoclassical			
Present value (billion €)	2918	11402	4680
% discounted GDP	4.2	16.5	6.8

Adam Smith

"The great Earl of Warwick is said to have entertained every day, at his different manors, 30,000 people; and though the number here may have been exaggerated, it must, however, have been very great to admit of such exaggeration."

***The Wealth of Nations,* Book III, chapter 4**

Robustness Tests

1. Sensitivity to additional controls
2. Sensitivity to sample of countries and time periods
3. Sensitivity to measurement of skills

Years of Schooling vs. Cognitive Skills in Growth Regressions

	(1)	(2)	(3)	(4)[a]	(5)[b]	(6)[c]	(7)[d]	(8)[e]
Cognitive skills		2.015	1.980	1.975	1.933	1.666	1.265	1.239
		(10.68)	*(9.12)*	*(8.28)*	*(8.29)*	*(5.09)*	*(4.06)*	*(4.12)*
Years of schooling 1960	0.369		0.026	0.024	0.025	0.047	0.004	-0.049
	(3.23)		*(0.34)*	*(0.78)*	*(0.29)*	*(0.54)*	*(0.05)*	*(0.66)*
GDP per capita 1960	-0.379	-0.287	-0.302	-0.298	-0.298	-0.255	-0.351	-0.310
	(4.24)	*(9.15)*	*(5.54)*	*(6.02)*	*(5.04)*	*(3.12)*	*(6.01)*	*(5.73)*
No. of countries	50	50	50	50	52	50	47	45
R^2 (adj.)	0.252	0.733	0.728	0.728		0.706	0.784	0.797

Notes: Dependent variable: average annual growth rate in GDP per capita, 1960-2000. Regressions include a constant. Test scores are average of math and science, primary through end of secondary school, all years. *t*-statistics in parentheses.

a. Measure of years of schooling refers to the average between 1960 and 2000.

b. Robust regression including two outliers (using *rreg* robust estimation command implemented in Stata).

c. Specification includes dummies for the eight world regions depicted in Figure 1.

d. Specification includes additional controls for openness and property rights.

e. Specification includes additional controls for openness, property rights, fertility, and tropical location.

Sensitivity of Effect of Cognitive Skills to Sample of Countries and Time Periods

Country/year sample ► ▼ Test-score specification	(1) Full	(2) OECD	(3) Non-OECD	(4) High-income[a]	(5) Low-income[a]	(6) W/o East Asia	(7) 1960-1980	(8) 1980-2000	(9) 1980-2000[b]	(10) Score-years outliers[c]	(11) Score-years core[c]
All math and science	1.980	1.736	2.056	1.287	2.286	1.301	1.522	2.996	3.523	1.888	2.175
	(9.12)	*(4.17)*	*(6.10)*	*(5.37)*	*(6.98)*	*(4.90)*	*(4.29)*	*(9.42)*	*(2.89)*	*(7.81)*	*(3.47)*
Only lower secondary	1.759	1.646	1.792	1.040	2.083	1.137	1.407	2.580	3.703	1.673	1.887
	(9.22)	*(4.02)*	*(6.19)*	*(4.70)*	*(7.44)*	*(4.82)*	*(4.56)*	*(8.88)*	*(3.49)*	*(7.83)*	*(3.45)*
No. of countries	50	23	27	25	25	40	50	50	22	25	25

Notes: Reported numbers are the coefficient on test scores in each model specification. Dependent variable: Unless noted otherwise, average annual growth rate in GDP per capita, 1960-2000. Control variables: Initial GDP per capita, initial years of schooling, and a constant. Test scores: Unless noted otherwise, average of math and science, primary through end of secondary school, all years. *t*-statistics in parentheses.

a. Countries above/below sample median of GDP per capita 1960.

b. Test scores refer only to tests performed until 1984.

c. Countries with largest (outliers)/smallest (core) residuals when regressing years of schooling on test scores.

Causality

- Years of schooling: Bils and Klenow (AER 2000)

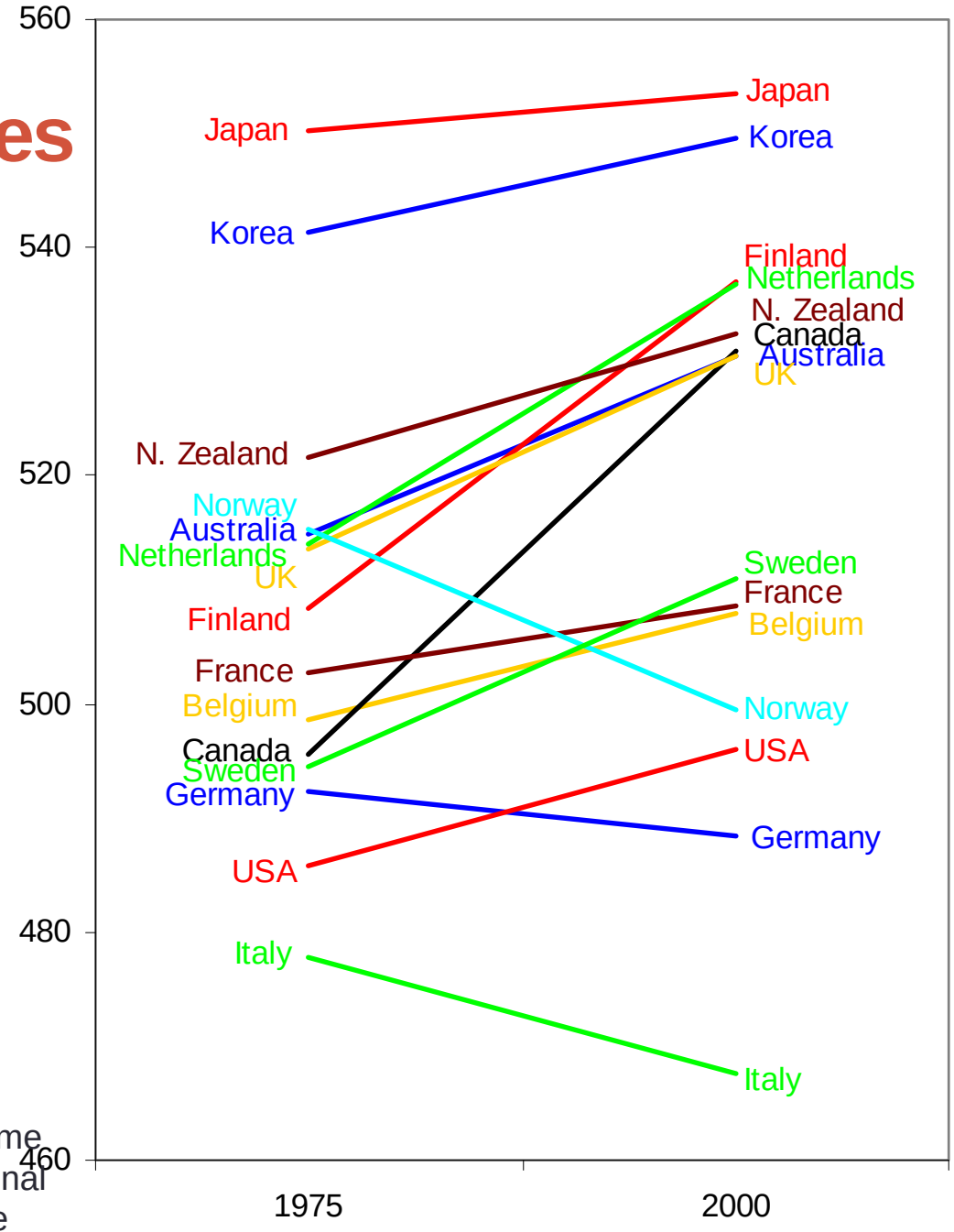
1. IV Models

- Variations in cognitive skills driven by institutional characteristics of the school systems (central exams, private schooling, teacher salaries, Catholic schools, autonomy)
- IV rules out that simple reverse causality or that test scores just reflect family background

2. DiD Model I

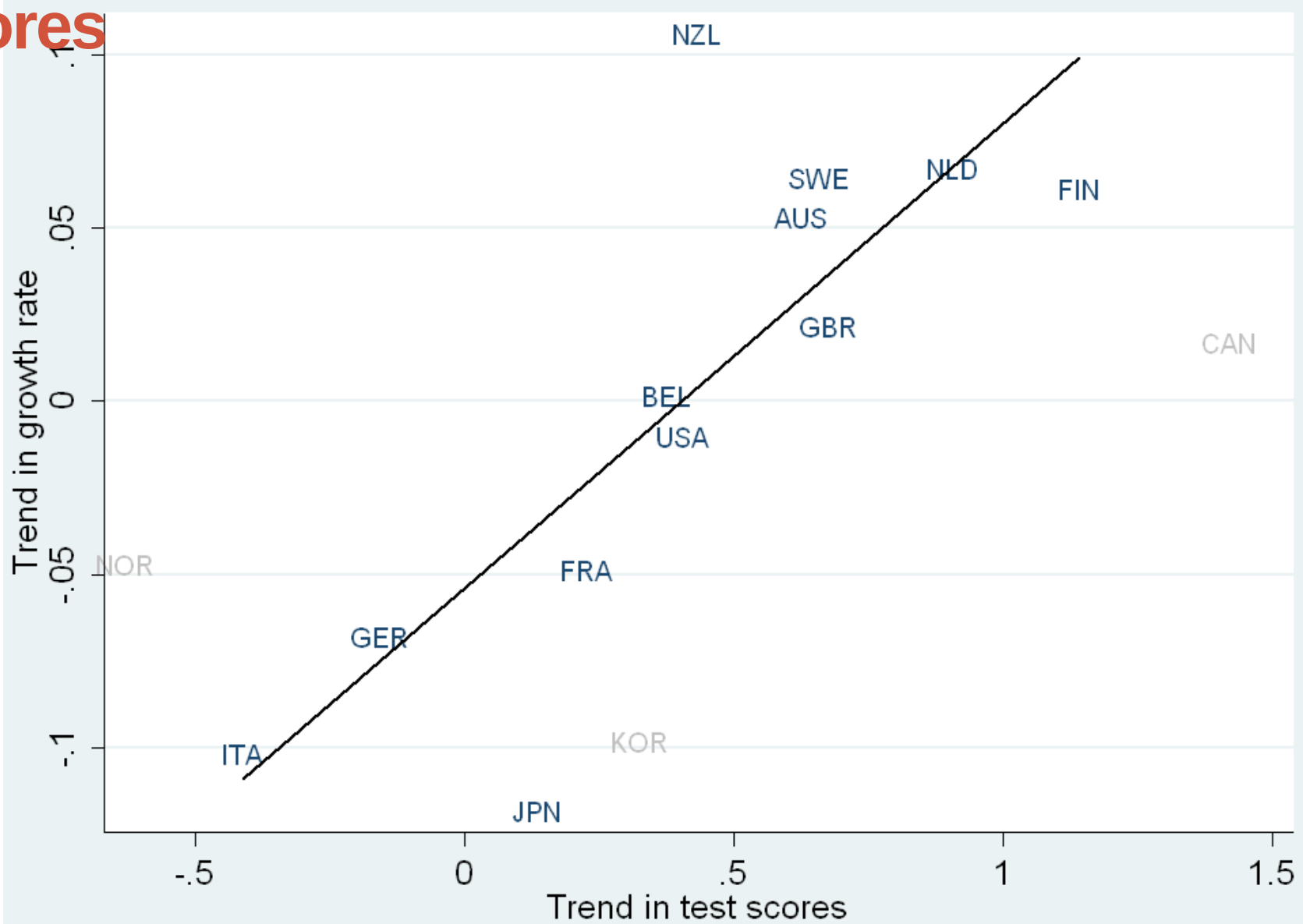
- Changes in test scores and changes in growth paths
- Eliminating level effects which may be interrelated with country-specific institutions and cultures

Trends in Test Scores



Depiction based on PISA 2000 performance and a backward induction based on the coefficient on a time variable from a regression of all available international test scores (by year, age group, and subject) on the time variable and dummies for age group and subject.

Trends in Growth Rates vs. Trends in Test Scores



Scatter plot of trend in annual growth rate of GDP per capita from 1975 to 2000 against trend in test scores.

Causality

- Years of schooling: Bils and Klenow (AER 2000)

1. IV Models

- Variations in cognitive skills driven by institutional characteristics of the school systems
- IV rules out that, e.g., test scores just reflect family background

2. DiD Model I

- Changes in test scores and changes in growth paths
- Eliminating level effects which may be interrelated with country-specific institutions and cultures

3. DiD Model II

- Comparing the impacts of U.S. and home-country education of immigrants on the U.S. labor market
- DiD rules out that test scores simply reflect cultural factors or economic institutions of home country

Comparing the Impacts of U.S. and Home-Country Education on the U.S. Labor Market: A DiD Specification

$$\ln y_{ic} = \alpha_0 + \alpha_1 S_{ic} + \alpha_2 PE_{ic} + \alpha_3 PE_{ic}^2 + \gamma_y H_{ic} + \upsilon_{ic}$$

$$\ln y_{ic} = \alpha_0 + \alpha_1 S_{ic} + \alpha_2 PE_{ic} + \alpha_3 PE_{ic}^2 + [\alpha_4 ORIGIN_i + \delta \overline{T}_c + \delta_O (\overline{T}_c \times ORIGIN_i)] + \upsilon_{ic}$$

DiD Estimates of Returns to Country-of-Origin Cognitive Skills for U.S. Immigrants

Sample:	U.S. educated[a] (1)	Educated in country of origin[b] (2)	All immigrants (3)	W/o Mexico (4)	All immigrants (5)	W/o Mexico (6)	Growth sample[c] (7)	Only English speaking countries (8)
Cognitive skills x Educated in country of origin			0.0873	0.1324	0.1375	0.1398	0.1670	0.1616
			(2.02)	*(3.31)*	*(3.16)*	*(4.13)*	*(3.77)*	*(3.57)*
Cognitive skills	0.0050	0.1582	0.0634	-0.0258	not	not	not	not
	(0.14)	*(2.37)*	*(1.06)*	*(1.42)*	identified	identified	identified	identified
Educated in country of origin			-0.1385	-0.1011	-0.1298	-0.0626	-0.1309	-0.0206
			(3.95)	*(3.03)*	*(2.98)*	*(2.07)*	*(2.58)*	*(0.83)*
Years of schooling	0.1155	0.0673	0.0700	0.0863	0.0579	0.0856	0.0553	0.0992
	(14.08)	*(7.35)*	*(7.43)*	*(13.47)*	*(4.14)*	*(17.40)*	*(4.06)*	*(15.41)*
Potential experience	0.0372	0.0235	0.0243	0.0215	0.0241	0.0227	0.0233	0.0205
	(19.71)	*(4.12)*	*(5.67)*	*(4.75)*	*(7.68)*	*(5.57)*	*(6.50)*	*(2.80)*
Potential experience squared	-0.00064	-0.00035	-0.00036	-0.0004	-0.00039	-0.0004	-0.0004	-0.0004
	(13.02)	*(4.79)*	*(6.10)*	*(4.90)*	*(7.40)*	*(5.87)*	*(6.46)*	*(3.25)*
Fixed effects for country of origin	no	no	no	no	yes	yes	yes	yes
Observations	50,597	258,977	309,574	187,506	309,574	187,506	273,213	72,091
No. of countries	64	64	64	63	64	63	47	12
R^2	0.157	0.170	0.180	0.132	0.196	0.150	0.202	0.156

Notes: Dependent variable: log(annual earnings). Cognitive skills refers to average test score of country of origin (centered at zero). Sample: All immigrants identified by country of birth not in school whose age is greater than 25, who are employed, and who earned more than $1,000 in 1999. Immigrants who had obtained some but not all of their education in the U.S. were excluded from the sample. Immigrants from all countries of origin for which there are cognitive-skill scores, except for the following countries (areas) which could not be identified because of census restrictions on release of data for small cells: Swaziland, Slovenia, Macau-China, Luxembourg, Liechtenstein, Estonia, Botswana, Bahrain, Tunisia, and Iceland. Israel could not be identified separately from Palestine; both were assigned the Israeli score. Robust absolute values of *t*-statistics in parentheses with clustering by country of origin. Source: Authors' calculations from 2000 Census IPUMS data.

a. U.S. educated immigrants are identified as immigrating to the U.S. before the beginning year of schooling.

b. Immigrants educated in their country of origin are identified as immigrating to the U.S. after the final year of schooling.

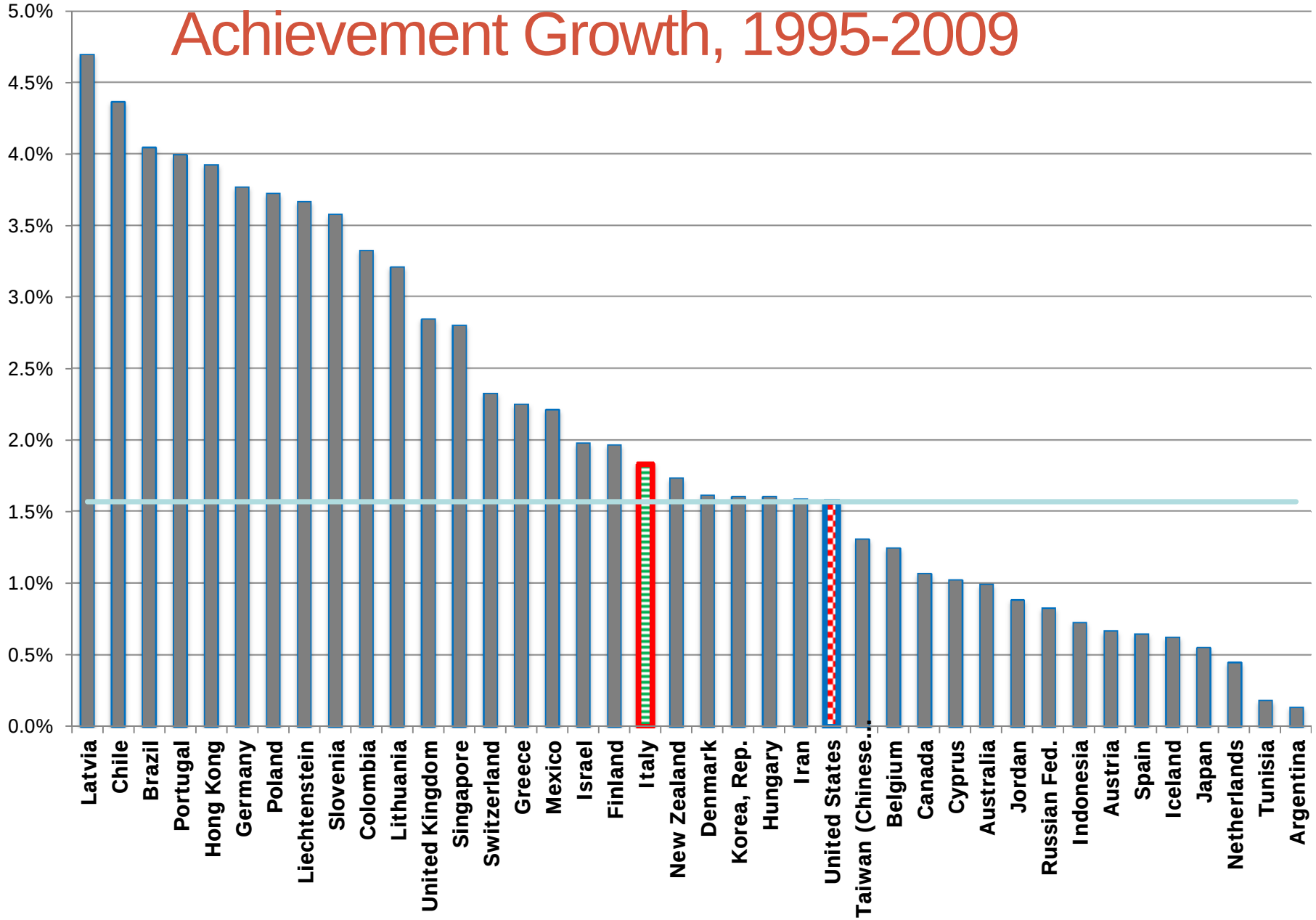
c. The economic growth sample relies on the data for immigrants from the 50 countries in the basic growth regressions.

Conclusion on Growth Estimates

- Strong and robust impact of cognitive skills
- Difficult to determine causality
- Series of alternative approaches
  - Each inconclusive by itself
  - Jointly provide considerable evidence of causal effect

Are there things to be done?

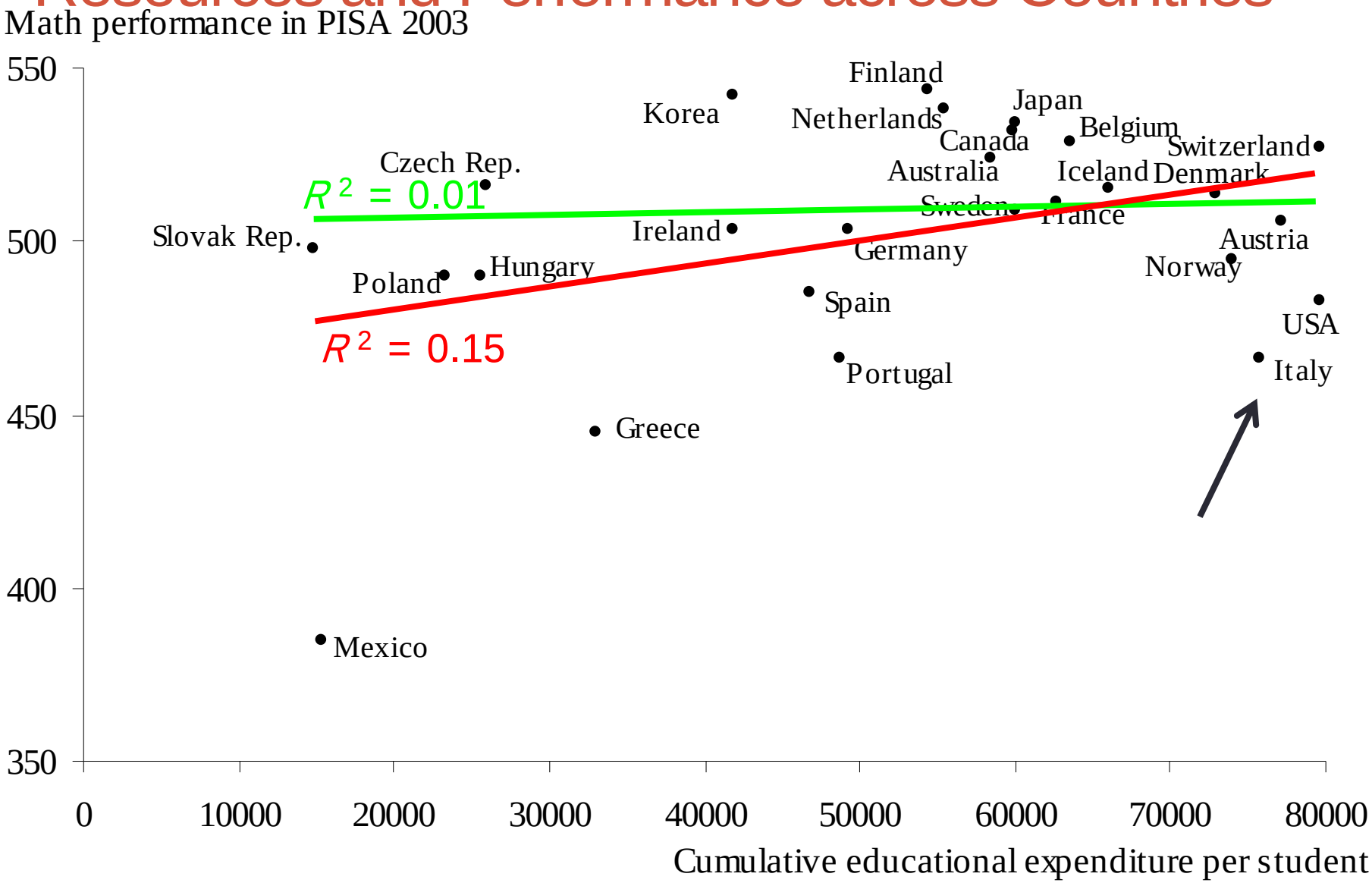
Achievement Growth, 1995-2009



Resource Policies

- Little evidence of success
  - Cross country evidence
  - Within country – developed
  - Within country – developing

Resources and Performance across Countries



Resource Policies

- Little evidence of success
  - Cross country evidence
  - Within country – developed
  - Within country – developing
- Consistent with detailed analysis
  - class size
  - school characteristics

Resource Policies

- Does not say “resources never have effect”
- Does not say “resources cannot have effect”

No expectation within current incentive structure

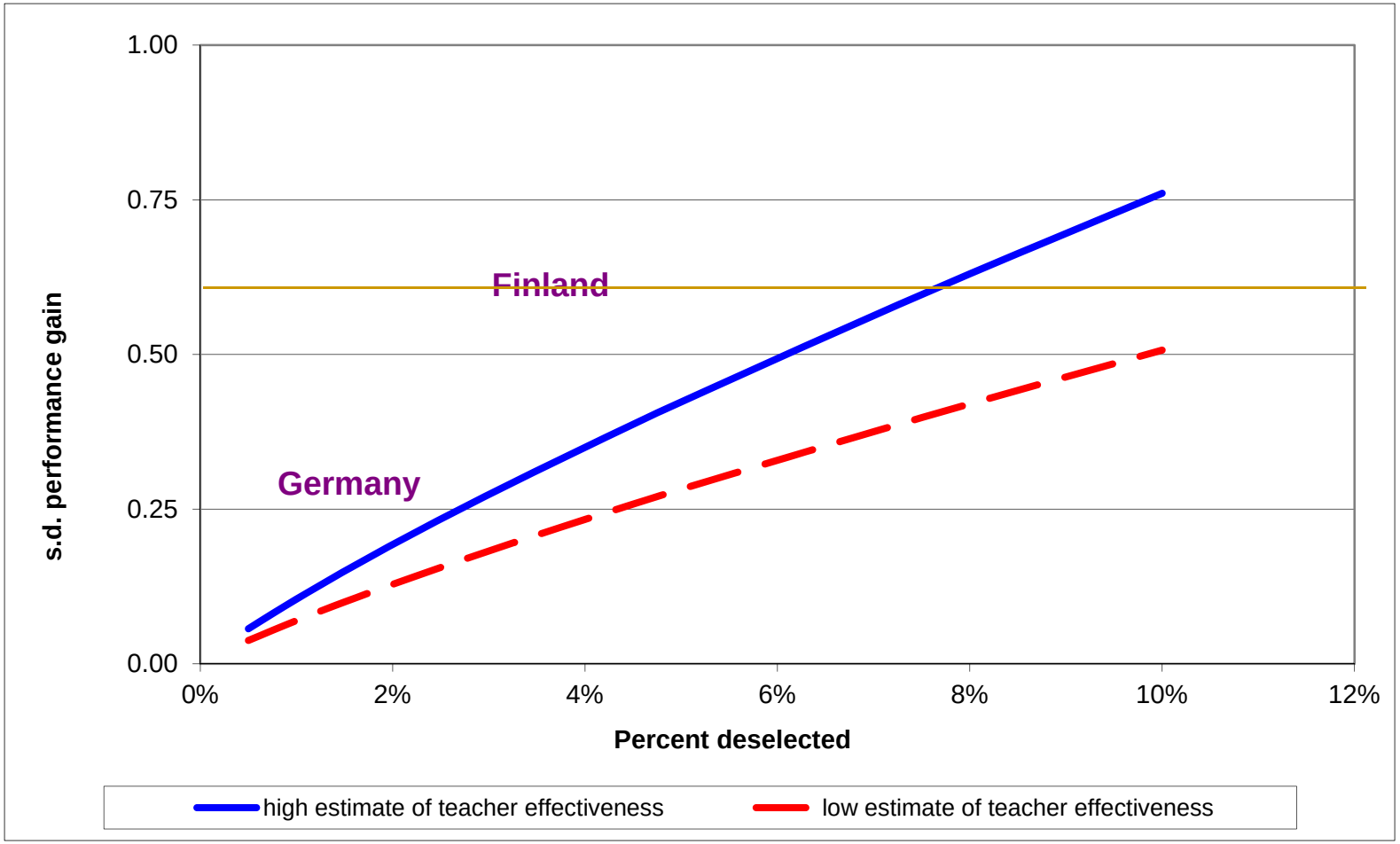
Teacher Quality

- Teachers most important input
- No identifiable characteristics
  - Master's degrees
  - Experience*
  - Certification
  - Preparation
  - Professional development
- Observable through both student performance *and* supervisor ratings
- Cannot regulate and pay on characteristics

Institutional Reforms Supported by Evidence

- Centralized exams
- Accountability
- Autonomy/decentralization
- Choice
- Direct performance incentives

Alternative Estimates of Least Effective Teachers (United States distribution)



Conclusions

- Gains very large from better teachers
- Difference between effective and ineffective enormous
- Gains justify substantial structural change

Cautions

- Gains only with achievement
- Gains take long time
- “too hard” → willing to accept large loss