Institut d'Economia de Barcelona

Document de treball de l'IEB 2016/16

THE EFFECT OF A SPECIALIZED VERSUS A GENERAL UPPER SECONDARY SCHOOL CURRICULUM ON STUDENTS' PERFORMANCE AND INEQUALITY. A DIFFERENCE-IN-DIFFERENCES CROSS COUNTRY COUNTRY COMPARISON

Afonso Leme, Josep-Oriol Escardíbul

Human Capital

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Postal Address:
Institut d'Economia de Barcelona
Facultat d'Economia i Empresa
Universitat de Barcelona
C/ John M. Keynes, 1-11
(08034) Barcelona, Spain
Tel.: + 34 93 403 46 46
ieb@ub.edu
http://www.ieb.ub.edu

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ABSTRACT: Countries differ in their upper secondary school systems in a way that some require their students to choose a specialization from a set of areas - typically natural sciences, economic sciences, humanities or arts - and follow that specialization for the course of their upper secondary education years (e.g. Portugal, Spain, Sweden) whereas by contrast, others including Finland, Denmark or the U.S. follow a general curriculum where students, albeit being able to choose between different classes in distinct areas, are not required to follow a single specialization and thus, receive a more general education. Because countries only follow one system or the other, a cross-country analysis is required to estimate the possible effects of these institutional differences. An international differences-in-differences approach is chosen to account for country heterogeneity and unobserved factors influencing student outcomes, by using both PISA and PIAAC data for 20 different countries. The regression results suggest that the choice of one system or the other does not account for differences across countries in either the mean performance or the inequality of students' test scores.

JEL Codes: I21, I24, I28

Keywords: PISA, PIAAC, Education inequality, Tracking, Specialization, Difference-in-Differences, Curriculum

Afonso Leme
Nova School of Business and Economics
Universidade Nova de Lisboa
Campus de Campolide
1099-032 Lisbon, Portugal
E-mail: afonso.scl@gmail.com

Josep-Oriol Escardíbul
University of Barcelona &
Barcelona Institute of Economics.
Av. Diagonal, 690
08034 – Barcelona, Spain
E-mail: oescardibul@ub.es

1. Introduction

The efficiency and equity of a country's educational system is a topic of major concern and interest for policymakers, researchers, parents and students alike. Educational systems can be considered widely different across countries regarding their characteristics. Nevertheless, one distinction that can be clearly made is whether a country applies educational tracking and the timing in which it does so. Tracking can be generally described as separating students into different school classes, usually by academic ability or curriculum focus – students whose overall achievement is above average are assigned to the same class, as are students whose achievement is at an average level or below it. Usually, this separation also determines whether a student follows an academic-based track that prepares them for entrance in a university or a vocational-based track that on contrast, is designed to prepare students for entrance in the labor market following the conclusion of their school years. Furthermore, tracking can occur within schools, as is more common in the US - a form of ability-grouping also called streaming - or it can lead to a division of students between different schools, as is the norm in countries such as Germany, the Netherlands and several other European countries (Maaz *et al.*, 2008). Some countries such as Germany and Austria track students as early as age 10, while the majority of OECD countries does so at age 15 or 16 (Woessmann, 2009). The discussion of the advantages and disadvantages of early tracking has been a topic of much heated debate for a long time (see Heath (1984) for a collection of arguments for and against ability-grouping between schools in the UK). Those in favor of it tend to argue that homogenous classes allow for a focused curriculum adapted to the level and learning pace of each student, in which the professor doesn't have to worry about losing the interest of fast learners or making the slowest ones fall behind, resulting into an optimal learning by all students**.** The arguments for comprehensive schools, as opposed to tracking, claim that lower-level students will be systematically disadvantaged by slower learning environments if they are separated early on by tracking, leaving them farther behind the level of the upper groups, and thus, increasing inequality – both in their educational achievement and later in their life, through lower earnings in their adult years (Pekkarinen *et al.*, 2009). This possibility that tracking aggravates economic inequality is also related to the fear that it leads to a distribution of students through socio-economic background, perpetuating a bias against more disadvantaged students (Brunello & Chechi, 2007). Furthermore, opposers of tracking, by assuming non-linear peer effects, can argue that in heterogeneous classes, the higher ability students lose nothing while lower ability ones benefit from this interaction, giving a raise to efficiency (Benabou, 1996). On the other hand, if it is assumed that students are better off with peers of their own level, tracking could even improve the level of mean performance and reduce inequality (Dobbelsteen *et al*. 2002). Thus, from a theoretical point of view, the effects of tracking are widely controversial, suggesting a substantial uncertainty about its impact on both the level and distribution of students' achievement (see Betts, 2011; Meier & Schutz, 2007 for a review on the theoretical considerations on the impact of tracking).

The empirical evidence on this matter is too, quite unclear. While the empirical literature tends to suggest that tracking aggravates inequality in achievement, the major issue with any empirical research on tracking is that other unmeasured factors bias the estimations of its impact. For example, studies that exploit changes in tracking policies in schools are potentially biased if other changes to schools are simultaneously made. Nonetheless, Hanushek and Woessmann (2006) analysis has given fairly robust evidence that early tracking increases inequality in achievement, without a clear impact on mean performance. To account for the unmeasured factors biasing the estimated impact of tracking, they apply an innovative international differences-in-differences approach, that compares average test scores and deviations from the mean at the country level, for different grades, before any country has introduced tracking and after tracking has been implemented in some countries.

However, there is a type of tracking that has never been investigated in the literature before. This type of tracking is present at the upper secondary school level for students who are following an academic path and similarly to the other types of tracking, it is applied by some countries and absent in others. Countries differ in their upper secondary school systems in a way that some require their students to choose a specialization from a set of areas - typically natural sciences, economic sciences, humanities or arts - and follow that specialization for the course of their upper secondary education years (e.g. Portugal, Spain, Sweden) whereas by contrast, others including Finland, Denmark or the U.S. follow a general curriculum where students, albeit being able to choose between different classes in distinct areas, are not required to follow a single specialization and thus, receive a more general education. To the best of our knowledge, there has never been any paper specifically analyzing either theoretically or empirically the possible impacts of this specific type of tracking. As specialized systems can be considered somewhat less common – something which is supported by the proportion of countries with such system in our study sample – some additional information regarding its characteristics and anecdotal evidence about its possible effects on student outcomes is given.

One of the clearest differences from the ability grouping tracking, in which schools make strong recommendations for what type of track the student should follow based on his previous achievement, is that the choice of track placement in this case – the specialization – is solely the student's and parents' choice, at times aided by psychological advice or tests too. This decision is usually based on the academic interests of the student and his plans for his area of study at the tertiary education level, as some university programs often ask for the completion of some courses specific to a certain area (e.g. it is unlikely for a student following an arts specialization to study medicine at the tertiary level). Hence, this type of tracking does not divide students by ability but rather by area of interest and specialization and for this reason, the theoretical framework concerning the effects of having classrooms with homogenous or heterogeneous levels of student ability does not directly apply. Although the different specialization areas are not designed to have different levels of difficulty per se, as Bishop (2010) points out, the maths-science lines have a reputation for being the most difficult and prestigious, giving better chances of being accepted in varied tertiary education programs. A study done by the Portuguese Ministry of Education in 2014 shows that the biggest proportion of students with high grade point averages (classified as "Excellent" or "Merit") is present in the maths-science track, but it is also the track that has the second highest proportion of "Fails" out of the four tracks (Cid *et al.,* 2014) – possibly giving further confirmation that it is the specialization that attracts the best students but the one with the highest level of difficulty too. Although the degree of specialization varies across countries – as in some specialized systems, students are still able to choose quite freely from courses of other areas, while in others this choice is much more restricted – students will in any case have different focuses and thus, it is plausible to think that this will make them excel or fall behind in certain areas when compared to their peers of different specializations. One of the clearest differences between specialization areas is that the science and economics lines consistently have a higher focus on mathematics than the others, while to some lesser extent the humanities lines have a higher focus on languages, writing and reading skills. Therefore, it is possible that international tests show in some way an effect of this type of tracking, either through a change in the distribution of results of a country (e.g. an increase in educational inequality) or even a change in the level of mean performance. Given that the biggest difference between specialization areas seems to be in the extent of their mathematics curriculum, our initial intuition supposed that if any impact would be found, this would be more likely seen through an increase in the inequality of results for the mathematics exams for countries following a specialized system.

Since countries only follow one system or the other[1], this type of tracking requires a cross-country analysis to estimate the possible effects of these institutional differences. For this, an international differences-in-differences analysis is used to account for country heterogeneity and unobserved factors influencing student

[1] An exception was found for the case of Finland where, as noted by Kirjavainen (2007), around 13% of upper secondary schools offer the option of following a specialized curriculum. Nevertheless, most of them still offer the general track.

outcomes, following the approach of Hanushek and Woessmann (2006). The impact of having a specialized system in upper secondary school, as opposed to a general one, is identified by comparing the change in outcomes between a point just before students have started this stage of schooling – measured using PISA data - and a later point, after they have completed it – using data from the recently done PIAAC study – across countries with a specialized and general systems. The regression results of this first analysis suggest that the choice of one system or the other does not account for differences across countries in either the mean performance or the inequality of students' test scores.

The paper is organized as follows. Section 2 presents the econometric strategy followed and Section 3 describes the data used. Section 4 presents the evolution of student outcomes across countries, as measured by PISA and PIAAC test results, and reports the main regression results. Section 5 concludes.

2. Econometric strategy

The common method to estimate the determinants of a student's achievement is to consider an education production function, where the achievement of a student - usually measured by test scores – is dependent on various factors: personal characteristics of the student such as gender or innate ability and previous educational trajectories; family characteristics that usually consider the highest level of education of a student's parents, income and physical resources available at home such as books, computers or the access to Internet; school characteristics such as its infrastructures, teacher's quality, class size, the curriculum taught, peer effects and even specific characteristics of a country's educational system.

Evidently, a student's achievement is dependent on an immense amount of factors - some of them, very hard to observe and measure. This has lead researchers to adopt a reduced-form model of the equation. One could consider such a model like the one shown in equation (1) to estimate the impact of a county following a specialized system, as opposed to a general one, on a student's achievement:

$$A_{icg} = \alpha_c + \gamma SPEC_{igc} + \beta X_{igc} + \varepsilon_{igc} \qquad (1)$$

where the achievement of student i in grade g and country c (A_{icg}) is determined by a country specific intercept (α), several characteristics of families and schools (vector X) and the existence of a specialized system in upper secondary school (SPEC, which is a dichotomous variable that takes value '1' if the country has a specialized upper-secondary academic level and '0' if this is general). However, two main issues arise with using this methodology to estimate the impact of our variable of interest, *SPEC*. First of all, as Hanushek (2003) has shown, we cannot be completely confident with any estimates of the β, due to insufficient data on all the characteristics of a student's family background, school characteristics and peer effects, not only at the contemporaneous level but also regarding their past influence. Not taking into account all of these hard-to-measure determinants to achievement will lead to the standard problem of omitted variables bias. Secondly, regarding the influence of having a specialized educational system in a cross-country analysis, if in a country every upper secondary school student in an academic track follows a specialization, *SPEC* will be a country-fixed effect (a constant) and as such, we cannot estimate its impact on achievement.

Hanushek and Woessmann (2006) face the same problem when trying to estimate the impact of early tracking on achievement. To solve this issue, they effectively apply an international differences-in-differences approach, by comparing the average achievement gain in countries with early tracking to that of countries without it - as no country applies tracking in the early primary grades, it is possible to compare the level and distribution of student performance in these grades by using international assessment programs such as TIMSS and PIRLS, to these levels in secondary school where some countries have separated students into differing-ability schools and others have not, by looking at the results of PISA and TIMMS for secondary school. As such, Hanushek & Woessmann (2006) use a model that regresses secondary-school outcomes on primary-school outcomes plus an indicator for the existence of tracking.

Given the similarity of their analysis to the one of this paper, the same methodology is followed. In this way, the level and distribution of performance of younger students, at grades before upper secondary school, is compared with those of older students, after they've been through a specialized or general educational system in upper secondary schooling. The impact of having a specialized system will then be estimated by:

$$\gamma = \overline{\overline{\Delta A}}_{spec} - \overline{\overline{\Delta A}}_{gen} + (\bar{\bar{\upsilon}}_{spec} - \bar{\bar{\upsilon}}_{gen}) \qquad (2)$$

where the double bar denotes the average achievement gain in each group of countries, the ones with a specialized educational system in upper secondary school (*spec*) and the ones with a general system (*gen*). Thus, by taking a double-difference we are correctly applying a difference-in-differences approach to estimate the effects of a specialized system. The estimation is still depended upon the expected composite errors (v) being uncorrelated with the existence of a specialized system, which would be violated if the observed tests used came from largely different cohorts of individuals such that the X's (vector of family and school characteristics) were to change or if countries with specialized systems generally applied different school policies between the two measured points of achievement - just before academic upper secondary schooling (denoted by A_c^1) and after it (A_c^2) - that would substantially differ from those applied in general system countries and that these differences would not show up in achievement of the first measured period for each country, A_c^1.

The equation used will analyze mean performance and inequality as measured by the within-country standard deviation and also the difference between different performance percentiles – the test score difference between the student performing at the 95th percentile and the student performing at the 5th percentile in each country and likewise for the 75th and 25th percentile. The identification will thus, follow the below form:

$$A_c^2 = \beta_0 + \beta_1 A_c^1 + \gamma SPEC_c + \varepsilon_c \qquad (3)$$

where A_c^2 represents the various ways of measuring students' performance and its distribution at the country-level at a point posterior to the conclusion of upper secondary education; which is dependent on a constant term (β_0); the same measure of students' performance at the country-level used for the dependent variable but at a point just before upper-secondary school (A_c^1); a dummy variable indicating whether students in a country follow a specialized system in upper secondary school ($SPEC_c$); and an error term (ε_c). Additional control-variables such as the GDP per capita and a country's cumulative expenditure per student by age 15 years old are added as robustness-checks.

3. Data

Since around the late 1950's international testing of students began to be undertaken with the objective of comparing the performance of students across countries using the same evaluation criteria. Although these early studies faced some problems of sampling and within-country selectivity, since then, they have improved substantially and are currently widely used by researchers to evaluate educational matters. One of the most famous and used studies (if perhaps not the most) is the triennial PISA test by the OECD that started in 2000, with the intent of improving education policies and outcomes. This assessment program tested around 510,000 students in the last round of 2012 over 65 economies, in the key subjects of mathematics, reading and science. Students who take part in this exam are 15 years old of age (or have turned 16 very recently), an age which is chosen due to the fact in many countries, this coincides with the end of compulsory education – and for the interest of this paper, with a point just before the entrance to upper secondary schooling too.

To assess whether specialization in upper secondary school has an impact on students' performance, we would additionally ideally use a test such as PISA, but that instead, evaluates students just after they have concluded this last stage of secondary education. However, as unfortunately such international exam does not exist, we are forced to use another one that tests individuals on a broader age group. In 2012, the OECD released the results of the first edition of PIAAC, a study that aims at evaluating adults from 16 to 65 years old in the areas of literacy, numeracy and problem-solving. Around 155,000 individuals were tested, over 24 countries in this first round of the study. The countries that are present on both PISA and PIAAC studies are the following: Australia, Austria, Belgium (Flanders only), Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea, Netherlands, Norway, Poland, Russian Federation, Slovak Republic, Spain, Sweden, United Kingdom (England and Northern Ireland only) and United States. The subjects that are common to both tests are the reading and mathematics parts of the exams – reading literacy (PISA) and literacy (PIAAC); and mathematical literacy (PISA) and numeracy (PIAAC).

As the methodology of this paper proposes to compare the performance of students and its distribution at a point before and after they've been through an academically-oriented education in upper secondary school (following a specialized or general system), several removals had to be done in the original PIAAC database and to a lesser extent, in the PISA database as well. Starting with PIAAC, this database has information on the highest level of education obtained by each examinee according to the ISCED 97 classification (UNESCO, 1997) – an international classification of different levels of education created by UNESCO to facilitate comparisons of education statistics and indicators across countries, given their wide variety in terms of structure and curricular content. This not only tells us whether an individual has completed at least upper secondary education - the basic condition to be eligible for this analysis - but also if this education had an academic or vocational orientation. Once again, as we are only interested in analyzing students that followed an academic education in upper secondary school (since they are the only ones subject to either a specialized or general system), students with a vocational education at this level were removed from the study. These individuals that were removed are classified as having a highest level of education ISCED 3C, a decision which is complemented with a section of the PIAAC database that has information specifically on whether this level of highest education was vocationally oriented. Some individuals did not report their highest level of education according to the ISCDED classification and for those from the countries of Canada and Estonia, this information is not available at all – therefore, they were also removed. Australia was also not considered in the study as the data for this country had to be paid for. Furthermore, PIAAC has information on the area of study for the highest level of education obtained – with this, individuals who followed an area which was clearly not academic, were removed too (e.g. agriculture, social services, manufacturing).

Finally, concerning the age group range for individuals in the PIAAC database, this decision is distinctly more subjective. The lower limit should not be a problem, as the selection of individuals who have at least completed an upper secondary academic education is the important criteria. Still, 16 years old individuals were removed as it is not likely they have completed an academic upper secondary school program at such age[2]. Hence, what concerns us is the upper age limit. Although, as mentioned in the introduction of this paper, there is no theoretical literature concerning what the effects of specialization might be, it is reasonable to assume that these effects (if they do in fact exist) are more visible for individuals who have recently finished upper secondary school. Factors such as the quality of post-secondary education in a country or the commonness of on-the-job training are very likely to have an impact on the skills of adults in that country (Becker, 1975; Lucas, 1988), which will in turn bias the estimated impact of upper secondary school specialization. Restricting the sample to younger ages will provide a more appropriate study group but will at the same time reduce the sample size of each country and thus, increase the chances of having measurement errors. On the other hand, expanding the sample to include older individuals might, as already mentioned, capture other determinants of skills rather than specialization. Therefore, we experiment with different age groups in PIAAC - up to 21 years old, 24, 29 and 34. This age selection is chosen, first of all, because for the countries of Austria, Germany and the United States, the individual age values are not reported. For these countries, the age information of individuals is given in age groups of 5 years intervals (e.g. 25-29, 30-34). Therefore, to match the age group selection of countries with an individual age info with those without it, we choose

[2] It is, however, possible (yet very unlikely) that 16 years old students have advanced some school years and thus, finished an upper secondary school academic program at this age. As we believe that the probability of having a misreported information regarding the orientation of the program is higher than this, we choose to still remove 16 years old students. In any case, for the whole sample of PIAAC there were only 13 students that reported having completed an ISCED 3A-B program.

these 4 groups. Once again, since we are not sure which is the ideal group in our PIAAC sample to test the effects of upper secondary school specialization, testing these 4 groups provides a robustness check to our results. Most importantly, we were able to verify that the essential results did not change.

Concerning the PISA database, removals were made mostly in countries that have tracking between academic and vocational schools before or at the age where students take this exam. Once again, since our methodology proposes to compare individuals that have been through an academic upper secondary education following either a specialized or general system with their equivalents at a point before this stage of education, students who are already following a vocational track at the age of 15 are not eligible for this analysis. In this way, in countries with no early tracking between vocational and academic tracks such as Norway, Finland or United States no removals needed to be made, whereas in countries with early tracking such as Austria or Germany, several removals were done.

Finally, regarding the information about whether a country follows a specialized or general system in upper secondary school, this data was gathered from different sources ranging from OECD documents, information available on the websites of the Ministry of Education of each country and other articles about the curriculum and educational system of a country. Although it was not possible to have the exact information on when such systems were introduced in each country, we are confident that they have remained the same way since at least 1995 (the period where the older age group of 34 years old for PIAAC is expected to have finished upper secondary education) and assume there have been no changes since then, which we were able to verify for the vast majority of countries in our sample. In the group of 20 countries analyzed in this study, 14 of them follow a general system and 6 a specialized one. The general system group is constituted by Austria, Belgium, Czech Republic, Denmark, Finland, Germany, Ireland, Japan, Korea, Poland, Russian Federation[3], Slovak Republic, United Kingdom and United States. The specialized system group is formed by France, Italy, Norway, Netherlands, Spain and Sweden.

Test scores for each individual in both PISA and PIAAC are estimated with plausible values based on a multiple imputation technique (see OECD, 2009; and Pokropek &

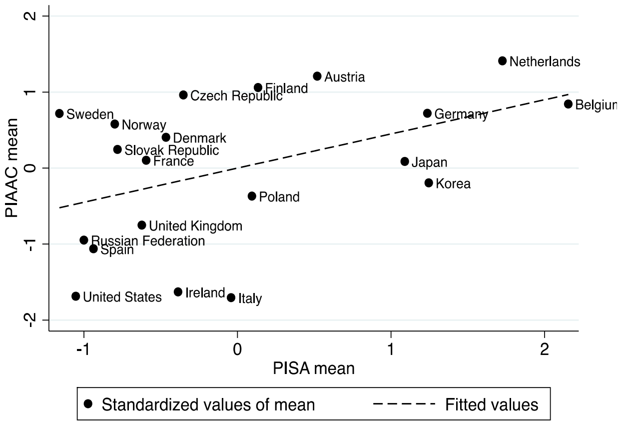
[3] OECD considers the results from the Russian Federation in the PIAAC survey to be preliminary. Furthermore, they do not include the region of Moscow which is not possible to remove independently from the PISA study. Although we decide to keep this country in our regression analysis, removing it from the sample did not change the results.

Jakubowski, 2012 for more on how plausible values and skills are estimated for PISA and PIAAC respectively). As PISA and PIAAC have different scales (PISA from 200-800 and PIAAC from 0-500), the variables analyzed in the next section are standardized to have a cross-country mean of zero and a standard deviation of 1.

4. Results

4.1. Evolution from PISA to PIAAC

Since our analysis mixes PISA with PIAAC data – and although their comparison is possible (see OECD, 2013, chapter 6, for a comparison of the two studies), very few studies have done so thus far – as a first step, it is interesting to see how their results are related for our study group in the different subjects of mathematics and reading, and for the measures of country-level mean performance and inequality (as measured by the within-country standard deviation). This will let us know how students' achievement in a country evolves from PISA to PIAAC, before considering the possible influence of a country following a specialized or general system. The age group considered in PIAAC for the Figures 1 and 2 displayed below is of individuals up to 24 years old, which in any case, showed a similar pattern to the other age groups.



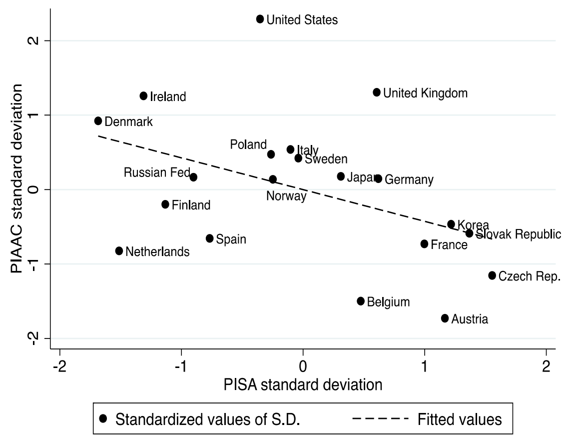


Figure 1- Evolution of Mathematics test scores from PISA to PIAAC across countries results. Mean of test scores in the national population (standardized across countries) on the left-hand side; Standard deviation on the right-hand side. Age group considered in PIAAC: up to 24 years old.

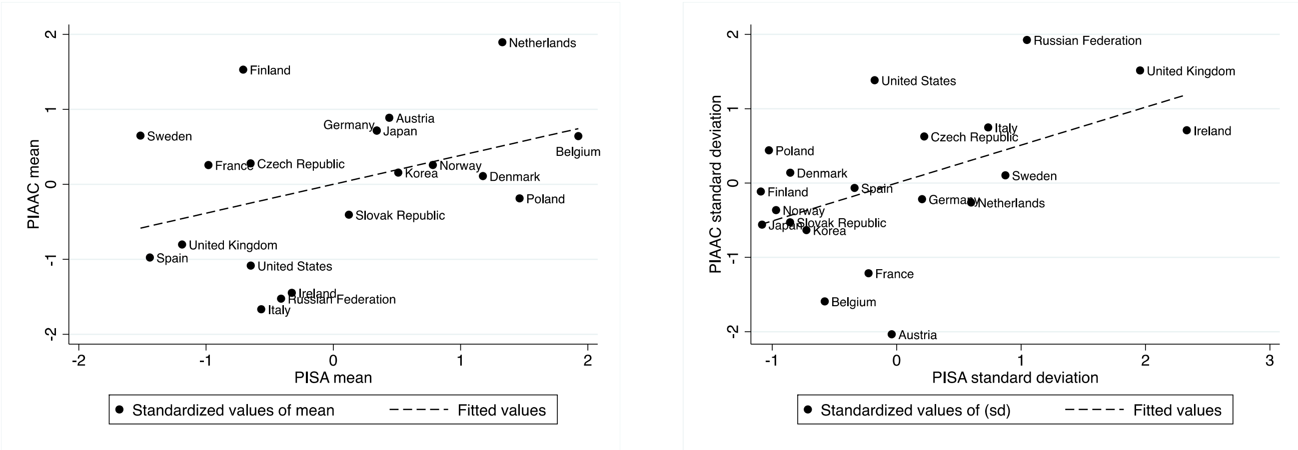


Figure 2 - Evolution of Reading comprehension test scores from PISA to PIAAC across countries results. Mean of test scores in the national population (standardized across countries) on the left-hand side; Standard deviation on the right-hand side. Age group considered in PIAAC: up to 24 years old.

Achievement shown in the results of PISA seems to be clearly related to the one shown for the same country in PIAAC. However, a curious pattern arises – while PIAAC results are shown to be positively related to the ones of PISA, this relationship is consistently negative for the inequality of the mathematics results. This pattern is consistent for all age groups in PIAAC and confirmed by the regression results. Although this result undoubtedly requires specific attention to what its reasons might be, as this falls out of the scope of the analysis of this paper, we leave it as a suggestion for possible future research.

Subsequently, regarding how the change in mean performance and inequality from PISA to PIAAC might be related to the different educational systems, a graphical analysis is applied as a first step. Given the importance devoted to inequality in the tracking literature and our initial intuition that if any impact would be found, this would be more likely seen through an increase in the inequality of mathematics exams for countries following a specialized system, the graphical analysis focuses on the change in inequality for this subject. The difference-in-difference methodology applied in this paper involves an investigation of the relationship represented in figure 3 below. It represents the relative standard deviation of mathematics test scores in our population of interest for each country (the difference from the international average of national standard deviation for this test) in PISA and PIAAC for countries with a specialized system and a general system. The age group considered in PIAAC is of individuals up to 29 years old for reasons of legibility, which in any case, showed a similar pattern to the other age groups. In Figure 3, countries with a specialized system are represented with a solid line while countries with a general system are represented with a dashed line.

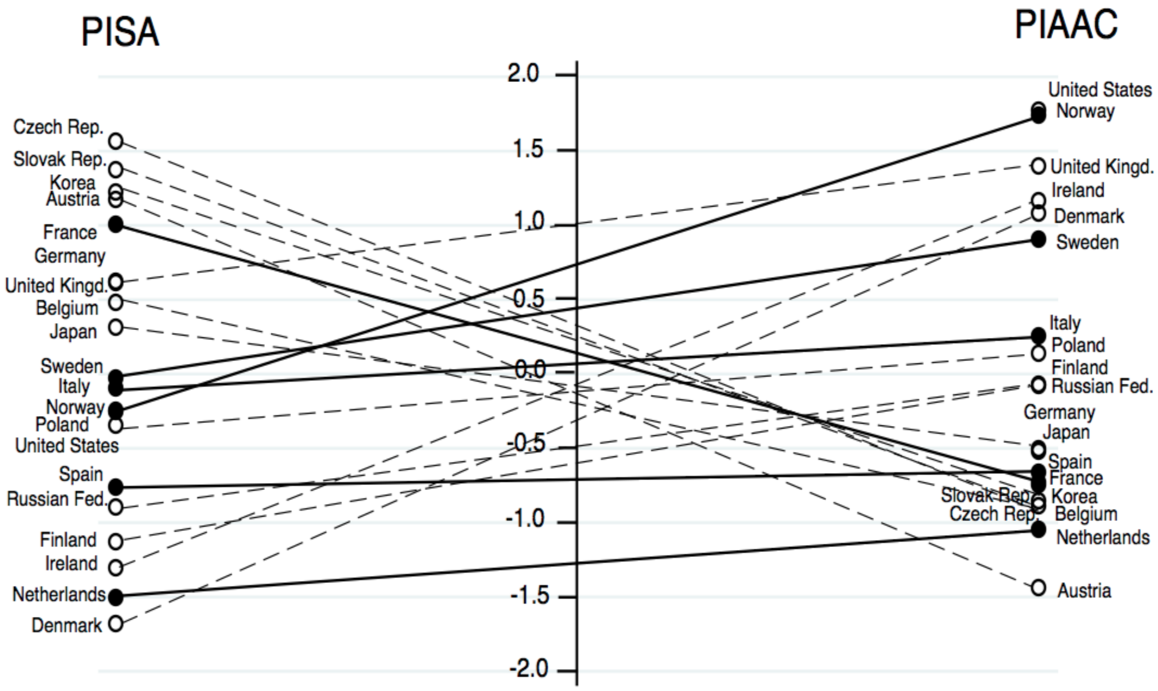


Figure 3 - Change in inequality from PISA to PIAAC across countries as measured by the national standard deviation of test score. Age group considered in PIAAC: up to 29 years old.

At first glance, the relationship appears to be quite unclear. Half of the countries with a general system increase their inequality while the other half decreases it. However, for the countries with a specialized system, a somewhat more consistent pattern appears. Out of this 6 countries, 5 of them increase their inequality (albeit with small increases for Spain and Italy) while France shows a decrease in inequality. These changes are perhaps more easily seen in Figure 4, where countries suffering an increase in inequality are above the zero line and those decreasing inequality are below it.

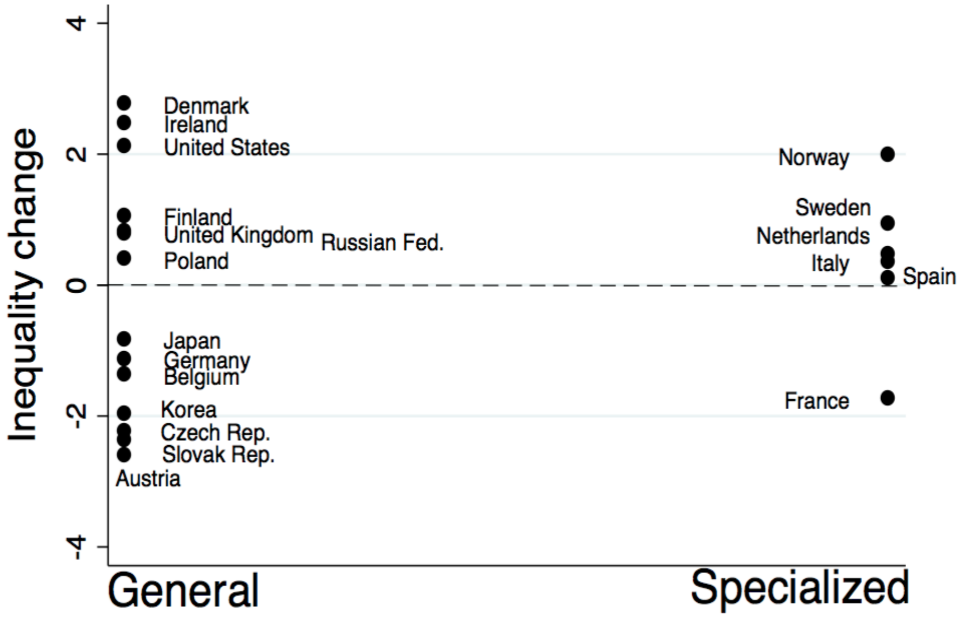


Figure 4 - Change in inequality from PISA to PIAAC across countries. Countries increasing inequality are above the zero line; countries decreasing inequality are below it. Inequality change defined as inequality in PIAAC minus inequality in PISA test

4.2 – Regression analysis

The regression analysis applies a differences-in-differences estimation, as described in section 2 of this paper, to estimate the impact of a country following a specialized system in upper secondary school. The regressions following equation (3) consider two variables as a dependent: on the one hand, the country-level mean performance in the subjects of mathematics and reading shown in PIAAC; on the other hand, inequality in those subjects. The analysis is developed separately for the 4 age groups - up to 21 years old, 24, 29 and 34. Therefore, as a mean to give robustness to our analysis, we regress these 16 different dependent variables for the measures of students' achievement in PIAAC (mean performance and inequality) on their respective PISA equivalent measure of achievement – with both variables standardized - and a dummy variable indicating whether students in a country follow a specialized system in upper secondary school.

Table 1
Mathematics achievement: PIAAC and PISA 2012

PIAAC age group:	21		24		29		34	
Measure of achievement:	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
PISA	0.480***	-0.305*	0.469***	-0.466**	0.477***	-0.430**	0.494***	-0.403**
	(0.161)	(0.168)	(0.156)	(0.172)	(0.161)	(0.176)	(0.160)	(0.170)
Specialized system	0.126	-0.460	0.213	-0.450	0.207	-0.069	0.236	0.088
	(0.489)	(0.352)	(0.514)	(0.401)	(0.465)	(0.517)	(0.458)	(0.530)
Constant	-0.010	0.095	-0.063	0.135	-0.062	-0.069	-0.070	-0.026
	(0.227)	(0.251)	(0.239)	(0.261)	(0.258)	(0.221)	(0.257)	(0.218)
R^2	0.241	0.146	0.211	0.225	0.126	0.181	0.234	0.170
F-test	0.023	0.089	0.025	0.021	0.028	0.061	0.023	0.082

*Dependent variables: Country-level mean performance and inequality (measured by the standard deviation of test scores). Number of Countries: 20. Robust standard errors in parentheses. Significance levels: ***1%, **5%, *10%.*

Table 2
Reading comprehension achievement: PIAAC and PISA 2012

PIAAC age group:	21		24		29		34	
Measure of achievement:	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
PISA	0.429**	0.408**	0.428*	0.521***	0.368	0.334*	0.346	0.371**
	(0.199)	(0.143)	(0.204)	(0.150)	(0.217)	(0.181)	(0.217)	(0.164)
Specialized system	0.108	-0.424	.0343	-0.334	0.278	0.277	0.204	0.357
	(0.543)	(0.352)	(0.533)	(0.351)	(0.545)	(0.510)	(0.544)	(0.485)
Constant	-0.006	0.127	-0.102	0.100	-0.083	-0.083	-0.061	-0.107
	(0.234)	(0.261)	(0.262)	(0.270)	(0.275)	(0.253)	(0.281)	(0.249)
R^2	0.189	0.220	0.172	0.284	0.126	0.135	0.111	0.175
F-test	0.105	0.021	0.138	0.009	0.254	0.099	0.280	0.068

*Dependent variables: Country-level mean performance and inequality (measured by the standard deviation of test scores). Number of Countries: 20. Robust standard errors in parentheses. Significance levels: ***1%, **5%, *10%.*

Concerning our variable of interest, the estimates of the dummy variable indicating whether a country has a specialized system in upper-secondary school are consistently non-significant across measures of achievement (mean performance and inequality), age groups in PIAAC and for the two subjects of mathematics and reading. As additional robustness checks, we experiment with different measures of inequality: the test-score difference between the individual performing at the 75th percentile and the one performing at the 25th percentile in each country; and likewise for the difference between the 95th percentile and the 5th percentile. The results of these additional regression analysis, for which an example is presented in the appendix of this paper in Table 3, do not change the estimates of the specialized system variable, which remain statistically insignificant. Moreover, adding further control variables such as the GDP per capita (in purchasing power parities, reported by The World Bank) and/or a country's cumulative educational expenditure per student by age 15 (reported by OECD, 2012) does not change the statistical significance of the specialized system variable either. An example of these regression results is also present in Table 4 in the appendix.

Regarding how achievement results in PIAAC relate to those of PISA, the regression analysis confirms what was seen in the graphical analysis – the point estimates of around 0.4 imply that countries tend to reduce both their mean performance and inequality from PISA to PIAAC. This result is consistent across test-pairs with statistically significant estimations for all but two test-pairs in the reading mean performance achievement, out of the 16 total estimations performed. However, as noted before, an exception is found for the inequality in the mathematics results which consistently show a negative relationship between PISA and PIAAC. This result suggests that, concerning our study group, countries that exhibit high levels of inequality in PISA, show low levels of inequality in PIAAC and vice-versa. Once again, as mentioned in the previous section, we leave the interpretation of this result for possible future research.

5. Conclusion

The analysis carried out in this paper provides preliminary results about the effects of a specialized versus a general upper secondary school curriculum on students' performance and inequality which, to the best of our knowledge, is the first analysis ever done regarding this topic.

Because countries only follow one system or the other, a cross-country analysis is required to estimate the possible effects of these institutional differences. We choose an international differences-in-differences analysis to account for country heterogeneity and unobserved factors influencing student outcomes. The impact of having a specialized system in upper secondary school, as opposed to a general one, is identified by comparing the change in outcomes between a point just before students have started this stage of schooling – measured using PISA data - and a later point, after they have completed it – using data from the recently done PIAAC study – across countries with a specialized and general systems. These changes are analyzed in terms of mean performance levels and different measures of inequality for the subjects of mathematics and reading and for various possible age groups in the PIAAC sample. Although outcomes in PIAAC are statistically significantly related to those of PISA for most test-pairs, the regression analysis suggests that the choice of one system or the other does not account for differences across countries in either the mean performance or the inequality of students' test scores. As a robustness check, different measures of inequality were considered, such as the difference between performance percentiles, and additional control variables were added - GDP per capita and a country's cumulative educational expenditure per student by age 15 - which in any case, did not change the estimated impact of having a specialized system.

Although the results of a first analysis regarding this topic suggest that this variation in upper secondary school systems across countries does not account for differences in students' outcomes, we believe that there is still room for further research regarding this matter: possibly by considering different databases; exploring differences in student outcomes from different specialization areas within a country following such system; or even by concentrating the analysis on a selected number of countries that are very similar between each other in Institutional, Socio- Economic characteristics and student outcomes in external evaluations (e.g. countries that PISA or PIAAC consider statistically similar) but differ in their upper secondary school system - the Scandinavian countries are perhaps a good example regarding this matter, as Finland and Denmark follow a general education system while Sweden and Norway a specialized one. Finally, regarding the consistent finding across test-pairs that inequality in the mathematics scores in PIAAC is negatively related to inequality in PISA in this subject for our study group, we believe this to be a possible topic for further research too.

Appendix

Table 3

Inequality as measured by percentil difference

Measure of inequality in PIAAC:	95th-5th percentil difference	75th-25th percentil difference
Inequality in PISA	-0.217**	-0.118
	(0.093)	(0.175)
Specialized System	-0.237	-0.143
	(0.235)	(0.142)
Constant	0.071	0.043
	(0.112)	(0.060)
R^2	0.148	0.071
F-test	0.029	0.486

*Dependent variable: Inequality in PIAAC mathematics test-scores measured by percentile differences. Age group considered in PIAAC: up to 24 years old. Robust standard errors in parentheses. Number of Countries: 20. Significance levels: ***1%, **5%, *10%.*

Table 4

Mathematics achievement - additional control variables

Measure of achievement	Mean	Standard Deviation
PISA	0.4177**	-0.453*
	(0.189)	(0.223)
Specialized system	0.169	-0.640
	(0.541)	(0.514)
GDP	0.363	-0.048
	(0.395)	(0.235)
Cumulative expenditure	-0.345	0.306
	(0.399)	(0.313)
Constant	-0.053	0.218
	(0.304)	(0.326)
R^2	0.256	0.298
F-test	0.031	0.069

*Dependent variables: Country-level mean performance and inequality (measured by the standard deviation of test scores). Number of Countries: 20. Robust standard errors in parentheses. Significance levels: ***1%, **5%, *10%.*

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