

What Are the Characteristics of Successful Education Systems?

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Contents

1	Introduction	1
2	What makes an education system successful?	2
2.1	Measuring education systems	3
2.2	Correlation between education system characteristics and PISA scores	4
2.2.1	Per capita GDP	4
2.2.2	Education spending	7
2.2.3	Teacher salaries	10
2.2.4	Share of young teachers	14
2.2.5	Teacher training	14
2.2.6	Class sizes	17
2.2.7	Teaching hours	19
2.2.8	Teaching methods	19
2.2.9	Teacher selection	21
2.2.10	Summary	21
3	What makes an education system more equal?	23
4	Case studies	31
4.1	Hungary	31
4.2	Singapore	34
4.3	Finland	35
4.4	Poland	36
5	Conclusion	37
6	References	38

1 Introduction

Good education systems are crucial for increasing productivity and social mobility. But what can be done to make education systems better and more equal? For example, do smaller class sizes lead to better education? What is the price of a more equal system? Will the best students perform worse if we try to close the achievement gap?

In this paper, I examine the relationship between student performance and education resources, as well as other policy-related factors that can influence student performance. Other variables, related to teachers that I consider include salaries, professional development programs and the number of lessons taught per year.

My main finding is that resources tend to have a positive correlation with student performance only up to a threshold. Above a certain level, it doesn't pay off to just spend more on education. That is also true for teacher salaries: student performance strongly correlates with teacher salaries if teachers make no more than college-educated people in the same age cohort, above that point, there is no correlation. There is a negative association between class sizes and student achievement, and a positive association between the share of young teachers, participation in teacher development programs and student achievement.

Beyond providing a country with an educated workforce, education can also increase social mobility. I examine the relationship between cross-school variation of student performance and the likelihood that a student will perform worse if he or she comes from a disadvantaged family. I also consider the role of admission policies, such as whether residence is the primary driver of the allocation of students to schools. I find that differences across schools are correlated with higher inequality of opportunity. Considering residence (rather than academic performance) at admission is negatively correlated with the role of family background in determining academic performance. I also find that policies aimed at closing the achievement gap don't hurt high-achieving students.

After examining these associations across countries, I turn to examining four education systems, Hungary, Singapore, Finland, and Poland, in detailed case studies. In my case studies, I consider some unique challenges and solutions in each of these countries' systems. In Hungary, I consider the key sources of inequality of opportunity (the worst among OECD countries): the segregation of high- and low-achieving students and the Roma-non-Roma gap. In Singapore, I examine why the country's education system has been successful and what are some of its shortcomings: while the teaching profession is valued in society, and the best students become teachers, it is a highly competitive education system which causes stress among students who spend a lot of time studying. The opposite is true in Finland,

which has one of the best education systems in Europe. Finnish students don't spend so much time in classrooms, and they aren't writing standardized tests, but the best students become teachers there, too. In Finland, the difference between schools is marginal, and family background is not a very important factor in determining student outcomes. Poland showed huge improvements recently thanks to an educational reform in which Polish students study one year longer in elementary schools and tracking begins later. They managed to significantly reduce the differences between rural and urban schools.

The remainder of this paper proceeds as follows. Section 2 examines the relationship between education system characteristics and student outcomes. Section 3 considers the determinants of equality of opportunity. Section 4 presents four country cases studies. Finally, Section 5 concludes.

2 What makes an education system successful?

In this section, I examine the association between education resources and PISA scores. In particular, I focus on the following factors:

- GDP/capita,
- salary (and salary progression) of teachers,
- education spending as a share of GDP,
- the amount spent on each student,
- class size,
- proportion of young teachers,
- professional teacher development programs,
- lessons taught per year,
- teacher selection,
- school autonomy,
- teaching methods.

The data I use can be found at the *OECD's Education GPS* site.¹ Data on the structures of specific countries' education systems can be found there, too.

2.1 Measuring education systems

The Programme for International Student Assessment (PISA) is a study by the Organisation for Economic Co-operation and Development (OECD) to evaluate education systems in 72 countries. I mostly focus on the 34 OECD member countries. The test measures 15-year-old students' performance on mathematics, science, and reading tests every three years. It examines how students can apply what they learnt, and not how students can reproduce classroom material. In this essay, I focus on reading and mathematics results. To facilitate comparison, PISA scores are normalized such that the average is 500 and the standard deviation is 100. To achieve a standard level of reading proficiency (defined as “be able to identify the main idea in a text of moderate length”), 407 points are needed. To be a top-performing student in reading (defined as “be able to critically evaluate a lengthy text, or to be able to deal with abstract concepts”), 626 points are needed (OECD 2019).

There are other international student assessment tests, such as Trends in International Mathematics and Science Study (TIMSS) and Progress in International Reading Literacy Study (PIRLS). Both of these studies are run by the International Association for the Evaluation of Educational Achievement. They exclude many European countries, and, more importantly, they measure knowledge instead of application, examining classroom material with tasks resembling those in classes. I chose the PISA test, because firstly, I believe skills and applying the knowledge are more important than solely knowing the material, and secondly, education systems teach the same material in different grades, making these assessments hard to compare across countries, while the skills measured by the PISA test develop over time and are not dependent on the way different countries sequence material.

Alternatively, I could look for data on the proportion of people studying in tertiary education (a common method for comparing the quality of different high schools in Hungary), but the quality of tertiary education differs along with country-specific factors. For example, some jobs may require a college degree in some countries but not others. Moreover, if there is a fixed amount of places available for tertiary education in a country, this data wouldn't be informative because improving the skills of high school students would not translate into more college attendance. So college attendance is useful to measure differences within a country, but not so much to measure differences accross countries.

¹<https://gpseducation.oecd.org/>

Skill-based tests, like the PISA, are highly correlated with future earnings, and their likelihood of unemployment. Hermann et al. (2018) look at the correlation between the scores of Hungarian 10th graders in the National Assessment of Basic Competences (which test is quite similar to PISA) in 2008 and their salaries in 2017. They find that a one standard deviation increase in Mathematics scores is associated with 8-9% higher wages and 2.7% lower unemployment.

2.2 Correlation between education system characteristics and PISA scores

In this section I report evidence on the relationship between various characteristics of education systems and PISA scores. An important caveat is that the correlations reported here do not imply a causal relationship between characteristics and outcomes. There are two main reasons why I do not want to claim that these relationships are causal and that simply changing one of these characteristics would result in higher test scores. First, it is likely that these factors interact with each other and form bundles. Therefore changing just one of them is unlikely to result in significant changes in test scores. Second, these associations are subject to omitted variable bias: there are likely to be other, often unobserved factors, that are correlated with both the factors I study and the outcomes.

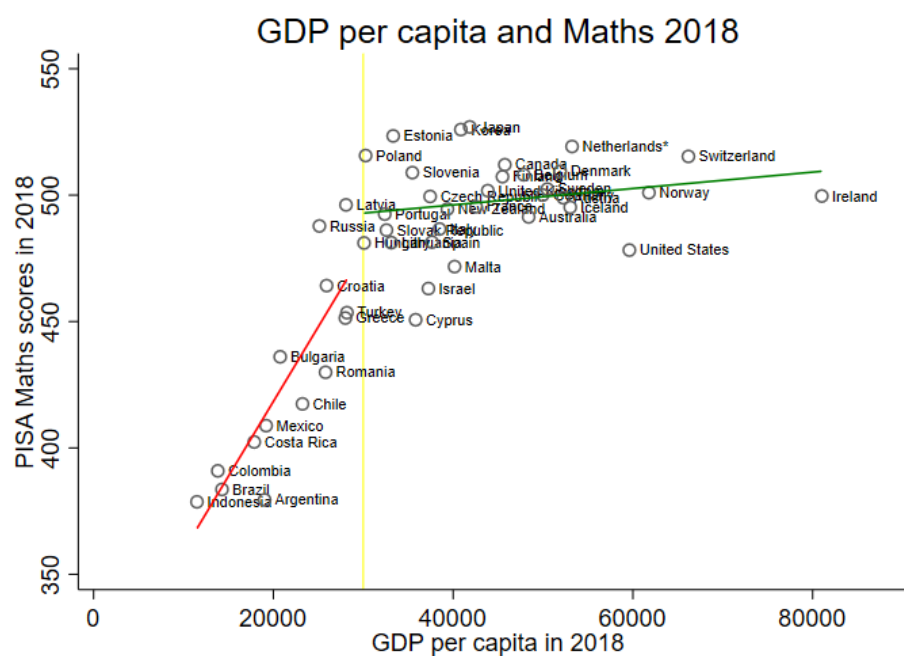
2.2.1 Per capita GDP

First, I examine the relationship between PISA scores and per capita GDP. While per capita GDP has little to do with education policy, we might reasonably expect that it is strongly associated with student achievement. In particular, we expect students in wealthier countries to perform better. Figure 1 shows the relationship between 2018 per capita GDP (with PPP adjustment) and PISA Maths scores. On average the relationship is strong and positive, if the GDP is below \$30,000: below that, an \$500 increase in GDP/capita is associated with a one-place improvement in the world ranking (increasing the mean score by 3). Above \$30,000, this relationship disappears. A similar pattern emerges for reading scores. For per capita GDP below \$40,000, increasing GDP by \$1,000 is associated with a one-place improvement (3 points), above that, this relationship disappears. Nevertheless, per capita GDP is the indicator most strongly correlated with PISA scores. The correlation is just as strong between per capita GDP and the proportion of the best achievers and standard level achievers.

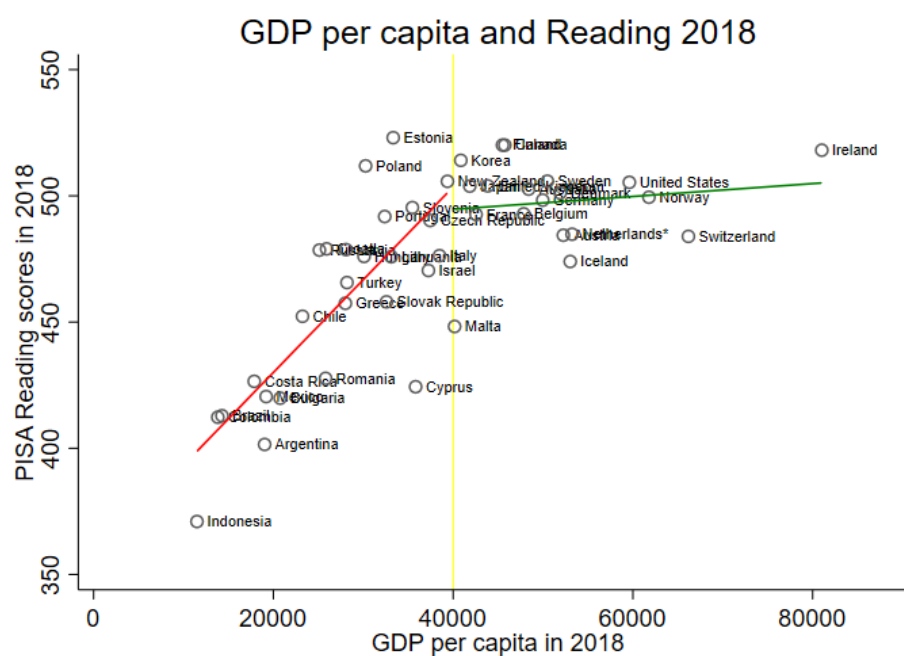
It is interesting to observe which countries are far from the overall trendline. These are countries that do much better or much worse than we would expect based on their per capita GDP. Saudi Arabia has a much lower average PISA score than we would expect based on its per capita income. This is most likely because of inequality: the top 10% has more than 60% of the pre-tax national income, and the bottom 50% has just 7.8% (World Inequality Database 2019). Other countries under the trendline (i.e., countries that have lower average scores than we would expect based on their per capita GDP) are the US, Israel, and Cyprus. In these countries, the segregation of minorities (Blacks and Hispanics in the U.S., Arabs in Israel, and Turkish Cypriots in Cyprus) leads to underachievement among these groups and results in lower average scores. Countries above the trendline (i.e., countries that have higher average scores than we would expect based on their per capita GDP) are countries in East Asia (e.g., Japan and South Korea) and in Eastern Europe (e.g., Poland and Estonia).

Figure 1: Relationship Between GDP per Capita and PISA Scores

(a) Mathematics



(b) Reading



Note: Figure shows the relationship between 2018 GDP per capita and 2018 PISA scores. Panel (a) shows Mathematics scores and Panel (b) shows reading scores.

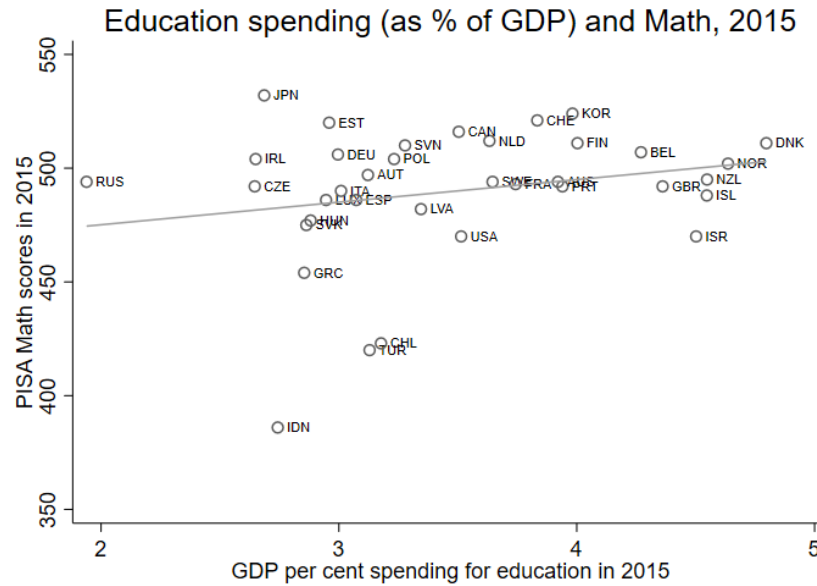
2.2.2 Education spending

Another interesting question is whether education spending is associated with student performance, since it is important to know how big is the role of increasing spending on education. In Figure 2, it is clear that education spending as a share of GDP is associated with better student performance. However, like in the case of GDP per capita, above a certain level, this association is weak. This suggests that spending more on education could be helpful in creating a stronger education system, but it is neither necessary, nor sufficient. The key seems to be combining higher spending with structural reforms and making sure that the extra money is well-spent. Outliers exist here as well: Japan achieves good results with low spending (2.69% of GDP), while Israel lags behind despite its comparatively high spending (4.5% of GDP). Hungary spends slightly above 3% of GDP, a bit lower than the average. Increasing education spending by 1% of GDP is associated with an increase of around 10 points in the PISA score, or moving 3-4 places up in the ranking among OECD members.

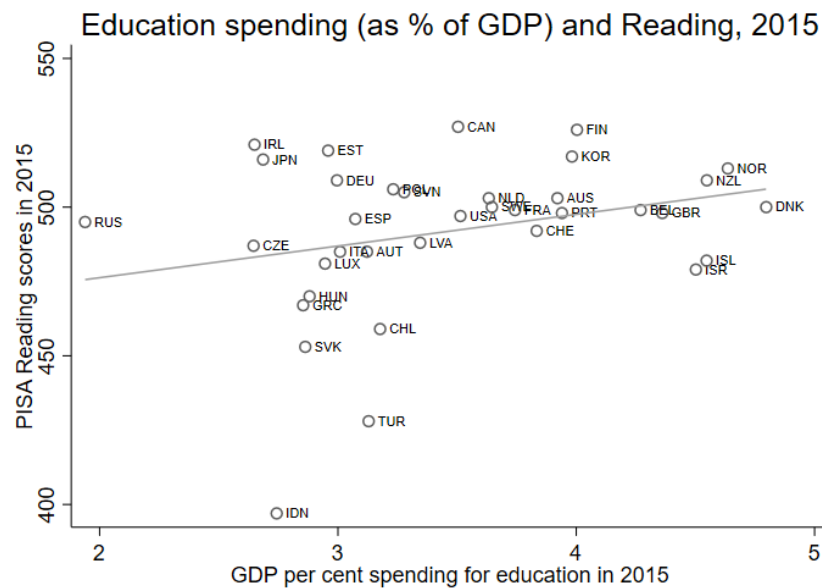
In Figure 3, I examined the correlation between student achievement and spending per child. The figure suggests that up to \$7,000, the spending matters a great deal: increasing the spending by \$500/student is associated with moving up in the ranking 3 places (\$1,000: 17 points increase), while above \$7,000/student an increase of \$4,000 is associated with moving up in the ranking 1 place. (\$1,000: 0.7 points increase) This relationship is similar to the relationship between GDP and test scores: if spending is low, a small change is associated with a large change in achievement, but if it is high, no matter how big the change is, the achievement won't change much. Interestingly, in Hungary, spending per student was the lowest in Europe in 2012, just \$4,500.

Figure 2: Relationship Between Education Spending (as percent of the GDP) and PISA Scores

(a) Mathematics



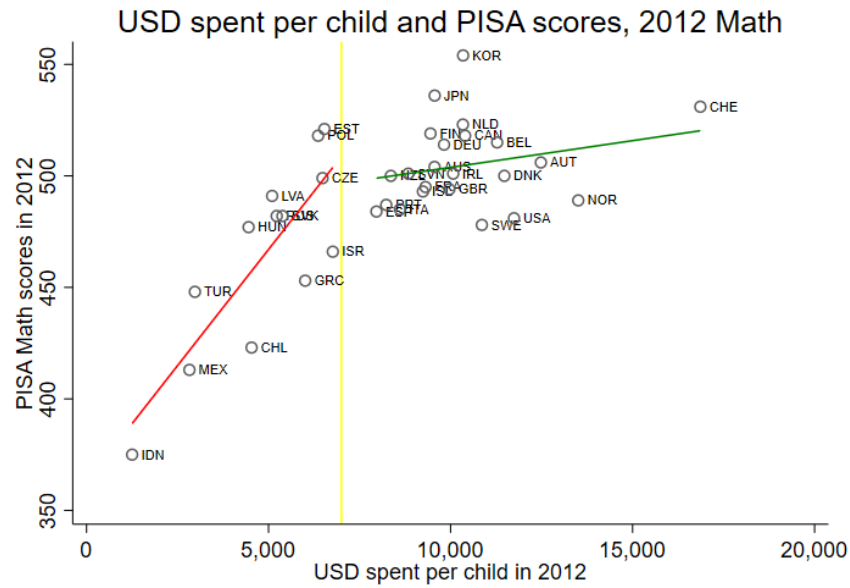
(b) Reading



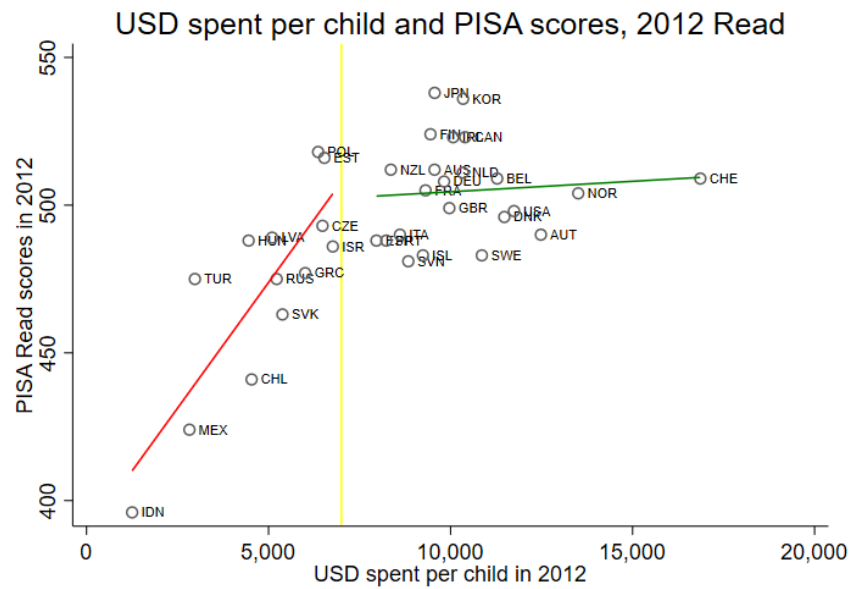
Note: Figure shows the relationship between education spending (as percent of GDP in 2015) and 2015 PISA scores. Panel (a) shows Mathematics scores and Panel (b) shows reading scores.

Figure 3: Relationship Between Education Spending (USD per child) and PISA Scores

(a) Mathematics



(b) Reading



Note: Figure shows the relationship between education spending (as US Dollars spent per child in 2012) and 2012 PISA scores. Panel (a) shows Mathematics scores and Panel (b) shows reading scores.

2.2.3 Teacher salaries

Teacher salaries have a considerable effect on teacher recruitment, so we might expect that by raising teacher salaries, not only will current teachers be more motivated and less likely to change professions, but that more people will apply to be teachers (Hough 2012). Figure 4 show the relationship between PISA reading scores and the ratio of salaries of 25-34-year-old teachers and their college-educated peers. This is a measure of how well-paid teachers are relative to similarly educated workers. There is a positive association: countries where teachers are better paid, achieve better on the PISA test. In most of the countries in Western Europe, the ratio is between 0.9 and 1 (i.e., teachers earn roughly the same as similarly educated workers in other professions), and with this ratio, a very good score is achievable. Finland for example has very good results with a ratio around 1. However, if the ratio is below 0.9, an increase or a decrease in the ratio is more strongly associated with an increase or a decrease in PISA scores. A very high ratio (in Latvia and in Portugal) is not associated with high student achievement. Interestingly, Hungary has a ratio of 0.6, which is among the lowest in OECD countries. This figure suggests that offering higher salaries makes teaching a more attractive career and enables schools to select better qualified teachers. At the same time, there is no correlation between the ratio of the best possible salaries (defined as the highest possible salary in the career of a teacher if he or she stays a teacher and doesn't become a principal, without bonuses) and starting salaries and student achievement. High starting salaries, combined with a relatively flat progression may be useful for recruiting high-quality and committed teachers. On the other hand, low starting salaries with a steeper progression may have the effect that high-quality teachers don't enter the profession but less-committed teachers are effectively "locked-in" because they want to stay on to achieve higher salaries (Barber and Mourshed 2007). However, it is important to note that if salaries are so low that teachers are struggling to pay for basic needs, teacher salaries should be increased.

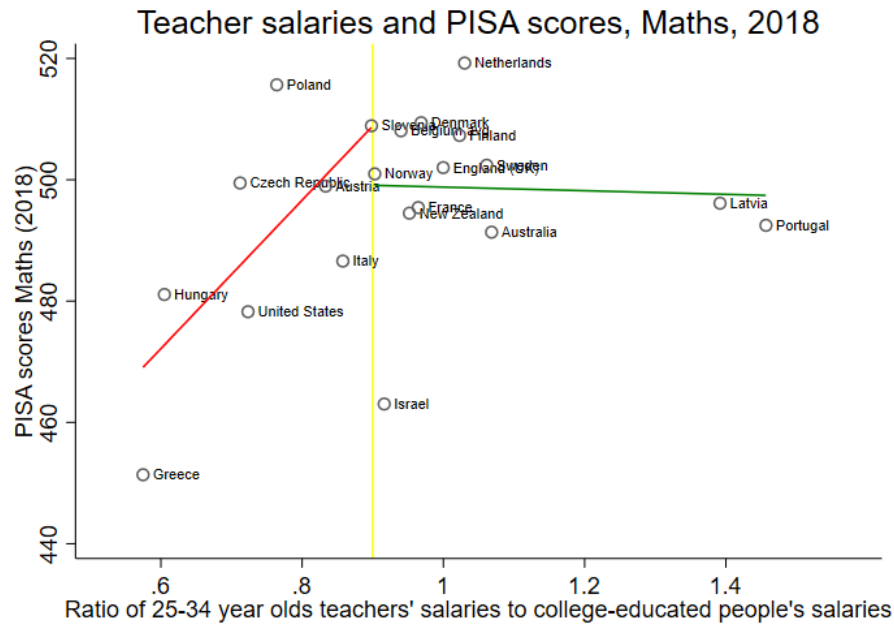
There is a negative correlation between the time to reach the maximum salary and student achievement in reading. Interestingly, concerning math points, the correlation is weaker. Perhaps, observing that it takes a long time to reach a high salary discourages potential teachers. For example, in Hungary, it takes 42 to years to reach the salary maximum (vs. an average of 26 years across 25 countries), as shown in Figure 5. To move up one place in the ranking among these countries, if this ratio is below 0.9, an increase of 0.03 is needed. (In Hungary, it means a 5% increase of starting salaries.)

These findings suggest that Hungary's teacher salary model ("Pedagogical Career Model") may not be optimal. Starting salaries are very low: the gross wage of a teacher in their first

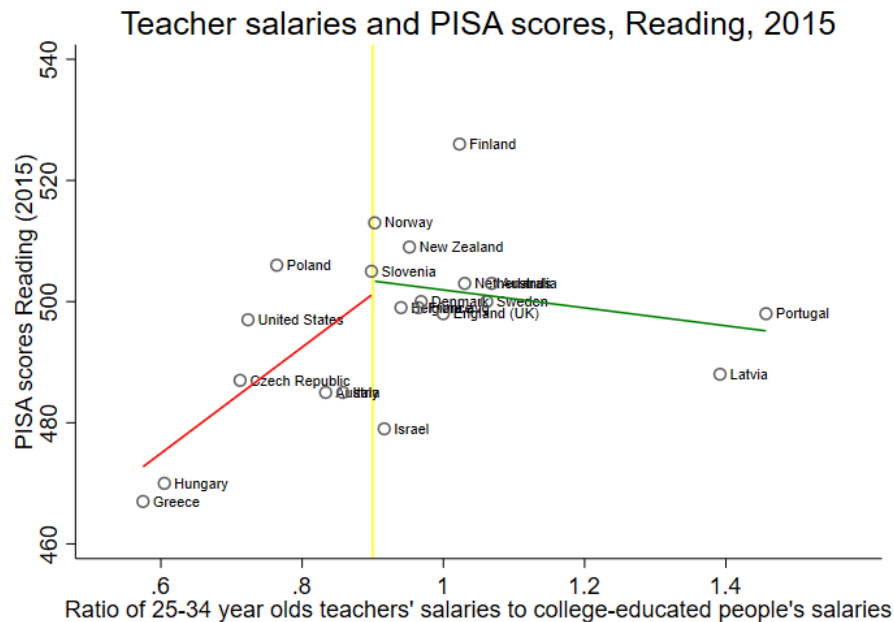
years is HUF 203,000 vs. 275,000 for all university graduates (officina.hu (2020), fizetese.hu (2020)), making teacher recruitment efforts difficult. At the same time, teachers can achieve a lot higher salaries up to 416,150, but this requires staying for 40+ years.

Figure 4: Relationship Between Salaries of Young Teachers and PISA Scores

(a) Mathematics



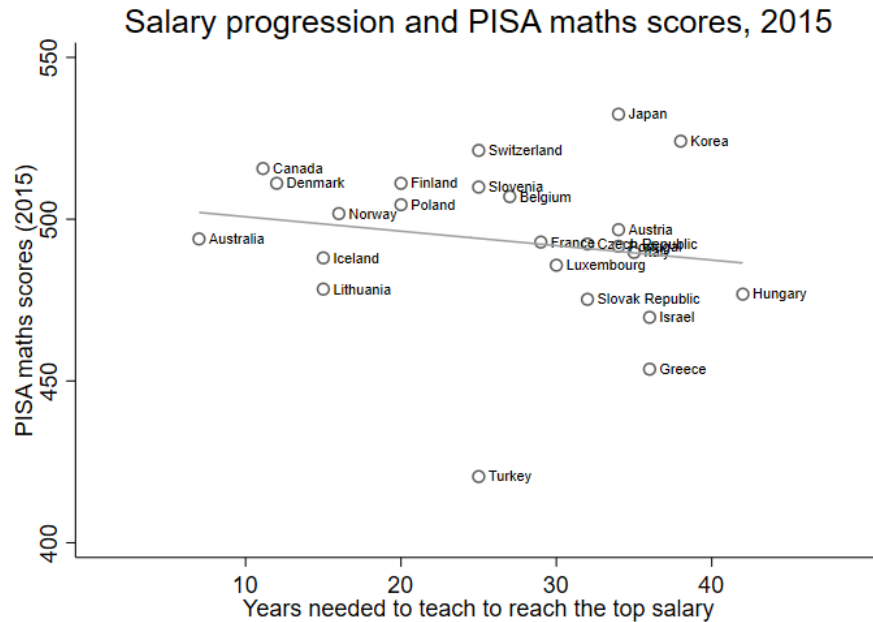
(b) Reading



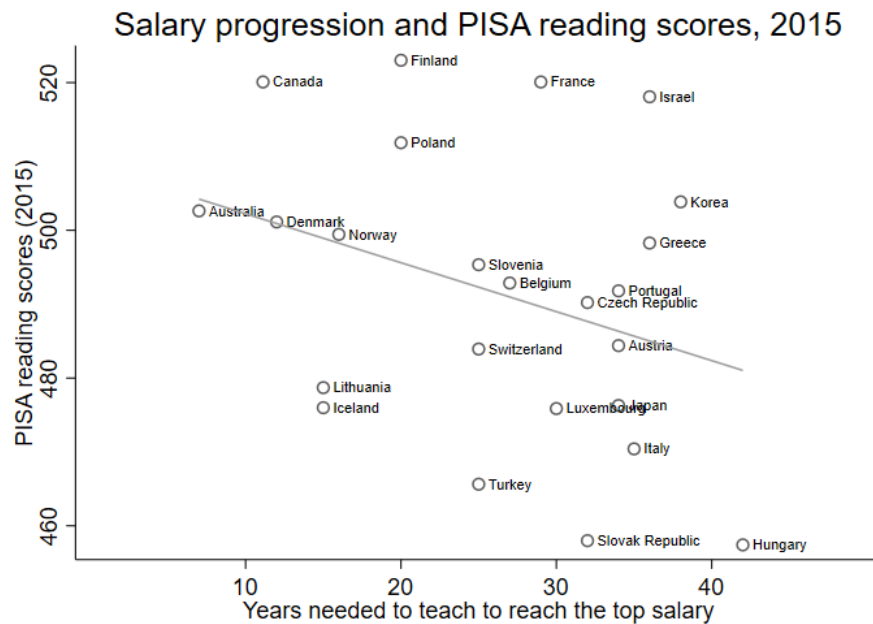
Note: Figure shows the relationship between the ratio of salaries of 25-34 year old teachers and their college educated peers and Pisa scores among OECD members in 2015-2017. Panel (a) shows Mathematics scores in 2018 and Panel (b) shows reading scores in 2015. If that ratio is higher than 1, then teachers earn more than the average salary of 25-34 year old college graduates, if it is lower than 1, they earn less.

Figure 5: Relationship Between the Years Needed to Teach to Reach the Maximum Salary Level and PISA Scores

(a) Mathematics



(b) Reading



Note: Figure shows the relationship between the years needed to teach in order to reach the maximum salary level and 2015 PISA scores. Panel (a) shows Mathematics scores and Panel (b) shows reading scores.

2.2.4 Share of young teachers

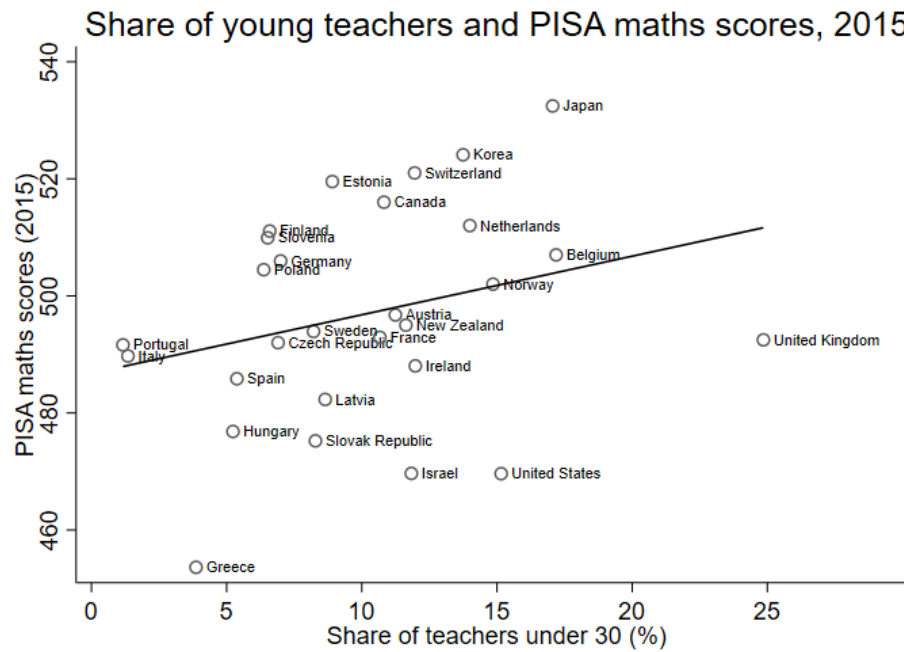
Another good indicator can be the proportion of young teachers. The share of young teachers seems to signal the attractiveness of the teaching profession, and therefore a higher share of younger teachers is associated with higher average scores. So young teachers aren't more effective, but if the teaching profession is more attractive, the education system will be better. Increasing the proportion of teachers under 30 by 10.5% correlates with a point increase of 10. However, this effect can be crowded out by the fact that more experienced teachers can be more efficient in teaching. This is confirmed in Figure 6.

2.2.5 Teacher training

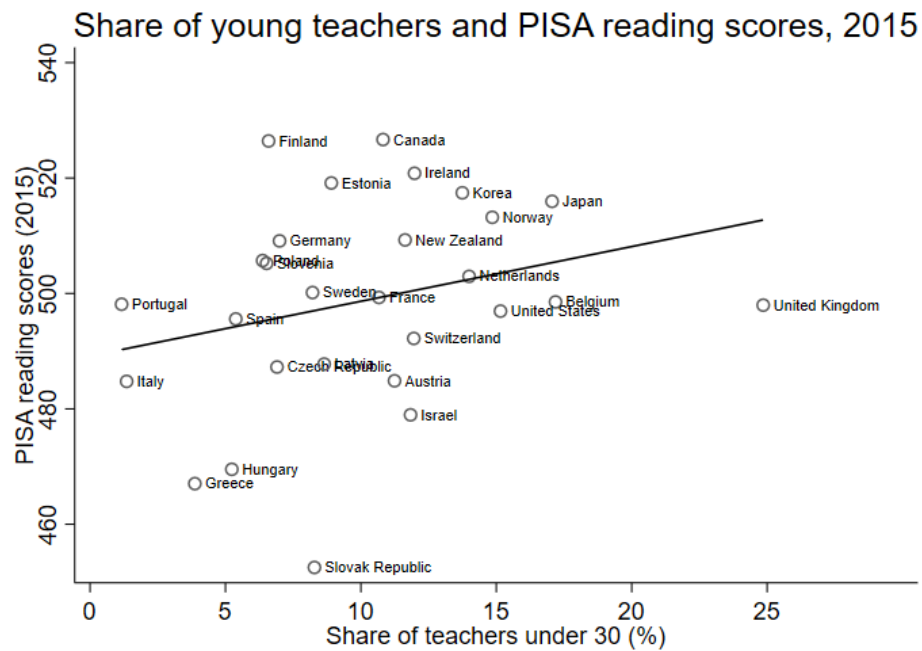
It can be expected that if teachers are learning throughout their career, they will develop more modern teaching practices, so we might expect that if more teachers are taking part in teacher training programs, the education system will be better. And indeed, that's the case: professional training programs seem to have a positive association with student achievement. Of course, this data can't tell us how useful professional training programs are, but improving teachers is key to having a better education system, and getting teachers to additional training programs may be a good way of improving them. A 30% increase in the proportion of teachers taking part in professional development programs is associated with a 10 points increase in student achievement. According to Barber and Mourshed (2007), in the best education systems, teachers are learning from each other, they create lesson plans together, and they observe each other's classes. In Singapore, which is not an OECD country, so it is not in the graph, there is a laboratory for new teaching practices. It is also noteworthy that Hungarian teachers are taking part in these programs in the smallest proportion among OECD countries, which can be seen at Figure 7. It is interesting that in the English-speaking world, many teachers take part in these programs.

Figure 6: Relationship Between the Share of Young Teachers and PISA Scores

(a) Mathematics



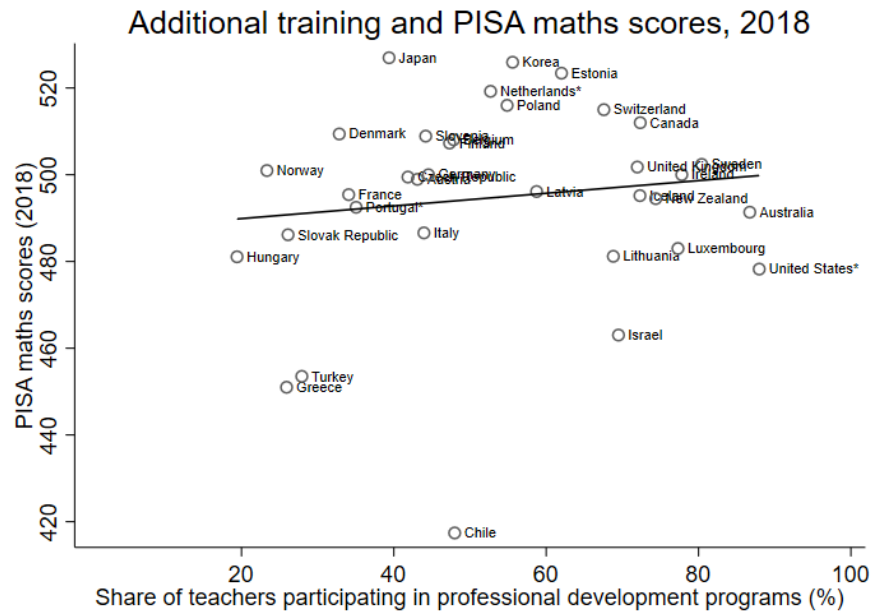
(b) Reading



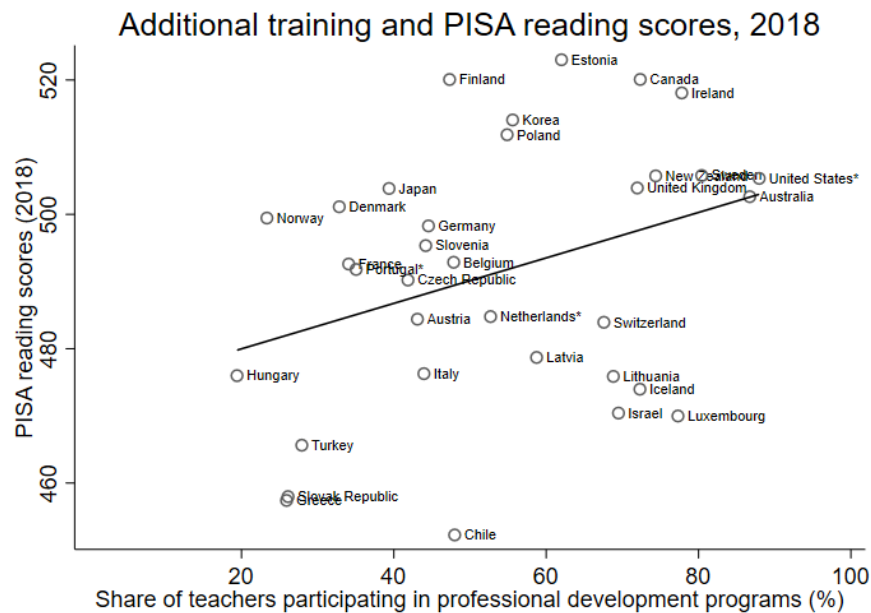
Note: Figure shows the relationship between the proportion teachers under 30 and 2015 PISA scores. Panel (a) shows Mathematics scores and Panel (b) shows reading scores.

Figure 7: Relationship Between Attendance in Professional Teacher Development Programs and PISA Scores

(a) Mathematics



(b) Reading



Note: Figure shows the relationship between the proportion of teachers who took part in professional development programs and PISA scores in 2018. Panel (a) shows Mathematics scores and Panel (b) shows reading scores.

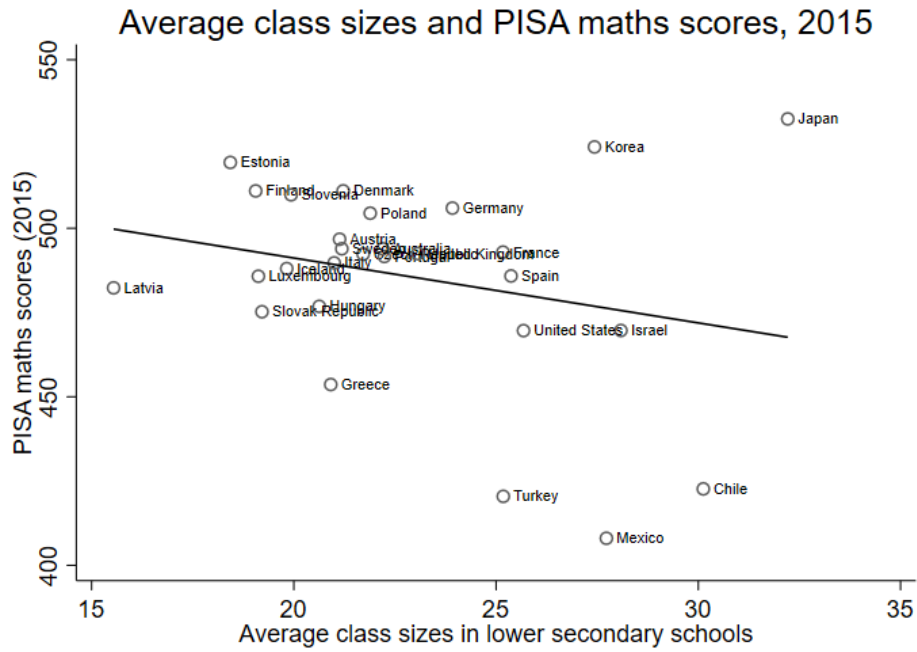
2.2.6 Class sizes

Many teachers' subjective experience is that they can teach more effectively in smaller classes, and results (with the exception of some countries) show that this presumption is right. As it is visible in Figure 8, overall smaller class sizes are associated with better performance. Nevertheless a great performance is achievable with big class sizes (Japan, South Korea), but they tend to be the exception. In an experiment in Tennessee in 1985-89, where students in the first four years were randomly assigned to normal classes (23 children) and small classes (15 children), they found that children in smaller classes didn't just have significantly better results in reading in the years when they were in small classes, (they were around 30 percentiles above their peers) but they also had a lower chance of dropping out of high school (by 6 percent). Moreover, they were 1.6 percentage points more likely to attend college than their peers studying in larger classes, but those who attended college because of smaller class sizes attended worse-quality colleges than their peers studying in large classes, though. Students attending smaller classes were estimated to earn \$109 more a year at age 27, which is insignificant, however, this gap might increase later due to the fact that salaries of college-graduates increase more over time (Chetty et al. 2011). Attending smaller classes for the first four years was equivalent to studying one more year after 8th grade (Boyd-Zaharias 1999).

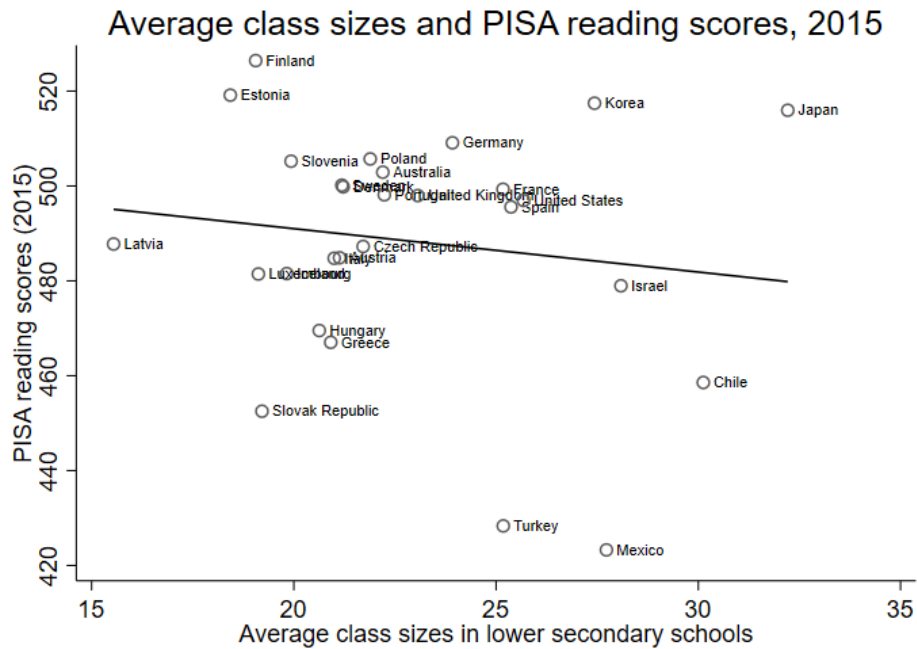
Halving class sizes results in around a 20 points increase, which is roughly the same as doubling starting salaries or spending twice as much on education. A reduction of average class size by 11 students is associated with a 10 points increase (around 2-3 places in the OECD ranking). However, this correlation might actually be stronger, since in many countries (in Israel, for example) disadvantaged students are put into smaller classes because it helps improve their performance. So since classes aren't created randomly, such that disadvantaged students tend to study in smaller classes, this results in the fact that the correlation between class sizes and student achievement is weak in Israel (Blank, Shafrir, and Shavit 2016). More importantly, if smaller class sizes aren't coming with different teaching methods, there isn't such a difference. If frontal instruction remains as the most important teaching method, smaller class sizes won't make much of a difference. Smaller classes are most likely to be helpful if they enable more interactive and individualized instruction. One potential drawback to smaller class sizes is that the average quality of teachers may suffer as more teachers are needed.

Figure 8: Relationship Between Class Sizes and PISA Scores

(a) Mathematics



(b) Reading



Note: Figure shows the relationship between average class sizes in lower secondary schools and 2015 PISA scores. Panel (a) shows Mathematics scores and Panel (b) shows reading scores.

2.2.7 Teaching hours

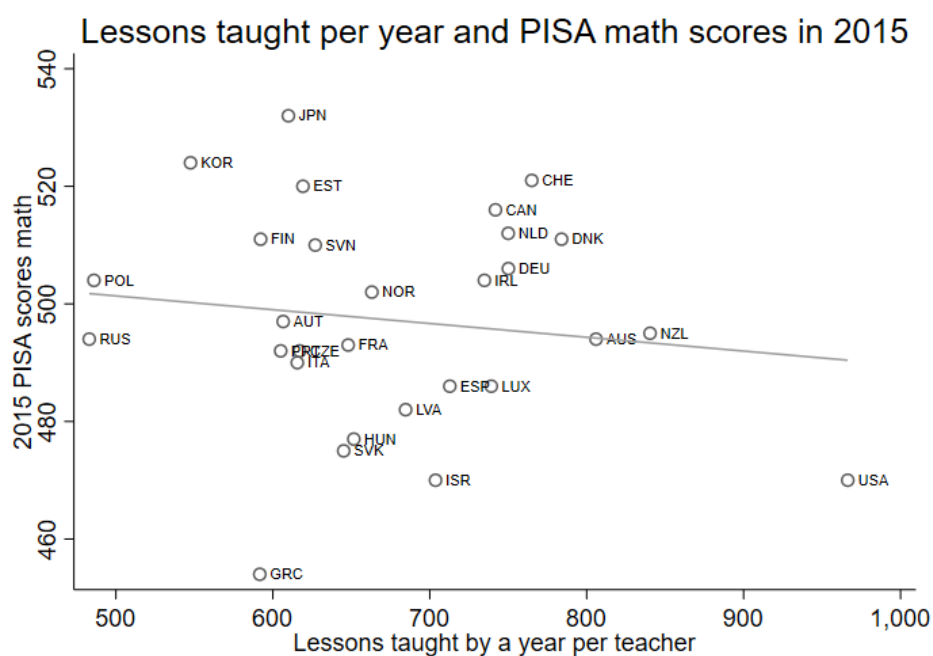
It can be expected that if teachers have to hold fewer classes a week, they have more time for preparation, or they are less stressed, hence student performance will improve. But that's not really the case. As visible in Figure 9, teaching hours/year of teachers (excluding South America) show no correlation with reading scores and show a very little correlation with math scores. I find that surprising, because fewer lessons give teachers more time for class preparation, thus enabling them to hold better lessons.

2.2.8 Teaching methods

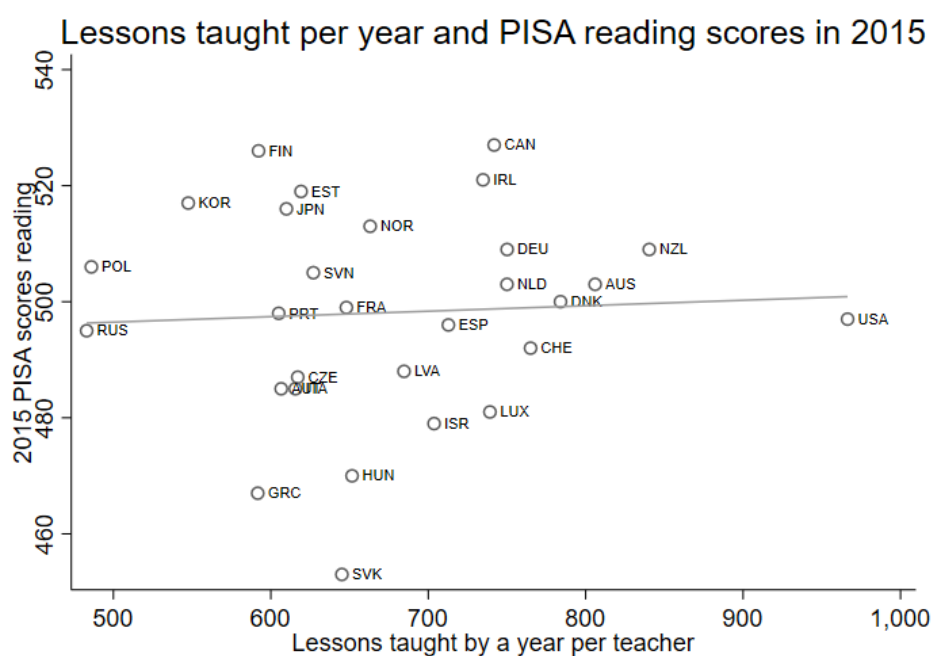
Teaching methods is the most country-specific among these variables, and it is hard to measure. It differs from school to school and from teacher to teacher, however, teaching methods must be taken into account. Many experiments (Jafari 2014) showed for example that working in groups is more effective than teaching by lectures. So trends in teaching methods matter a lot. As Barber and Mourshed (2007) say, “the quality of an education system cannot exceed its teachers”, and to improve teachers and their instruction, it is not enough to just make systemic changes in the curriculum or in the school structure, but to ensure that teachers' activity in classrooms have an effect, and that the right people become teachers. That is why the selection of teachers, as well as continuous improvements to their teaching practice are important.

Figure 9: Relationship Between Lessons Taught by a Teacher per Year and PISA Scores

(a) Mathematics



(b) Reading



Note: Figure shows the relationship between the average amount of hours taught by a teacher per year and 2015 PISA scores. Panel (a) shows Mathematics scores and Panel (b) shows reading scores.

2.2.9 Teacher selection

If teaching is a popular profession, countries can be more selective when choosing future teachers. For example, in Finland and Singapore, there 8 to 10 applicants for each spot in teachers' colleges, and they are in the top third or the top quarter of their academic cohort. Hence in these countries, teachers are selected *before* the teacher training and few trainees drop out, resources for teacher training are better allocated. This is important because the cognitive skills of teachers are highly correlated with student achievement: if teachers have better numeracy than literacy skills than students will also have better scores in the Math test (Hanushek, Piopiunik and Wiederhold 2019). This study found that a one standard deviation increase in teachers' cognitive skills is associated with 0.1-0.15 standard deviation increase in students' skills. These results are controlled for other adults' cognitive skills. To put it simply, teachers matter most. However, teaching is a prestigious profession, which takes some time to develop in a country - changing teacher salaries can be done relatively quickly, but changing attitudes towards the teaching profession is a slow process.

2.2.10 Summary

Several variables appear related to student achievement, including class sizes, teacher salaries, and education spending. (See Table 1 for a summary of these relationships.) Overall, it seems that there is no single variable or policy lever that can uniformly improve student achievement. For example, if you reduce class sizes and leave everything else constant, there won't be a large change in achievement. A policy that works well in one country, might fail in another. In South Korea, for example, big class sizes are part of their success, because if class sizes are bigger, fewer teachers are needed, and, therefore, they can be selective when choosing teachers. However, this policy might be a specific attribute of South Korea. Therefore, it is not a good idea to select an education system showing good results and copy it in its entirety, but it is worth watching trends. If it is known that for example that countries which recently gave teachers more autonomy showed progress in student achievement, it might be worth considering as policy.

I also found that variables dependent on spending and country wealth show a strong correlation only up to a point. This suggests that a certain level of spending may be necessary to enable the education system to achieve good results. Below this threshold an increase in spending may be strongly correlated with student achievement, but after this threshold is reached, spending additional money shows little correlation with student achievement. So having the necessary resources are crucial, but there is no need to overspend: above a certain

spending level, student achievement can be increased by different policies.

Table 1: Summary of the Relationship Between Different Factors and PISA Scores

Variable	Strength of correlation
<i>Per capita GDP</i>	Below \$30/40,000: increase by \$500-\$1000 Above \$30/40,000: no correlation
<i>Teacher salaries</i>	If the ratio of average salaries of teachers / average salaries of college-educated people is below 0.9: increase by 0.03 Above 0.9: no correlation
<i>Education spending as % of GDP</i>	Increase by 0.25%
<i>Education spending per child in USD</i>	Below \$7000: around \$170 Above \$7000: no correlation
<i>Class size</i>	Reduce by 4 children
<i>Share of young teachers (under 30)</i>	Increase by 3.5%
<i>Teachers taking part in professional development programs (3 month before asking)</i>	Increase by 10%
<i>Lessons to be taught</i>	No correlation

3 What makes an education system more equal?

So far, I have examined the average scores of countries. However, average scores potentially mask substantial within-country variation. In 2015, among OECD countries, the difference between the mean scores of the country at the 10th percentile (Greece) and the country at the 90th percentile (Ireland) was 61 points.² That's exactly the same as the difference between the mean score of a child in the top and the bottom quartile by socioeconomic status in the most equal education system, Estonia. The average top vs bottom quartile difference is 89 points. In other words, within-country differences between children of the most and least advantageous socioeconomic backgrounds are bigger than the differences between the children of the best and worst-performing education systems.

For example, children in the bottom quarter of PISA's economic, social and cultural score (ESCS) in Hungary score similarly to an average child in Mexico, while children in the top quarter of ESCS score better than the average child in Canada. This difference is 113 points, one of the highest among OECD countries. Minorities tend to score far below the national average, because of segregation in education systems. For example, according to the US National Center for Education Statistics, in the U.S. the 2018 average PISA score in reading was 505, placing the U.S. 9th in the ranking of 36 OECD-member countries. However, White students scored 531, one of the highest in the world, while Black students scored 448 on average, comparable to average scores in Serbia and Chile. Similarly, in Israel, the average reading score is somewhat below the OECD average (470 v. 488), but the average masks massive inequality between Hebrew-speaking and Arabic-speaking students. The former score like students in rich European countries (506), while the latter score like students in some of the poorest countries (362), like Lebanon and Indonesia (Yanko 2019). On average, in OECD countries, a disadvantaged student is 2.7 times as likely to score below the standard (407 points) as a non-disadvantaged student.

Within vs. across-school variation. Another thing to discuss is whether the variation takes place within schools or between schools, so whether the difference is bigger between high and low performing schools, or high and low performing children in the same school. There was only one country among OECD members, where the variation between schools was bigger than within schools—it was Hungary. And it is not good news: there is a strong

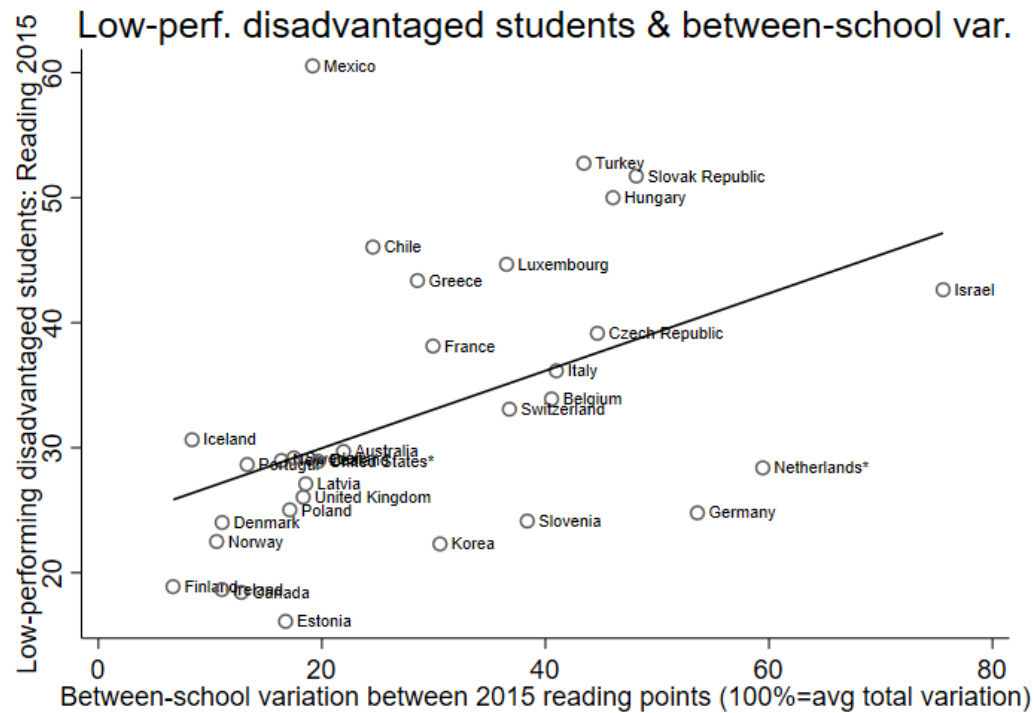
²It is important to distinguish the difference between the best-performing and worst-performing students and the difference between students of the best and worst socioeconomic backgrounds. Here I discuss the latter, differences by socioeconomic background.

correlation between the strength of variation between schools and low performing students with poor socioeconomic backgrounds, as shown in Figure 10. The higher the variation between schools, the more students from the bottom quarter of the ESCS perform at a low level. Moreover, as Figure 11 shows, the higher the between-school variation is, the more family background matters.

The variation between schools is large in Israel because Arabs there tend to study in separate schools, but the most common cause of big differences between schools is early tracking. In Germany and in the Netherlands, tracking starts very early: in Germany, after 4th grade, students can go to various types of school, however, they can change track later on. In the Netherlands, students are going into Pre-University Education or Pre-Vocational Education after 6th grade. In these countries, a disadvantaged student is twice as likely to score below 420 than non-disadvantaged students. This increased chance is around or smaller than the OECD average. In Hungary and Slovakia, early selection of top-performing students causes large variation between schools, along with vocational programs. In these countries, a disadvantaged student is much more likely to score below 420 points than a non-disadvantaged student. So the earlier tracking begins, the higher variation between schools is going to be, however, it is possible to ensure that disadvantaged students won't lag behind even if tracking begins earlier.

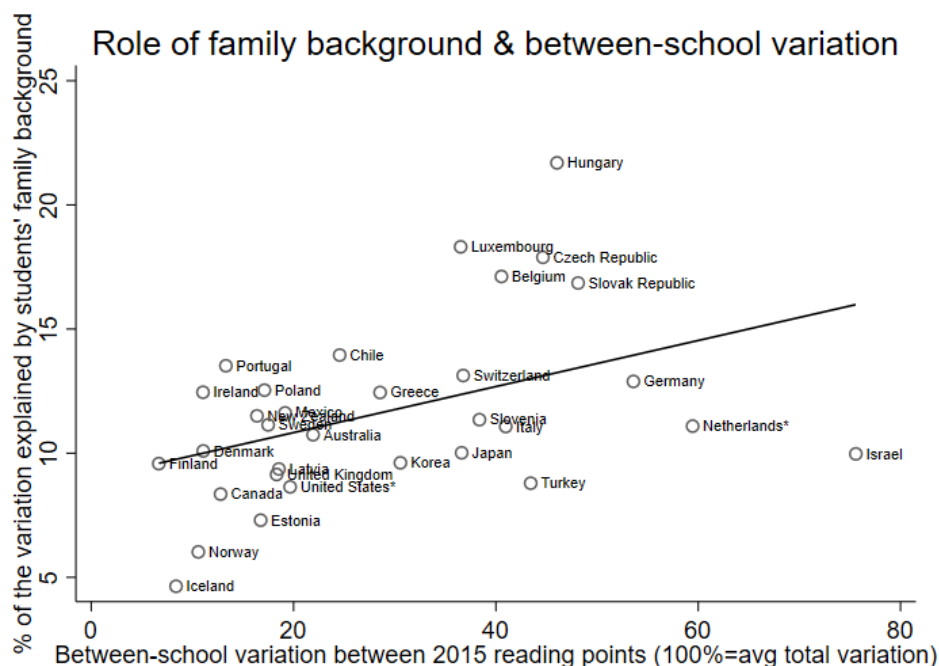
Peer effects. The isolation of students increases inequality because of peer effects, so that it matters a great deal who the peers of a student's are. This is why early tracking increases inequality and why the isolation of children with high-SES and low-SES, and high-performance and low-performance increases inequality of opportunity. Therefore, if the average socioeconomic background score of a class is lower, it makes student performance worse, and vice versa (Sacerdote 2011).

Figure 10: Relationship Between Across-school Variation and Low-performing Students in the Bottom Quarter of the ESCS



Note: Figure shows the relationship between *between-school* variation in reading scores (where 100% is the average total variation) and the percent of low-performing students (students scoring below level 2 or 407 points) in the Bottom Quarter of PISA's Economic, Social, and Cultural Background Score distribution in reading in 2015.

Figure 11: Relationship Between Across-school Variation and the Effect of Family Background on Student Performance



Note: Figure shows the relationship between *between-school* variation in reading scores (where 100% is the average total variation) and the percent of variation in PISA 2015 reading scores that can be explained by the students' family background.

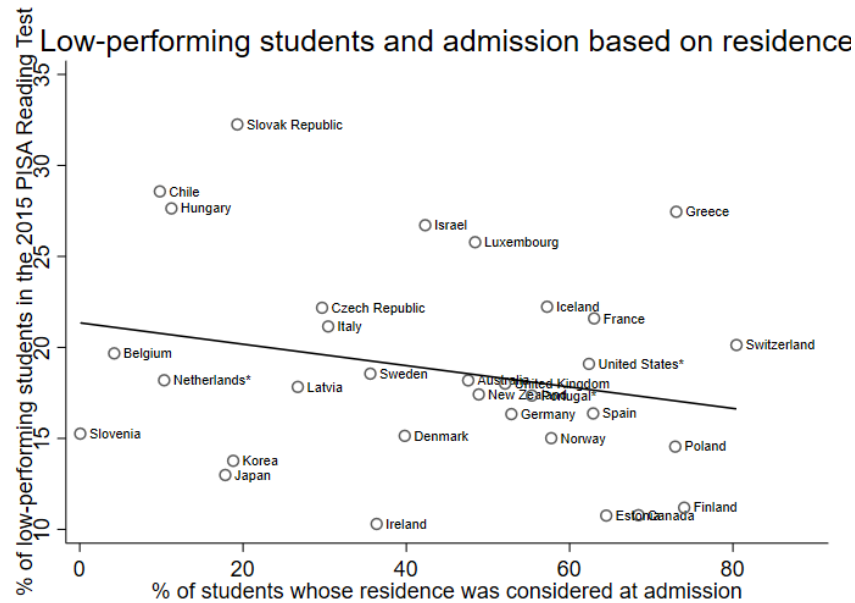
Diversity. If schools are more diverse (so at admission, they always consider the residence of the students, not just their academic performance or other factors), the percentage of low-achieving students (scoring below 420 points) tends to be lower. What is more, there is a positive correlation between the percentage of top-performing students and the fact that at admission, residence is considered. This is surprising because many argue that if school admissions were based purely on residence rather than entrance exams, top performing students would be hurt.

Of course, considering residence in admissions does not guarantee diversity. It mostly depends on city structure: specifically, whether students from the bottom- and top quarter of the ESCS live in the same school district. In Hungary, for example, a large fraction of the Roma live in segregated neighborhoods and settlements. Nevertheless, this is a way in which more diverse school communities can be created. For example, if it is not allowed to transfer kids to the neighbouring village's school (so children from wealthy families will go

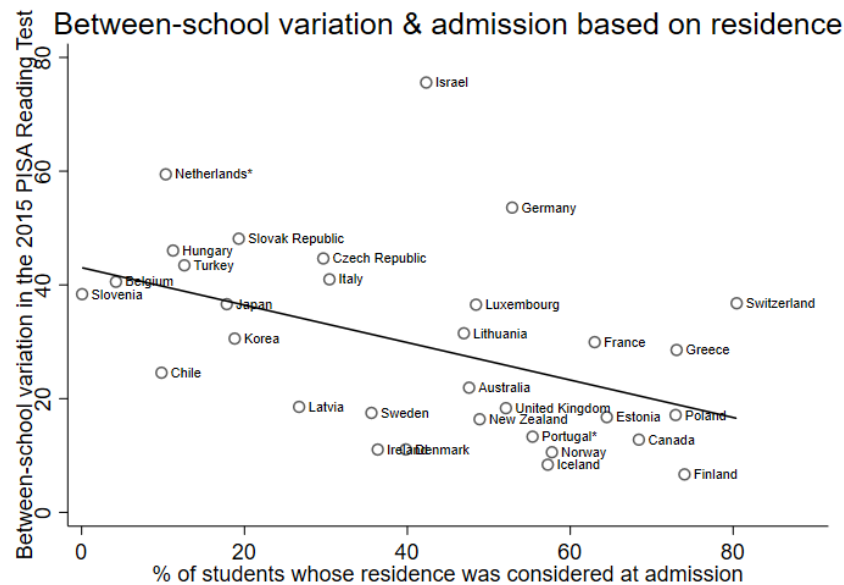
to the same school as children with low ESCS), then schools are going to be more diverse, if these rules aren't avoided by "moving on paper", so that families are giving an address to the government office before school enrollment so that they can go to their preferred school. All in all, in countries, where residence is considered more often at admission, the percentage of low-performing students tends to be lower, not only at the bottom quarter of the ESCS, but overall. It also decreases score variation between schools. Actually, in countries with recent large improvements (Estonia, Finland, Poland), residence is almost always considered at admission (Figure 12).

Figure 12: The Importance of Considering Residence at Admission

(a) Percent of low-performing students in reading



(b) Variation in reading scores



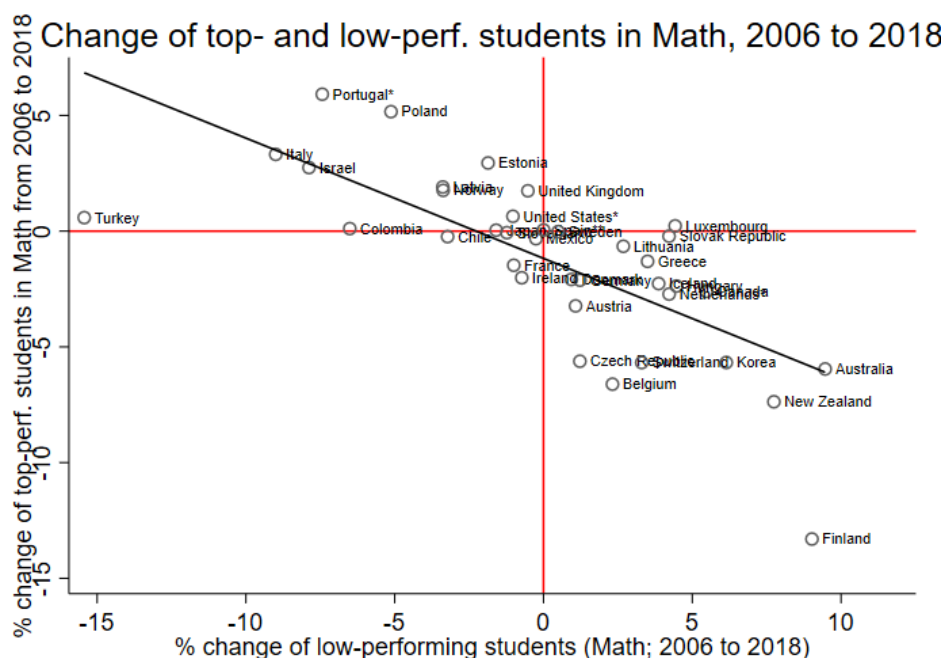
Note: Panel (a) shows the relationship between the percent of low-performing students in Reading in 2015 and the percent of students who principal reported that residence was considered at admission (a similar pattern emerges for considering students only in the bottom quarter of the ESCS). Panel (b) shows the relationship between across-school variation in 2015 PISA reading scores and the percent of students whose principal reported that residence was considered at admission. Here again, 100% is the total average variation.

Closing the achievement gap vs. high-achieving students. A common concern is that policies aimed at closing the achievement gap hurt high-achieving students. For example, focusing on low-achieving (less than 420 points³) students to achieve a certain limit may result in fewer high-performing (more than 607 points⁴) students, because it can be thought that concentrating resources on low-achievers and leaving fewer resources to top-performers. Putting together children from a wide range of family backgrounds and academic performance will increase equity, but parents of top-performing students may fear that their children would progress more slowly. However, there is little evidence that this is the case, moreover, top-performing students can gain non-cognitive skills in terms of cooperation with a diverse group of people, or it might increase their social sensibility, which can be quite valuable later on. It also decreases social prejudice (Green et al. 2019). Among the countries which were able to significantly reduce the number of students who performed under 420 points from 2006 to 2018 in Maths, I didn't find any where the number of students performing above 607 points didn't grow, and vica versa. (Figure 13) There is a strong negative correlation between the change of low- and top-performer students from 2006 to 2018, so if the number of low-performing students decreases, the number of top-performing students will increase.

³When this level is reached, according to the OECD, “students can interpret and recognise situations in contexts that require no more than direct inference. They can extract relevant information from a single source and make use of a single representational mode. Students at this level can employ basic algorithms, formulae, procedures or conventions to solve problems involving whole numbers. They are capable of making literal interpretations of results.” I take a student to be low-performing if she or he isn't reaching this level.

⁴At this level, according to the OECD, “students can develop and work with models for complex situations, identifying constraints and specifying assumptions. They can select, compare and evaluate appropriate problem-solving strategies for dealing with complex problems related to these models. Students at this level can work strategically using broad, well-developed thinking and reasoning skills, appropriate linked representations, symbolic and formal characteristics, and insight pertaining to these situations. Students at this level have begun to develop the ability to reflect on their work and to communicate conclusions and interpretations in written form.”

Figure 13: Relationship Between the change of top- and low-performing students between 2006 and 2018



Note: Figure shows the relationship between the change (in percents) of low- (X axis) and top-performing (Y axis) students in Maths between 2018 and 2006.

Summary. Reducing the achievement gap mostly results in better results for everyone, including top achievers. The main way to reduce inequality in student achievement, and to reduce the influence of children's family backgrounds on achievement is through reducing differences between schools. That means that schools should be more inclusive, so top-achievers and bottom-achievers shouldn't be separated from other kids, and neither should be children coming from the most advantaged and the most disadvantaged families. This can be achieved by selecting children into schools based on residence, and not based on wealth, religion, or academic achievement. Early tracking increases differences between children, because it separates top-performing and low-performing children, and there is little chance that low-scoring children can catch up.

4 Case studies

In the sections above, I analyzed correlations between many variables, but I didn't have the chance to go beyond these. In the following short case studies, I will focus on four specific education systems: Hungary, Singapore, Finland, and Poland. For each country, I highlight some key issues.

4.1 Hungary

In 2018, Hungary performed slightly below the OECD average, both in reading (476 points vs 487 points OECD average) and in mathematics (481 points vs 489 points). The variation in performance (so the variation between points of the best- and worst-performing children, not taking into account the socioeconomic background) was nearly the same as the OECD average. The salary of a 25-34 year old teacher is just 60% of a college-educated 25-34 year old, which is the 2nd lowest number among OECD countries. This salary can be doubled, but it takes 42 years, though, which is the highest number among OECD countries. Around 3% of the GDP is spent on the education system (OECD 2014), or around 5500 USD on a student per year in primary education and 6900 USD in secondary education (OECD 2017). Only around 20% of teachers participated in professional development programs, which is the lowest among OECD countries. Whereas the performance was around the OECD average, the education system doesn't seem to reduce inequality of opportunity.

Socioeconomic status and student performance. The effect of students' family background on performance is one of the largest among OECD countries - a 10th grader whose mother finished elementary school performs worse on the same test than a 6th grader whose mother finished high school, according to the National Assessment of Basic Competences (2019). 44.4% of test score variation can be explained by the student socioeconomic status and the average socioeconomic status of their peers in the same school, which is the highest among all countries participating in PISA. Just by the students' socioeconomic status, 21.7% (reading) and 21.3% (math) of the test score variation can be explained, both are the highest among OECD countries. There are two different but interrelated types of segregation that contribute to this huge inequality of opportunity. First, low-performing and high-performing students study in different schools. Second, students of low-SES and high-SES backgrounds study in different schools too.

Segregation by performance: high-achieving students. The isolation of top-performing students can be explained by the early selection of students in 4th grade and 6th grade. A study by Horn (2013) shows that the 6-year and 8-year academic tracks have higher value-added than the 4-year academic track, however, students studying on a 6-year academic track perform better in reading only in 8th grade and in math only in 10th grade than their peers studying on 4-year academic tracks. The difference of performance between students studying in 8-year academic tracks and students studying 6-year or 4-year academic tracks increases over time. Moreover, in areas where students cannot study in 8-year academic tracks, because there isn't such a school in the region, the numeracy performance of students in general schools is better than in areas where the top of the academic cohort can learn in 8-year academic tracks. Because high-SES students have a higher chance of studying in 8-year academic tracks, Horn's study shows that 6-year and 8-year academic tracks increase the inequality of opportunity in Hungary.

Segregation by performance: low-achieving students. The isolation of low-performing students can be explained by vocational schools. In vocational schools, students' numeracy and literacy skills simply do not improve: the average result of 8th graders in primary schools is the same as the average result of 10th graders in vocational schools. This widening inequality is most likely explained by the lack of appropriate general knowledge classes. Disadvantaged students are 9.6 times more likely to be enrolled in a vocational school than advantaged students.⁵ That is the highest number among OECD countries, and more than twice as the OECD average. Low-SES and high-SES students study in different schools not just because they tend to be low- and top-performing, but low-SES students tend to live in the countryside while high-SES students tend to live in Budapest, and this leads to big differences between schools. These schools aren't performing worse just because their students' performance were worse when they enrolled, so vocational schools (where low-SES students tend to study) are adding less value than mixed or academic schools. Vocational schools have an outstanding negative effect - students who were rejected from a good class performed worse than those who were accepted, but this difference is bigger if they continued their study on the vocational track. This may be due to the fact that not just the quality of teachers is worse in a vocational school than in the preferred school, but in vocational schools, the expectations are much lower and the curricula is different, so that might be a

⁵I refer to children as disadvantaged, if they are in the bottom quarter of the distribution of the PISA score of Economic, Social, and Cultural Status in Hungary, and refer to them as advantaged, if they are in the top quarter of the distribution of PISA ESCS score.

reason why vocational schools have a very detrimental effect (Hermann 2013). These huge differences can be illustrated by the fact that while both in 6th grade and in 8th grade, students who eventually continued their studies in the academic track performed better than their peers who went to the vocational track, from 6th grade to 8th grade, they both showed improvements of around the same amount, so their differences didn't grow. But that was not the case from 8th grade to 10th grade, since there was no improvement whatsoever among children studying in vocational schools (Hermann 2018a).

However, while in Hungary vocational schools perform poorly in improving the skills of their students, it is not the case everywhere. For example, in Denmark, because they don't abandon totally the 'general knowledge' classes, significantly more vocational school students have the necessary numeracy or literacy skills, and thus, they are able to improve throughout their careers and get to better-paying positions (Köllő 2011). Moreover, in Hungary, a disadvantaged student is twice as likely to be enrolled in vocational schools than average student. In neighbouring countries (Slovenia, Austria, Czech Republic), they are less than 1.5 times likely to study in vocational schools. Here again, this figure (that 31.6% of disadvantaged students are enrolled in vocational track opposed to 15.9% of all students) is a record-setter in OECD countries, and 1.4 times much as the average. Vocational schools are not necessarily bad, however, if the skills of students aren't improved, they will have less chance to improve later. Moreover, it is important whether vocational schools have a role of selecting low-performing or low-SES students, and not improving their skills, or a role of preparing students for a job, and not denying the opportunity to advance. In Hungary, the selection of good students and low-performing students is coded in the education system, and this comes together with selecting low-SES and high-SES students into different schools.

Early dropout. What is more, low-performing students are not required to finish their education. They can leave school at the age of 16—in Hungary in 2019, the proportion of early school-leavers (18-24 year olds who didn't finish elementary school) was 11.8%, which is higher than in Slovakia, the Czech Republic, and Poland. While decreasing the school-leaving threshold did increase the proportion of non-studying children, it didn't increase the proportion of those who didn't finish high school (Hermann 2018b). That implies that most of the children interrupting their studies earlier wouldn't finish high school, suggesting that decreasing the school-leaving age mostly affects students coming from disadvantaged family backgrounds. From 2010 to 2018, the proportion of students receiving high school certificates (*érettségi*) from high school decreased. While in 2010, 64.4% of 18-year-olds graduated from high school, in 2019, only 61.9% did. This drop is partly explained by students leaving school

early due to the decrease in the compulsory schooling age from 18 to 16 and partly by more students studying on the vocational track. This drop was the most steady and significant in Eastern Hungary, where it dropped from 62.8% (2010) to 58.7% (2019). Those children who aren't studying at the age of 17 are not working either. While around 2.5-3% of 17-year olds were working in 2018, 5-6% of them didn't study or work, so the unemployment between non-studying 17-year olds is around 70% (Köllő and Sebők 2018).

The Roma vs Non-Roma gap. One of the largest challenges in Hungary is the gap between Roma and Non-Roma children. The average performance of Roma children in the National Competence Test is 1 standard deviation lower than the national average. According to a study by Kertesi and Kézdi (2011), these differences are mainly attributable to health, home environment, family background and school fixed effects (i.e., the average quality of schools attended), which are worse among the Roma. In 2015, according to the KSH, only 1-2% of the Roma had a college degree (vs 25% of all Hungarians) and only 10-15% completed high school (vs 60% of all Hungarians).

4.2 Singapore

Based on student achievement, Singapore is the best education system in the world - students in Singapore score an average 549 in reading and 569 in mathematics. However, it is an unequal education system - family background is an important determinant of performance (26.6% of reading performance and 23.4% of maths performance is explained by students' and their schools' socioeconomic status (so the socioeconomic background of students attending the same school), the OECD averages are 21.6% and 22.1%.)

Teacher selection. In Singapore, being a teacher is valued by society, and it is hard to become a teacher - only one in eight applicants become teachers. They are from the top third of their academic cohort in Singapore. Their salaries are fair, but that's not the main driver of becoming a teacher. Learning is valued highly in Singapore (Barber and Mourshed 2007).

Homework and time spent in classrooms. Children in Singapore spend 9.4 hours with homework each week, compared to the global average of 5 hours (Teng 2014). While an average school day is around 5 hours, children in Singapore tend to spend their afternoons with private tutoring, which supplements classroom learning. Private tutoring in Singapore

was a 1 billion dollars industry in 2019 (Kah Ceng 2019). Private tutoring also tends to increase inequality. The median price is \$500, but the bottom quintile household earns around \$2,000, the next quintile around \$5,000, so paying for tutoring is taking a big share of their income. While 67% of Singaporeans enrolled their children in tutoring at some point, only 20% of those in the bottom quartile did. Moreover, for almost half of Singaporeans, the main reason why they enrol their children in tutoring is to keep them competitive, so they don't want their children to be behind those who receive tutoring (Blackbox Research 2012).

Tests and competitiveness. Singapore's education system is very competitive. While teaching methods are up-to-date, class sizes tend to be bigger, and students face a lot of exam-related pressure. The PSLE test, which is written at age 12 determines whether a student is going to study in vocational schools or in general secondary schools. So tracking begins early and students take important examinations and spend lots of time studying for them early on. The fear of failure among students in Singapore is the second highest among 77 countries. Parents can choose schools, and residence is usually not considered.

4.3 Finland

Finland is among the best education systems in the world, and it is also one where it matters little which school someone attends. The average score is 520 in reading and 507 in mathematics. These averages are not not extraordinary, but the Finnish education system is more equal, only 10.7% of reading and 13.2% of maths performance variation can be explained by students' and their schools' ESCS. It can be explained by the fact that parents are not allowed to freely choose schools, so low-SES and high-SES children tend to study in the same schools. So in Finland, every school provides education of mostly the same quality to every children. Just like in Singapore, being a teacher is valued by society, and it is hard to become a teacher - only one in ten applicants become teachers. They are from the top quarter of their academic cohort in Finland. Their salaries are around other college-graduates' salaries, but that's not the main driver of becoming a teacher, according to the McKinsey Study by Barber and Mourshed (2007). Education in Finland is compulsory from age 7 to 16, and after that, students can choose between academic upper secondary schools and vocational schools. A way to guarantee the equity of education is that tracking begins quite late. In Finland, the education system is decentralized, and the curriculum provides goals only. Teachers are trusted and are not regularly inspected.

Homework and time spent in classrooms. Children in Finland spend only 3 hours on homework a week, and an average school day is around 5 hours. (Teng 2014) So Finnish children have a lot of free time and the ability to play, which are key factors in child development. (Goldstein 2012)

Tests and competitiveness. In Finland, students don't write standardized high-stakes tests until the age of 16. Moreover, in Finland, almost all the schools give the same education, so the difference between schools is very low. Low- and top-performing students or advantaged and disadvantaged students are the least isolated among OECD members. Mostly this is because parents don't have the freedom to choose between schools, so there aren't schools for the elite. In Finland, children aren't afraid of failure, and they tend to have a low level of stress.

4.4 Poland

In many ways, Poland and Hungary are similar. Both countries spend around 3% of GDP on non-tertiary education. Both countries transitioned from communism to democracy in 1990. In 2000, both countries had the same average PISA scores (480 in Reading, slightly below the average of OECD countries). So it is fair to say that they started from the same point, and even today Poland doesn't spend significantly more on education than Hungary. However, while Hungarian students' outcomes declined recently, Poland showed huge improvements: in 2018, among 36 OECD countries, it ranked 6th in Reading (512 points) and 5th in Mathematics (516 points), showing the best results in the region. In Poland, family background can explain just 14% of score variation in Mathematics and 15% of score variation in Reading, compared to the OECD averages of 22.1% and 21.6% (and 21.3% and 21.7% in Hungary). So Poland has one of the best and most equal education systems, with relatively low spending. How did they do this?

The 1999 Education Reform. A main cause of this improvement is the structural reform of the Polish Education System in 1999. The most important point of this reform was extending the general common core curriculum by one year, and delaying tracking by a year, so students choose different schools only at the age of 16. In the first six years, students learn in elementary schools, they spend the next three years in Gymnasiums, and only choose between various school types after 9 years. (Le Donne 2014) This is why in Poland, OECD's index of social and academic inclusion is high. Students from different family

backgrounds and students performing differently tend to study in the same schools, which motivates students who previously studied in weaker vocational schools. Overall, high- and low-performing students studying together improved low-performing students' scores significantly. Moreover, new gymnasiums were able to employ more highly qualified teachers, and students from rural areas had the chance to study in gymnasiums. Most importantly, the new reform gave schools the ability to create their own study programs in line with the national framework which contains which skills students should have. Teachers can also choose their own teaching style. So decentralization, increasing teacher and school autonomy helped improve student outcomes. The education reform also contained standardized testing, so even though the education system is decentralized, they can monitor and compare students' results on a national level. Admission to elementary schools and lower secondary schools is based on students' residence, which is a way of mixing students with diverse achievement levels. In Poland, education is compulsory until the age of 18, so nearly every child finishes upper secondary education. Interestingly, in 2016 the ruling PiS party reversed this reform, so the school structure is 8+4 years again, as before 1999 (Czarzasty 2017).

Time spent in classrooms. In the first three years, students have around 4 lessons a day, in 4th and 5th grade, around 5 lessons a day, in and from 6th to 12th grade, around 6. There are never more than 32 lessons a week (Polish Eurydice Unit 2014). It is safe to say that Polish students spend an hour less in school each day than Hungarian students, so more lessons don't correlate with better skills.

Teacher salaries. Despite the fact that the Polish education system improved a lot, salaries of teachers are low compared to similarly educated workers - secondary school teachers only receive three quarters of the salary of an average worker with a degree.

5 Conclusion

Education systems are very complex and there isn't a magic formula describing the relationship between inputs and outputs. In this essay, I analyzed associations between some characteristics of education systems and student performance. I showed that spending-related factors are associated with student outcomes up to a certain level. I also showed that teacher training, teacher salaries, and teacher selection are very important factors.

Non-spending related factors don't exhibit similar thresholds. Average class sizes are also associated with PISA scores. On average, a class reduction of four is related to a one-place

improvement in the PISA rankings. Intuitively, one might think that if a teacher has to teach less, she or he can be more effective, but there is no such correlation.

Education systems should help to reduce differences between children coming from different family backgrounds, however, they might actually increase differences in some cases. I found that the smaller the differences were between schools, the smaller the role of the family background was on student performance, and the fewer children of low SES performed poorly. I found that where free school choice was not allowed, or academic performance or parents' wealth or religion was not considered at admission, the role of family background at determining student performance was reduced. In most cases, where tracking began earlier, the differences were larger, but there are big differences between countries. In countries where performance-based selection is not a characteristic of the educational system until students are older, the education system is much more equal - this is what we have seen in Poland and in Finland. The complexity of education systems can be illustrated by the different approaches of Singapore and Finland - while both countries have high student achievement, they achieve it in a different way. Apart from the fact that those education systems are well-founded and teachers are selected, they differ along most other dimensions. While Singaporean kids spend the most time studying, Finnish kids don't really have much homework. In Singapore, there is a big emphasis on tests and competitiveness, in Finland, working forms are more cooperative.

Given the complexity of factors, to improve a country's education system, it is not sufficient to copy a successful country's education system, because cultural or other country-specific effects might play an important role too.

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