An international comparison of school systems based on social mobility

Mattéo Godin * and Jean Hindriks **

Abstract – We propose an international comparison of school systems in OECD countries in terms of social mobility in schools based on the PISA (Program for International Student Assessment) test results in mathematics between 2003 and 2015. For each country, we calculate students' interdecile social mobility in schools on the basis of their ranking in the PISA test in mathematics, compared to their social ranking in their country, and compare this new index of equity to those generally used in OECD studies (slope and intensity of social gradient, percentage of resilient students). A new representation, the "Great Gatsby curve of school", in reference to the Great Gatsby curve of income, is proposed: the social mobility of a school system is closely linked to the educational inequality between students and schools. Countries such as Belgium or France with high levels of school inequality also stand out for low social mobility in schools. Inversely, countries such as Finland or Canada are characterised by low school inequality and high levels of social mobility in schools. A second important conclusion of the analysis is that the countries in which social mobility in schools is above average are also most often those with school achievement levels above the average.

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Two school systems can be identical in terms of inequality in students' academic achievement, but very different in terms of social mobility in schools, meaning the prospects for students from socially disadvantaged families to become some of the best students. This is an upward mobility prospect, from the bottom to the top of the social ladder. In the reports produced by the OECD, social mobility in schools is often analysed by comparing the academic achievement of students from different social backgrounds using a composite economic, social, and cultural status index (ESCS). The link between achievement (or test scores) and the socio-economic index of students is thus very rigorously analysed in the OECD's studies, which focus on the equity of school systems (see OECD, 2014a; OECD, 2016). The OECD distinguishes the slope of the social gradient, which measures the difference in score associated with a unit variation in students' socio-economic index, and the intensity of the social gradient, which measures the proportion of variance in score attributable to the variation in the socio-economic index of students.

However, this measure of social mobility in schools based on the social gradient presents several drawbacks. First of all, it assumes a linear relationship between students' test score and their socio-economic index. As a result, an essential component of social mobility is lost: the "unlikely success", i.e. the fact that underprivileged students can be top performers; the OECD refers to these as "resilient students"[1]. The relationship between students' achievements and their socio-economic index is therefore not necessarily linear, and imposing it can lead to erroneous interpretations. For example, the intensity of the social gradient is an index that overestimates social mobility in schools in countries where the link between academic results and socio-economic status is convex[2]. Second, social mobility based on the social gradient is governed by a cardinal approach, which is more sensitive to measurement errors, notably in the variation of the socio-economic index. In this respect, we propose a more parsimonious ordinal approach to the use of PISA data: the school ranking and the social ranking of students are put in parallel, without attaching importance to the gaps in test scores and socio-economic variables. Third, the intensity of the social gradient is intrinsically dependent on the dispersion of the scores and that of students' socio-economic indices. This dependence is a problem if one wishes to analyse the social mobility dimension and the educational inequality dimension independently. A cross-cutting approach to social mobility based on inter-decile mobility eliminates this problem of dependency with regard to the variables dispersion because, by construction, the variables are reduced in all countries to a uniform distribution (in deciles, for example). The same comment applies as well to the use of intergenerational income elasticity between parents and children as a measure of social mobility (Black & Devereux, 2011)[3]. This measure mechanically increases if income inequalities increase from one cohort to another. Dahl and Deleire (2008) propose, for this reason, that intergenerational elasticity be replaced with intergenerational rank correlation. Chetty *et al.* (2014) use the latter in their comparison of social mobility in income between different regions in the United States.

In this article, we propose to analyse the social mobility of school systems based on the ordinal approach, in an international perspective. We define a student's social mobility in schools by comparing, within each country, the student's position on the achievement ladder and position on the social ladder. The percentage of resilient students is therefore measured in each country without comparison with the results of students from other countries, contrary to the approach taken by the OECD (2012). This approach to social mobility thus clearly separates the country's average performance and social mobility.

This concept of social mobility in schools is closely tied to the concept of equal opportunity in schools *stricto sensu*. For social justice theorists such as Rawls (1971) and Roemer (1998), a fair system is a system in which there is equal opportunity to achieve academic success and assuming equal diplomas, to access jobs with responsibilities[4].

1. Resilient students are those in the bottom quarter of the socio-economic index of students whose results on PISA tests are found in the upper quarter, all countries combined (OECD, 2012). This notion of resilience refers back to what the sociology of education terms "unlikely successes" or "paradoxical trajectories".

2. By construction, a linear model has less explanatory power if the relationship between the variables is non-linear.

3. Black and Devereux (2011) propose a summary of the literature on the measurement of intergenerational income elasticity and the mechanisms underlying this intergenerational transmission. Hertz et al. *(2007) compare at the international level the correlation between the years of education of the parents and their children (see Table 2). In our article, we focus on measuring inter-generational transmission in terms of academic results (i.e. quality and not quantity of education).*

4. Our approach also needs to be put in perspective with the approach to inequality of school opportunities put forth by Boudon (1973) according to which: (i) the value attached to a given academic level varies with an individual's social position, (ii) and social position influences the individual's expectations and schooling decisions.

This approach to social mobility is an *ex post* perspective on equal opportunity – *ex post* distribution of school performance based on social origin – not an *ex ante* perspective on equal opportunity – expected school performance *ex ante* depending on social origin, which lines up more with the social gradient approach (Fleurbaey & Peragine, 2013)[5]. On the empirical study of equal educational opportunity from an *ex ante* perspective based on PISA tests, we refer readers to the summary report by Ferreira and Gignoux (2011). It should be noted that our approach to studying social mobility in schools is more restrictive than the classic approach to equal opportunity, in a context that is sometimes multidimensional (income, health, school)[6], which seeks to decompose inequality of outcomes between inequality due to circumstances (compensation) and due to individual choices (responsibility). It should be noted here that some authors such as Kanbur and Wagstaff (2014) are fairly sceptical about the political relevance of this approach due to a twofold problem of measurement and decomposition. This same difficulty can be found in studies aimed at identifying the mechanisms underlying family influence on school achievement, and in particular to identify the relative influence of biological factors (nature) and environmental factors (nurture) in social mobility. Such causal analysis of social mobility and its mechanisms goes beyond the scope of this article. On this topic, we refer readers to the literature review by Bjorklund and Salvanes (2011) which offers, for a few countries, empirical estimates of social mobility based on the correlation of education attainments between brothers (including heterozygote and homozygote twin brothers).

In this article, we will address the issue of the quality of school systems from a broader perspective that includes school performance, school inequality and social mobility. We will see that these dimensions are not necessarily conflicting. In particular, we show that performance is likely to go hand in hand with social mobility. In other words, our approach based on the use of a social mobility index more than confirms the results of the latest studies of the OECD (2014a, 2016), which noted the absence of conflict between performance and social mobility. Furthermore, the real novelty of our study lies in highlighting the inverse relationship between school inequality and social mobility in schools (the "Great Gatsby curve" of school). It is important to specify that our results do not establish any causal link, but are based on correlations, the effect of which is simply to reverse the burden of proof[7].

To conduct our analysis, we used the results in mathematics on PISA tests (2003, 2006, 2009, 2012 and 2015). According to Hanushek and Woessmann (2015), knowledge in mathematics and sciences are good predictors of students' income prospects. Restricting, as we do, the analysis to achievement in mathematics is not believed to lead to bias in the results, insofar as scores on PISA tests in other subjects are strongly correlated (for example, more than 87% between mathematics and reading). Moreover, mathematics typically constitutes a pillar of success and excellence in school. A gap in mathematics skill can trigger either a transfer to a less demanding school, a repeat of the academic year, or redirection to a less-demanding academic track. In addition to assessing students, PISA surveys students about their social background. The social status of students is then measured by the economic, social and cultural status index (ESCS), a composite index that incorporates, in addition to the profession and the level of education of parents, a measure of the family's educational and cultural resources (number of books at home, place to study, presence of artworks, a dictionary, etc.). It thus becomes possible to compare the students' educational rank, based on their rank on PISA tests, with their social position, based on their rank in the composite index of social origin[8].

One final clarification should be made here. Our approach to social mobility considers only part of the social inequality reproduction chain: the school system. It is for this reason that reference is made to "social mobility in schools". Our results thus need to be interpreted from this perspective. More generally,

5. *To understand the difference, consider* x *the random variable of academic results and* s *the variable indicating the student's socio-economic status. School achievement is distributed according to conditional probability density* f(x;s) *with average* E(x;s). *Equal opportunity* ex ante *consists of equalizing* E(x;s) *for all* s. *Equal opportunity* ex post *consists of equalizing* f(x;s) *for all* s.

6. *See Roemer and Trannoy (2015), for a presentation of the main theoretical and empirical contributions on equal opportunity.*

7. *This is all the truer as we are working on instantaneous data by student cohort (PISA), it is thus impossible to identify time sequences between variables and therefore specify causal changes. In this type of analysis, it is also always risky to deduct from correlations observed at the aggregate country level any causal relationship at the individual level. One advantage of comparing countries, and not schools, consists of eliminating all student selection problems between schools that strongly bias relations between inequalities and school performance (Hanushek & Woessmann, 2011).*

8. *The PISA data in mathematics are of good quality and relatively well harmonised to enable a precise and comparable measure between countries of the link between socio-economic status and school performance (in contrast to a social mobility analysis based on income).*

it is also important to study, downstream from the school, the role of the labour market and, upstream of the school, the role of parent-child transmission. As research in sociology clearly suggests, a school that is non-egalitarian yet awards degrees with little influence on the professional futures of students would not be a catalyst for reproducing social inequalities. Conversely, an egalitarian school with degrees leading to a strict hierarchy of jobs, would play a decisive role in the reproduction of inequalities as the most favoured social classes would always enjoy a decisive academic advantage (see Dubet *et al.*, 2010). In an article that has since become renowned, Solon (2004) proposes a social inequalities reproduction model integrating all these three levers: hereditary transmission (via cognitive skills and non-cognitive attitudes, themselves the complex interaction between biology and social environment), school transmission (via private and public investment in education), and professional transmission (via the parents' professional network). Our international comparison of school systems reflects school mobility in different countries, which is to be contrasted with differences in professional mobility and inequalities on the labour market between the same countries. To be clear, this article does not presuppose that young people's future is determined entirely in schools and that there is no chance of social success outside school. It should also be noted that the "psychological" hold of diplomas has become a reality in many countries, with people willingly believing that the entire fate of individuals is determined by their studies. Social success through academic success appears, in such cases, to be more important than social success through professional merit. While the hold of schooling can be regretted, it is a reality in which our analysis, focused on the school as a vehicle for inequalities, takes on its full meaning.

Social mobility

A distinction is made between three forms of social mobility: absolute mobility, relative mobility and ordinal mobility. The first two are most often used to measure social mobility on the basis of income (Fields & Ok, 1999). The purpose of this section is to compare the ordinal mobility of school systems in OECD countries. We limit our analysis to only those Member Countries that have participated since the start (2003) in PISA surveys (27 out of 35 countries)[9]. The reason for this restriction is not only the availability of PISA data, but also a concern to build a group of countries that is relatively homogeneous, economically and socially. This is because international comparisons open themselves up for criticism when they integrate groups of highly heterogeneous countries with overly differing scales of student performance and socio-economic status. This observation is particularly important in our case, as we know that the influence of socio-economic status on academic performance is very different by group of countries studied (see OECD 2014a, Figure II.2.3)[10]. The comparison tools are Spearman's correlation coefficient and inter-decile mobility. These two indicators measure mobility from a purely ordinal point of view in the form of mobility between social position and academic position. Inter-decile mobility also makes it possible to distinguish upward mobility from downward mobility.

In such a perspective, education is viewed as a "positional" good and not as an absolute good that has a direct positive effect on students (see Dubet *et al.*, 2011). Consequently, to circumvent the zero-sum game in which a position gained by a student implies a position lost by another student – as indeed assumes the principle underpinning Spearman's correlation, we weight students' social mobility based on their initial social position. Concretely, we apply a new index that places greater emphasis on the upward mobility of students found at the bottom of the country's social ladder: the interdecile mobility index. According to this index, each place gained in the school rankings by a disadvantaged child "counts more" than each place lost in the same school rankings by a child from a well-off background. Then, to this approach to social mobility in schools, we add a measure of the average performance of school systems to assess the interaction between these two criteria. We conclude the

9. The countries included are Australia, Austria, Belgium, Canada, Switzerland, Czech Republic, Germany, Denmark, Spain, Finland, France, Great Britain, Hungary, Ireland, Iceland, Italy, Japan, South Korea, Luxembourg, the Netherlands, Norway, New Zealand, Poland, Portugal, Slovakia, Sweden and the United States.

10. Keskpaik and Rocher (2011) propose a categorisation of countries according to their "equity profile" depending on the relative importance of the different components of the PISA index on student socioeconomic status. Our list of 27 OECD countries encompasses Groups 1 and 2, respectively, characterised by lesser influence of the social environment and the importance of cultural capital. In reality, the PISA index of socioeconomic status was estimated on the basis of OECD countries only and not partner countries (Rutkowski & Rutkowski, 2013). Our decision to restrict the focus to OECD countries therefore lends greater robustness to our international comparison of social mobility.

analysis by comparing the school inequalities and the related social mobility.

Spearman's mobility in schools

Spearman's mobility is based on Spearman's rank correlation[11]. For each country, students are ranked on the basis of their socio-economic index and this ranking is compared with their ranking based on their result on the PISA test (see Box on data processing). We then measure the rank correlation between these two rankings, the so-called Spearman correlation. Spearman's mobility is equal to 1 minus Spearman's rank correlation. Spearman's mobility thus measures the absence of link between the student's social position and the student's academic position. If the two rankings are perfectly correlated in the sense that the student's social position is identical to the student's academic position, the Spearman mobility index is equal to zero. Inversely, if the academic position is independent of the student's social position, the Spearman mobility index is equal to 1 (perfect mobility if Spearman's correlation is equal to zero). One weakness of the Spearman mobility index is its relative instability due to the high sample variability in individual mobilities in PISA. One of the first ways of limiting this effect is to work with several waves of PISA surveys to stabilise the mobility measurement. This is what we do by merging the PISA 2003, 2006, 2009, 2012 and 2015 studies.

The OECD countries have all a Spearman mobility above zero but less than one. In other words, students' social position is partly correlated with their academic position. Students' academic results within the same country are linked to the socio-economic position of students within the same country. However, this link varies from country to country (Figure I). Belgium's Spearman mobility index is the 7th lowest out of the 27 countries considered

11. For a normative justification of this measure of social mobility, see Agostino and Dardanoni (2009).

Box – **Technical note on data processing (PISA 2003-2015)**

Analysis was based on a sample of 1,031,451 students age 15 covering over 8,000 schools in 27 OECD countries over 5 years (2003, 2006, 2009, 2012 and 2015)[a]. These countries are Czech Republic (CZE), Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), the Czech Republic (CZE), Germany (DEU), Switzerland (CHE), Denmark (DNK), Spain (ESP), Finland (FIN), France (FRA), Great Britain (GBR), Hungary (HUN), Ireland (IRL), Iceland (ISL), Italy (ITA), Japan (JPN), South Korea (KOR), Luxembourg (LUX), the Netherlands (NLD), Norway (NOR), New Zealand (NZL), Poland (POL), Portugal (PRT), Slovakia (SVK), Sweden (SWE) and the United States (USA).

In PISA studies, instead of only one value on a PISA test score, a set of "possible values" and associated probabilities are found for the students. The "possible values" therefore represent not only an estimate of competencies, but also the uncertainty associated with this estimate. This uncertainty is inherent in the PISA test in which, due to time limitations, it is not possible to ask the students tested to cover all the questions in all subjects. In our analysis, we use the arithmetic average of the different "possible values" (between 5 and 10 depending on the years). For each wave of the PISA survey, we calculate the test score position (rank) of pupils, each in their respective countries, then compare this to their social position (rank) in their respective countries based on "ESCS" index (Economic, Social and Cultural Status).

The ESCS index is a composite index of the student's economic, social and cultural status that integrates the parents' profession (ISEI) and their level of education (PARED), and a measure of the family's educational and cultural resources (HOMEPOS[b]) including the number of books in the home, but also tangible goods, such as the existence of an internet connection, educational resources such as the presence of dictionary and cultural goods, such as the presence of artworks and works of classical literature.

We then aggregate the individual mobility data on the five waves of the survey to calculate an average for each country taking into account the student weights, "Final Student Weight". This student weight aims to ensure greater reliability in results by improving the overall representativeness of the sampling. If these weights are not used, certain students' profiles will be under or over-represented in the sample[c].

a. As mentioned above, this list of countries is the result of the dual requirement to limit ourselves to sufficiently homogeneous countries (OECD countries) that participated in all the PISA tests between 2003 and 2015 and for which the PISA socioeconomic index is sufficiently reliable (see Rutkowski and Rutkowski, 2013).

b. The PISA index on economic, social and cultural status of students (ESCS) is normalised to zero for all countries participating in the PISA survey (72 countries for PISA 2015). Its average value and standard deviation vary from country to country.

c. See Jerrim et al. *(2017) on the importance of using student weights in PISA studies.*

over the period 2003-2015, while France's is the 2nd lowest. In contrast, the mobility indices of Norway, Iceland, Italy and Canada are among the highest.

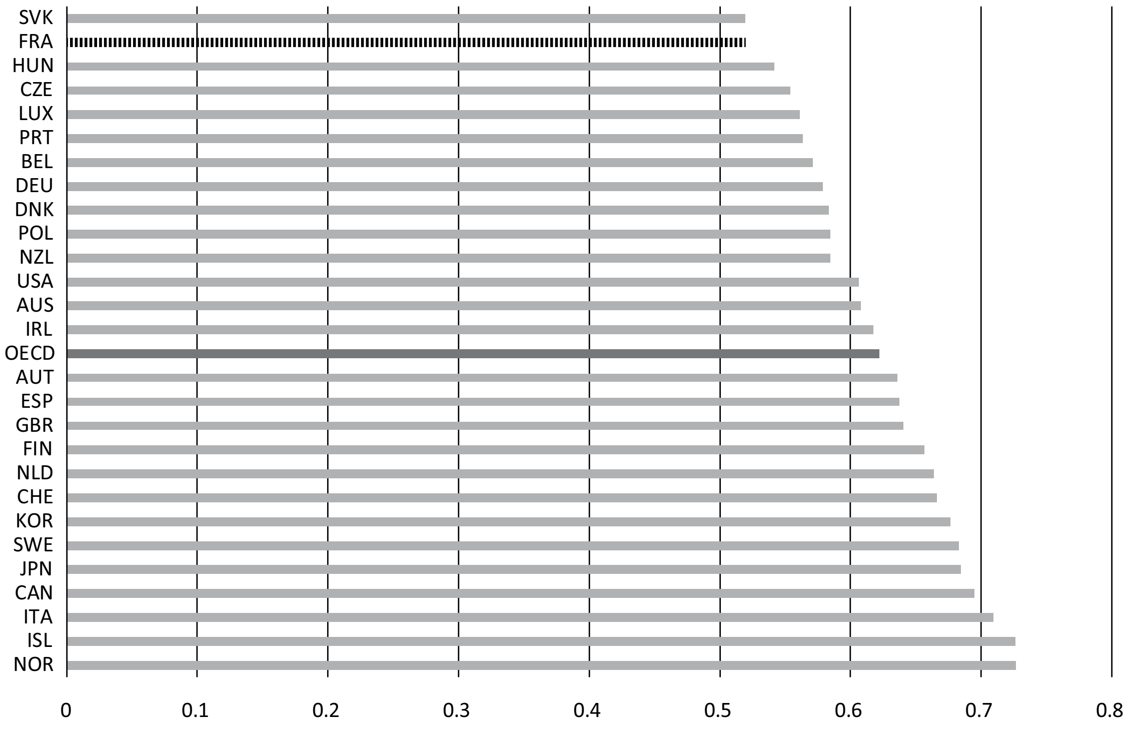
Another way of limiting the impact of sample variability on the Spearman mobility index is to limit individual mobility to interdecile mobility: individual mobility is only registered when there is a change across deciles. Thereafter, we adopt this interdecile mobility measure with a social dimension that, unlike Spearman's mobility, distinguishes upward mobility from downward mobility according to the social position of the students involved. Toward this end, social mobility in schools is no longer necessarily a zero-sum game insofar as, if a socially disadvantaged student moves up one rank at the detriment of a socially-advantaged student, the overall impact on social mobility is positive[12]. It should also be noted that this approach echoes the theory on equal opportunity developed in Boudon (1973), the starting point of which is the simple idea that the importance an individual places on a given academic level varies according to that individual's social position. For example, the Baccalaureate is a greater promotion for a worker's son than for a top executive's son. This theory thus implies that each social position carries a different system of expectations and decisions[13].

Interdecile mobility in schools

According to this approach, individual mobility is only taken into account if the student changes decile between social position and academic position[14]. To determine this, we classify students in each country by socio-economic decile and by decile of score on the

12. *In this sense, interdecile mobility in schools goes beyond the model on education as a positional good, the impact of which would be a zero-sum game (see Dubet, 2011).*
13. *The conclusion of Boudon (1973) is that school policies are illusory in establishing equal opportunity if they fail to change the social stratification of expectations and decisions. Our contribution aims precisely at showing, on the basis of international comparisons, that certain schools systems manage better than others to limit this social stratification with a beneficial effect on both average performance and school inequalities.*
14. *See above, Chetti* et al. *(2014) for a comparable approach to measuring intergenerational mobility in income in the United States.*

Figure I
Spearman's mobility at school (PISA 2003-2015)



Note: Spearman's mobility is equal to 1 minus Spearman's rank correlation. In our case, Spearman's correlation measures the correlation between the social position of pupils and their test score position. The higher Spearman's correlation, the lower Spearman's mobility index.
Reading note: For France, Spearman's mobility index is 52%, compared with 72% in Norway or Canada.
Scope: 27 OECD countries participating in the 2003-2015 PISA surveys.
Sources: OECD, PISA 2003-2015 in mathematics; authors' calculations.

PISA test (using the average of the different possible values for the test in the area of mathematical culture). The first socio-economic decile encompasses the 10% of students at the lowest level of the country's social ladder[15]. The first decile on PISA test includes the 10% of students whose test results are the lowest in the country. For each student, we take the ratio of test decile to the socio-economic decile to calculate individual mobility. A student in the first socio-economic decile found in the 10th test decile therefore obtains an individual mobility ratio of 10/1. Conversely, a student in the 10th socio-economic decile found in the first test decile has an individual mobility ratio of 1/10. Total interdecile mobility is the simple average between individual mobilities[16]. If the entire population has a rank on the test matching its socio-economic decile, then the individual mobility ratio is equal to 1 for everyone and total interdecile mobility is therefore also equal to 1. The upward mobility of a socially disadvantaged student always increases interdecile mobility. The value of the total interdecile mobility index therefore grows with upward mobility. Perfect interdecile mobility is found in situations of equal opportunity in the sense that each social decile is equally represented in each academic decile[17]. The minimum mobility value is equal to 1. We then normalise our interdecile mobility index to state it as a percentage of perfect mobility.

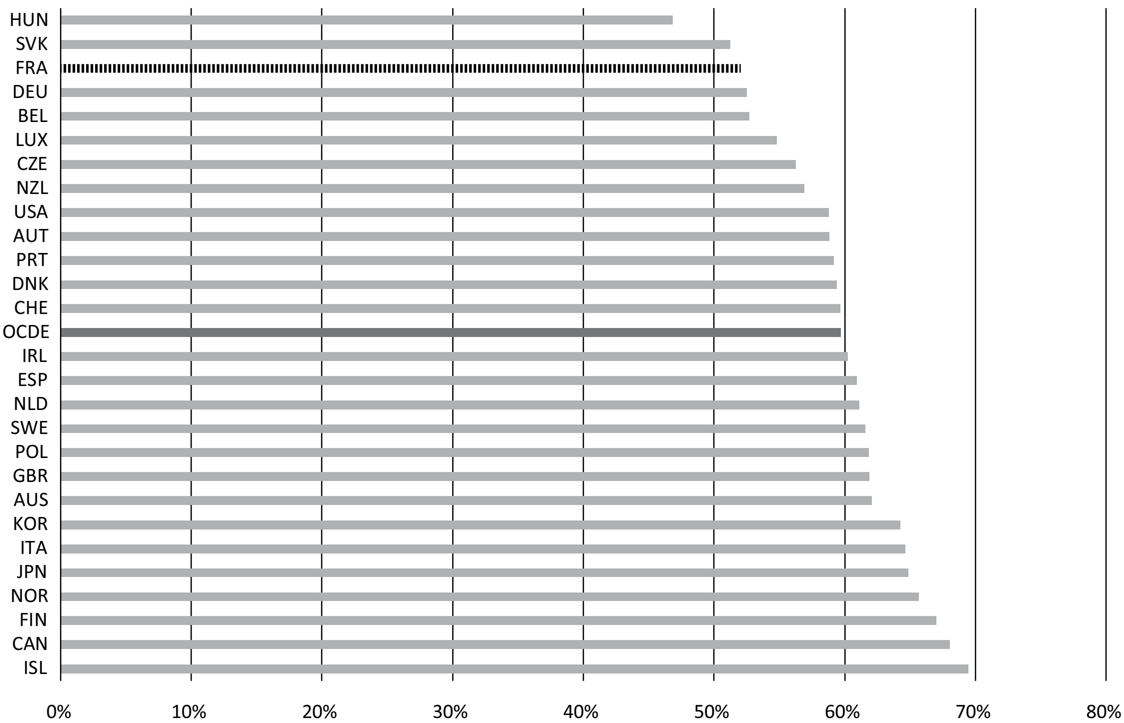
France is at the bottom of the ranking in terms of normalised interdecile mobility (Figure II) with a rate of 52% (as compared to the OECD average of 62%). It occupies the 3rd-worst

15. To be precise, PISA surveys attach a weighting to students in order to ensure that the sample is a correct representation of the different groups in the population (see the OECD's technical report, 2014). The deciles are thus formed by taking into account student weights so as to give the same "total student weight" to each decile.

16. The average between individual mobilities is in fact an arithmetic average "weighted" on the basis of student weights in each successive wave of the PISA study.

17. Perfect mobility is found when, in each academic decile, there is an equivalent number of representatives of each social decile. This situation is one of equal opportunity on average. Formally, perfect mobility is equal to $\frac{1}{100}\sum_{i=1}^{10}\sum_{j=1}^{10}\frac{j}{i}=1.61$, *where* i *indicates the social decile and* j *the academic decile.*

Figure II
Interdecile social mobility at school (PISA 2003-2015)



Note: Normalised interdecile mobility measures the average mobility of students between their socio-economic decile and their test score decile (using student weights). The value is equal to 0 if there is no mobility and increases with upward mobility to reach 100% in the event of perfect mobility. Perfect mobility is found when, in each test score decile, there is an equal representation of each socio-economic decile.
Reading note: In the OECD, the interdecile mobility index is 60%, which means social mobility equivalent to 60% of a perfect mobility situation.
Scope: 27 OECD countries participating in the 2003-2015 PISA surveys.
Sources: OECD, PISA 2003-2015 in mathematics; authors' calculations.

position in the 27 countries over the period 2003-2015. Canada, Iceland and Finland are some of the best in class when it comes to normalized interdecile mobility, with interdecile mobility close to 70%.

One important remark needs to be made here, as we could be criticised for comparing social mobility between countries without taking into account social disparities between these countries. Social disparity is indeed different, whether looking at Finland and Iceland or the United States and Canada. However, the difference in social mobility has a very low correlation with a country's social heterogeneity. If we compare countries based on their social disparity, measured by the dispersion of the socio-economic index of students and their social mobility, the correlation is less than - 0.2. This suggests that it would be difficult to attribute low social mobility to high social disparity. This is partly the result of our mobility index, which flattens out variations in performance scales and socio-economic status between countries by reducing the whole to a uniform decile scale. Moreover, as Dubet *et al*. suggest (2010), the relationships between societies and their school systems are relatively distinct. Societies that are relatively comparable from the social perspective can have very different school systems. Conversely, societies that are relatively different from the social perspective can have very comparable school systems.

Social mobility and social gradient

To assess the equity of a school system, the OECD uses the concept of social gradient (see OECD, 2014a). Social gradient measures the impact of students' social origin on their results on tests. The distinction needs to be made between slope and intensity. The slope of the social gradient indicates the magnitude of the "average" gap in academic achievement between students based on the socio-economic gap between the same students. The intensity of the social gradient indicates the percentage of variance in academic achievement between students attributable to students' socio-economic origin. For all the OECD countries studied in the 2012 PISA survey, the average intensity of the social gradient is 14.8% (see OECD, 2014a, Figure II.2.2). This intensity of social gradient is a measure of inequity, i.e. the percentage of academic inequality that can be explained by socio-economic inequalities between students. We calculate this social gradient's intensity for the successive waves of PISA surveys between 2003-2015, taking into account student weights[18]. This intensity of social gradient is closely correlated with our interdecile mobility index. However, the two indices are logically distinct. This is because interdecile mobility is an ordinal (rather than cardinal) metric of mobility which, moreover, favours upward mobility over downward mobility. This means, most notably, that the proportion of resilient students is better valued with our interdecile mobility than with the social gradient based on the assumption of linear relationship between the social index and test score.

Restricting the link between test scores and social index to a linear relationship can lead to false interpretations. For example, the intensity of social gradient underestimates social mobility in countries where the relationship between academic achievement and socio-economic status is convex (due to less precision in the linear model). Another difference is that the intensity of the social gradient depends mechanically on the ratio between the dispersion in socio-economic indices and the dispersion in academic performance. In particular, for two countries with identical slope of the social gradient, the intensity of social gradient will be mechanically higher in the country where the dispersion in socio-economic indices is greatest and/or the dispersion in student scores is lowest. The reason is simple: the higher the variance of the socio-economic indices, the greater the "explanatory" power of the linear model will be; vice versa, the higher the variance of the test scores, the lesser the explanatory power of the linear model. This is because the intensity of social gradient is formally linked to the slope of the social gradient according to the expression:

$$\sqrt{(\textit{social gradient intensity})} = \textit{social gradient slope} \times \frac{\textit{SD ESCS}}{\textit{SD test scores}} \quad (1)$$

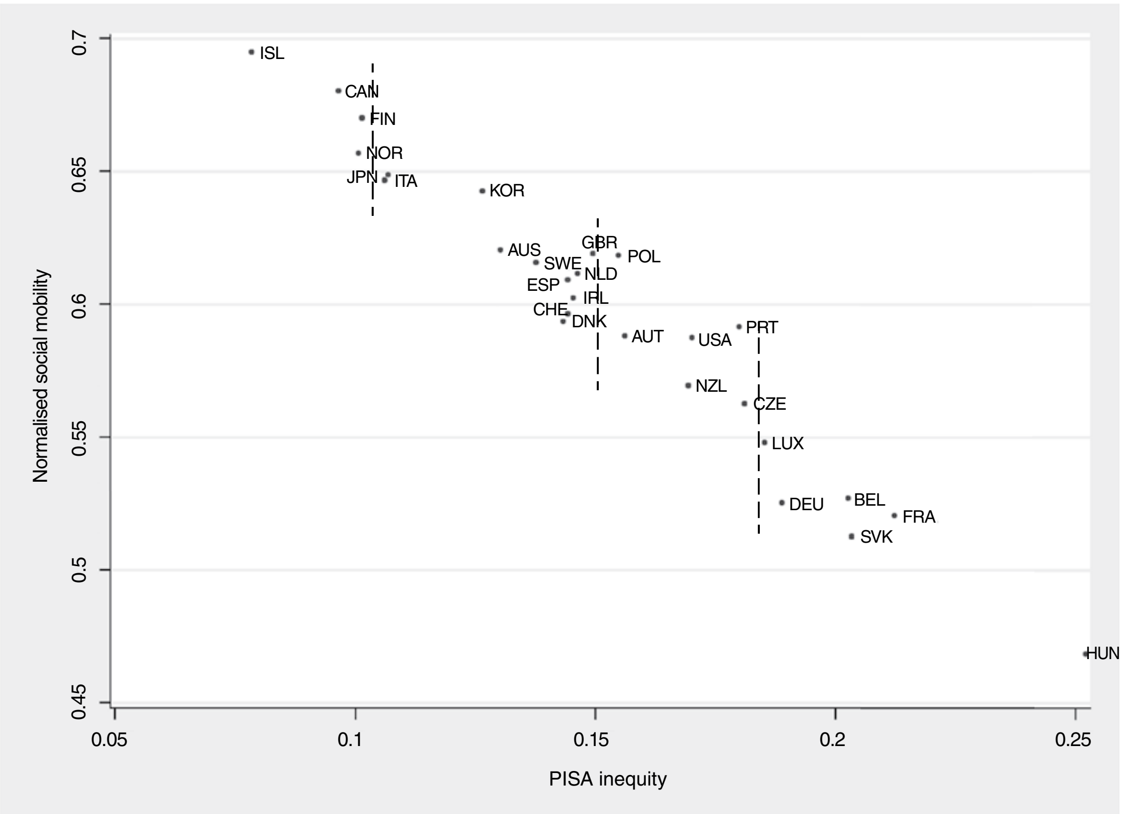
The advantage of our social mobility index is that it does not depend "mechanically" on test scores inequalities or socio-economic inequalities. We can thus compare social mobility between countries with very different educational or social inequalities, without bias in the comparison.

18. It is the index most often used to measure the link between social background and academic achievement. See for example Crahay (2012), Danhier et al. (2014) and OECD (2014a).

A comparison between social mobility and the intensity of social gradient comes with a number of surprises (Figure III). Countries like Denmark and Poland, which are comparable in terms of intensity of social gradient, turn out very different in terms of interdecile mobility. With the interdecile approach, Denmark comes out below Poland. The social elevator seems to work better in Poland than in Denmark for the most marginalised students in society, something that was not visible based on intensity of social gradient. Similarly, based on intensity of social gradient, Canada is comparable to Italy, when social mobility is much better in Canada. The school system in Canada thus provides better opportunities to students who are more socially marginalised than does Italy. Another interesting comparison involves Portugal and Germany, which share the same intensity in social gradient, but diverge in interdecile mobility, Portugal faring much better. Conversely, while Portugal and Denmark have the same interdecile mobility, Portugal shows higher intensity in social gradient.

Another standard way of measuring inequality in opportunity is to measure the slope of the social gradient (the difference in score associated with the variation of a socio-economic index unit). The correlation between the slope and intensity of the social gradient in mathematical culture is 0.62 (OECD, 2014a). The social gradient slope is also correlated with our interdecile mobility index, but only partially. In reality, the social gradient slope is governed by the *ex ante* perspective on equal opportunity (average performance at a given socio-economic level). The interdecile approach, in contrast, reflects the *ex post* perspective on equal opportunity (distribution of performance levels *ex post* for a given socio-economic level). This *ex post* perspective on equal opportunity is more comparable to the intensity of social gradient, the difference being that we do not, in principle, impose a linear relationship between performance on tests and students' socio-economic index. Interdecile mobility therefore, beyond the social gradient, measures the possibility for students from very disadvantaged social backgrounds to perform

Figure III
Social mobility and social gradient (PISA 2003-2015)



Note: The PISA iniquity index measures the proportion of the variance of test scores in mathematics (using student weights) explained by the socio-economic index of students: it reflects the intensity of the social gradient. Normalised social mobility is identical to that in Figure II.
Scope: 27 OECD countries participating in the 2003-2015 PISA surveys.
Sources: OECD, PISA 2003-2015 in mathematics; authors' calculations.

beyond expectation (based on the line of social gradient), and thus escape the hold of social environment.

Social mobility and resilience

The OECD (2014a) defines resilient students as students from the lower socio-economic quartile of their country who perform in the upper quartile of all students in a comparable situation in other countries (i.e. in the lower socio-economic quartile). In Denmark, the proportion of resilient students is 4.9%, compared with 6.4% on average in OECD countries (see OECD 2014a, figure II.2.4). Inversely, Poland's percentage of resilient students exceeds the average (8.4%), whereas the intensity of the social gradient is identical between the two countries (cf. Figure III). It could therefore be concluded that it is entirely possible to predict the social mobility index by comparing the intensity of the social gradient with the percentage of resilient students for each country. This is partly true and suggests that the social mobility index brings together in a single index these two distinct criteria, namely the percentage of resilient students and the social gradient. However, it does more than that. Let us compare Belgium and France, which in our figure III show the same interdecile mobility and the same intensity of social gradient. It can be observed, however, that the percentage of resilient students is above the OECD average in Belgium (7.2%) and below it in France (5.2%). Interdecile mobility is thus indeed different from the percentage of resilient students as measured by the OECD. In reality, the OECD defines resilient students on the basis of an international comparison of achievement of socially disadvantaged students (belonging to the lower socio-economic quartile of their country). In contrast, interdecile mobility approaches resilient students on the basis of an intra-national comparison of the results of socially disadvantaged students with all the students in the country. By measuring the resilience within each country, we separate it from the countries' average level of performance. In the approach taken by the OECD, a country can post a high percentage of resilient students if the average level of academic performance is higher than that of other countries, as this makes it easier for disadvantaged children in this country to achieve better results than disadvantaged students in other countries. By separating social mobility from average performance, our approach thus allows for a more accurate measure of the fairness of a given school system. This interdecile mobility index also offers the benefit of approaching social mobility more generally, as it is not limited to studying mobility between the lower quartile of the population and the upper quartile.

In the following section, we compare this metric of social mobility in school systems with their levels of performance and inequality. By contrast to the OECD's social gradient, this indicator of social mobility in schools does not mechanically depend on social inequalities and academic inequalities. As a result, our analysis of the link between social mobility, performance and inequality of school systems takes on a new shading. We call this three-dimensional approach the "golden triangle" of school systems[19]. In particular, we wish to verify whether these three criteria are compatible with one another.

Social mobility and performance

The golden triangle

Let us draw on a figure with bubbles (Figure IV) in which the bubbles' coordinates represent the values of two variables (average score relative to the OECD average and variance of a country's scores relative to the average OECD variance) and their size represents the value of the third variable (social mobility in the school relative to the OECD average). This approach differs from the conventional approach taken by the OECD, which compares school systems on two dimensions: average performance (higher or lower than the OECD average) and intensity of social gradient (greater or lower than the OECD average)[20]. The data used combine five successive waves of PISA tests between 2003 and 2015. For each country, we calculate the average, across the five PISA tests, between average performance, inequalities in academic performance and interdecile mobility (always

19. To clearly illustrate how social mobility in schools is distinct from school inequality, let us take two school systems, A and B, with the same inequality in achievement between students. Let us also assume that they are equivalent in terms of average performance. However, school system A is characterised by a total lack of social mobility in schools: i.e., the academic position is completely determined by the student's social position. Conversely, school system B is characterised by perfect social mobility, which means that the student's academic position is completely independent of social position. It seems essential to take into account this difference in evaluating the two school systems, regardless of their performance and distribution of academic achievement. This is what we will do now.

20. See OECD 2014a, Figure II.1.2.

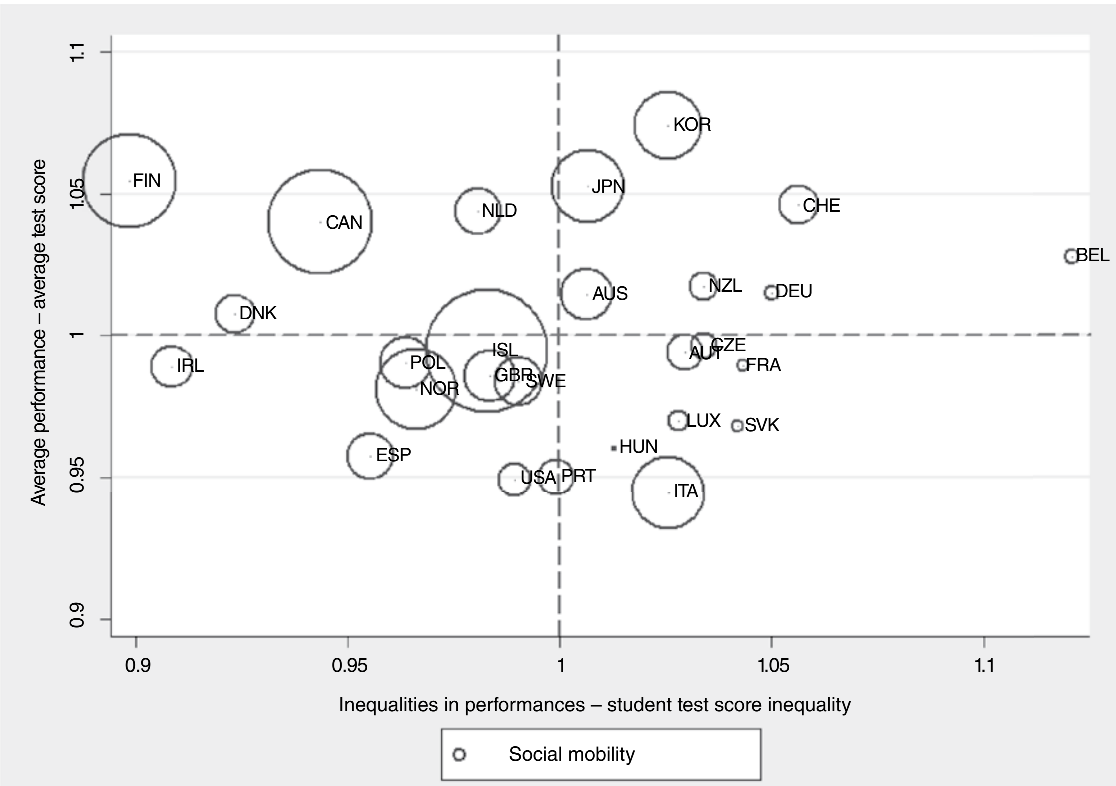
using the student weights). The size of the bubbles is larger above the horizontal line, which illustrates a form of synergy between performance (average achievement) and social mobility in schools (interdecile mobility index), and to the left of the vertical line, which illustrates a synergy between equality in academic achievement and social mobility in schools (figure IV). It can also be very clearly seen that a country like France is characterised by low social mobility, high income inequality and low average performance. Conversely, a country such as Canada combines high social mobility with low income inequality and a high average performance level.

Here, we analyse in greater detail the link between social mobility in schools and average performance. Studies from the OECD have often highlighted the fact that performance and equity in the sense of intensity of social gradient are not contradictory. Out of the twenty-three countries displaying performance above the average in mathematics on PISA 2012, twenty have a social gradient that is equal to or less than the average (OECD, 2014a, pp. 27–28). We would like to check this result for the social mobility index based on the five waves of PISA surveys in 2003-2015.

School performance

For each country, we calculate its average performance on mathematics tests based on all PISA tests between 2003 and 2015 and the average social mobility index over the same period. We then compare these two average indices (Figure V). The result is that social mobility and performance are positively correlated. Countries with better performing educational systems are often countries where social mobility in schools is higher. This result confirms the OECD's findings as to the link between the intensity of the social gradient and average performance. In addition, to our knowledge, the OECD's studies do not give a precise correlation between these two indicators. In our

Figure IV
Average test score, test score inequality and social mobility (PISA 2003-2015)



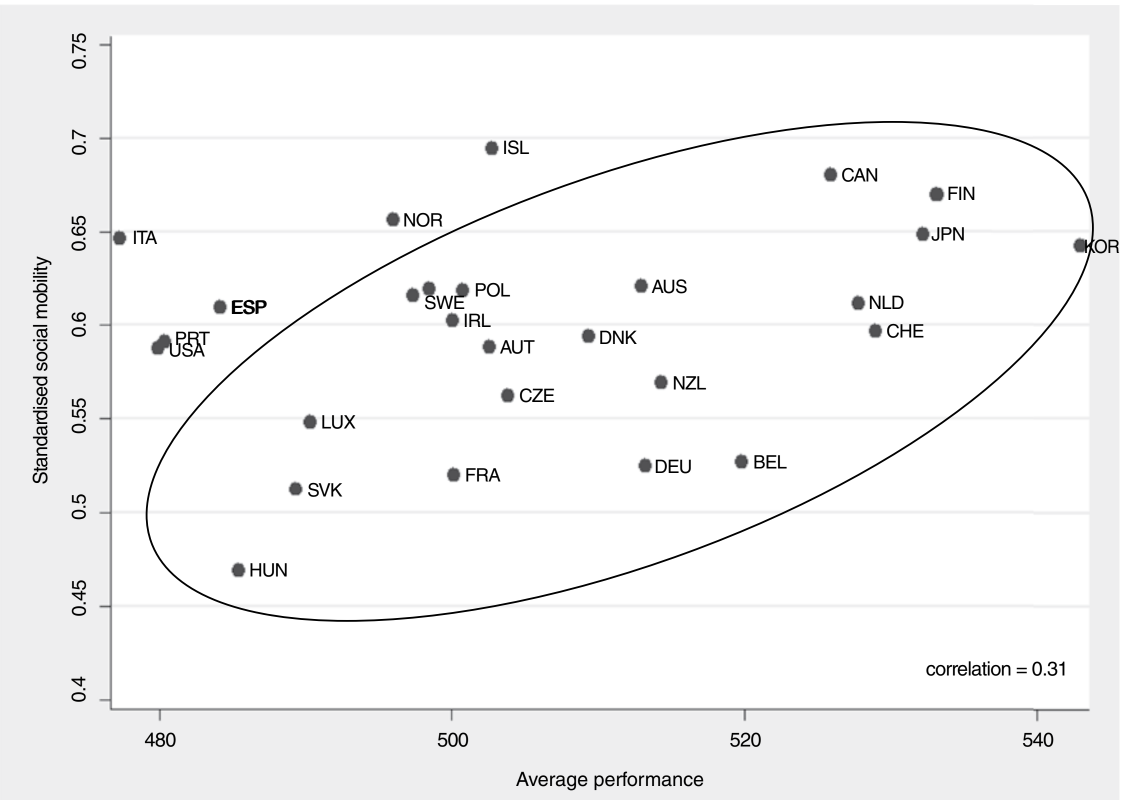
Note: The horizontal axis shows the test score inequality between students in each country relative to the OECD average. Test score inequality above 1 indicates above-average inequality in that country and vice versa. The vertical axis indicates the average test score in mathematics in each country relative to the OECD average. Performance above 1 indicates a country performing above the OECD average. The size of the bubbles indicates the normalised social mobility (figure II).
Scope: 27 OECD countries participating in the 2003-2015 PISA surveys.
Source: OECD, PISA 2003-2015 in mathematics; authors' calculations.

case, the correlation between social mobility and average performance across all PISA 2003-2015 surveys is + 0.31. How should this positive correlation be interpreted? As stated in the introduction, it is important to be careful in interpreting the results, precisely for two reasons. Firstly, our correlation is not a causality. Secondly, this correlation is a result aggregated at the country level, which rules out the possibility of a potential conflict between performance and equity at the more disaggregated level (in particular due to selection of students across schools). Taking into account these reservations, one possible explanation of the connection between performance and social mobility is that a policy of equal opportunity makes it possible to open up the "pool of talents" among working-class children, which then improves the overall performance level.

Our interpretation of the connection between performance and social mobility is based on the classic methodological individualism hypothesis in economics according to which facts and social processes need to be understood as the addition of behaviours and individual representations. This concept of "cognitive rationality" offers, in our view, a possible interpretation of our relationship between performance and social mobility. In a school system where children have equal opportunity for academic success, trust in individual action is greater and everyone is encouraged to invest fully in their schooling. In contrast, in a school system where a student's chances in school are highly correlated to social origin, the school becomes a place of "learned helplessness" for the children from working-class neighbourhoods. The consequence is a lack of motivation and academic performance.

The positive relationship between performance and social mobility should be considered as an extension of the results often repeated in the OECD's studies, indicating a possible complementarity between equity and school system performance. Freeman *et al.* (2010) have shown the existence of a similar virtuous

Figure V
Social mobility and academic performance (PISA 2003-2015)



Note: The average performance is the average of test scores in mathematics on the five successive waves of PISA surveys (using student weights). Normalised social mobility is identical to that in Figure II.
Scope: 27 OECD countries participating in the 2003-2015 PISA surveys.
Source: OECD, PISA 2003-2015 in mathematics; authors' calculations.

circle between equity and performance, based on an international comparison of standardised tests in mathematics, Trends in International Mathematics and Science Study (TIMSS), between 1999 and 2007 for a total sample of more than 250,000 students in grade 8 (13-14 years). However, in their analysis, equity is measured by the equality of academic performance and not by social mobility. A final question must be raised regarding the link between performance and social mobility. Is this correlation robust when the set of countries considered is extended beyond the OECD countries? While such an extension is possible, the results need to be qualified for two reasons. Firstly, the PISA socio-economic index was built exclusively for the countries of the OECD and not for partner countries (Rutkowski & Rutkowski, 2013). Secondly, the heterogeneity of the participating countries, whose educational or cultural traditions, as well as economic living conditions, can be very different, makes comparison with our reference countries (OECD) less reliable. Ollinger (2017) estimated the relationship between social mobility and performance based on achievement in mathematics for 44 countries having participated in PISA 2015 with a human development index comparable to that of the OECD countries. He found a correlation close to zero between performance and social mobility (see Ollinger, 2017, figure 9). However, this is not so surprising given that the 17 additional countries are, on average, less developed than the 27 in our reference group: their performance level is lower whereas their interdecile mobility index is higher (but less reliable: interdecile mobility is higher in Russia and Montenegro than in Canada or Finland), which drives down the correlation between performance and social mobility.

This leads us to question the link between educational inequalities and social mobility. As explained above, the OECD studies do not really examine this link between inequality and equity insofar as their equity index (based on the intensity of the social gradient) is mathematically dependent on educational inequalities (see equation 1). More educational inequalities mechanically reduces the intensity of the social gradient and thus the level of equity as defined by the OECD. Inversely, our index of equity (based on social mobility) is mathematically independent of educational inequality (as the distribution of test scores is transformed into a uniform distribution, in decile). The empirical results presented in the following section are therefore new.

The Great Gatsby curve

The controversy over the Great Gatsby curve

Alan Krueger (2012) popularised, in a speech at the Centre for American Progress, the expression "*The Great Gatsby Curve*" in reference to the inverse relationship between intergenerational mobility of incomes (measured by the intergenerational elasticity of labour income between fathers and children) and economic inequality (measured by the Gini coefficient on labour income). This empirical finding inspired by the work of Miles Corak (2013) has stirred some controversy. First of all, in the public opinion, because it contradicts the American dream that economic inequality is not an obstacle to social mobility. If economic inequality reduces social mobility, then growing inequality limits the possibilities for individuals to escape their fate. This is the tragic tale of Jay Gatsby, summarised in the closing lines of F. Scott Fitzgerald's work: "*So we beat on, boats against the current, borne back ceaselessly into the past.*" The Great Gatsby curve has also raised debate in the academic world. As Corak suggested from the outset, this correlation is not a causality. It furthermore relies on fairly strong hypotheses regarding the measurement of income between different generations (Corak, 2013). More surprisingly still, Corak *et al.* (2014) have shown that this correlation might simply not exist altogether. The Great Gatsby curve is "intrinsically biased" by the fact that it uses intergenerational elasticity in income as a social mobility index. As a result, by construction, an increase in income inequalities between generations mechanically increases intergenerational elasticity, thereby reducing social mobility. If, inversely, social mobility is measured with rank-order, by construction independent of income distribution, the relationship between social mobility and income inequality falls sharply. In reality, Corak *et al.* (2014) show that Sweden, Canada and the United States have relatively similar social mobility, while income inequalities are very different between these three countries, thus invalidating the Great Gatsby curve in income. We are now revisiting this Great Gatsby Curve for education, comparing the inequality of academic achievement to our social mobility index in schools.

The Great Gatsby curve in schools

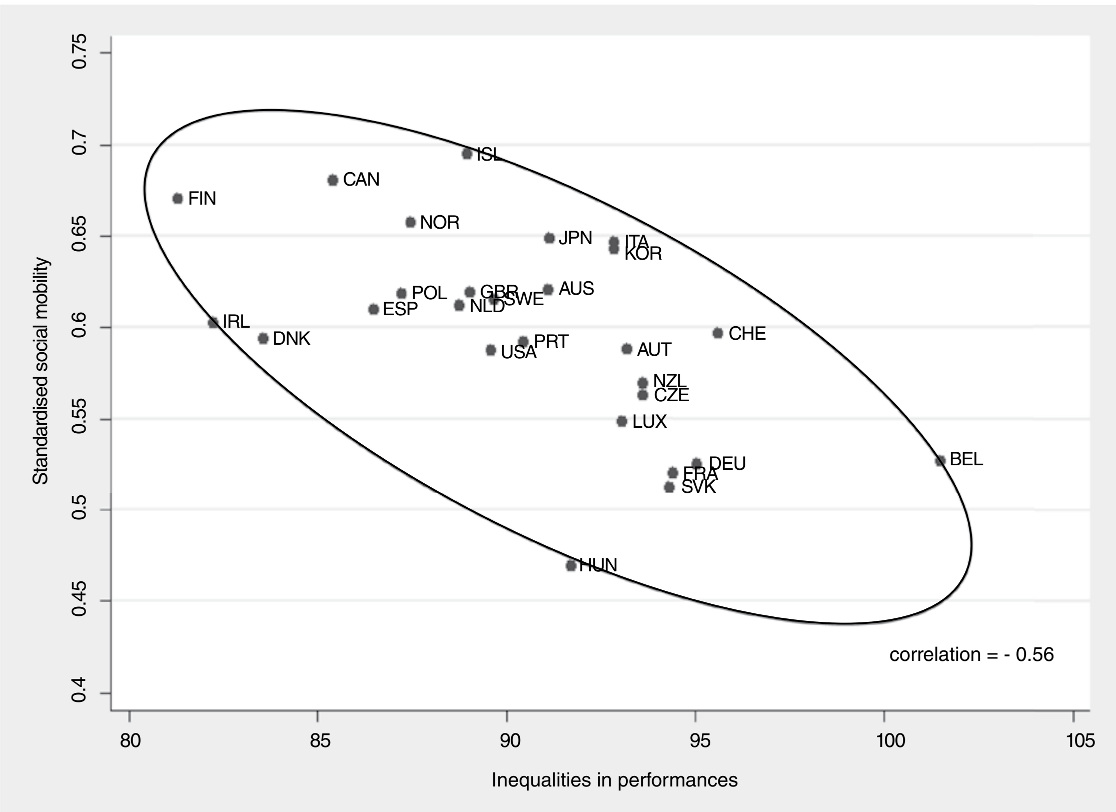
In this section, we compare interdecile social mobility in schools and educational inequalities between countries. For each country, we calculate the average interdecile mobility index over the period and test scores inequality between students (always using student weights). The result is a negative correlation of - 0.56 between interdecile mobility in schools and standard deviation in test scores (Figure VI). This relationship is particularly worrisome in that it concerns the capacity of the school system to promote social mobility in the presence of educational inequality. It also puts into perspective the political division on equality of opportunity and equality of outcomes. Both forms of equality appear to reflect two faces of a same reality.

Interpreting the inverse relationship between mobility and educational inequalities is difficult, because we have only a correlation and not a causal relationship. We thus cannot claim that academic inequalities reduce social mobility in schools. What we can establish is that school systems with low educational inequality are also often characterised by greater social mobility in schools. A possible (and not final) way to interpret this relationship is related to the vertical differentiation among schools. In reality, using Theil decomposition and for each country, we calculated the between-school share of the student test scores inequality, the other part representing within-school inequality[21]. By superimposing this inequality between schools with social mobility in schools, we found a negative correlation of - 0.55 (Figure VII). This relationship suggests that those school systems with "vertical differentiation" in schools, as is the case in Germany or Belgium, have less social mobility than school systems with "horizontal differentiation" as in Canada or Finland[22].

21. France has been removed from this part of the analysis due to its separation between lower and upper secondary school students, at age 15. "Late" students remain in lower secondary school and are therefore automatically separated from "on-time" students who are in upper secondary schools. This situation, which is specific to France, accentuates inequalities between schools. In the other countries, the age at which students normally move from lower to upper secondary schools is 16 (e.g. "Gymnasium" in Germany, Austria, Netherlands, Switzerland and Central European countries).

22. By "vertical differentiation", we mean a segmentation of schools by academic level of students, and by "horizontal differentiation" we mean segmentation of schools according to the pedagogical approach or the school project.

Figure VI
The Great Gatsby curve of students inequality (PISA 2003-2015)

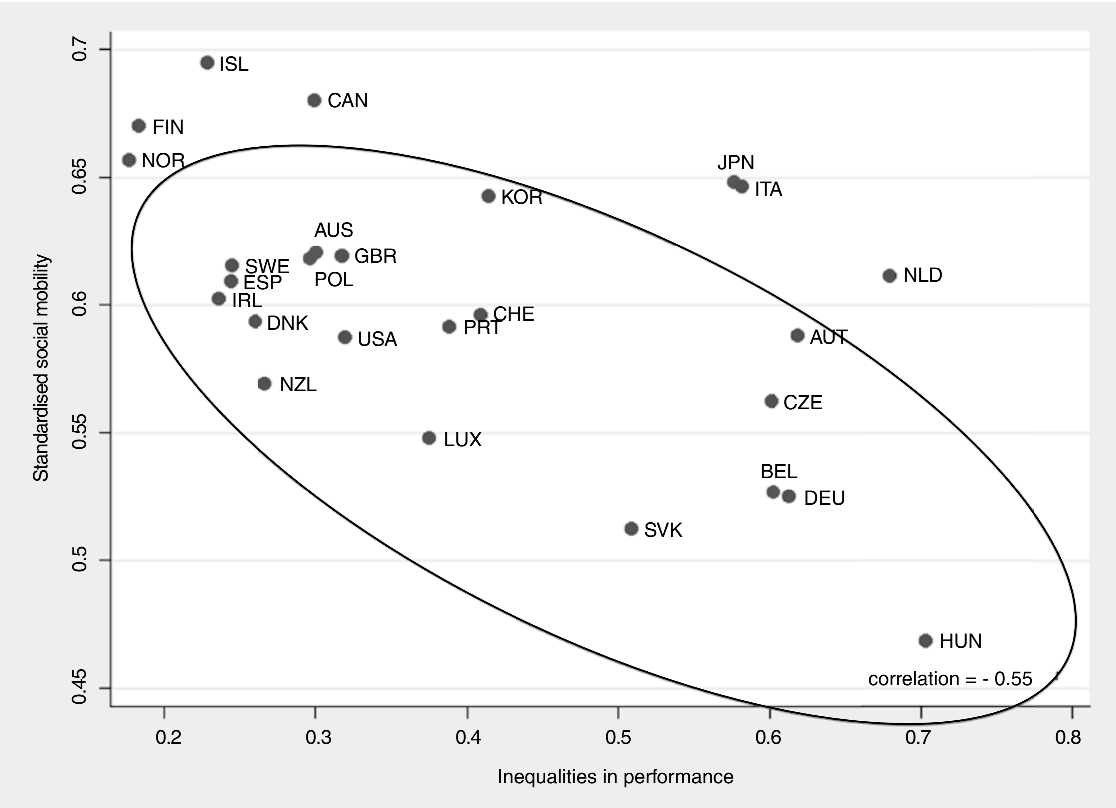


Note: Inequality of test score between pupils is measured by the standard deviation of pupils' test scores in PISA tests (with student weights). Normalised social mobility is identical to that in Figure II.
Scope: 27 Oecd countries participating in the 2003-2015 PISA surveys.
Source: Oecd, PISA 2003-2015 in mathematics; authors' calculations.

Mankiw (2013) criticised the interpretation of the Great Gatsby curve by suggesting that the inverse relationship between inequality and social mobility is due to the greater social heterogeneity of the more unequal groups. In a heterogeneous group with high inequality, social mobility would, according to him, be lower. This criticism is rejected by our comparison of school systems as social heterogeneity (measured by the dispersion in the socio-economic index of students) and academic inequalities (measured by the dispersion of results in mathematics) are not correlated among the countries considered. In our PISA sample, this correlation is actually null (- 0.01 between 2003-2015). Another criticism of Mankiw (2013) concerns the selection by talent, which he depicts using the metaphor of the chess players. It seems obvious that a group including both "novices" and "masters" will have less mobility (only the masters will win) than groups where novices and masters are separated (everyone has a chance to win). By separating players into groups of differing levels (ability grouping), mobility is encouraged within each group. This criticism of the selection by talent group is relevant at the level of the schools, but is no longer so at the country level. In fact, the opposite proves to be true at the country level: school systems with ability-grouping, as is the case in Belgium, are also those that display low social mobility. In contrast, school systems such as Canada's, without ability-grouping, have high social mobility[23]. Ultimately, what our Great Gatsby curve reveals is that the link between inequality and social mobility in schools lies in the complex alchemy within each school system and not in pseudo-differences in social or talent-related disparities between countries.

23. *The detailed results are available upon request.*

Figure VII
The Great Gatsby curve of school inequality (PISA 2003-2015)



Note: Inequality between schools is measured according to a Theil decomposition, as the share of inequality in students' test scores between schools, as opposed to inequality within schools. Normalised social mobility is identical to that in Figure II.
Reading note: France has been removed from this part of the analysis due to the separation between lower and upper secondary school students, at age 15. The "late" students are in lower secondary school and the "on time" students are in high school, which widens inequalities between schools.
Scope: 27 OECD countries participating in the 2003-2015 PISA surveys.
Source: OECD, PISA 2003-2015 in mathematics; authors' calculations.

Questions can be raised as to the robustness of this Great Gatsby curve by enlarging the set of countries studied. Ollinger (2017) recently confirmed this correlation between social mobility and educational inequality for a larger group of developed countries (44 countries, including the countries of the OECD) based on mathematics results in the PISA 2015 test, but also based on the results in science and reading. The Great Gatsby relationship proves even robust when the country perimeter is extended to include the 72 countries participating in PISA 2015. Ollinger (2017) also calculated the correlation between the intensity of the social gradient and the inequality between schools (as defined before). Based on PISA 2015 (with 44 countries), he found a positive correlation of 0.34 in mathematics, 0.44 in science and 0.43 in reading. On our side, on the basis of our wider PISA 2003-2015 sample (for the 27 countries) we have confirmed the Great Gatsby curve with correlation rates in science and reading comparable to those found in mathematics.

* *
*

Comparing school systems requires characterising them with precision. Drawing upon the literature, we analyse school systems taking account of three dimensions: average student performance, educational inequalities and social mobility in schools. The originality of our study stems from our ordinal approach to social mobility. In this article, we show that contrary to the education equity indicators used by the OECD, the interdecile social mobility indicator enables social mobility to be studied independently of the other two dimensions: school inequalities and average performance in schools. This new angle for approaching social mobility in the school yields new results.

Based on PISA tests between 2003 and 2015 in the OECD countries, we have shown a strong relationship between social mobility and educational inequalities, which we call the Great Gatsby curve in schools. The social mobility of a school system therefore appears to be closely linked to school inequality. Countries such as Belgium or Germany, with high inequality between schools, are also characterised by low social mobility in schools. In contrast, countries such as Poland or Canada, with less inequality between schools, display higher social mobility in schools. In the former case, it can be said that the vertical differentiation model applies to schools, while in the latter case, the horizontal differentiation model is in play. The second finding of our study is that social mobility and school system performance more often go hand in hand than diverge.

Our study reveals that while countries have all adopted measures and policies to promote equality of opportunity in schools, some have achieved their aims far better than others. Our analysis, by comparing different school systems, also shows that change can be achieved without pitting excellence against equity or equality against social mobility in schools. Such an outcome should encourage politicians to go beyond ideological positions to address the issue of the quality of education in a pragmatic and practical manner. Our study also has a number of limits. While it highlights new associations between educational attainment, educational inequality and social mobility by comparing different school systems, it does not establish any causalities. In addition, our results are tightly conditioned by the quality of the PISA data, in particular that of the specific sample of 15-year-old students.

Various developments in different directions are underway. First of all, we are currently continuing our investigation of social mobility, carried out so far at the aggregate country level (country comparison), by schools level comparison to identify schools with high social mobility and their common characteristics. Furthermore, our social mobility index should be submitted to a careful analysis of its normative properties and be compared with other possible indices of social mobility. ☐

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