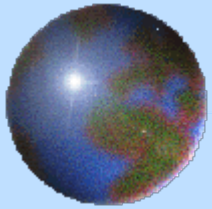


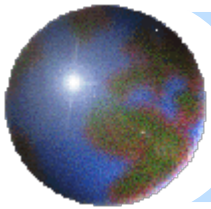
The Importance of School Systems

Evidence from International Differences in Student Achievement

Ludger Woessmann

ifo Center for the Economics of Education

University of Munich



School Systems and Student Achievement

A. Motivation

1. Achievement and economic growth (JEL 2008; JoEG 2012; Science 2016)
2. Resources and achievement (EJ 2001; EPol 2005; EER 2006)

B. An economist's view on international tests

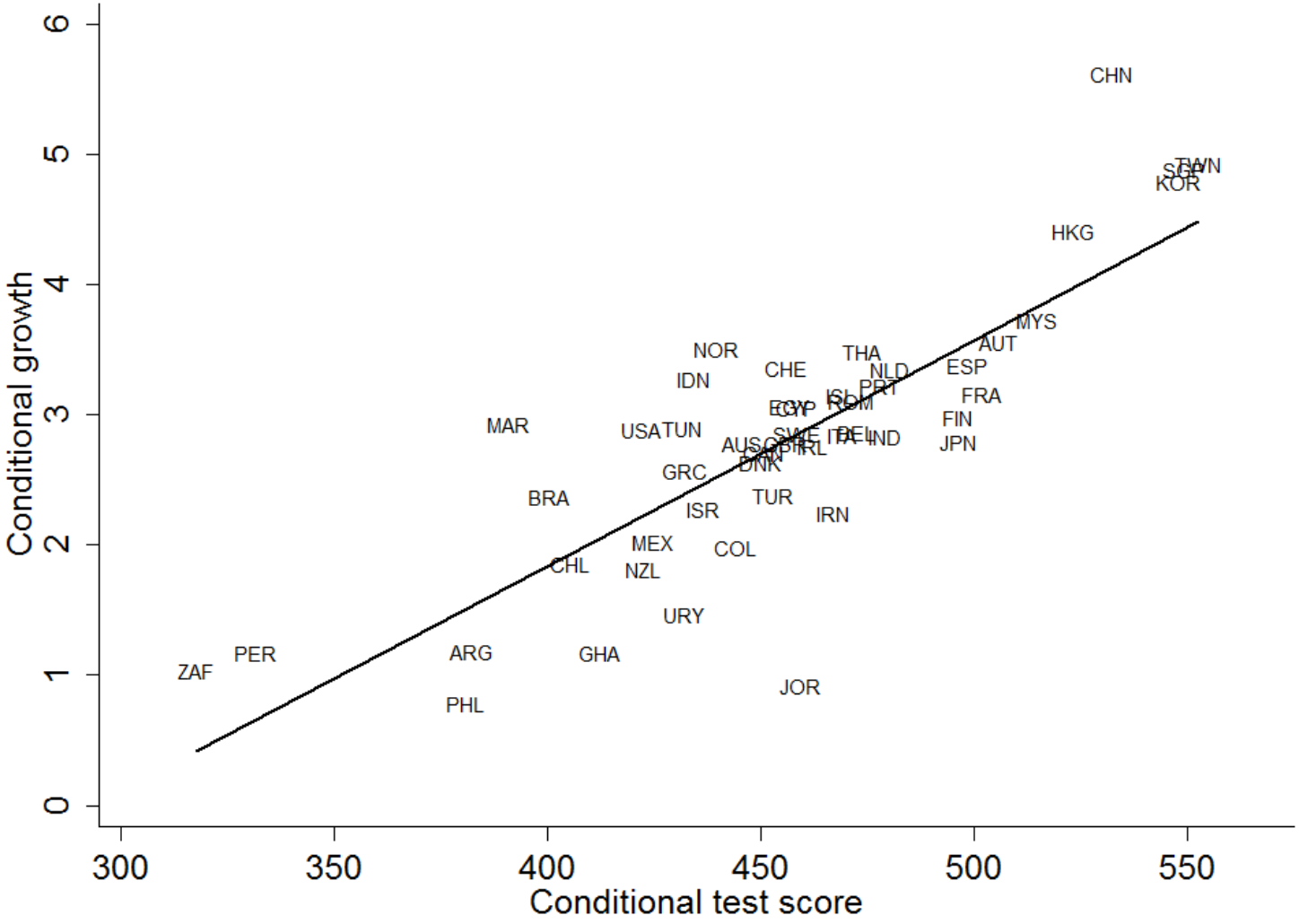
1. Theory: The importance of institutions
2. Data: The promise of international comparisons (OxBES 2003; JEP 2016)
3. Empirical model: The issue of causal identification

C. School systems and student achievement

1. Private competition (EJ 2010)
2. School autonomy (JDE 2013)
3. Student assessments (NBER 2018)
4. Tracking (EJ 2006)

D. Conclusion

Motivation I: Achievement and Economic Growth



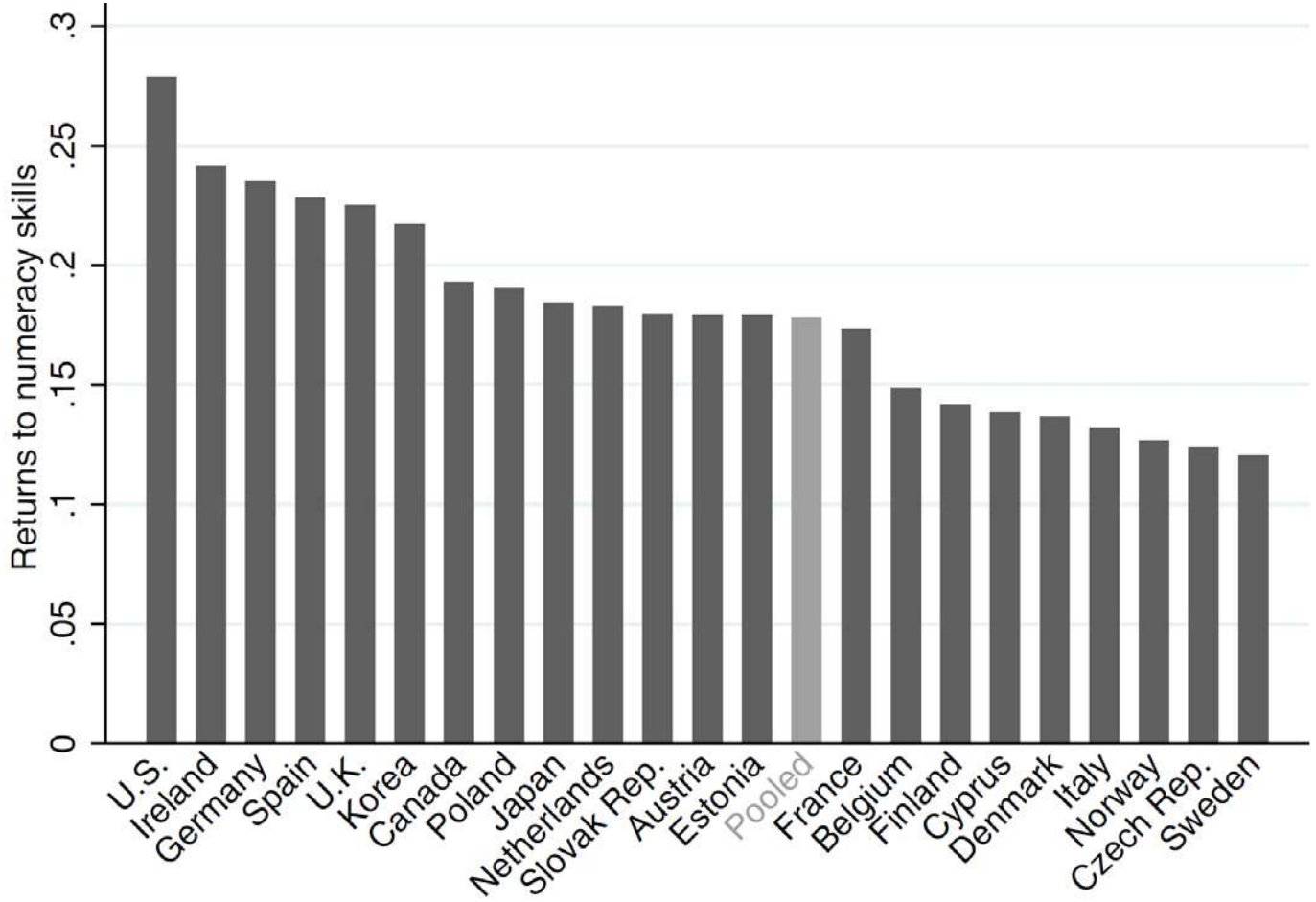
Added-variable plot of regression of average annual growth rate (in percent) of real GDP per capita 1960-2009 on initial level of GDP per capita, initial years of schooling, and average student achievement test scores (mean of unconditional variables added to each axis). Based on Hanushek/Woessmann (JoEG 2012; Science 2016).

Motivation I: Achievement and Economic Growth

- **Causality** (Hanushek/Woessmann *Journal of Economic Growth* 2012)
  - Before-after: scores before 1985, growth since 1985
  - Instrumental variables: institutions of school systems
  - Diffs-in-diffs: home- vs. U.S.-educated immigrants on U.S. labor market
  - Diffs-in-diffs: changes in test scores and in growth paths
- **Evidence from U.S. states**
  - Development accounting (Hanushek/Ruhose/Woessmann *American Economic Journal: Macro* 2017)
- **The cost of low educational achievement**
  - Projections (Hanushek/Woessmann *Economic Policy* 2011; OECD 2015: "Universal Basic Skills")
- **Education and historic economic development**
  - A human capital theory of Protestant economic history (Becker/Woessmann *Quarterly Journal of Economics* 2009)
  - Education and catch-up in the Industrial Revolution (Becker/Hornung/Woessmann *American Economic Journal: Macro* 2011)

Motivation Ib: Achievement and Individual Earnings

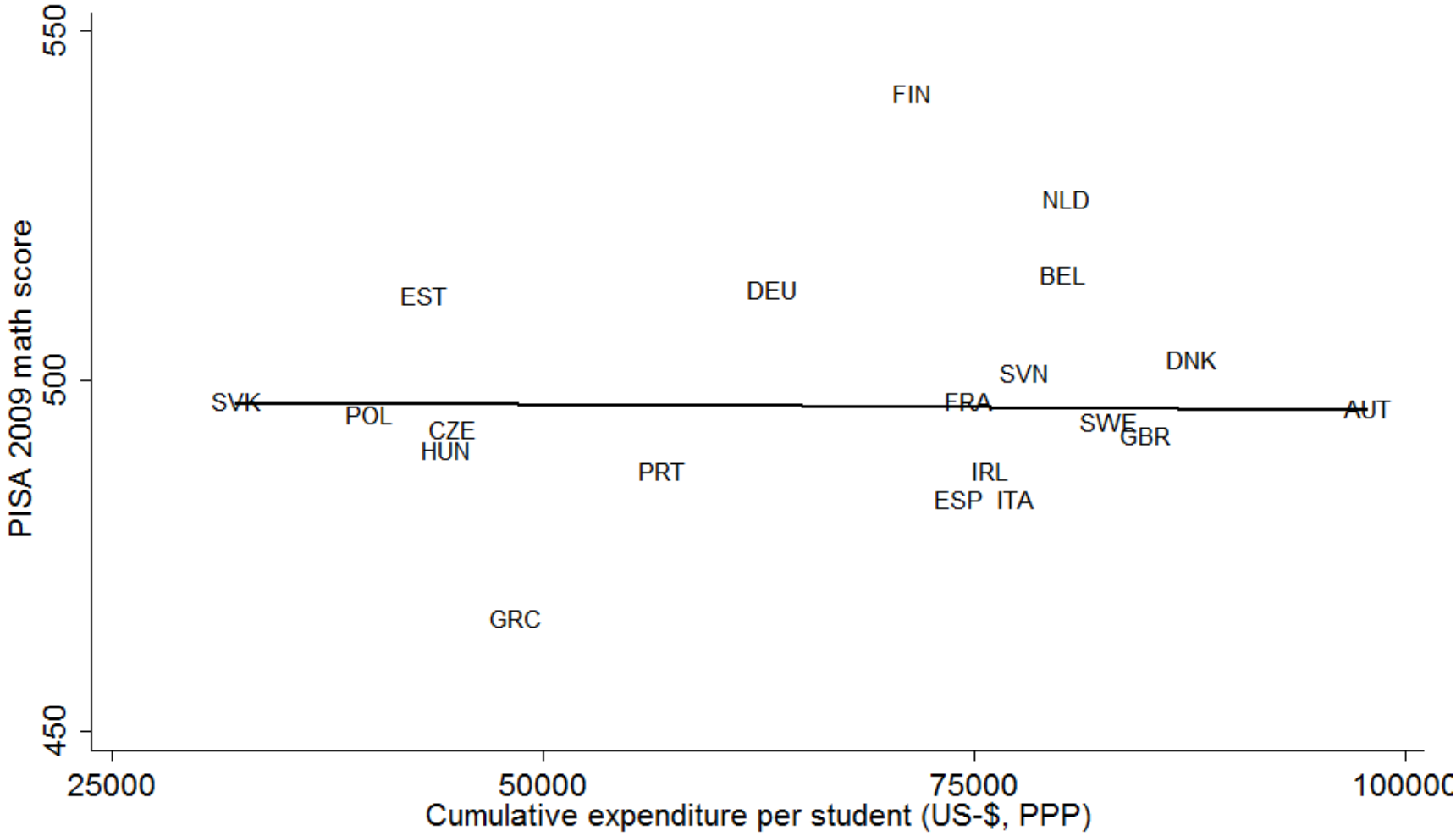
Returns to skills around the world: Evidence from PIAAC



Coefficient estimates on numeracy score (standardized to SD 1 within each country) in a regression of log gross hourly wage on numeracy, gender, and a quadratic polynomial in actual work experience, sample of full-time employees aged 35-54. Data: PIAAC. Source: Hanushek/Schwerdt/Wiederhold/Woessmann (EER 2015; EL 2017).

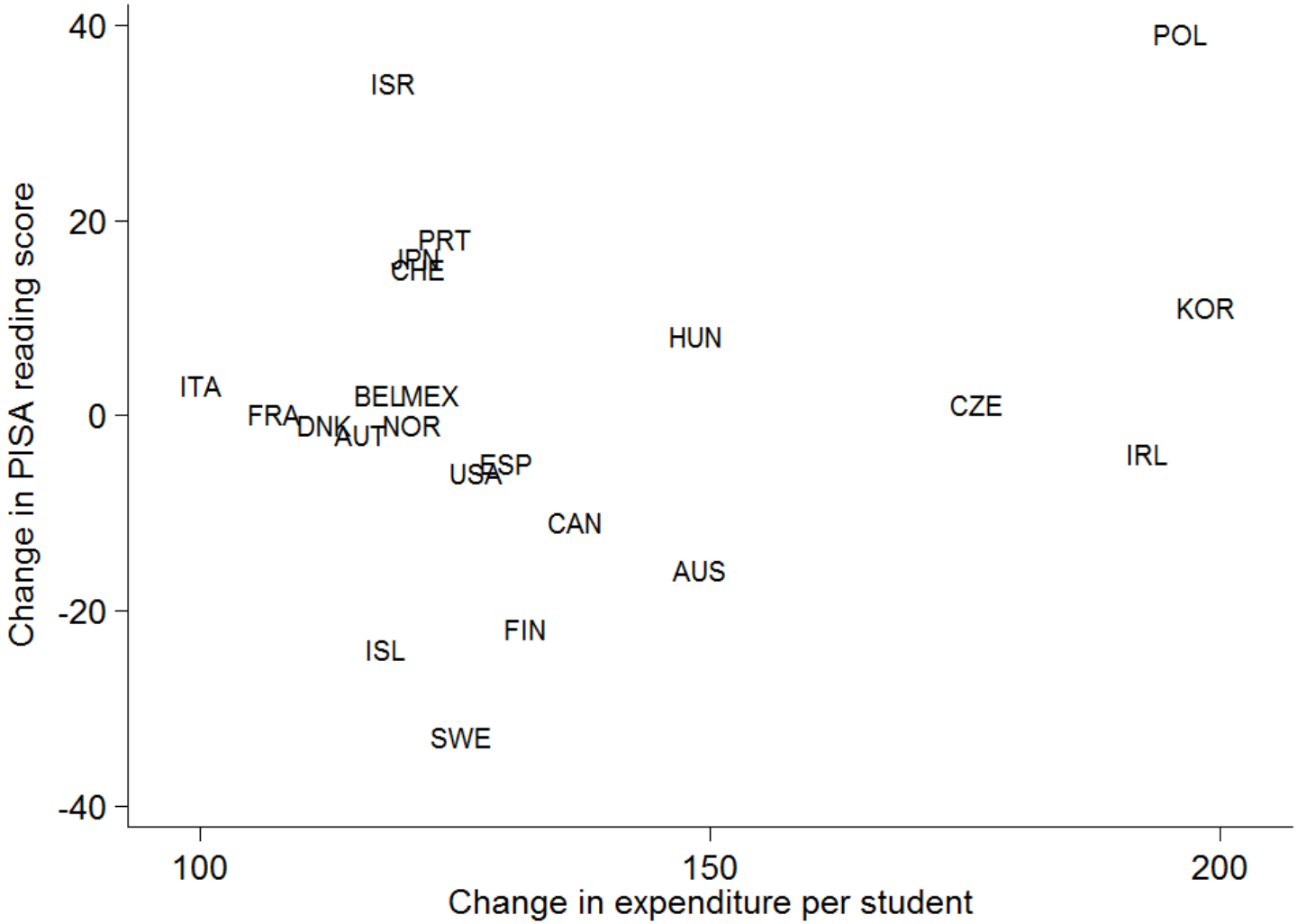
Motivation II: Resources and Achievement

Spending and math achievement of EU countries in PISA:



Own depiction based on PISA 2009 data. Regression line of best fit (without three outliers).

Changes in Educational Spending and in Achievement across Countries



Scatter plot of change in expenditure per student, 2000-2010 (constant prices, 2000 = 100) against change in PISA reading score, 2000-2012. Source: Hanushek/Woessmann (*The Knowledge Capital of Nations* 2015).

Motivation II: Resources and Achievement

- **Expenditures**
  - Changes in spending and changes in achievement (Gundlach/Gmelin/Woessmann *Economic Journal* 2001)
  - Panel fixed effects (Hanushek/Woessmann *Economic Policy* 2011)
- **Class-size effects**
  - Regression discontinuity: maximum class-size rules (Woessmann *Economic Policy* 2005)
  - Instrumental variables, school fixed effects: natural cohort fluctuations (Woessmann/West *European Economic Review* 2006)
- **Computers**
  - Student fixed effects: within-student across-subject variation (Falck/Mang/Woessmann *Oxford Bulletin of Economics and Statistics* 2018)

Theory: Institutions and Achievement

- **Incentives**
  - Best way to use investments efficiently and effectively is to ensure that everyone in the system has incentives to focus on improving student outcomes

→ **Institutional framework**: provides the incentive schemes that create better student outcomes

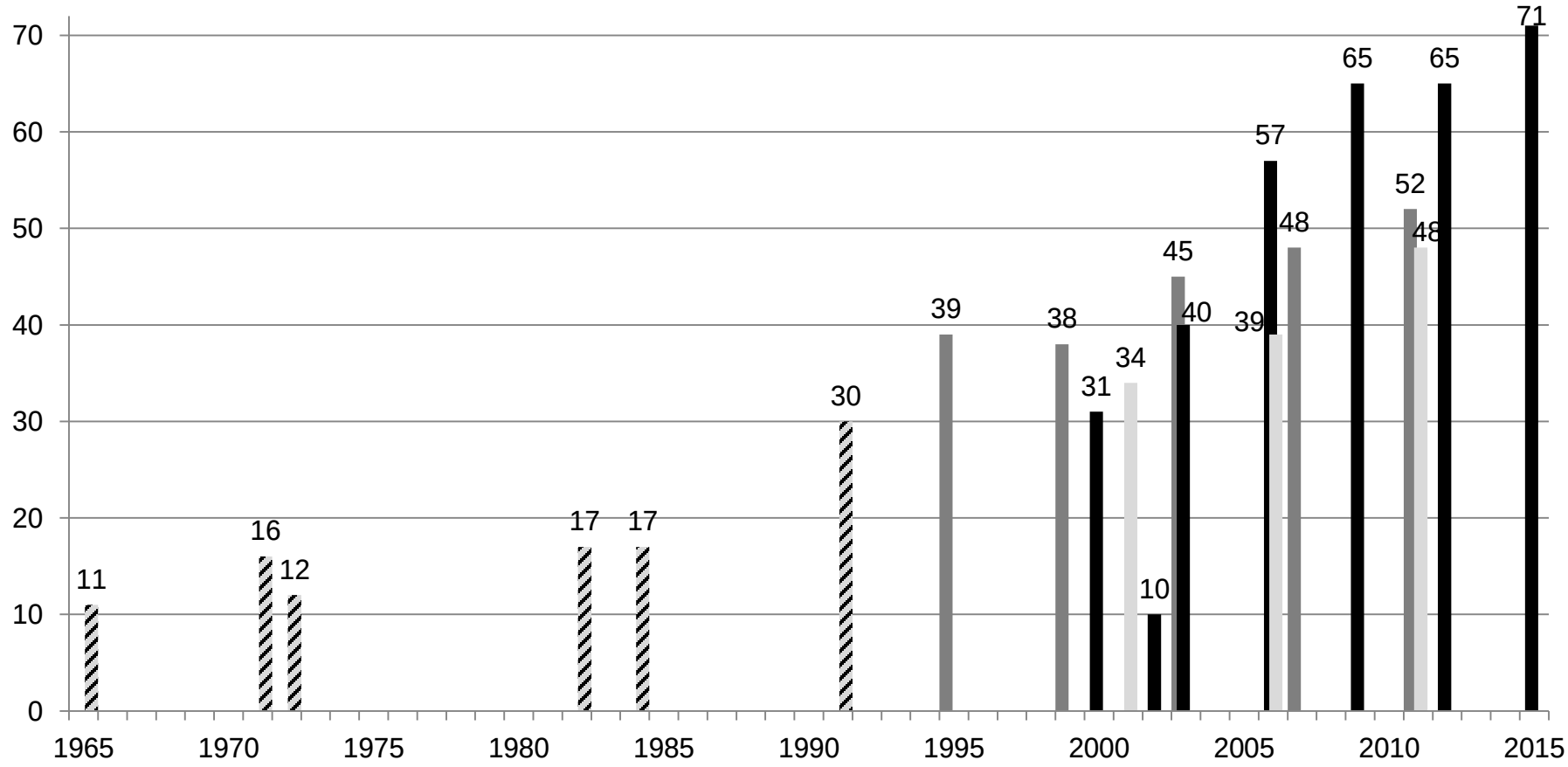
  - Choice and competition
  - Accountability
  - Autonomy

The International Perspective

"If custom and law define what is educationally allowable within a nation, **the educational systems beyond one's national boundaries suggest what is educationally possible**."

Arthur W. Foshay (1962)
on the first pilot study of international student achievement

Data: Countries Participating in International Tests, 1964-2015



Shaded: pre-1995 IEA studies (1964: 1st math; 1971: 1st science; 1972: 1st reading; 1982: 2nd math; 1984: 2nd science; 1991: 2nd reading); dark grey: IEA's TIMSS study; black: OECD's PISA study; light grey: IEA's PIRLS study. Source: Woessmann (JEP 2016).

Strengths and Weaknesses of Cross-Country Comparative Approach

- **Unique advantages**
  1. Exploit variation **uniquely international**
     - E.g., national accountability systems, tracking, private school structure
  2. International variation frequently **larger**
  3. Identify systematic **heterogeneity**: specific vs. general results
  4. Identify **general equilibrium** effects
  5. **Circumvent** key **selection** issues
     - By using system-level aggregated measures

- **Concerns**
  1. Relevant variation often limited to **# countries**
  2. Mostly **cross-sectional**
  3. Possible bias from **unobserved** country factors like culture

→ **Identification** difficult, restricted to certain issues

Empirical Model: Identification in International Test Data

- Early studies **within** different countries
  - Heyneman/Loxley (AJSoc 1983); Toma (JLawEc 1996)
- Early studies using **country-level** variation
  - Bishop (AER 1997); Hanushek/Kimko (AER 2000); Lee/Barro (Eca 2001)
- First econometric studies using international micro data to estimate extensive **multivariate cross-country education production functions**
  - Woessmann (EduNext 2001; OxfBulEcStat 2003; EmpEco 2007; ...)
  - Hold constant large set of observable factors usually unavailable in national datasets (observationally equivalent students)
- Fundamental **challenge**: inputs not exogenous

  1. Omitted variables 2. Selection 3. Reverse causation

→ Interpret OLS estimates as descriptive **stylized facts**

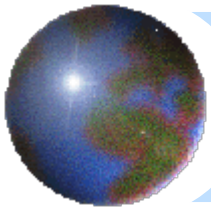
Some Stylized Facts

- Broad **descriptive** patterns
  - Simple model of three combined factors accounts for more than **80%** of total cross-country **variation** in student achievement
  - **Family background** and **institutions** contribute roughly equally
  - Contribution of school **resources** quite limited

Woessmann (*Journal of Economic Perspectives* 2016)

Empirical Model: Identification in International Test Data

- Use of **quasi-experimental** methods
  - Literature started to adopt more elaborate techniques directly developed to address identification issues in specific contexts
  - Intuition: try to get close to set-up of controlled experiments with observational data: nature makes “random assignments”
    → Use as a “natural” or “quasi-experiment”
  - Aim to identify exogenous variation in observational data



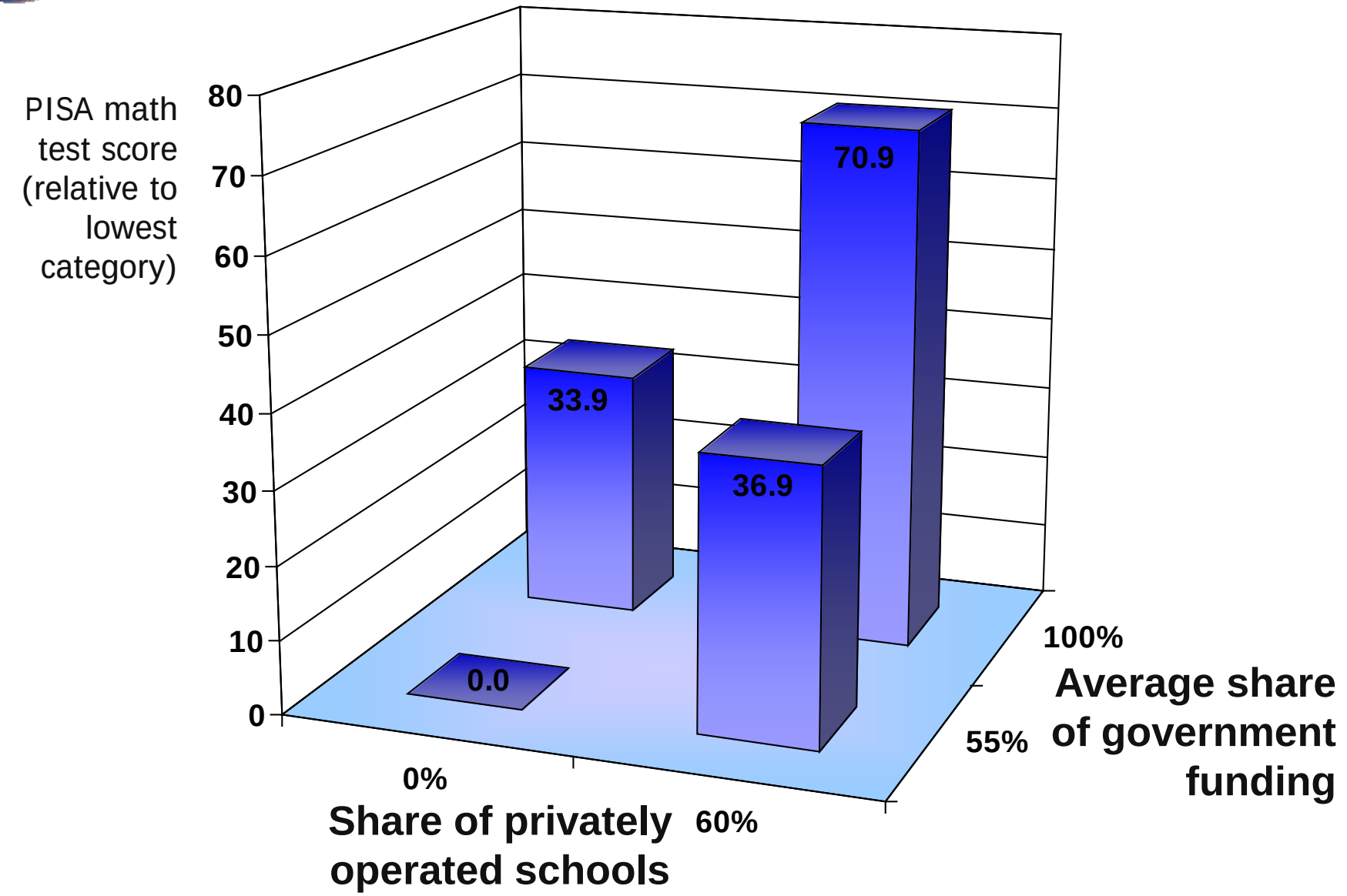
Approaches for Identification in International Test Data

- **Instrumental variables**
  - Class size (Woessmann/West *EER* 2016)
  - Private competition (West/Woessmann *EJ* 2010)
- **Regression discontinuity**
  - Class size (Woessmann *EPol* 2005)
- **Differences-in-differences** (across subjects or grades)
  - Central exams (Jürges/Schneider/Büchel *JEEA* 2005)
  - Tracking (Hanushek/Woessmann *EJ* 2006; Ruhose/Schwerdt *EEduR* 2016)
  - Teaching practices (Schwerdt/Wuppermann *EEduR* 2011; Bietenbeck *LabE* 2014)
  - Class size (Altinok/Kingdon *OxfBul* 2012)
  - Instruction time (Lavy *EJ* 2015; Rivkin/Schiman *EJ* 2015)
  - Teacher cognitive skills (Hanushek/Piopiunik/Wiederhold *JHumR* forthc.)
- **Panel fixed effects**
  - School autonomy (Hanushek/Link/Woessmann *JDevE* 2013)
  - Student assessments (Bergbauer/Hanushek/Woessmann NBER 2018)

School Systems and Student Achievement

1. Private Competition
2. School Autonomy
3. Student Assessments
4. Tracking

1. Private Competition: Private vs. Public Operation & Funding



Woessmann/Luedemann/Schuetz/West (Edward Elgar 2009); Woessmann (MIT Press vol. 2009)

Effects of Private Competition: Instrumental-Variable Estimates

- In late 19th century, Catholic doctrine spurred efforts to establish private schools
  - Most successful in countries with substantial Catholic share (and no Catholic state religion)

Encyclical on the Religious Question in France (1884): The Church "has always expressly condemned mixed or neutral schools; over and over again she has warned parents to be ever on their guard in this most essential point."

Leo XIII

3rd Plenary Council of Baltimore of officials of Catholic Church in United States (1884)

"Every Catholic Child in a Catholic School"

West/Woessmann (*Economic Journal* 2010)

IV Model using Historical "Natural" Experiment

Historical catholic resistance to state schooling

(share Catholics 1900)
(interacted with an indicator whether Catholicism was the state religion)

↓

Private competition today

(share private schools 2003)

↓

Student achievement

(PISA score 2003)

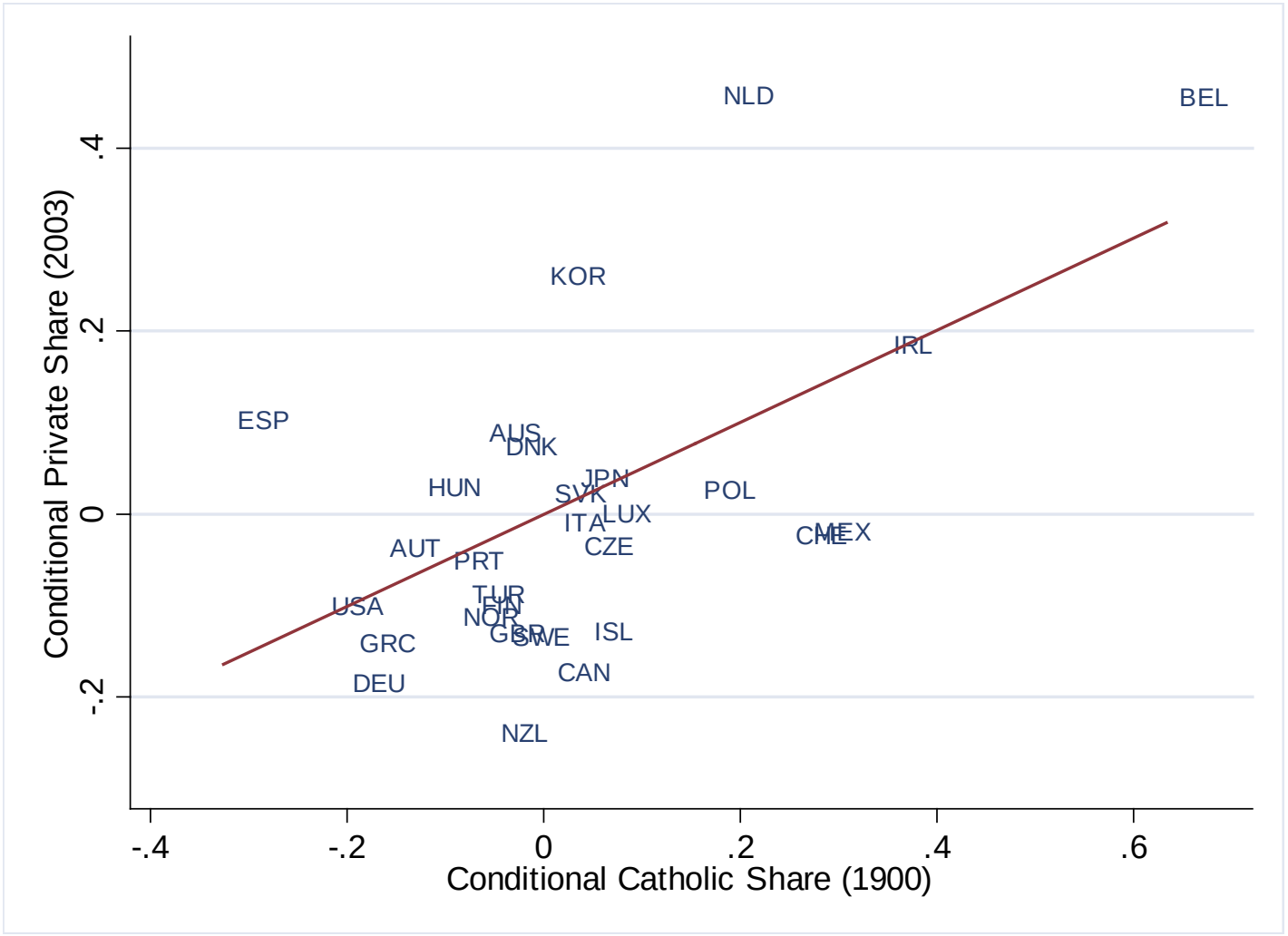
West/Woessmann (*Economic Journal* 2010)

Effects of Private Competition: Instrumental-Variable Estimates

- Identifying assumption
  - 1900 Catholic share not directly related to current student achievement
  - Control for contemporary differences in Catholic share
  - Note: Protestants traditionally place far greater emphasis than Catholics on value of education (Becker/Woessmann QJE 2009)
    - Catholic share negatively associated with literacy rates in 1900 (r = -0.75)

→ Bias against finding beneficial effects of competition

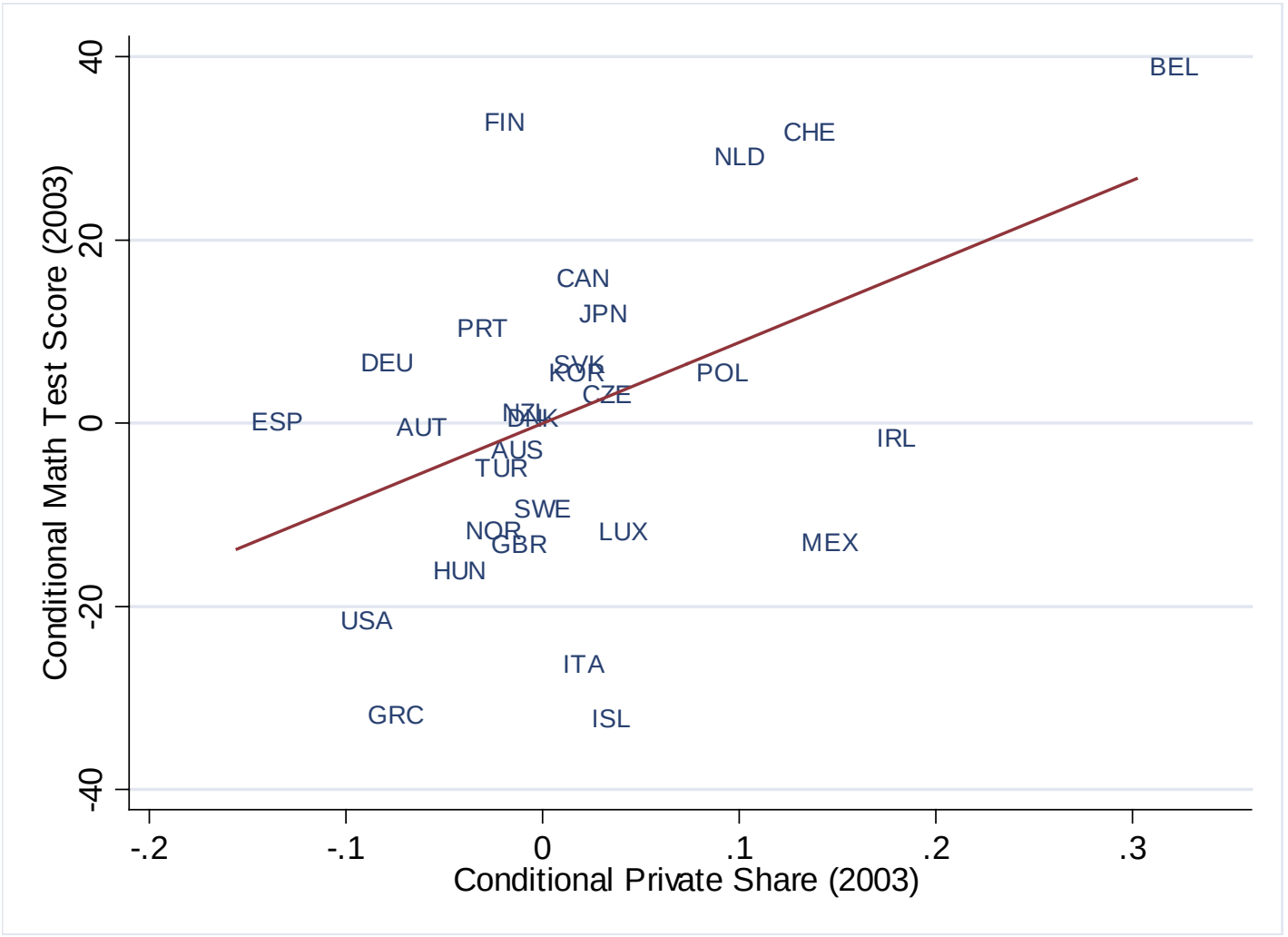
Historical Catholic Shares and Current Private Schooling



Added-variable plot of a regression of the share of PISA 2003 students enrolled in privately operated schools on Catholic population share in 1900 (interacted with an indicator whether Catholicism was the state religion) and additional student- and country-level control variables. Based on a student-level regression aggregated to the country level.

West/Woessmann (*Economic Journal* 2010)

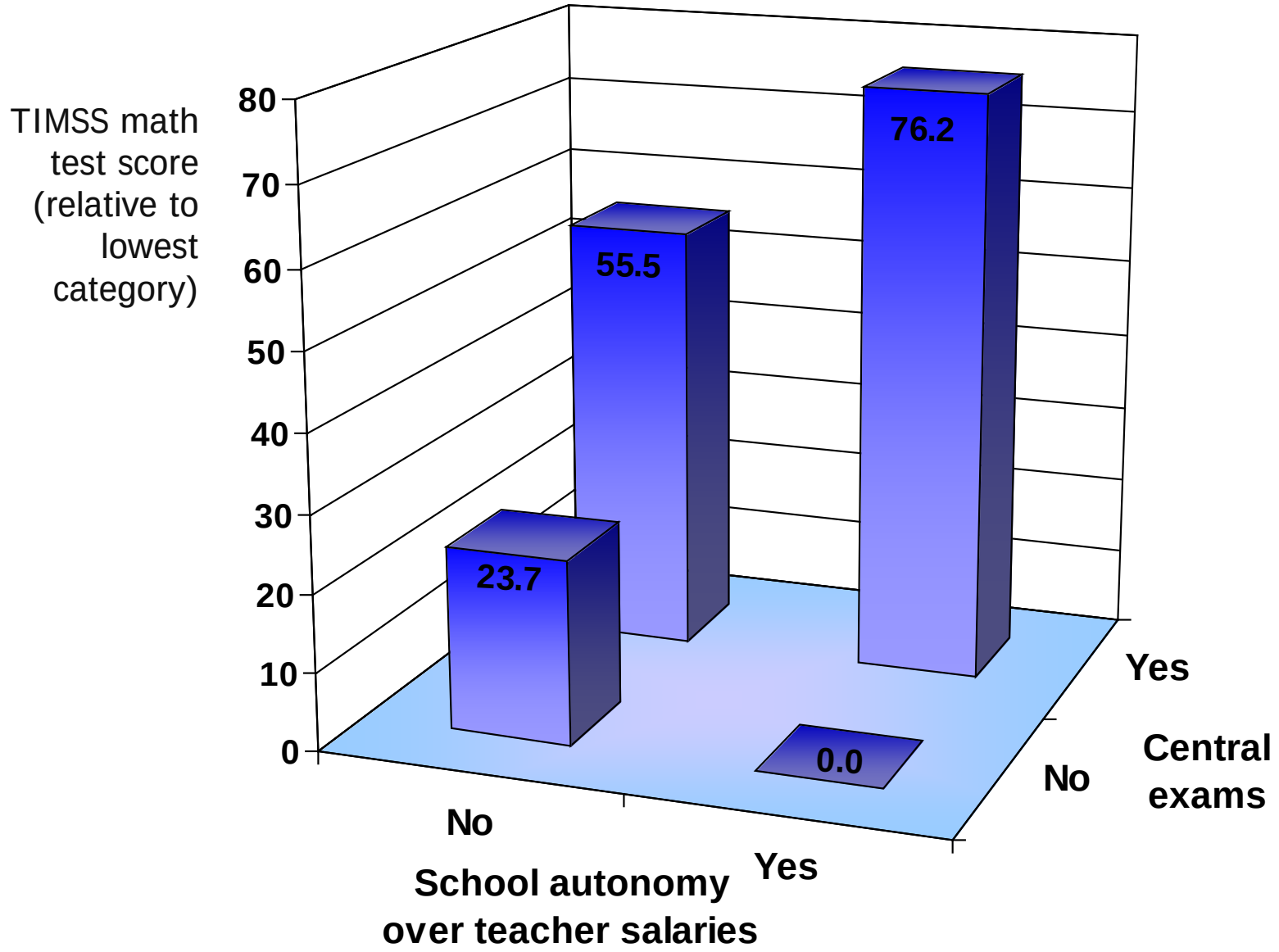
Private Schooling and Student Achievement



Added-variable plot of IV regression of PISA 2003 math achievement on share of students enrolled in privately operated schools (instrumented by Catholic share in 1900 interacted with an indicator whether Catholicism was the state religion) and additional student- and country-level control variables. Based on a student-level regression aggregated to the country level.

West/Woessmann (*Economic Journal* 2010)

School Autonomy and External Exams



Woessmann (*Education Economics* 2005)

2. School Autonomy

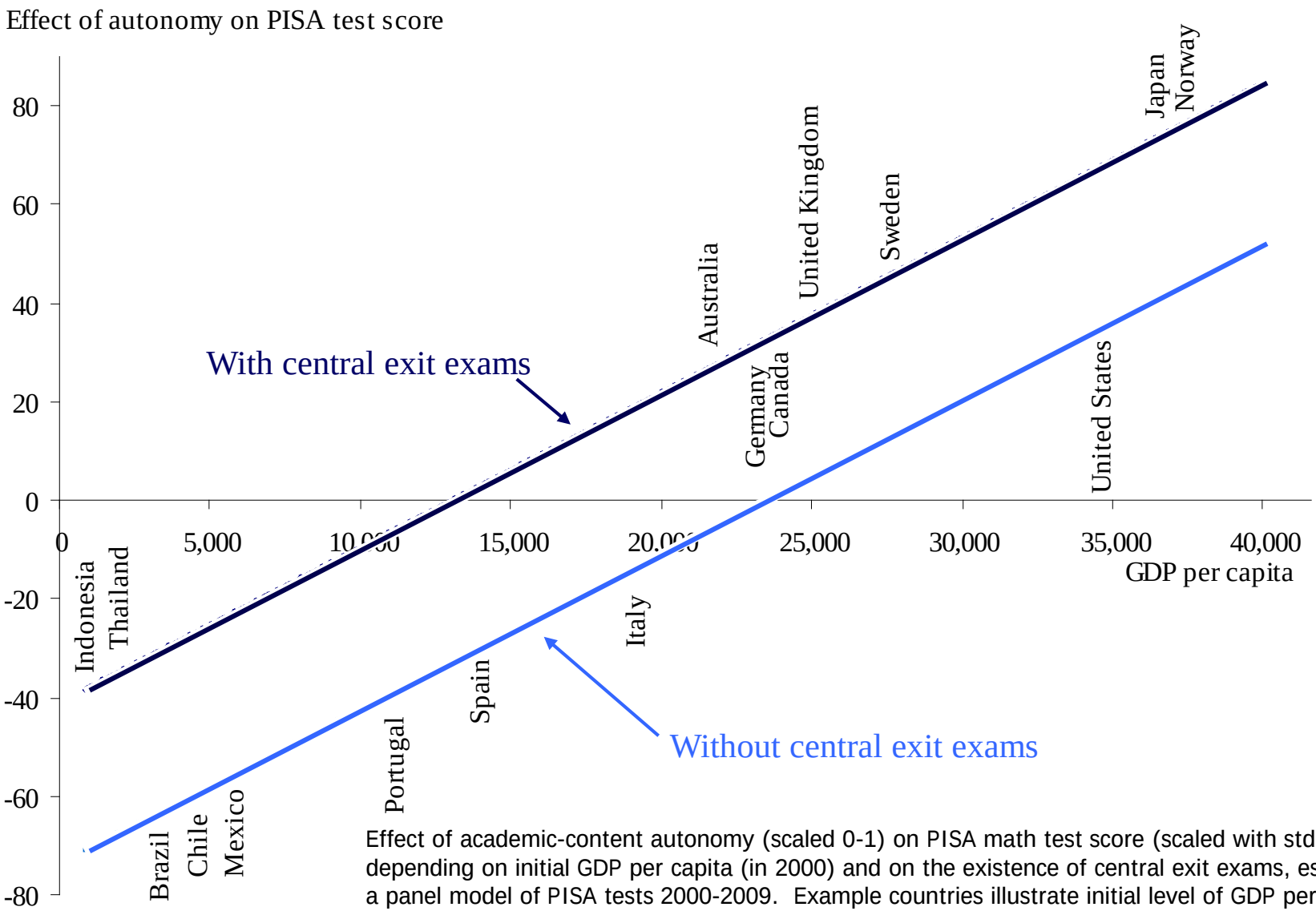
1. **Idea**: effect heterogeneous by development level
   - Autonomy conducive in school systems that already have surrounding conditions to ensure high performance
   - But detrimental in low-performing systems that lack basic standards

2. **Data**: panel of international tests
   - Student-level dataset of four international PISA waves, 2000-2009
   - Covers over 1 million students in 42 countries

3. **Analytical approach**: cross-country panel analysis
   - Concern: endogeneity bias from selection of students and schools into autonomy and from unobserved country heterogeneity
   - Solution: exploit country-level variation over time after including country fixed effects that control for systematic, time-invariant differences

Hanushek/Link/Woessmann (*Journal of Development Economics* 2013)

Effect of Autonomy Reforms on Student Achievement by Level of Development



Effect of academic-content autonomy (scaled 0-1) on PISA math test score (scaled with std. dev. 100) depending on initial GDP per capita (in 2000) and on the existence of central exit exams, estimated in a panel model of PISA tests 2000-2009. Example countries illustrate initial level of GDP per capita.

Hanushek/Link/Woessmann (*Journal of Development Economics* 2013)

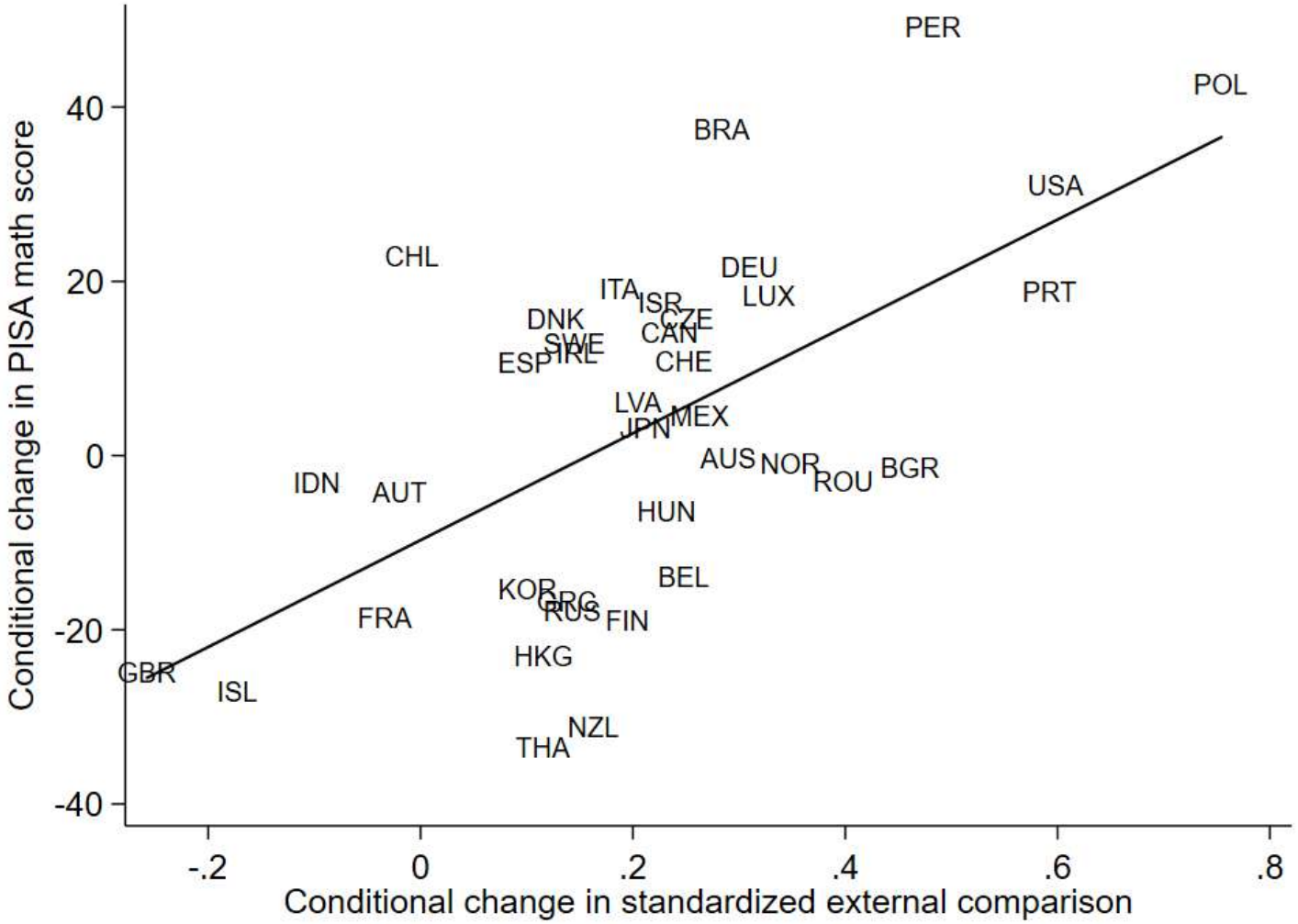
3. Testing

1. **Idea**: alternative uses of student assessments generate different incentives
   - Testing students to provide external comparisons
   - Standardized monitoring without external comparison
   - Teacher-generated tests used to assess pace of classroom learning
   - Inspectorates of teacher lessons

2. **Data**: panel of international tests
   - Student-level dataset of six international PISA waves, 2000-2015
   - Covers over 2 million students in 59 countries

3. **Analytical approach**: cross-country panel analysis
   - Investigate reforms over time, taking out country and year fixed effects

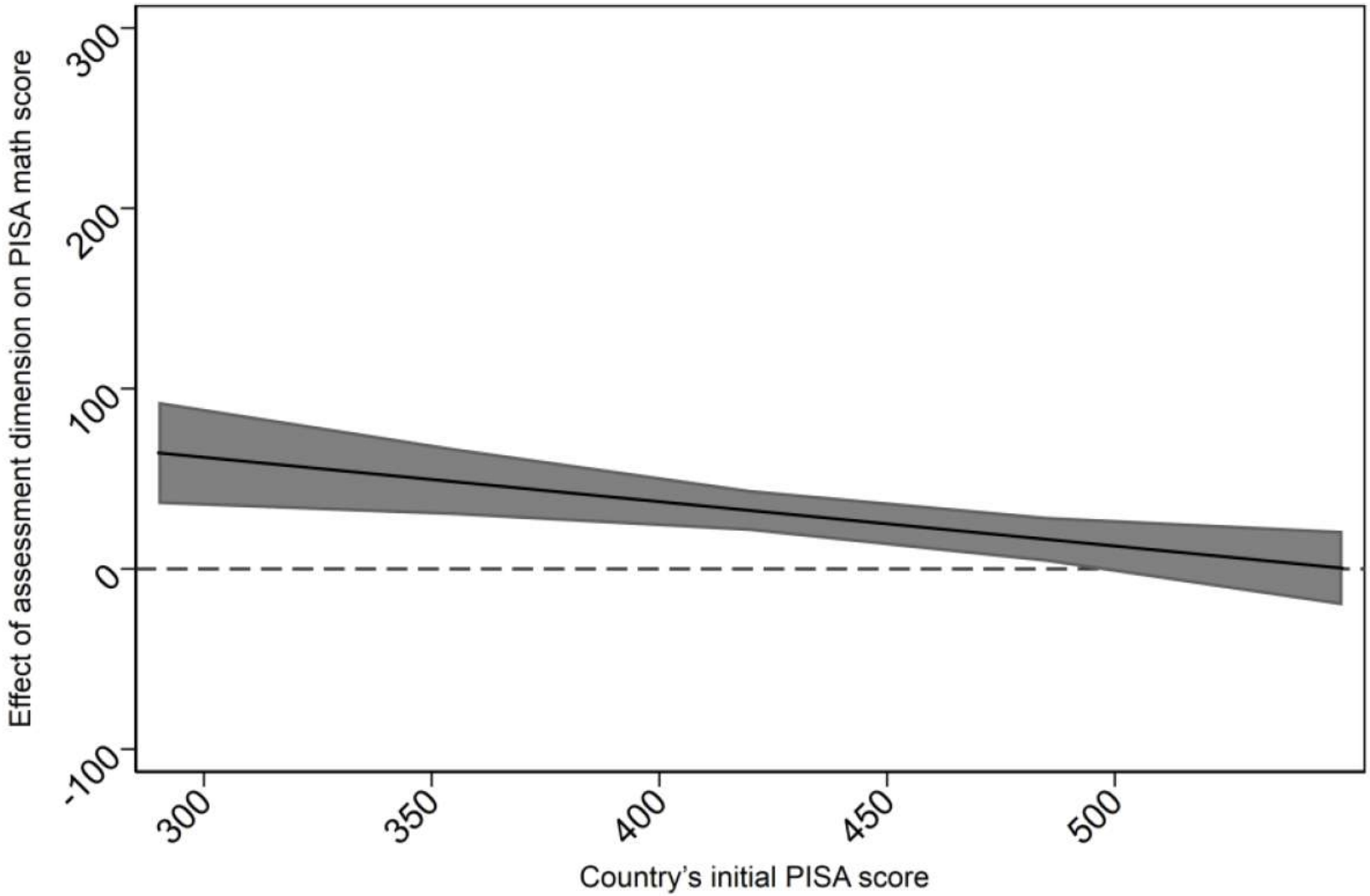
15-Year Change in Standardized External Comparison and in Student Achievement



Added-variable plot of the change in countries' average PISA math score between 2000 and 2015 against the change in the use of standardized testing for external comparison, both conditional on a rich set of student, school, and country controls, based on a long-difference fixed-effect panel model estimated at the individual student level. Mean of unconditional change added to each axis.

Bergbauer/Hanushek/Woessmann (NBER 2018)

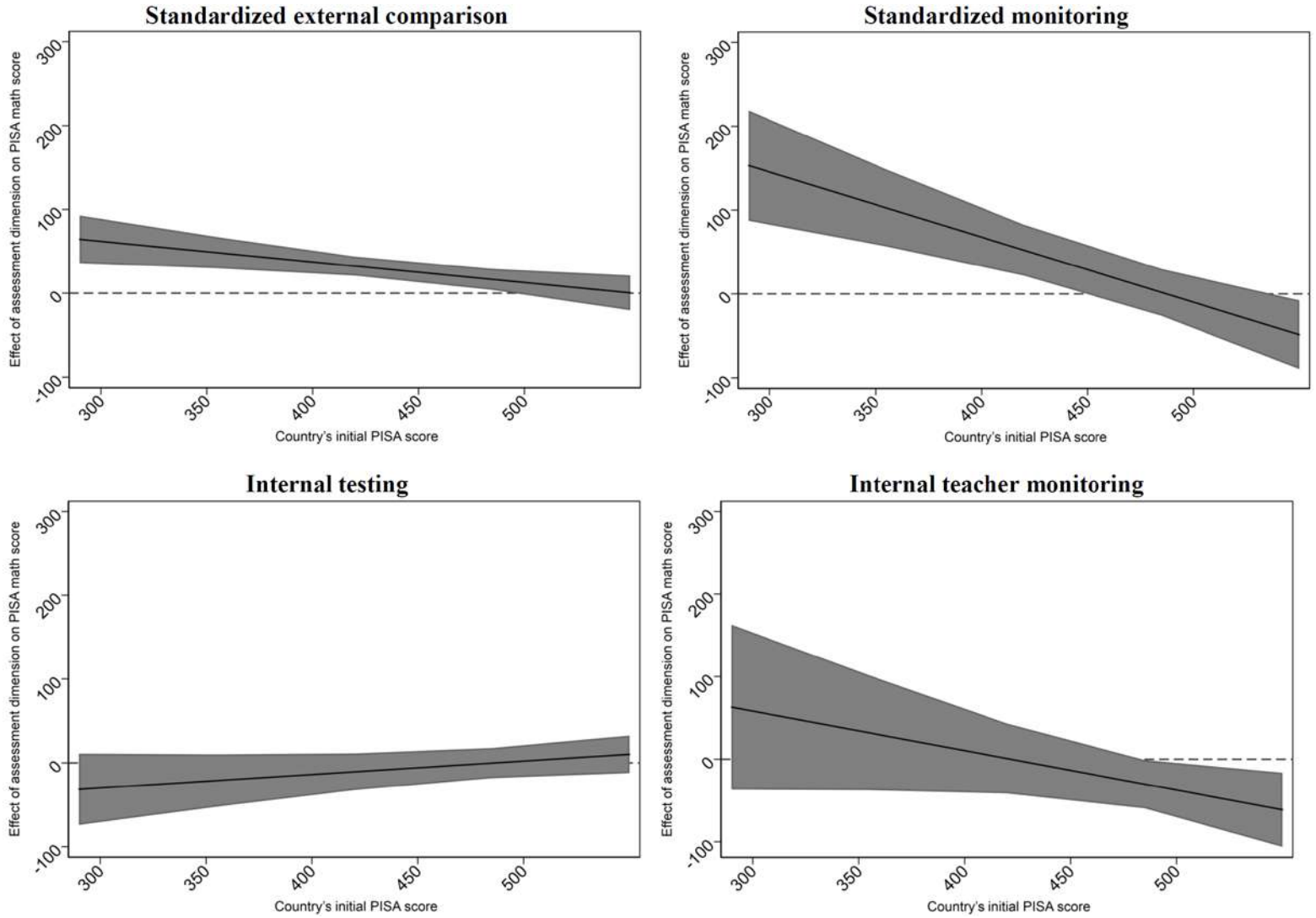
Effect of Standardized External Comparison by Initial Achievement



Average marginal effects of student assessments on PISA math score by initial country achievement, with 95% confidence intervals.

Bergbauer/Hanushek/Woessmann (NBER 2018)

Effect of Assessment Reforms on Achievement by Initial Achievement

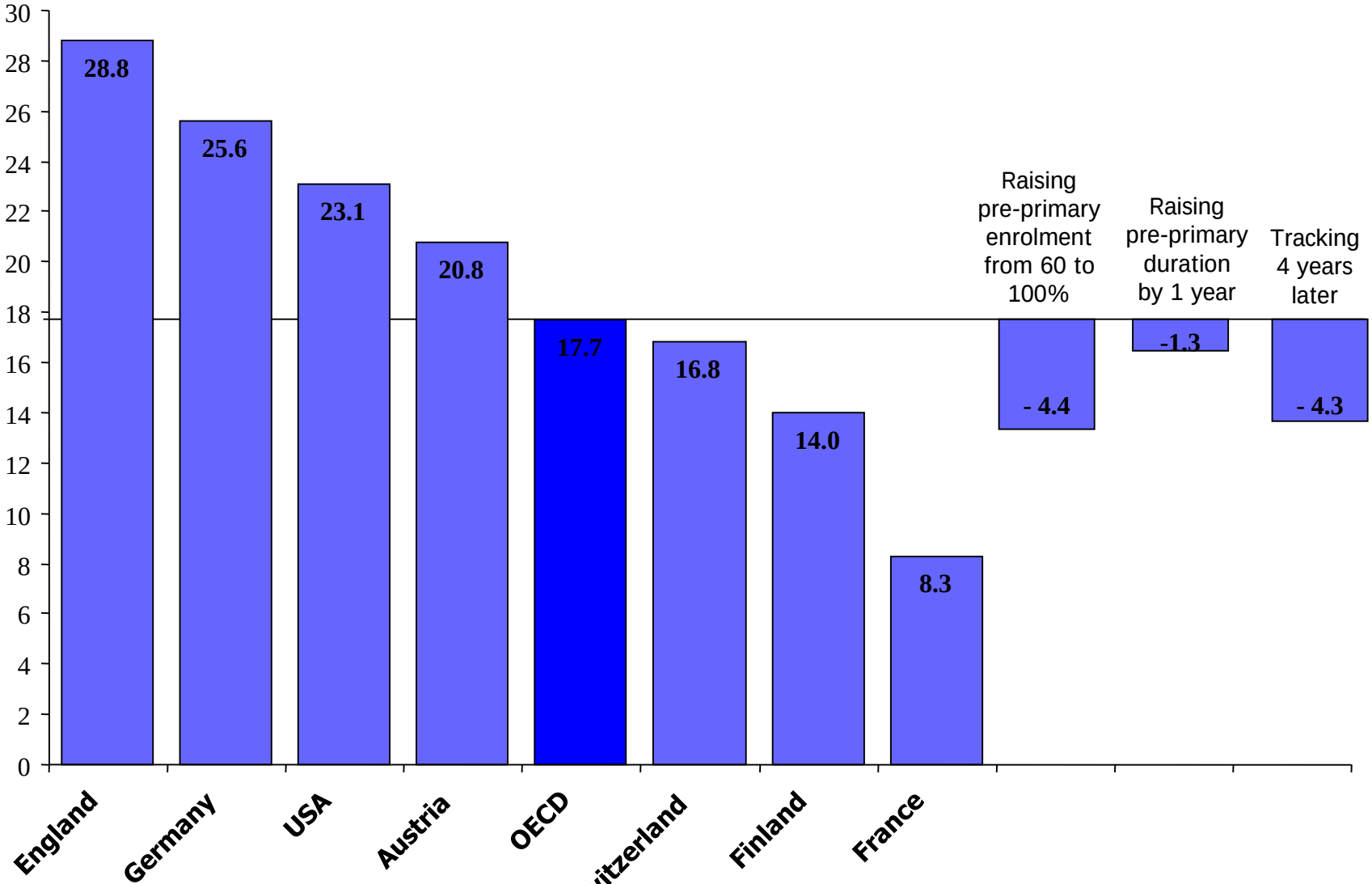


Average marginal effects of student assessments on PISA math score by initial country achievement, with 95% confidence intervals.

Bergbauer/Hanushek/Woessmann (NBER 2018)

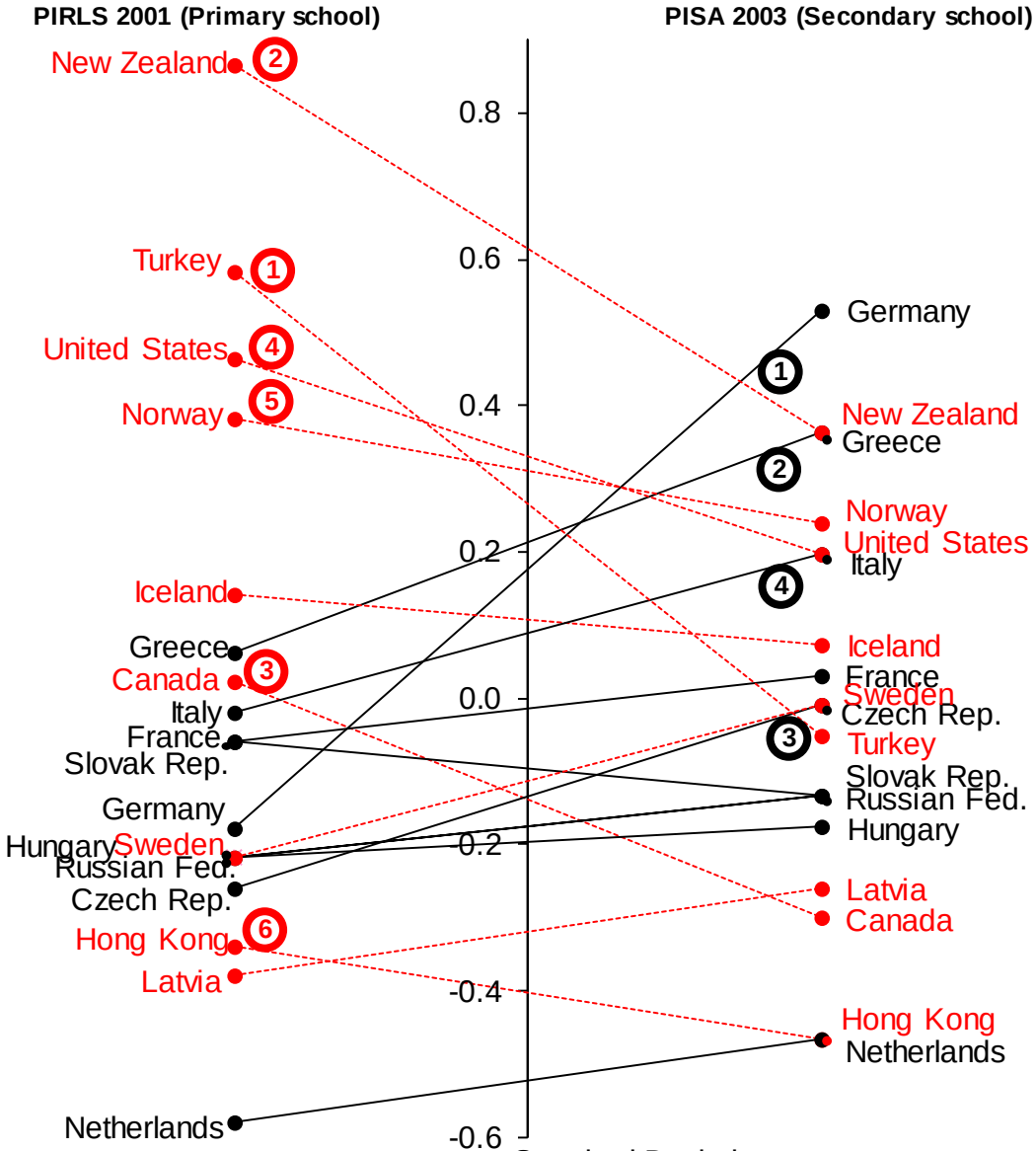
School Policy and Inequality of Opportunity

Effect of family background on student achievement



Schuetz/Ursprung/Woessmann (*Kyklos* 2008)

4. Tracking and Inequality



Change:

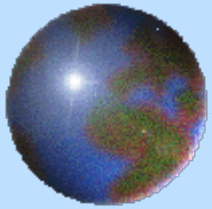
1.	Germany	0.71
2.	Greece	0.30
3.	Czech Rep.	0.25
4.	Italy	0.22
5.	Sweden	0.21
6.	Latvia	0.12
7.	Netherlands	0.11
8.	France	0.09
9.	Russian Fed.	0.08
10.	Hungary	0.04
11.	Iceland	-0.07
12.	Slovak Rep.	-0.08
13.	Hong Kong	-0.13
14.	Norway	-0.14
15.	United States	-0.27
16.	Canada	-0.32
17.	New Zealand	-0.50
18.	Turkey	-0.63

- **Early tracking**
- **No early tracking**

Hanushek/Woessmann (*Economic Journal* 2006)

School Systems and Student Achievement

- What can we learn from **international student tests**?
  - Educational achievement crucial for economic **prosperity**
  - Scope for improving student achievement
    - Limited role of **resources**
    - Important role of **institutions**
      - Private **competition**
      - School **autonomy**
      - Student **assessments**
      - **Tracking**
- **Young field**, work in progress
  - Expanding scope for possible investigations
- **Future** perspectives
  - Teacher policies
  - International migration
  - Personality and preferences



Thank You

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