Equality and efficiency:
an application to the secondary school design

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Materials for this presentation comes from

"Does School Tracking Affect Equality of Opportunity? New International Evidence" (with G.Brunello), IZA Discussion Paper No. 2348/2006 (a revised version is appearing in *Economic Policy* August 2007)

"Intergenerational mobility and schooling decisions in Italy and Germany: the impact of secondary school track" (with Luca Flabbi), IZA Discussion Paper No. 2879/2007

"Should you compete or cooperate with your classmates ?", (with M.Bratti and A.Filippin), mimeo 2007

Papers downloadable at http://checchi.economia.unimi.it

The general problem of stratification/integration goes as follows: suppose you have two types of students, High (in a fraction equal to n) and Low (in a corresponding fraction equal to $(1-n)$).

How do you form m classes (obviously with $m < N$, $N =$number of students) ?

Similar problems emerge in work-organisation and in city planning (Benabou, Kremer).

Two general solutions:

① mix students according to their type: each class will contains $n\frac{N}{m}$ students of type H and $(1-n)\frac{N}{m}$ students of type L.

Call it the **INTEGRATED SOLUTION**.

② sort students according to their ability (supposed to be observable): if class size is independent of students' ability, nm classes will be populated by type H only, and $(1-n)m$ classes will be filled with type L.

Call this the **SEGREGATED SOLUTION**.

What is the most efficient solution ? and the more egalitarian ?

Efficiency can be assessed in terms of human capital accumulation (at individual and aggregate level), which is then reflected in

- ✓ competences
- ✓ employability
- ✓ earnings

It mainly depends on the externalities created by *peer effects*.
If the peer effect in the educational production function is linear, there is no dominant solution.
If the peer effect is non-linear (type H gains more/less than type L from the environment), then segregation/integration solution dominates.

Equality of outcomes is clearly favoured by the integration solution.

However, educational production function also includes

- ✓ teachers' quality
- ✓ teachers self-sorting
- ✓ compensatory policy in class size
- ✓ specialisation of teaching according to the learning body
- ✓ differentiated curricula

and therefore there is no definite answer to the optimal configuration.

The secondary school is an interesting case study. Some countries (notably Austria, Germany, Netherlands and Italy) sort students into different tracks, while other countries (US, UK, Sweden, Denmark) keep them together.

Can we use cross-country comparisons to provide answers to the equality/efficiency conundrum ?

"*..at a theoretical level, there are good arguments for selection as well as for comprehensive education. The main argument for selection or tracking is presumably that it is much easier to teach lower variance classes. Since teachers can focus on the ability level of particular groups of students, students of all ability levels might benefit from selection. One argument against selection is that there might be positive peer effects from the most able students. By tracking these students into separate classrooms, the most able students may benefit from being with each other. However, the lower ability ranges loose from not having this peer group around. We know very little about the different impact of peer group effects on different types of students empirically, so it is difficult to judge a priori whether this leads to lower or higher average performance in a selective system".*

Manning and Pischke (2006)

Recent literature in the economics of education (Hanushek and Wößmann 2006, Ammermüller 2005, Schuetz, Ursprung and Wößmann 2005) claims that school tracking is detrimental to skill formation.

We deem quite hard to identify a country specific effect of tracking measures. We rather prefer to investigate whether school tracking modifies the impact of family background on

⇨ educational attainment
⇨ employment probability
⇨ earnings
⇨ skills possessed in adult life

With school selection, parental background can affect educational outcomes both directly, by influencing individual talent and resources, and indirectly, by conditioning the selection of pupils into different tracks.

However there are several problems to be tackled:
1. a proper measure of what we indicate as TRACKING
2. a proper dataset, allowing the comparison of different age cohorts in different countries under alternative educational systems
3. the possibility to exclude confounding factors (public/private divide, resources allocate to schooling)

In Brunello and Checchi (2007) we measure tracking by the fraction of educational career spent in separate tracks.

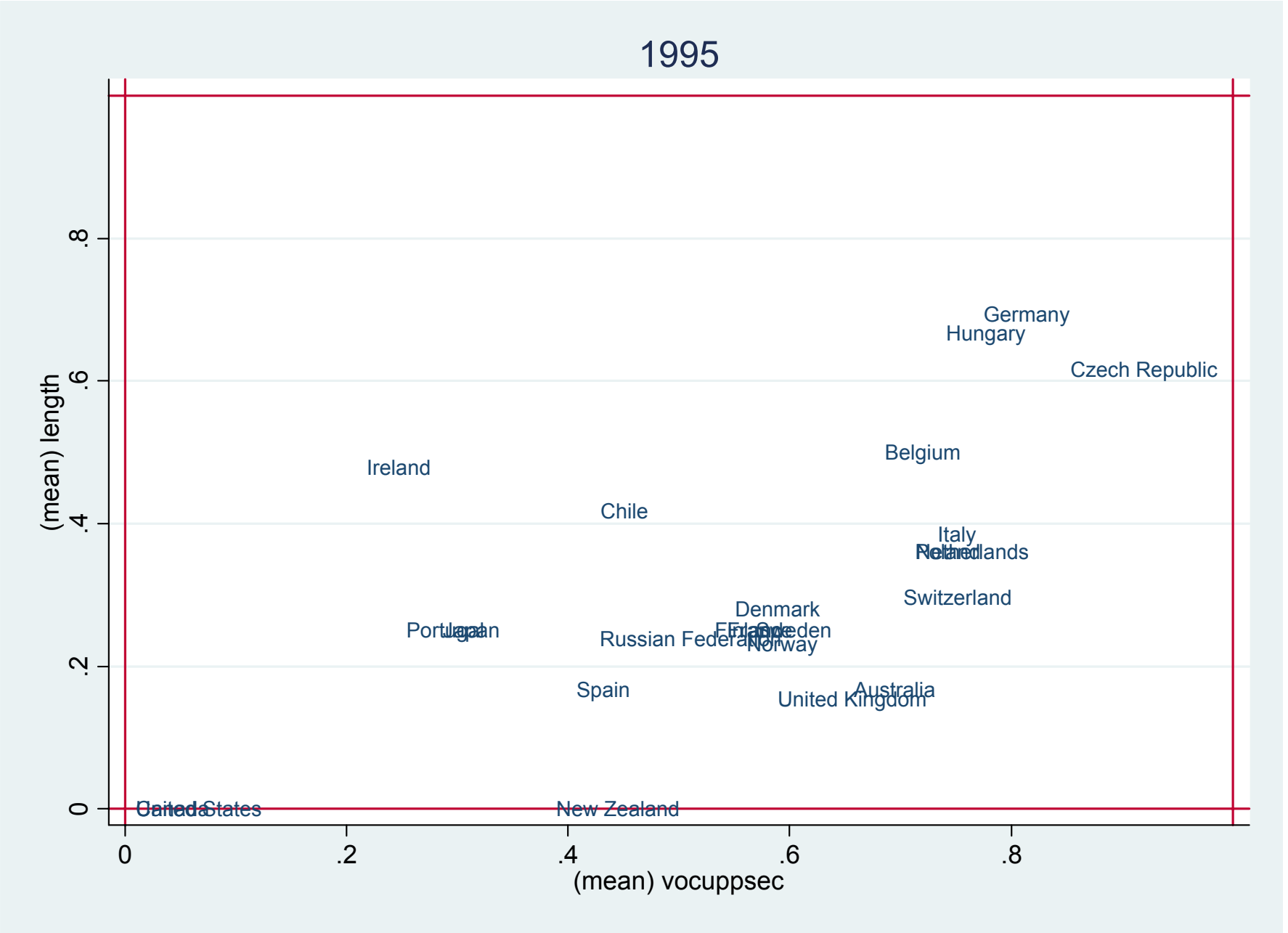
As confounding variables that can also affect the family background effects are:
* public-private
* resources invested in education (share of public expenditure in education over GDP, student-teacher ratio in secondary education)
* percentage of the student population enrolled in pre-primary education

Tracking modifies the impact of family background on educational choices through three channels

* length of tracking (when allocation is partly based on family background, the longer the track, the stronger is the effect of parental background)

* size of people in low-quality tracks (larger low-quality tracks implies higher average ability, and therefore better peer effects)

* differential impact of peer effect in different tracks (differences in teaching induced by dispersion in ability by tracks create additional non-linearities in the effect of the size of students in low-quality track)


1995
(mean) length
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Germany
Hungary
Czech Republic
Belgium
Ireland
Chile
Italy
Switzerland
Denmark
Norway
Spain
Australia
United Kingdom
New Zealand

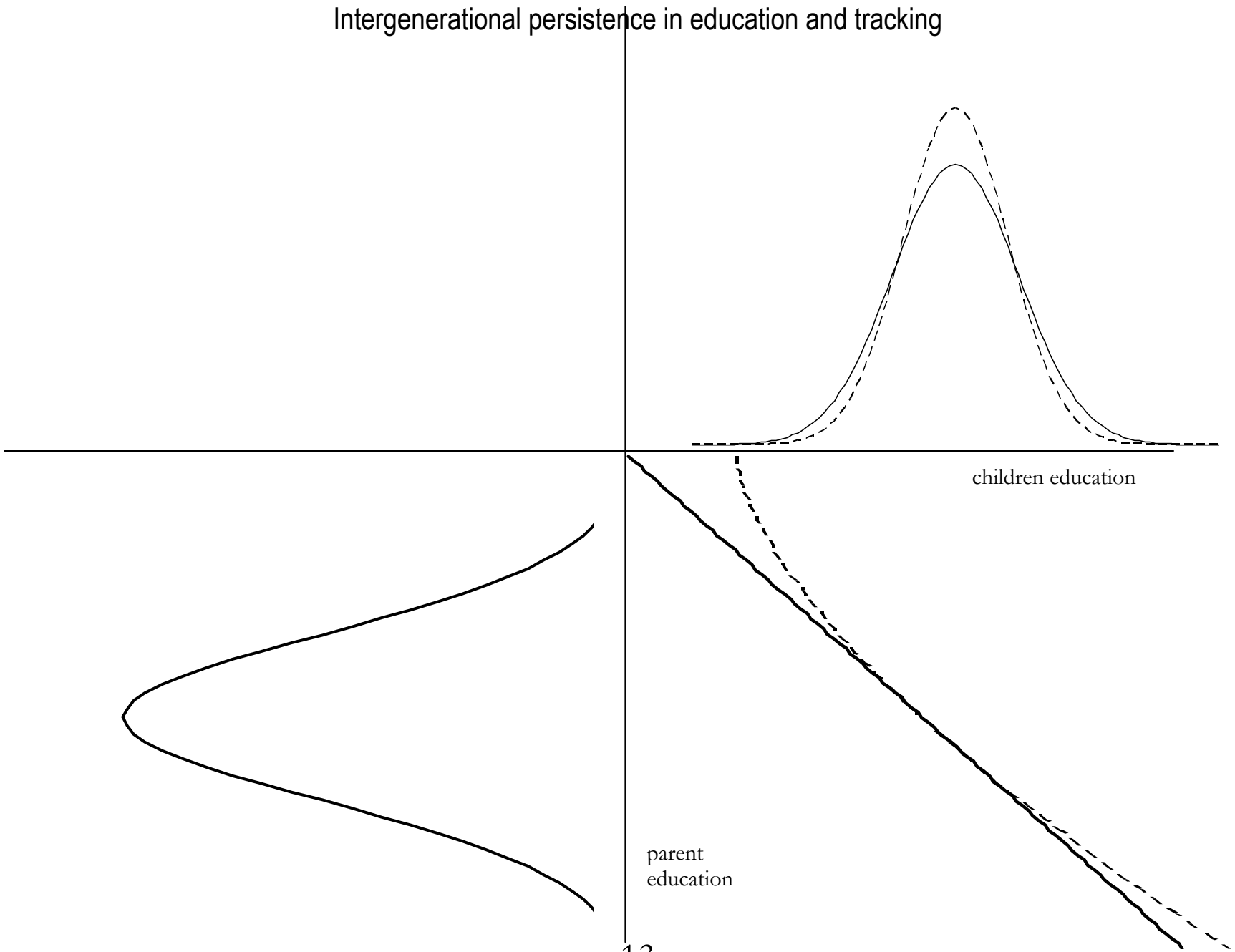
Our empirical strategy is to estimate the following relationship

$$Y_{ijk} = \delta_{jk} + \alpha X_{ijk} + \beta_1 FB_{ijk} + \beta_2 FB_{ijk} C_{jk} + \gamma FB_{ijk} T_{jk} + \varepsilon_{ijk}$$

where Y is the outcome of interest of individual i belonging to cohort j in country k, δ are dummies (country (k) $\times$ cohort (j)), X is a vector of individual controls, FB is the indicator of family background (parental education), T is a (vector of) school tracking indicator(s) and C_{jk} are potential confounding factors.

Our parameter of interest is γ. If it has a sign in accordance with β_1, we claim that tracking reinforces family influence, and therefore increases inequality of opportunities. Otherwise it may reduce parental impact and increase equality of opportunities.

Intergenerational persistence in education and tracking



Descriptive statistics (unweighed)

	ECHP		ISSP		ISSP		IALS		PISA
year of survey(s)	1995 2000		1991-1999		1999		1994-1996-1998		2003
birth year of cohort 1	1971-75		1967-73		1965-1971		1962-67		1988
birth year of cohort 2	1976-80		1975-81		1975-1981		1972-77		-
	cohort 1	cohort 2	cohort 1	cohort 2	cohort 1	cohort 2	cohort 1	cohort 2	
observations	**16163**	**15911**	**447**	**611**	**3405**	**3251**	**7421**	**6029**	**275369**
age	21.97	22.03	21.78	21.05	30.96	21.14	31.24	21.24	15.79
male	50.01	46.71	46.53	43.04	47.47	47.57	44.09	47.40	49.59
drop-out (without scn.degree)	33.69	33.20	33.18	42.78	31.92	31.74	31.20	31.46	
college enrol/completed	27.64	28.75	47.98	32.82	23.53	31.51	27.71	15.36	
years of education (mean and sd)			11.62 (2.27)	12.01 (1.96)	13.12 (3.94)	12.27 (2.61)	12.66 (3.31)	12.30 (2.56)	
log literacy skill (average across areas) (mean and sd)							5.62 (0.22)	5.62 (0.21)	6.15 (0.21)
employed	45.50	45.29	62.75	60.67	77.62	48.53	74.52	46.41	
on-the-job training	17.32	16.95					44.55	53.09	
log wage (mean and sd)	5.42 (2.04)	5.59 (2.06)	8.65 (1.07)	9.15 (1.41)	8.52 (2.32)	8.07 (2.40)			
both parent without secondary education	35.43	29.28	35.43	29.28	29.99	18.03	54.71	39.26	30.38
at least one parent with secondary education	23.56	25.66	23.56	25.66	45.55	47.34	26.98	33.95	27.97
at least one parent with college degree	41.01	45.06	41.01	45.06	24.46	34.64	18.31	26.79	41.65
books at home					125.18	145.10			158.43
number of countries	12 (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Portugal, Spain, United Kingdom)		6 (Australia, Germany (both East and West), Hungary, Poland, Slovenia and United States		21 (Australia, Canada, Chile, Czech Republic, France, Germany, Hungary, Israel, Japan, Latvia, New Zealand, Norway, Philippines, Poland, Portugal, Russian Federation, Slovakia, Slovenia, Spain, Sweden, United States)		17 (Belgium, Chile, Czech Republic, Denmark, Finland, Germany, Hungary, Ireland, Italy, Netherlands, New Zealand, Norway, Poland, Slovenia, Sweden , Switzerland, United Kingdom and United States)		41 (Australia, Austria, Belgium, Brazil, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong (China), Hungary, Iceland, Indonesia, Ireland, Italy, Japan, Korea, Latvia, Liechtenstein, Luxembourg, Macao (China), Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Russian Federation, Slovakia, Spain, Sweden, Switzerland, Thailand, Tunisia, Turkey, United Kingdom, United States, Uruguay, Serbia and Montenegro)

Summary table for empirical results

	parental background	parental background × tracking length	parental background × share in vocational	parental background × share in vocational squared	parental background × pre-primary enrolment	parental background × student/ teacher ratio	parental background × educational expenditure	parental background × share in private schools
educational attainment								
years of education	+	+					–	
probability of drop-out	–	– IALS-ISSP	+ ECHP-ISSP	– ECHP-ISSP				
probability of college	+	+	–	+			–	–
schooling inequality	–		+	–		+		+
labour market								
probability of employment	–	– ECHP-ISSP	+					
earnings	+	+					– ECHP	
earnings inequality		+ ECHP-ISSP	– ISSP		±			–
life-long opportunities								
literacy	+	–	–					–
literacy inequality	+	–	–	+	+		–	
training	+/– IALS/ECHP		+ ECHP	– ECHP				

⇨ tracking length always reinforces the impact of parental background

⇨ share in vocational tends to counteract parental background

⇨ evidence of non-linear impact of vocational share (peer-effect)

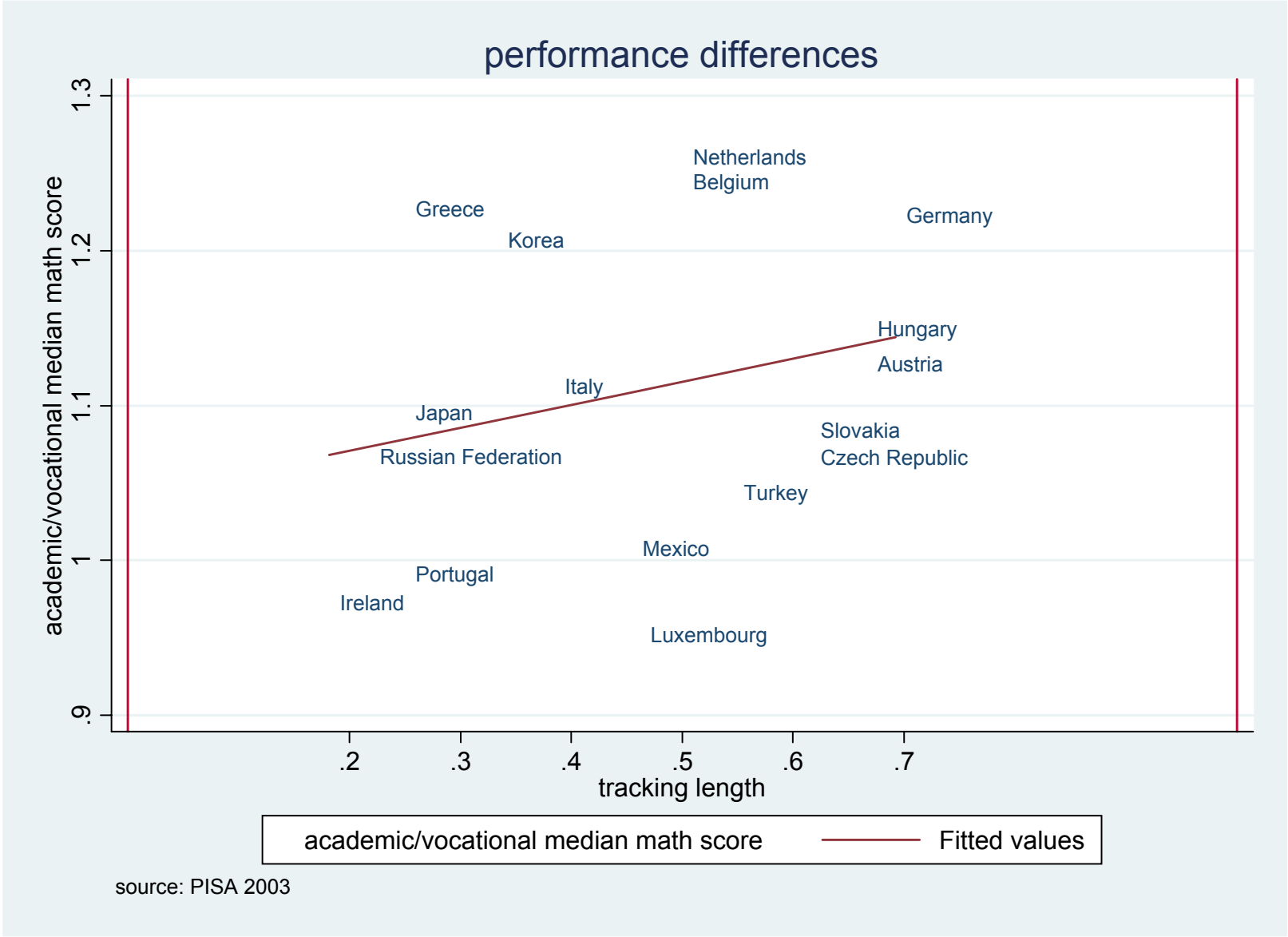
Tracking is detrimental to the equality of opportunity, both in educational attainment (already in the literature) and in labour market outcomes (novel in the literature). This effect is attenuated when the peer effect works in the opposite direction, by raising the quality of vocational schools.

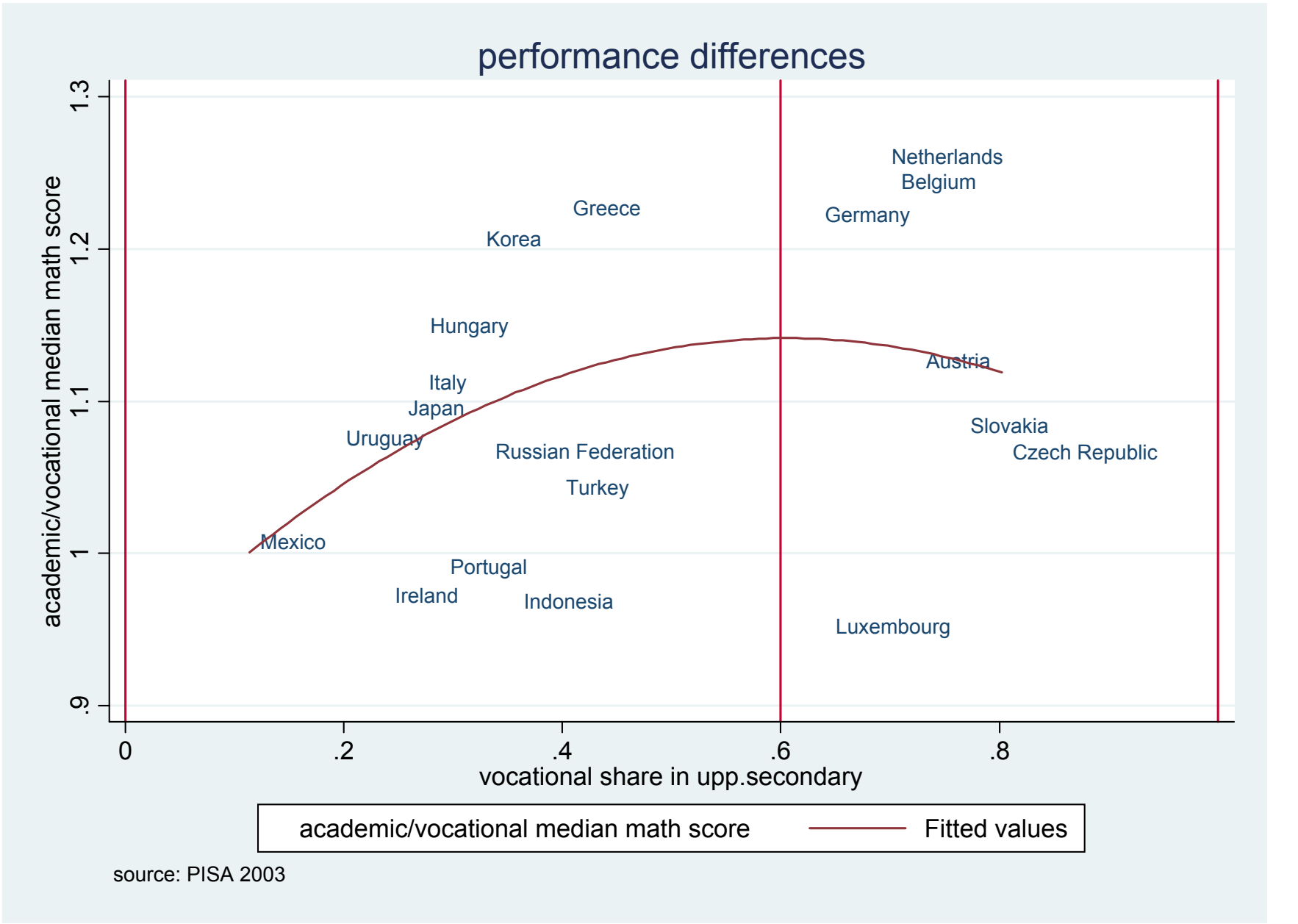
However it keeps more people in schools, thus reducing dropout rates. This may explain why tracking is also beneficial to competencies acquisition in adult life. On the job training may reinforce this effect.

The size of the low-quality sector has a non-linear impact, possibly due to peer effects. The welfare simulations call attention to the quality of vocational schools.

Early tracking increases inequality and is exposed to the risk of talent misallocation. Late tracking (even at tertiary level) gives individuals more options but is exposed to the risk of overducation. Between the two, we prefer the second risk.

BUT TRACKINGS ARE NOT ALL ALIKE !



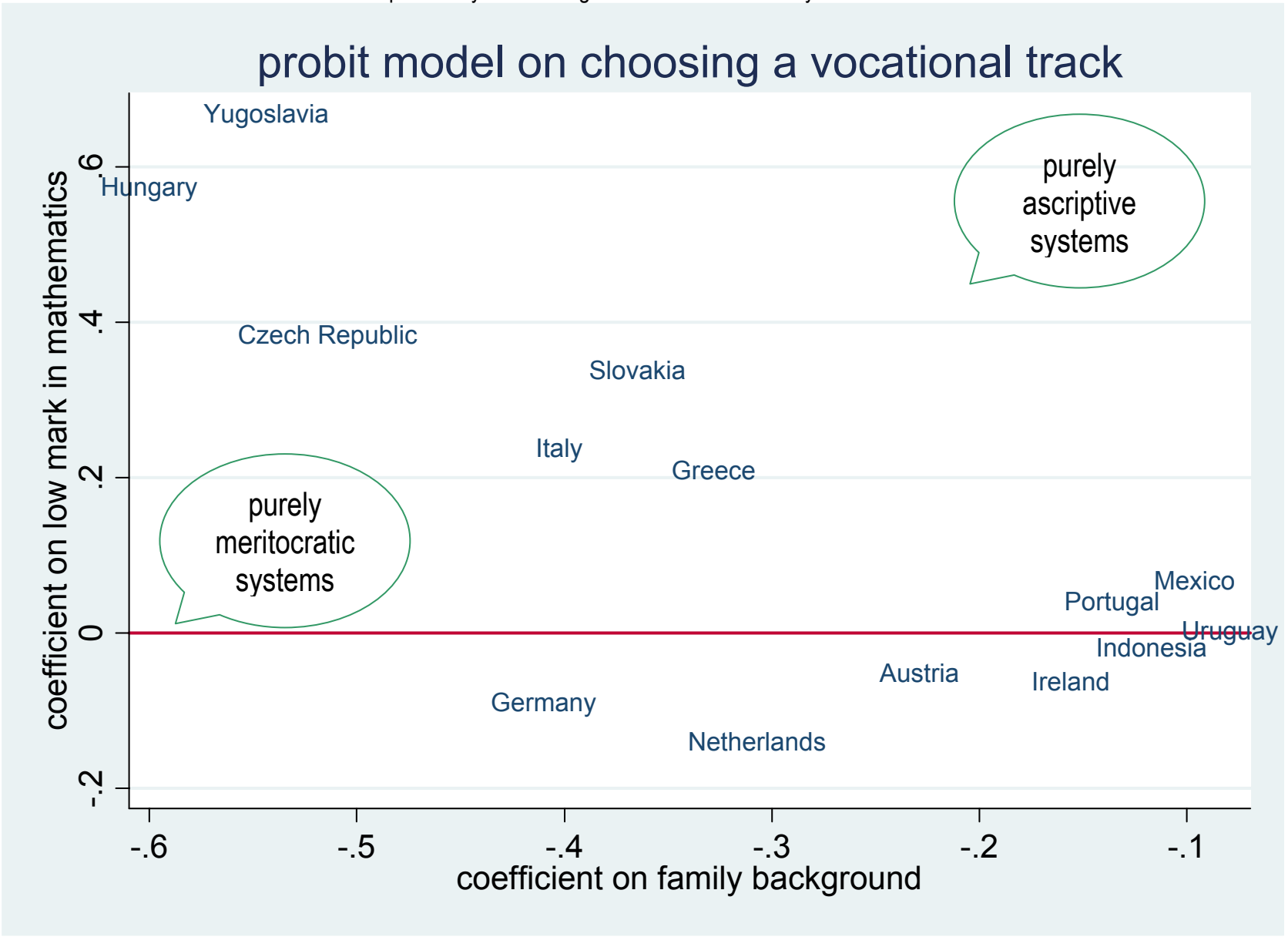

performance differences
academic/vocational median math score
1.3
1.2
1.1
1
.9
0
.2
.4
.6
.8
vocational share in upp.secondary
Netherlands
Belgium
Germany
Greece
Korea
Hungary
Austria
Italy
Japan
Slovakia
Uruguay
Russian Federation
Czech Republic
Turkey
Mexico
Portugal
Ireland
Indonesia
Luxembourg
academic/vocational median math score
Fitted values
source: PISA 2003

These are average effects. But a tracking may be more or less equitable depending on how the allocation to different tracks is performed.

Using PISA 2003 we investigate what affects allocation to lower quality track (VOCATIONAL).

Sorting may occur on
* ability (proxied by previous schooling performance)
* family background (proxied by parental education, books at home, parents' occupational prestige)

Determinants of the probability of choosing a vocational track – 15-year-old students – PISA 2003



The more developed is the tracking, the less relevant is ability and the more relevant is the family.

Some countries (Mexico, Portugal, Ireland, Indonesia, Uruguay) seem not to sort students on observables (and the performance gap between ACADEMIC and VOCATIONAL is negligible).

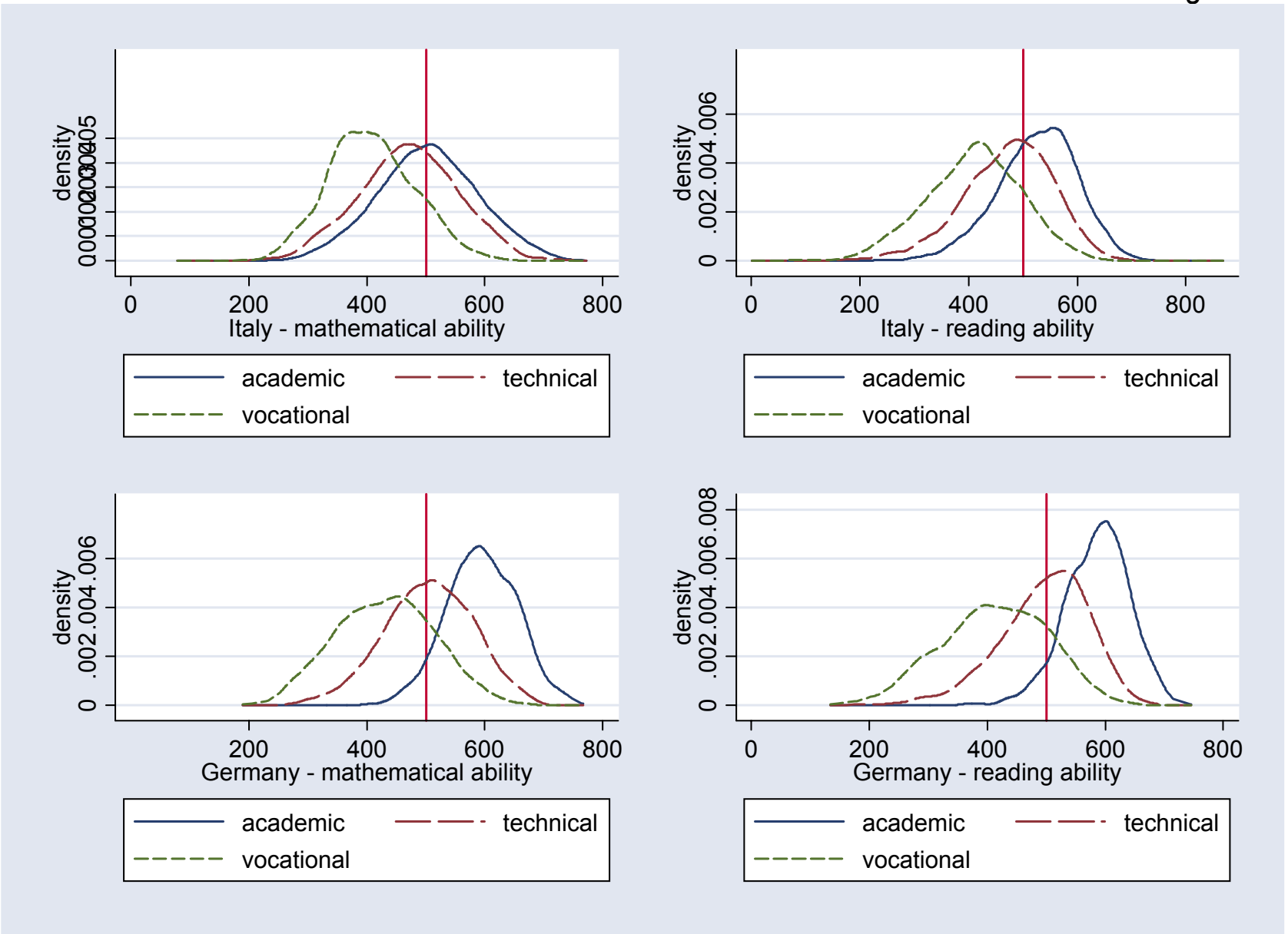
Some other countries (Hungary, Slovakia, Czech Republic) sort students on both ability and family, thus creating a larger gap between ACADEMIC and VOCATIONAL.

Remaining European countries (Austria, Germany, Netherlands, Italy, Greece) rely more on parental education than on ability in track allocation.

In Checchi and Flabbi 2007 we focus on the differences in tracking between Italy and Germany.

In Italy more than half on the students in the academic and vocational schools have a comparable level of ability as measured by these test scores, while this is true only for one forth of the students in the German sample.

Evidence from PISA 2003 - Kernel estimates of the distribution of mathematical and reading abilities



Given earlier decision and compulsory orientation in Germany, the role of parental background should be more relevant in Italy than in Germany, given the greater freedom of choice they can exert in the secondary school choice.

We analyse the impact of some measures of family background onto three choice variables:

- ✓ the type of school attended (PISA 2003)
- ✓ intention expressed by 15-year-old to proceed further in education (PISA 2003)
- ✓ the effective proceeding to college education (national representative samples: ISTAT, SOEP).

With respect to the choice of secondary school type, the multinomial model based on three alternatives (academic, technical and vocational), we show that parental education has a stronger impact in Italy than in Germany (it makes the selection of “academic track” more likely and conversely the choice of “vocational track” less likely).

Parents' impact is more important for male children than for female children in Italy while in Germany the impact is quite similar on both subsamples.

With respect to aspirations to proceed further in education, the fraction of students expecting to enrol University is clearly different across tracks, but the differences in aspirations are also significant across countries: the 87.9% of students in the Italian academic track aspire to complete tertiary education (ISCED 5A-5B-6), while the same percentage declines to 51.3% among young Germans in the Gymnasium. The fraction of students aspiring to university enrolment is lower in technical schools (39.2% in Italy and 24.0% in Germany) and somehow negligible in vocational schools (24.7% in Italy and 15.7% in Germany).

This is at odds with actual behaviour: in 2002 (most recent available data) the 23.6% of the age cohort attained a tertiary degree in Italy, while 29% of Germans in the same cohort achieved a degree.

Once again, parental education is mostly significant only in Italy, even when fully accounting for ability, while it is almost insignificant in the German case.

The type of secondary school attended affects the intention to enrol University: if we compute the odd ratio of a student choosing the academic track compared with the technical track, it ranges between 6.0 and 2.8 in Italy and 2.0 and 0 in Germany.

With respect to effective enrolment at university, we find that most of the predictive power relies on the type of secondary school attended (consistently with aspirations), but parental education still exhibit a statistically significant effect in both countries.

Our main policy implication is that tracking can be efficient, in the sense of reducing mismatch and increasing intergenerational mobility, only if it is based on (cognitive) ability and therefore only if the information when the decision is taken is high enough (relevant age ?).

In this respect any policy that increase information when children are entering the secondary school level is very promising. An alternative or complementary policy to achieve a stronger tracking by ability could be increasing mobility across tracks based on grades or standardized test.

An additional difference between comprehensive (i.e. integrated) and tracked (i.e. segregated) systems is related to the relationships that develop among students.

In tracked systems the environment is more homogeneous, social pressure tougher, and therefore competition is dampened. On the contrary, in comprehensive systems individual competition is enhanced.

In Bratti, Checchi and Filippin 2007 we have exploited information on students' attitudes with respect to competition and cooperation to analyse a standard problem of public good.

Effective group work requires students to share ideas, take risks, disagree with and listen to others, and generate and reconcile points of view. These norms do not necessarily pervade classrooms. Students are used to working individually, being rewarded for right answers, and competing with each other for grades. Placing students in groups does not mean they will actually cooperate. There is considerable and disturbing evidence that students often do not behave pro-socially. One problem is failure to contribute. When groups create a single product and receive one grade, students sometimes do not do their fair share. (Blumenfeld et al. 1996, p.38)

Learning in classes has strong similarities with the problem of public goods. Group learning (the public good) has positive externalities, since all students seem to improve in achievements. However, individual incentives favour free riding, and these incentives are increasing in student level of achievements. Group norms may reverse individual incentives, but they are strongly dependent on the environment.

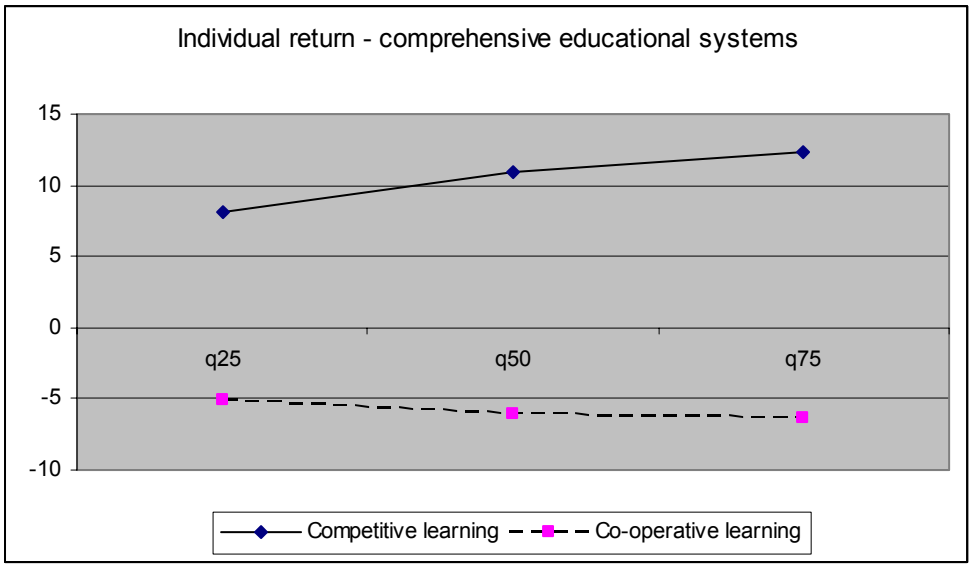
We propose a model where each student can allocate her effort between two types of activity, cooperation or competition. Cooperation corresponds to group learning, and provides positive externalities to the entire class irrespective of individual contribution. Competition has a private return only, which is increasing in ability. As a consequence, under spontaneous ordering (corresponding to whole-class teaching) there is an excess of competition and limited cooperation. However, when group norms are modified (because stronger social control in more homogenous environment, i.e. tracked systems), then these conclusions could be reversed.

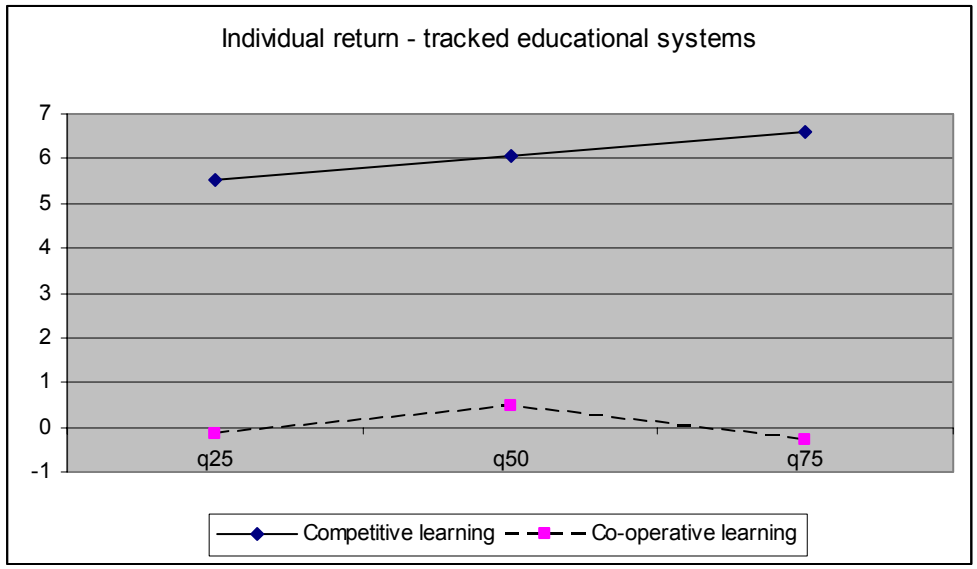
Performance in math tests – PISA 2003

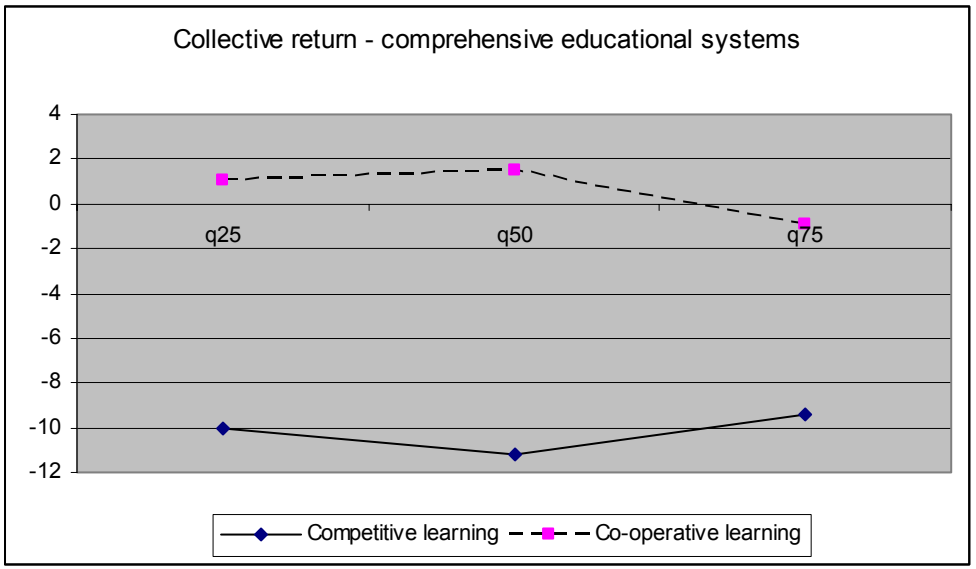
	individual attitude	school attitude	individual +school attitude
Female	-15.815	-18.732	-16.229
	[24.49]***	[29.62]***	[25.22]***
Age of student	3.142	2.96	3.069
	[3.46]***	[3.25]***	[3.38]***
Highest parental occupational status	0.755	0.759	0.757
	[40.42]***	[40.41]***	[40.51]***
Highest parental education in years of schooling	1.463	1.489	1.464
	[13.57]***	[13.76]***	[13.58]***
Computer facilities at home	6.598	6.608	6.547
	[15.68]***	[15.74]***	[15.59]***
Index of home possessions	6.533	7.008	6.616
	[14.55]***	[15.53]***	[14.72]***
Hours All homework	1.398	1.561	1.413
	[20.94]***	[23.99]***	[21.52]***
How many books at home	12.293	12.215	12.225
	[51.14]***	[50.89]***	[51.01]***
Competitive learning	8.586		8.859
	[27.05]***		[31.20]***
Co-operative learning	-3.844		-4.032
	[13.53]***		[15.21]***
school average competitive attitude		-4.116	-8.237
		[1.81]*	[3.66]***
school average cooperative attitude		6.543	8.051
		[2.78]***	[3.46]***
Observations	110711	110711	110711
R-squared	0.24	0.23	0.24
Log likelihood	-633129	-633707	-633074

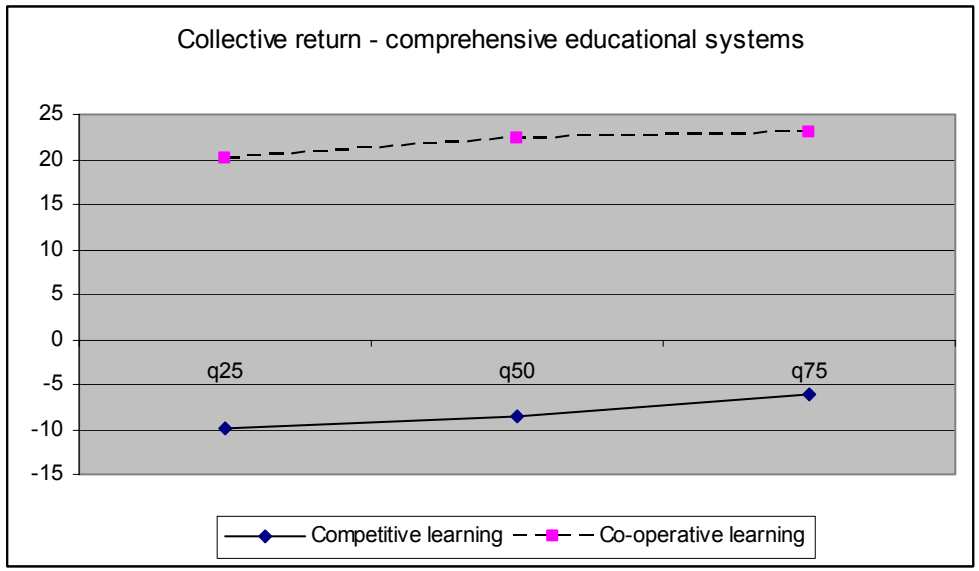
Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%
robust errors or clustered by country+school – country controls included

Quantile regressions: returns to cooperative/competitive attitudes – PISA 2003









Concluding:

ON ONE HAND

⇨ separating students according to ability/background reinforces parental influence on schooling and working life → increases the inequality of opportunities

ON THE OTHER HAND

⇨ however tracked systems seem to foster skill formation for the bottom tail of the ability distribution→ by retaining low quality students longer in schools they increase the overall production of human capital (i.e. efficiency);

⇨ tracked systems also constitute a more homogenous environment that favours cooperation among students → increases the equality of outcomes.