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How a student's month of birth is linked to performance at school: New evidence from PISA

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HOW A STUDENT'S MONTH OF BIRTH IS LINKED TO PERFORMANCE AT SCHOOL: NEW EVIDENCE FROM PISA

OECD Education Working Paper No. 221

Pauline Givord, OECD

This working paper has been authorised by Andreas Schleicher, Director of the Directorate for Education and Skills, OECD.

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Abstract

Because of the regulations concerning school entry in most school systems, a child's date of birth may significantly affect his or her age at entry into school, and thus their first experience of schooling. Using data from the Programme for International Student Assessment (PISA), this paper provides a comparative analysis of the impact of a student's month of birth on cognitive and non-cognitive outcomes. It describes school regulations regarding school entry in over 45 countries and economies, and discusses the reasons why a student's date of birth may have consequences on his or her performance in school.

The results show that a student's month of birth has consequences on performance in the three main domains assessed by PISA, and also on the student's progress through education, as those children who were the youngest in their grade cohort at entry into school were more likely to have repeated a grade in primary school.

This paper also shows that, in several school systems, being the youngest in the school-entry cohort has an impact on self-confidence, notably on self-perceived competence and self-efficacy, and also on future education outcomes. These results call for raising awareness amongst educators and parents of the initial disadvantage experienced by the youngest children in their first years of school. The paper concludes with a review of existing recommendations to reduce age-related effects on education outcomes.

Résumé

Du fait des règles sur la scolarisation, la date de naissance d'un enfant impacte son âge effectif d'entrée à l'école, et donc la nature de sa première expérience de scolarisation. En utilisant les données du Programme International de Suivi des Acquis des élèves (PISA), cette étude une analyse comparative de l'impact du mois de naissance sur des mesures cognitives et non cognitives des élèves à 15 ans. Il décrit les régulations sur l'entrée à l'école dans plus de 45 pays et économies, et discute les raisons pour lesquelles la date de naissance d'un élève peut avoir des conséquences sur ces performances scolaires.

Les résultats montrent que le mois de naissance d'un élève a des conséquences sur ses performances dans les trois principaux domaines mesurés par PISA, ainsi que sur le parcours éducatif des élèves : dans de nombreux systèmes éducatifs, les élèves les plus jeunes d'une cohorte scolaire ont une plus grande probabilité d'avoir redoublé une classe à l'école primaire.

Cette étude montre aussi que, dans plusieurs systèmes scolaires, être le plus jeune de sa cohorte scolaire a un impact sur la confiance en soi, en particulier sur l'auto-évaluation de la compétence et sur le sentiment d'auto-efficacité. Ces résultats appellent à une sensibilisation des éducateurs et des parents sur les difficultés spécifiques que rencontrent les élèves les plus jeunes dans les premières années d'école, et fournit une revue des recommandations qui ont été proposées pour réduire ces effets liés à l'âge sur la réussite scolaire.

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Introduction

Does the quality of a child's future depend on which month he or she was born? The question may seem odd, but empirical evidence has shown that the age at which children enter primary school may have long-lasting consequences. In all systems, the age at which children enter primary school varies from one child to another as a function of the child's birthday relative to when the school year begins. Since the school year begins at roughly the same time for all students in an education system, but children's birthdates are spread across the calendar, the age at which a child enters primary school may have repercussions on his or her education outcomes and, ultimately, on his or her future.

In several OECD countries, fourth- and eighth-grade students who are amongst the oldest in their cohort often perform significantly better at school (Bedard and Dhuey, 2006[1]). These differences may persist after completing compulsory education, as is seen, for instance, in Canada (Smith, 2009[2]), France (Grenet, 2010[3]), Italy (Ponzo and Scoppa, 2014[4]), Mexico (Peña, 2017[5]), Portugal (Madeira et al., 2018[6]), the United Kingdom (Crawford, Dearden and Meghir, 2010[7]; Bell and Daniels, 1990[8]) and the United States (Bedard and Dhuey, 2006[1]; Cascio and Schanzenbach, 2016[9]).The month a child was born has been shown to be related to the probability of repeating a grade (Fertig and Kluve, 2005[10]; Chen, 2015[11]; Madeira et al., 2018[6]), being diagnosed with learning disabilities, such as attention deficit hyperactivity disorder (ADHD) (Dhuey and Lipscomb, 2010[12]; Elder and Lubotsky, 2009[13]), completing post-secondary education (Bedard and Dhuey, 2006[1]), educational attainment (Kawaguchi, 2006[14]) and labour market outcomes (Bedard and Dhuey, 2007[15]; Grenet, 2010[3]; Fredriksson and Öckert, 2013[16]). However, in some countries, including Finland, the "penalty" of being amongst the youngest in class has no impact on labour market outcomes in adulthood (Pehkonen et al., 2015[17]).

There are several reasons why performance in PISA may vary depending on the month a student was born. The first is related to the fact that students in a given country/economy sit the PISA test at the same time (the testing window lasts a few weeks; see the *PISA 2018 Technical Report*). This means that, at the date of the test, depending on when in the year they were born, some students are a few months older than their peers when they sit the test (the PISA sample includes students aged from 15 years and 3 completed months to 16 years and 2 months). An "age-at-test" or "absolute age" effect has already been documented amongst students in the first grades of primary school (Crawford, Dearden and Greaves, 2014[18]).

The second factor that explains an association between the month of birth and performance is related, as mentioned above, to the fact that students' birthdates are spread across 12 months, while the school year begins at roughly the same time for all students in a given education system. Consequently, the exact age, in months and days, at which children enter primary school may vary significantly from one child to another. The "age at entry effect" is related to the fact that some children may be more or less "ready" to start school. Children who are not mature enough when they start formal schooling may have negative first experiences with school. This may damage a child's self-confidence, and thus undermine his or her self-esteem and motivation to learn (Thompson, Barnsley and Battle, 2004[19]; Suziedelyte and Zhu, 2015[20]; Crawford, Dearden and Meghir, 2010[7]; Dee and Sievertsen, 2018[21]). By contrast, students who are more mature when they start school may achieve early successes, prompting a virtuous cycle of reinforcement, support and more success. Families' decision to delay or advance their child's entry into primary school, in relation to the standing

regulations regarding age at entry, may also mitigate this effect, as the decision may be based on students' "readiness" to participate in school.

These age effects may be reinforced by the dynamics in the classroom. If age is related to performance, then students of different ages are likely to be ranked differently within their class, and to learn alongside classmates who are more or less competent than they are. Older and more competent children may inspire their younger and less-advanced peers (Cascio and Schanzenbach, 2016[9]; Peña, 2017[5]). But when teachers adapt the pace of learning to the "average student" in the class, the youngest students may be discouraged if catching up turns out to be too difficult. Such effects on school achievement, if they occur early in formal education, may have long-term consequences – not only for performance, but for socio-emotional outcomes too.

For instance, a study using longitudinal data for students in England shows that students' ordinal academic rank within a class during primary school had lasting consequences on their future schooling that were not related to underlying ability. Students who had a high rank in a subject (such as English, mathematics or science) amongst the students in their class in primary school usually attained higher test scores in that same subject throughout secondary school than a student with a similar absolute level of performance but who ranked lower in his or her primary school class (Murphy and Weinhardt, 2018[22]). The rank in primary school in one subject also affected the likelihood of choosing to study this subject at the end of secondary school – and at university.

The authors suggest that the rank given in a subject affects children's self-confidence. Indeed, some researchers (Muller and Page, 2016[23]) observe that the proportion of US senators and representatives who were amongst the oldest in their school-entry cohort is larger than the proportion of such "older entrants" in the American population. The same was observed amongst corporate CEOs in the United States (Du, Gao and Levi, 2012[24]). These results may reflect a tendency for older children to benefit from their advantageous position in their cohort to learn early the skills that are required for leadership (Dhuey and Lipscomb, 2008[25]).

Third, the "schooling-length effect" may explain the relation between age and education outcomes. Students born just after the school-entry cut-off date are expected to start schooling a year later than those born just before this cut-off date, and thus would be exposed to a shorter total duration of schooling. This means that at the time they sit the PISA test, 15-year students may be enrolled in different grades. In addition, students may have started primary school earlier or later than defined by the system's regulations, or they had repeated or skipped a grade at some point before they sat the PISA test.

While the impact of month-of-birth on several academic outcomes is well documented, which of these factors predominate is still under debate. For students who were born within a 12-month window and sit a test on the same day, it is not possible to measure separately the impact of age at entry into school, the effect of the age of the student who sat the test and the duration of schooling, as these three factors are perfectly linearly aligned. Similarly, it is usually difficult to disentangle whether it is the impact of the student's relative age – that is, the age as compared to that of his or her classmates – that matters, or the absolute age that explains observed differences.

In addition, the conclusions may vary depending on when the outcomes are measured. In the first grades of primary school, variations in outcomes between students born at different times of the year are expected to make a difference, as they are related to large differences in maturity at the time these students sit the PISA test. For instance, students who were almost six years old when they first entered primary school were 20% older than the youngest

students in their class who had just turned five. This difference in age is less likely to make a difference later. Students who sat the PISA test when they were almost 16 were only 6% older than their youngest peers who sat the test. But the disparities related to their relative maturity in primary school may have a long-lasting impact on their performance.

The magnitude of these month-of-birth effects is also expected to vary across school systems. For instance, in school systems where performance in early grades may have an impact on students' progression through school (through grade repetition or tracking into distinct schools or programmes), the differences in maturity observed in early grades are expected to have long-lasting consequences if maturity is mistaken for ability.

The absolute age at entry into primary school might call for different policy approaches than the relative maturity of students in the early grades. Mitigating the effects of relative age may require making teachers and parents aware of the penalty suffered by the youngest students in a class, and adjust their assessments based on this effect (Crawford, Dearden and Greaves, 2014[18]). It may also require changes in the organisation of schooling, particularly as the duration of learning days and class size in the early grades appear to moderate the effects of relative age on performance (Dhuey et al., 2019[26]).

Mitigating the negative effects of absolute age at entry into school might call for adjusting curriculum demands or changing the rules regarding school starting age. For instance, the belief that older children are more developmentally aligned with the demands and opportunities of formal schooling (meaning that absolute age at entry matters for "readiness" for school) is one of the reasons for the "greying of kindergarten" observed in several US states since the 1980s (Dhuey, 2016[27]). This term refers to the tendency to delay the age at entry into school by moving the cut-off dates from later in the school year to earlier. In addition, parents in some countries delay their child's entry into school – what is known as "redshirting"[1] – because of the perceived benefits of relative maturity amongst pupils in elementary school.

Using PISA data it is possible to compare the magnitude of the impact of these month-of-birth effects over a large range of outcomes. Information is commonly collected about the month and year of birth of the students who sit the test; these students are also asked to report their age at entry into school. In PISA 2018, information about the rules regarding school entry (notably the cut-off values and the date of the beginning of the school year) was collected from 54 countries and economies. With this information, it is possible to identify the relative age, amongst their grade cohort, of all students in these school systems who sat the PISA test. One may then relate the relative age, within the student's cohort, and the student's age when he or she sat the test, with performance outcomes and non-cognitive outcomes, such as the likelihood of having repeated a grade, students' self-concept, self-efficacy and their expectations for the future. The variation, across countries, in the strength of these relationships may, in turn, be related to school-system specificities, such as the prevalence of grade repetition and early tracking.

The next section compares the regulations regarding eligibility to enrol in school – and how strictly they are applied. The subsequent section describes in greater detail why it is difficult

[1] Redshirting was as a term for referring to the red jerseys athletes wore in their first year of university athletics, where a redshirt (noun) was "a high-school or college athlete kept out of varsity competition for one year to develop skills and extend eligibility" and originated "from the red shirts worn in practice by such athletes". The term is an Americanism from circa 1950–1955. Redshirting is used in an academic sense when parents decide to delay enrolling their child in school despite the child being eligible to attend.

to measure the causal impact of a student's age when he or she sits the PISA test, and the impact of age at entry into school, on cognitive and non-cognitive outcomes. The relationship between performance in PISA and a student's age when he or she sat the test, and, when data are available, the age at entry into school is then analysed. The impact of these variables on performance and socio-emotional outcomes (such as self-concept, self-efficacy, attitudes towards competition and exposure to bullying) is also discussed. The final section examines the distinctive features that may explain why the impact of students' age at entry into school is stronger in some school systems than in others.

How countries regulate age at entry into primary school – and how strictly that regulation is applied

Regulation of entry into primary school

During the past 50 years, the age at first entry into school has been falling around the world (Dhuey, 2016[27]). In the majority of school systems that participated in PISA 2018, children normally start primary school at the age of 6 (Table A A.1). However, in 5 countries and economies, they may start school earlier, at the age of 5; and in 14 countries, children are expected to start primary school at the age of 7.

The legal starting age for primary school provides only an indication of the actual age of children at the beginning of their first year of school. Elementary instruction is organised in grades that span one year. At the same time, eligibility to enrol often depends on cut-off dates: children must be a certain age by a specific date in the year in order to be allowed to enrol in school. This means the precise age at entry into school varies, depending on the date on which the child was born. Even amongst countries with the same starting age for primary school, the actual average age at entry may vary.

These variations can be illustrated using PISA 2018 data. System-level data collections also include information on the first day (dd/mm) of the school year at each level of education, and on the cut-off date (dd/mm) for eligibility to enrol in school (Table A A.2). The cut-off date was defined as the date at which a child should have reached the theoretical starting age for primary school, i.e. for being eligible to enrol in school, using 2017/2018 as the reference year. This information was available for more than 50 of the 79 countries and economies that participated in PISA 2018. In some countries, such as Australia, Canada and the United States, both school entry and cut-off dates vary by jurisdiction and thus could not be provided by federal authorities. In Argentina, only the date of the first day of school varies by jurisdiction; and in Bulgaria, Indonesia, Latvia and Lithuania the school year begins on the same date for all students, but cut-off dates may vary by jurisdiction. In New Zealand, no cut-off date is used; the only rule that applies is that a student must be enrolled by their 6th birthday. In Switzerland, cantons have their own cut-off dates for reaching the minimum enrolment age for kindergarten or the first learning cycle. This cut-off range is between 1 April and 31 July – in only 17 of 26 cantons it is the 31 July. In Colombia, the cut-off is the first of February in the Southern Hemisphere and the first of September in the Northern Hemisphere. As it is not possible to distinguish between students located in regions for these two countries, Colombia is not included in the following analyses.

In almost all PISA-participating countries and economies, the school year starts in August or September in the Northern Hemisphere, and in February or March in the Southern Hemisphere (Table A A.2). The only exceptions are Japan, where the school year begins on the first of April, New Zealand, Singapore and Brunei, where it starts in January, and Thailand, where it starts in May.

In 24 of the 57 PISA-participating countries and economies with available data, the cut-off date and date of the first day of school coincide or almost coincide, meaning that all children are expected to have attained the compulsory age of entry into primary school the day, or by the end of that month, that they begin school (Table A A.2). This is the case, for instance, in Austria, where a child is expected to enter school the first of September if he or she had turned six before this date. In 21 countries/economies, the cut-off date corresponds to the end of the

calendar year. For instance, in Denmark, a child enters primary school the first of August if he or she is going to turn 6 before the 31st of December that same year. Finally, in some European countries (Bosnia and Herzegovina, the Czech Republic, Hungary and Serbia), the school year begins at the end of the summer, but cut-off dates are much earlier in the year (April or May). In Brazil and Estonia, students are eligible to start primary school if they turn six by the end of the month following the first day of school.

In all school systems, the use of a cut-off date means that, when strictly applied, students born just before the cut-off date are expected to be older by one year than the children enrolled the same year in their class, but who were born just after the cut-off.[2]

In which countries/economies do students advance or delay entry into primary school?

A child's actual age at entry into primary school may be different from the one prescribed through official regulations. For instance, parents may choose to delay their child's entry into school because they are aware of the competitive advantage of being older in school or simply because they think that their child is "not ready" for school. Such practices (sometimes referred to as "redshirting") are common in Germany, Hungary (Hámori and Köllő, 2011[28]) and the United States (Dhuey, 2016[27]). In some other contexts, families may favour early entry in primary school, which is perceived as more stimulating than kindergarten, especially if their child was born just after the cut-off date and is judged "mature enough" to enter school. Such practices are notably common in Indonesia, Lebanon (Barakat and Bengtsson, 2017[29]) and Poland (Herbst and Strawiński, 2016[30]).

The prevalence of advancing or delaying entry into school in PISA-participating countries/economies may be estimated using the contextual questionnaire distributed in PISA 2018. In this questionnaire, students were asked to report their month and year of birth, and how old they were when they started primary school (possible answers ranged from "4 years" to "9 years or older", and included "I do not remember").

In countries/economies where information about the prevailing regulations regarding entry into school are available, one may compute the theoretical age at entry into primary school for every student who participated in PISA – and then compare this theoretical age with the actual age at entry reported by students.[3] It would then be possible to identify those students who had advanced or delayed entry into school.

[2] However, depending on the relative position of the cut-off date compared to the date of the start of school, the range of ages when students actually start school varies. For instance, in a school system where the theoretical age at entry into primary school is 6 years and the school year begins on 1 September; a December 31 cut-off date implies a range in school-entry ages from 5 years 8 months to 6 years 7 months; a September 1 cut-off date implies a range from 6 years to 6 years 11 months; and a May 1 cut-off date implies a range in school-entry ages from 6 years 3 months to 7 years 4 months. This means that the cut-off date may have an impact on students' actual average absolute age at entry (Dhuey, 2016[27]).

[3] Some students may misreport their age at entry into school. For instance, some of the students who had been enrolled in pre-primary school too may have no clear memory of the age at which they entered pre-primary, as opposed to primary, school. This may be especially the case in school systems with optional pre-primary school. For instance, in Ireland children may be enrolled in infant classes in primary school from age 4, but the first two years of primary school are classified as ISCED 0.T. As students are asked about the grade in which they are enrolled on the date they sat the PISA test, it is possible to reduce the incidence of these misreports. As it is likely that students who are enrolled in the modal grade of their school cohort at 15 and who had never repeated a grade started compulsory education "on time", in the following text these students are considered to have entered school at the normal age (even if they reported a distinct age). The comparison between the corrected and initial variables at school entry is provided in Table A A.3.

On average across OECD countries, the vast majority (90.2%) of students started primary school at the "normal age" as defined by school authorities (Table A A.4). This proportion varied across school systems, though. In 15 of the 45 countries/economies with available data,[4] including the OECD countries Finland, Iceland, Korea, Norway, Poland, Sweden and the United Kingdom, more than 95% of students reported that they had started primary school at the normal age. By contrast, in Brazil, Ireland,[5] Lebanon, the Philippines, Qatar, Ukraine and the United Arab Emirates, less than 80% of students reported so. In some countries, such as Brazil, Ireland, Lebanon, Peru, Portugal and the United Arab Emirates, more than 10% of students had started primary school earlier than the official age at entry, while more than 10% of students in Belarus, Brazil, Denmark,[6] Germany, Luxembourg, the Netherlands, the Philippines, the Slovak Republic, Turkey and Ukraine reported a delayed entry into school.

In general, only small proportions of students reported that they had delayed or advanced entry into school by more than one year. But in some countries, the proportion of students who delayed entry was so large that it makes it unlikely that the finding is due only to misreporting; the finding could, perhaps, signal a difficulty with or lack of accessibility to primary school. For instance, in Brazil, where the percentage of the 15-year-old population covered by PISA is one of the lowest of all PISA-participating countries/economies (see *PISA 2018 Results Volume I: What Students Know and Can Do*), more than one in six students reported an age at entry into primary school that was two years older than the legal starting age.

Reporting delayed entry into primary school was also more common amongst socio-economically disadvantaged than advantaged students (Figure 1). On average across OECD countries with available data, the difference between the two groups was five percentage points. Amongst OECD countries, in Germany, Luxembourg, the Netherlands and the Slovak Republic, more than 15% of disadvantaged students reported late entry into primary school, while the proportion of advantaged students who so reported was 10 percentage points smaller. Note that this contrasts with evidence observed in Australia and some US states (which cannot be reproduced with PISA data because of a lack of information on the regulations that apply), which shows that redshirting is more prevalent amongst advantaged families (Dhuey et al., 2019[26]; Hanly et al., 2019[31]). By contrast, advantaged students reported significantly more often than their disadvantaged peers, on average, that they had entered primary school at a younger age than stipulated in the applicable regulations for enrolment in school. This is the case in 12 countries and economies (of the 45 with available data); but in 5 countries/economies, disadvantaged students reported significantly more often than advantaged students that they had started school at a younger age than set forth in regulations.

In 34 of the 45 countries/economies with available data, it was more common for boys than for girls to have delayed entry into primary school, as previous evidence has shown (Dhuey et al., 2019[26]; Hanly et al., 2019[31]). On average across OECD countries in 2018, only 4.4% of girls, but 6.3% of boys reported that they had entered primary school when they were

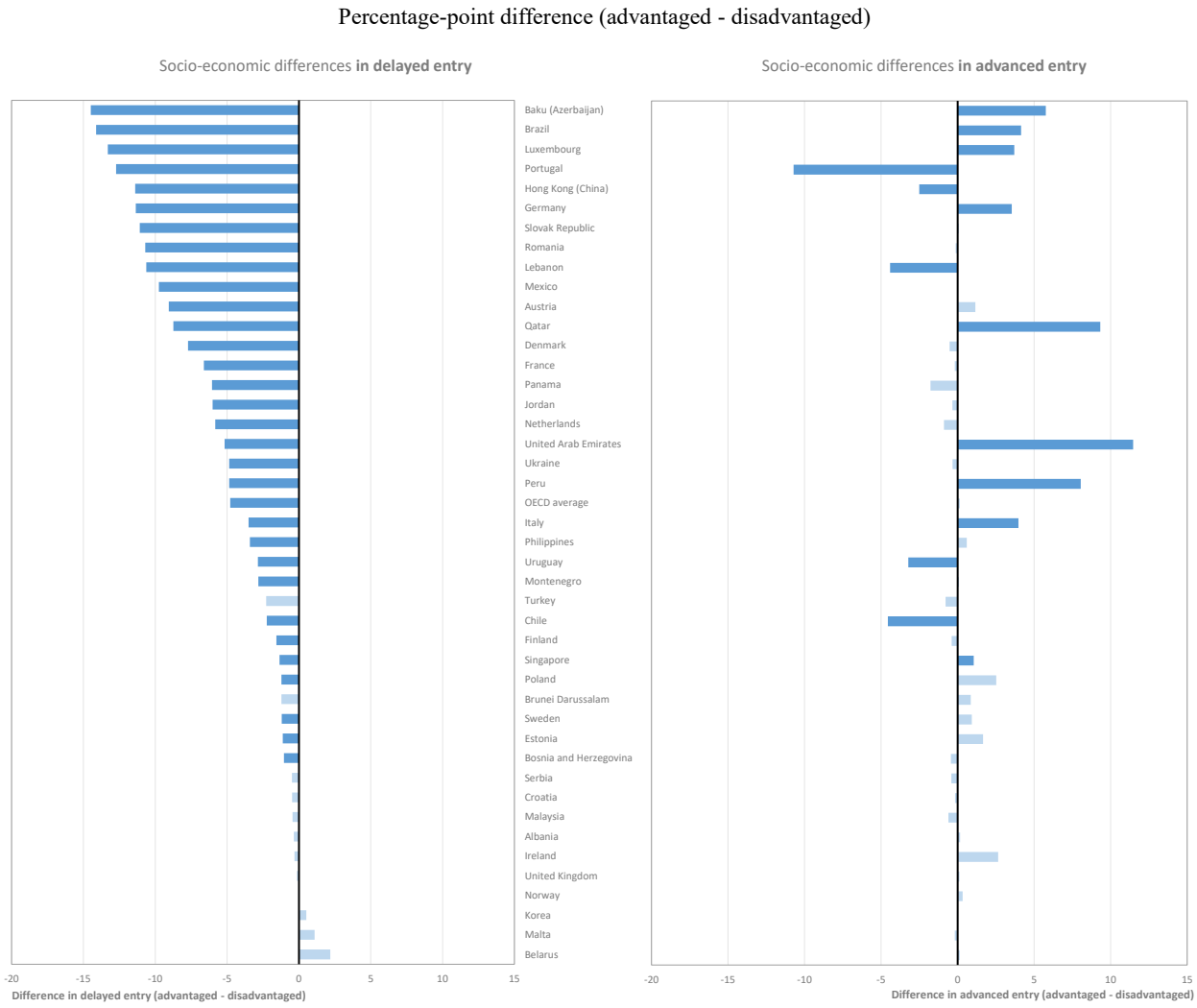
[4] For some countries and economies, the age at primary school is not available in the data.

[5] In Ireland all forms of pre-primary education are optional but children from the age of 4 can be enrolled in infant classes in primary school.

[6] For Denmark, the questionnaire was not accurately translated for the variable measuring the age at school entry: the questionnaire asked students at what age they enter grade 1, which corresponds to the second year of primary school. For this reason, using grade 1 may incorrectly assume that a large proportion of Danish students delayed entry into school. The correction aforementioned may have corrected part of this issue, but the numbers may be higher than the actual proportion of students who entered school. According to Danish school authorities, for those who started school in the 2018/19 school year, 0,9 started early, 92,9 % started on time, 6,2 % started late.

a year or more older than the official starting age. The gender gaps in starting school earlier than the official starting age were generally small in most PISA-participating countries and economies. However, in 10 countries/economies, including the OECD countries Chile, France, Luxembourg and Portugal, boys were more likely than girls to have started school earlier than the official age, while the opposite was observed in Croatia, Denmark, Estonia, Ireland, Montenegro and the United Kingdom.

Figure 1. Socio-economic differences in advanced and delayed entry into primary school



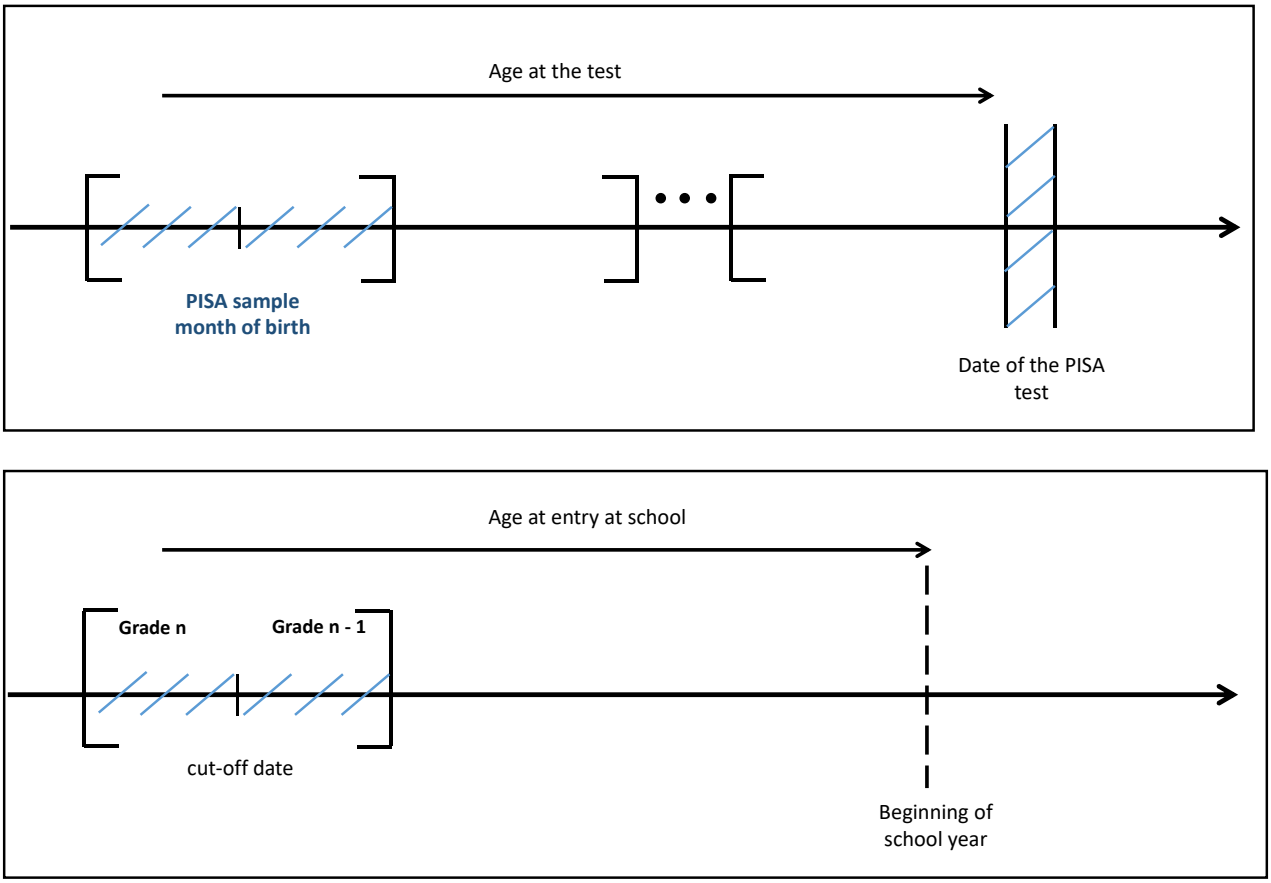
Notes: Statistically significant differences are marked in a darker tone.
A socio-economically advantaged (disadvantaged) student is a student in the top (bottom) quarter of the PISA index of economic, social and cultural status (ESCS) in his or her own country/economy.
Countries and economies are ranked in descending order of the difference between advantaged and disadvantaged students in the percentage of students who had delayed entry into primary school.
Source: OECD, PISA 2018 Database, Table A A.5 and Table A A.6.

School outcomes may be related to the month of birth through distinct but related reasons

Age at which students sat the PISA test

As discussed earlier, there are several reasons why the performance of members of the same grade cohort may vary depending on their birthday. Depending on their month of birth, some students may be older than others when they sit the PISA test and this may make a difference in performance as age may be related to greater maturity (Figure 2, first panel). This is mentioned in related literature as the "age-at-the-test effect".

Figure 2. Age at the PISA test and age at school entry, by month of birth



PISA covers students who are aged between 15 years 3 months and 16 years 2 months at the time of the assessment (and who are enrolled in an educational institution at grade 7 or higher). In practice, in several countries, less than 25% of the entire PISA sample are students between the ages of 15 years 3 months and 15 years 5 months (Table A A.7). For instance, of the 36 OECD countries, only in Finland, Greece, Iceland, Ireland, Israel, Korea, Poland, Slovenia and Sweden is this proportion larger than 20%; in Canada and France, this proportion is smaller than 10%. This may be partly due to marginal variations in the

proportion of students whose date of birth coincides with this range of age in the PISA sample. In addition, some samples include students who are slightly older than the theoretical range. In any case, the average age of students in the PISA sample in all countries and economies ranges from 15 years and 8 months to 15 years and 11 months.

School starting age

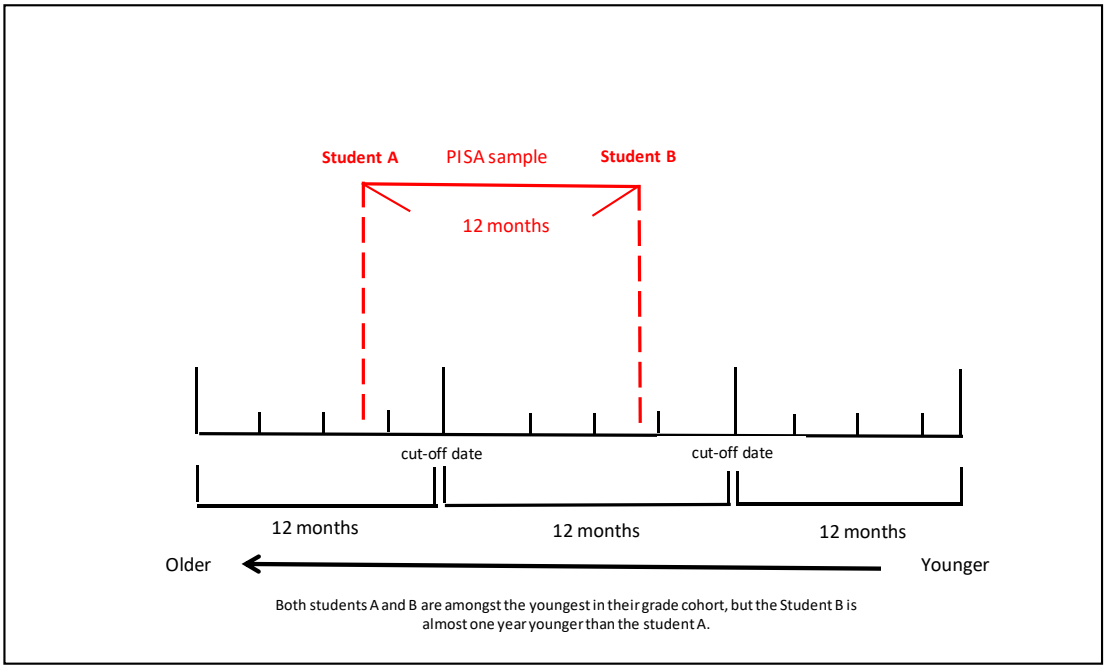
A second reason is the "school-starting-age effect", related to the fact that students entered school at different ages and thus are more or less "ready" for school; and that this first experience with schooling may have a long-term impact on their cognitive and socio-emotional development. The school starting age directly depends on the mandatory age for starting school, which may differ from one country to another. Within a school system, it can also vary within a cohort of students, depending on when students were born relative to the cut-off date used for enrolment (Figure 2, second panel). In addition, some parents may choose to enrol their child earlier or later than defined in the regulations. Because of this, the correlation between the age at which a student starts school and his or her outcomes may not reflect a causal effect, as the decision to start school is based on the child's "readiness" at the date schooling begins. For instance, some students may enter school at a younger age than expected because they have been shown to be more mature than their peers of the same age. This early maturity may be one of the reasons they perform better at school. The correlation of school starting age and education outcomes may thus overstate the true average impact of school starting age.

The theoretical relative age at entry into school, as defined by the strict application of the national regulations for admission to primary school, is not subject to these selection effects as it is based only on the student's birthday and not on any decision made by the relevant school. For countries and economies with available information about the regulations regarding school entry (cut-off date for school eligibility and first day of the school year), one may calculate the theoretical relative age of a student within his or her school-entry cohort. Specifically, the relative age is set to one month for students born the month just before the cut-off date, and 12 months for those born just after the cut-off date. Defined this way, the variable measures the theoretical relative age of students within their cohort as defined by the school regulation (the "assigned school entry age"). This corresponds to the theoretical age at which the student should have started school had the regulations been enforced without exception.

Using the theoretical relative age means that one focuses on the potential impact of the date of birth, whatever the reasons that may explain the impact. The estimated parameters would be interpreted as the difference in outcomes between two children, one born the month just after the cut-off date (thus the eldest in his or her school-entry cohort) and one born almost one year later, but the month just before the cut-off date and thus amongst the youngest in his or her school-entry cohort.

Caution is advised when interpreting the meaning of the theoretical relative age, especially for countries where a 12-month spread of PISA-sampled students (which is defined by the choice of a particular testing date for PISA) does not completely overlap with a 12-month school-entry window. For example, Figure 3 presents a hypothetical country where there is one month misalignment between the 12-month spread of the PISA sample and the 12-month school-entry window. In this case, both Student A, who is the oldest in the sample, and Student B, who is the youngest in the sample, are grouped into the "youngest" quarter-year relative to the cut-off date. The following sections elaborate the implications of these cases and how this issue is addressed in this paper.

Figure 3. Age at the test and age at school entry depending on the month of birth



In addition, the impact of the actual age at entry on future education outcomes may be measured using an instrumental variable strategy in which the theoretical relative age in the cohort is an instrument that causes quasi-random variation in the age at entry. Even when the school-entry regulation is not strictly applied, the cut-off date implies that the month of birth strongly predicts the observed relative age at entry in a cohort, while it, itself, is not related to future education outcomes. The month of birth is also not expected to directly affect these education outcomes, except through their effect on the age at entry (see specification 4 in the estimates and Box 1).[7]

[7] Instrumental variable is a method to estimate causal relationships in a linear regression when the explanatory variable (here the actual relative age at entry) is expected to be correlated with the error term. This correlation may occur notably because of non-random measurement error (for instance, if the students who misreported their true age at entry are more likely to be those with low performance) or in case of omitted variables that affect both the outcome and the explanatory variable (for instance, if low ability students are more likely to delay entry at school and also to perform poorly at the PISA test). Intuitively, an instrumental variable is a variable that induces change in the explanatory variable but has no independent effect on the outcome. Details can be found for instance in (Wooldridge, 2010[64]). As illustrated in Table A A.8, in all countries/economies, the observed relative age at entry is highly correlated with the theoretical relative age at entry, even when gender, socio-economic status and immigrant background are taken into account. In some countries, such as Finland, Jordan, Korea, Luxembourg, Norway, Singapore, Spain, Chinese Taipei and the United Kingdom, there is almost a one-to-one correspondence between the observed relative age at entry and the theoretical age, as implied by a strict application of school regulations (the coefficient measuring this association ranges between 0.98 and 1.02). This is consistent with the observation, discussed in the previous section, that in these countries very few children enter primary school earlier or later than implied by a strict application of school regulations.

Duration of schooling

Apart from these two age effects, a third potential reason why a student's month of birth may have an impact on performance is the so-called duration-of-schooling effect. Through this effect, some students who sat the PISA test may have benefitted more than others from having spent more time in school, depending on their age at entry into primary school.

In addition, depending on the school system (notably regarding the age at entry into primary school), PISA-participating students may be enrolled in distinct grades. This could be because some students who had started school at the same time were held back or had skipped a grade because of their previous academic performance (or because the student had started primary school later or earlier than the applicable regulations stipulate). But in some cases the choice of a particular testing date for PISA resulted in the PISA cohort encompassing two distinct age-at-starting-school cohorts, as determined by the school start date and the cut-off date for determining age eligibility (see the second panel in Figure 2). Such a situation was observed in around half of the 25 OECD countries with available data on school-entry regulations, namely Austria, Chile, the Czech Republic, Estonia, Finland, Germany, Hungary, Ireland, Korea, Luxembourg, Portugal, the Slovak Republic and Turkey. By contrast, in Denmark, France, Iceland, Italy, Japan, Mexico, the Netherlands, Norway, Poland, Spain, Sweden and the United Kingdom, the PISA sample was composed of only one grade cohort. Students enrolled in a higher grade may have learned more complex notions than students in lower grades, and thus attained higher performance in PISA.

Restricting the estimation sample by grade, or controlling for the actual grade in which a student is enrolled, may also lead to biased results when comparing the impact of age on performance. For instance, repeaters are expected to be the oldest in the grade in which they are enrolled, while their performance is often lower; similarly, students who had skipped a grade are expected to be both the youngest in their grade and the best performers. Because of these selection effects, the correlation of age and performance, when restricting the sample to students enrolled in one grade, would appear weaker than the true causal impact of age on performance. For this reason, in the following sections, the estimates are controlled for the theoretical grade the students should be enrolled in, depending on their month of birth. Caution is advised in interpreting this as a measure of the causal impact of being enrolled in one or the other grade on performance in PISA. However, as discussed above, in an additional estimate one may use an instrumental strategy to measure the impact of the actual grade a student is enrolled in for school systems where the PISA sample encompasses two grades by design (see Box 1 for a discussion).[8]

Relation between students' age when sitting the PISA test, the duration of schooling and school starting age

Generally, one cannot disentangle the impact of these three variables in a school system, as they are linked in a straightforward way as:

[8] Being born before or after the cut-off date is a strong predictor of the actual grade the students are enrolled in when they sat the PISA test (see Table A A.8), while it is not expected to be related to any future education outcomes (except through this impact). While they rely on the same idea, the identification strategies are not exactly the same regarding the impact of grade and the impact of the relative age within a school cohort. For the former, the identification relies on using the discontinuities created by the cut-off date and comparing students of almost the same age. Those born just after the cut-off date are expected to be enrolled in a lower grade than those born just before. For the latter, identification relies on the assumption that the impact of the relative age would be linear, and that within the same theoretical school cohort (and thus the same grade), those born just after the cut-off date are almost one year older than those born just before.

Age_at_the_test= School_Starting_Age + Duration of schooling (1)

Students' age when they sat the PISA test corresponds to the impact of maturity at that moment, while the age at entry into school captures the idea that initial maturity at entry into school may or may not have a cumulative impact on further achievement. Both the age at the time of the PISA test and the age at entry into school may affect performance in an absolute way – the former if differences in maturity still matter in the ability to perform well on a test when the student is around 15 years old, and the latter if being more or less "ready" for entry into primary school may result in more or less positive experiences that may shape a student's perception of schooling.

Their potential impact on performance may also be due to a student's relative age compared to that of their peers in their grade cohort. Such effect may work in two opposite directions. Being around more mature peers may be stimulating; it could also have negative effects, particularly on their self-esteem, if younger students suffer from "invidious comparisons" with their older peers.

A student's age when he or she sits the PISA test is positively and simply related to the relative age at entry into school. From the equation above (1), one can easily obtain:

Age_at_the_test= cst+ relative_age_schoolentry+grade+#yearslate-#yearsearly (2)

where #yearslate and #yearsearly correspond, respectively, to the numbers of years a student was held back (including delayed entry into school) and the number of years he or she had skipped compared to a "normal" progression through school, and the constant depends on the relative positions of the dates of the PISA test, the beginning of the school year and the cut-off date for enrolment in primary school.

In countries and economies where the PISA sample includes only one grade cohort, the student's age at the time he or she sits the test is expected to be positively related to the relative age at entry into school. Figure 4, for instance, illustrates this relation in a fictitious case that does not consider advanced or delayed entry into school. Such a positive and continuous relationship was observed in real data (see Figure 6). For instance, in Denmark, the average age at the PISA test was 15.8 years, and the average age of those who were amongst the youngest quarter in their grade cohort when they started primary school was 15.4. Amongst the second quarter, the average age was 15.6 years; 15.9 years was the average age of those amongst the third quarter; and 16.1 years was the average age amongst students in the fourth and oldest quarter. The correlations between any outcomes and age at the time of the PISA test, on the one hand, and relative age at entry into school, on the other, are expected to be equal or almost equal in these school systems, as these variables are directly related. The theoretical grade that any one student would enrol in, and the average age of his or her cohort do not vary over the sample. This also means that for these school systems, one cannot disentangle the impact of one or the other age variable from the grade in which a student is enrolled.

Figure 4. Age at the PISA test and relative age in the school cohort (case 1)

Only one school cohort in the PISA sample.

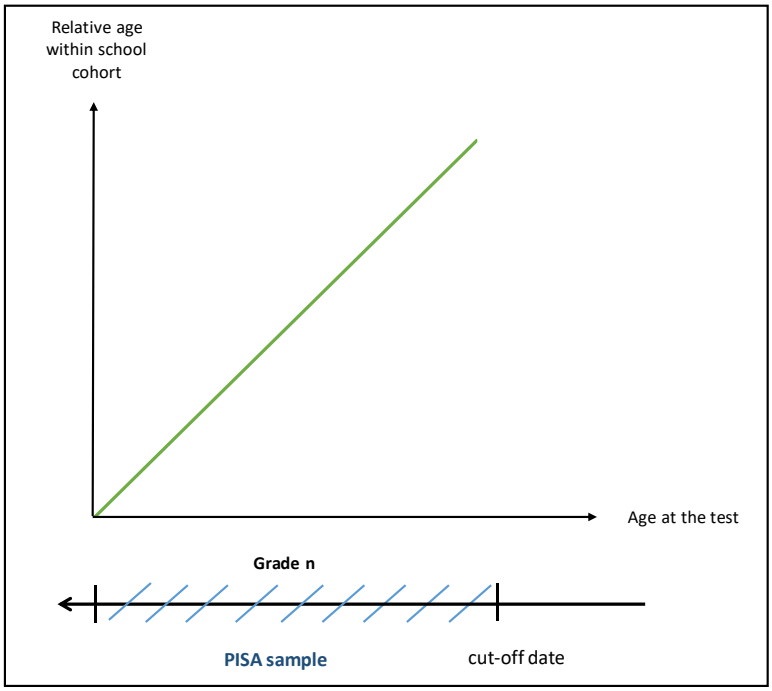
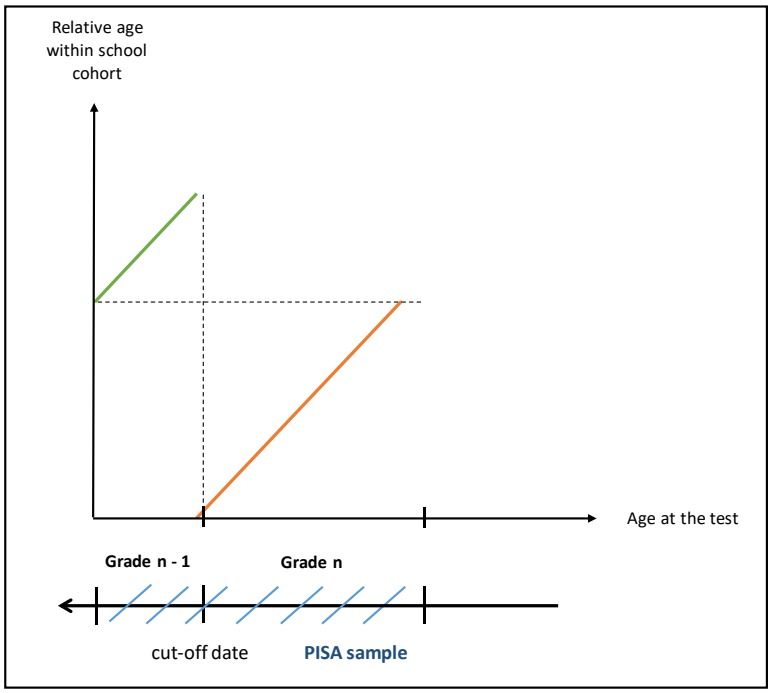


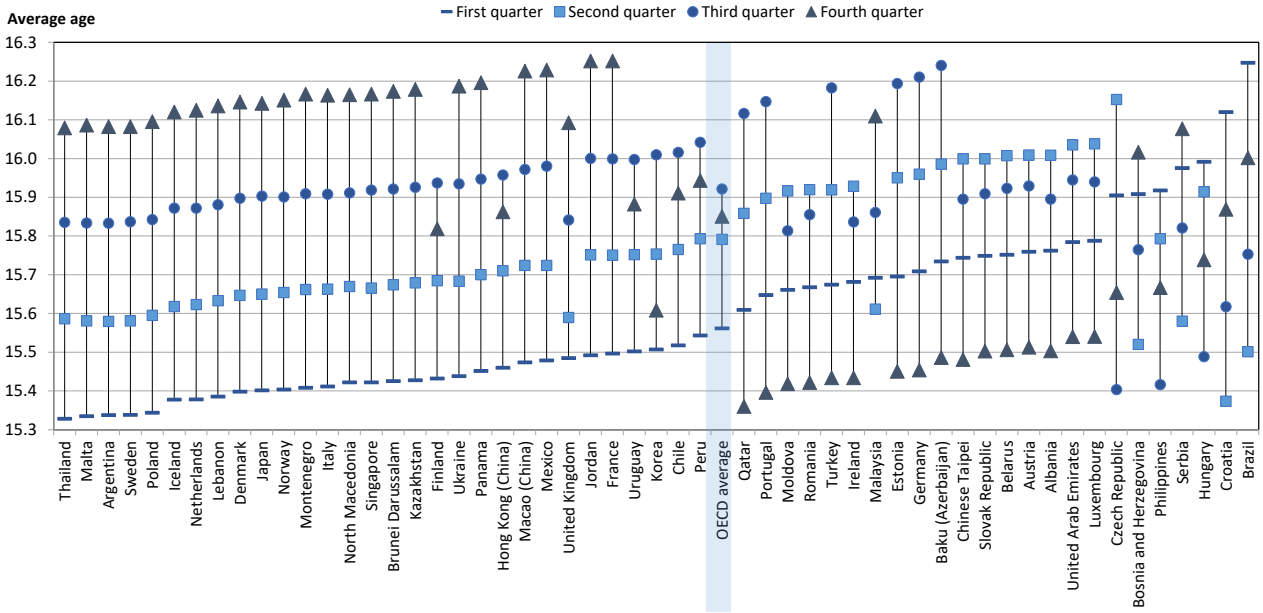
Figure 5. Age at the PISA test and relative age in the school cohort (case 2)

Two school cohorts in the PISA sample.



However, the relationship between age at the time of the PISA test and relative age within a grade cohort is expected to be discontinuous in school systems where the PISA sample includes two distinct grade cohorts. This is illustrated in the Figure 5, as the theoretical grade is not constant over the sample, again in a fictitious case where all students comply with the school-entry regulations. In such a case, the sampled students born before the cut-off date are expected to be enrolled in a higher grade, and they are amongst the oldest of the PISA sample, while they are the youngest within their grade cohort, defined by the age at entry into school. Conversely, the sampled students born after the cut-off date are expected to be enrolled in a lower grade and appear to be the youngest of the PISA sample, while they are amongst the oldest in their grade cohort. For instance, in Germany, amongst the students who sat the PISA test, the average age of students who are the eldest amongst their grade cohort (those in the fourth quarter of relative age) is 15.5 years, while the average age of the youngest students relative to their grade cohort (those in the first quarter of relative age) is 15.7 years (see Figure 6). Again, in real situations, the relationship may be less clear-cut than illustrated in the Figure 5, as some students may have entered primary school earlier or later than regulations stipulate, or had repeated or skipped grades at some point in their schooling.

Figure 6. Average age and quarter-year of relative age in the school cohort



Note: Countries and economies are ranked in ascending order of the average age of students in the first quarter-year of birth in the school entry cohort.
Source: OECD, PISA 2018 Database, Table A A.9

For these school systems, one should thus take into account the fact that students who sit the PISA test may be enrolled in multiple distinct grades, given the design of PISA. When one does not take into account the difference in grade – by design – in these systems, the correlation between performance and the age variables would be biased, because these correlations would not only measure the impact of the age variable, but also the variable of being enrolled in a distinct grade. For instance, the impact of a student's age on his or her performance on the PISA test is expected to be inflated when one does not take into account the multi-grade cohort, which is a design feature of PISA, while the impact of relative age on

performance is expected to be underestimated, since the eldest students within a cohort are enrolled in a lower grade.

As discussed above, one should not control for the actual grade in which a student is enrolled, as that is expected to be partly related to his or her past academic record, which could also partly explain current education outcomes. For this reason, in the following section, the estimations include a measure of the theoretical grade in which a student should be enrolled (apparent in Equation [2]). This theoretical grade is only related to the student's month of birth, and thus cannot be related to education outcomes. Measuring simultaneously the impact of students' age when they sat the PISA test and their age at entry into school at the school-system level is usually not possible. In theory, the PISA design may make it possible, in some cases, to identify the impact of these two dimensions at the same time. First, in several school systems, not all students sit the PISA test on the same date, and this may result in variations in students' age at the time of the test that are not directly related to the relative age within the cohort. According to the PISA standards, students should take the test within eight consecutive weeks for computer-based tests (six consecutive weeks for paper-based tests). In a few countries, such the United Kingdom, the length of time is slightly longer, for practical reasons (Table A A.10).[9] In countries where the period for the test exceeds one month, one may, in theory, identify separately the impact of the student's age at the time of the test and the relative age amongst students in the same grade cohort. Some students born in the same month (thus with the same relative age within their grade cohort) may have been tested over two consecutive months; those tested at the end of the period would be older by at least one month than those tested at the beginning of the period. However, these age variables are still highly correlated, and their links with any outcomes cannot be precisely estimated simultaneously. In addition, one cannot be certain that, from one month to another, the conditions in which the students sit the test are exactly the same.

In countries where the PISA sample includes two grade cohorts, the measure is even more complicated, as one should consider that students who sit the test may, by design, not be enrolled in the same grade. Restricting the sample to students born the month just before the cut-off and those born just after the cut-off would allow for comparing performance between students who are almost the same age at the date of the test, but who are enrolled in two adjacent grades. However, performance differences between these two groups of students cannot be interpreted as the impact of one year of schooling. Rather, the differences would reflect a combination of the impact of one additional year of schooling and the impact of being one of the eldest or the youngest in their grade cohort. In addition, the estimate would refer to too small a sample to provide results with sufficient statistical precision.

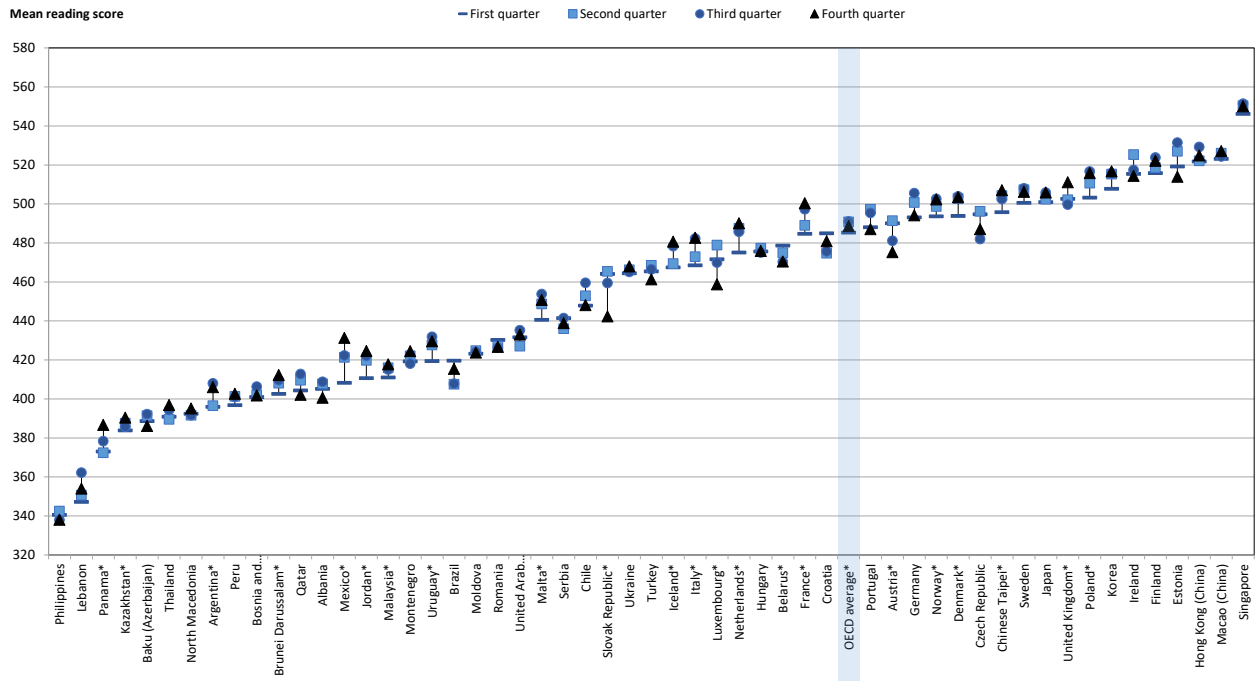
[9] The testing was conducted over a period covering one or two months and in most education systems, except the United Kingdom and Ireland, it took place between March and June 2018.

Age and schooling

Age and average performance

In the vast majority of the 79 countries and economies that participated in PISA 2018, significant differences in performance in reading, mathematics and science were observed, depending on students' age at the time they sat the test. On average across OECD countries, the difference in average reading performance between students aged between 15 years and 3 months and 15 years and 5 months and those aged between 16 years and 16 years and 2 months amounted to 13 score points (see Table A A.11). As described below, the impact of age may partly reflect that in some countries/economies, older students may be enrolled in a higher grade and thus have spent more time at school. In the countries where the PISA sample covers two grade cohorts, students who are in the oldest grade cohort (depending on their date of birth) usually scored higher than those who are in the youngest cohort (see Box 1 for a discussion). In addition, as discussed earlier, a student's age at the time he or she sits the test may be correlated with performance in PISA not because of differences in the maturity of students, which are relatively small when students sit the PISA test, but perhaps because the student's age at that point is a reflection of whether the student started schooling earlier or later than their peers.

Figure 7. Reading performance, by quarter of relative age within the school cohort



Note: Statistically significant differences between fourth and first quarter-year of birth is marked with an asterisk next to the country/economy name.
Countries and economies are ranked in ascending order of the mean reading performance of students in the first quarter-year of birth.
Source: OECD, PISA 2018 Database, Table A A.12

In most countries with available information about regulations on entry into school, through which it is possible to estimate the theoretical relative age of a student in his or her grade cohort, the age at entry into school appears to be positively correlated with performance in PISA (Figure 7). This finding corroborates earlier evidence (Sprietsma, 2008[32]) using data from PISA 2003. On average across the 25 OECD countries with available data, being born the month just after the cut-off date used to determine entry into primary school (and thus being, in theory, the oldest the grade cohort) was related to an improvement of 16 score points in reading performance compared to students born the month just before the cut-off date (and thus the youngest in the grade cohort). Such a positive and significant correlation between relative age within the grade cohort and performance in reading was observed in 17 of the 25 OECD countries with available information, and in half of the 29 partner countries and economies with available information. Only in Denmark and Japan was the performance difference between these two groups of students less than 10 score points, while in the Czech Republic, Estonia, Germany, Italy, Mexico, Panama and Uruguay the difference was more than 20 score points. As discussed below, one cannot distinguish between the impact of the age at entry into school and the impact of the age at which the student sat the PISA test.

Similar patterns were observed in mathematics and science performance. On average across the 25 OECD countries with available data, being older by one year in the grade cohort was related to an improvement of 15.2 score points in mathematics and of 14.3 score points in science (Table A A.13 and Table A A.14). For the sake of comparison, the OECD average gender gap in PISA performance was around 30 score points in reading, 5 score points in mathematics and 2 score points in science (OECD, 2019[33]). In most school systems, the apparent performance penalty for the youngest students in one domain was also observed in the other two domains, with a few exceptions: in Ireland, the correlation was significant only in mathematics; in the Czech Republic and the Slovak Republic, this correlation was significant only in reading; in Chile it was significant in mathematics and science but not in reading.

Box 1. Identifying the grade equivalent of PISA scores from variations in school-starting cohorts within the PISA population[10]

In order to describe what differences in PISA scores mean, it is tempting to compare them to differences in some more easily understood benchmarks, such as the average progress through schooling children make from one year to the next. This "grade equivalent" is the combination of two distinct effects: an absolute-age effect, through which students are expected to be more mature in higher grades, and the effect of having attended an additional year of schooling, and therefore benefitted from exposure to a more advanced curriculum and from additional learning opportunities compared with students of the same age but who are in lower grades.

In 2018, more than 20 countries and economies chose to conduct PISA testing at a time when the PISA-eligible population was expected to be found in two contiguous grades, rather than in a single grade. For students in these countries, the expected "relative age" at entry into primary school does not increase as a function of the "absolute age" within the PISA cohort, but shows a sharp discontinuity. Indeed, some of the youngest students who sat the PISA test in 2018 (those who were not much older than 15 years and 3 months) were amongst the oldest students in their first-grade class; and some of the oldest students who

[10] The author thanks Francisco Avvisati for his contribution to this box.

sat the PISA test were amongst the youngest students in their first-grade class. When the PISA test was conducted, the youngest students in the PISA cohort were expected to be in a lower grade (e.g. grade 9) than the oldest students (grade 10).

For countries where there was no single expected grade in the PISA cohort, it is possible to identify the grade equivalent of PISA scores (the number of score points earned by students in the lower expected grade in the PISA cohort and by those in the upper expected grade in that cohort) from the same regression analyses that measure the effect of relative age, and under some assumptions about the shape of relative-age effects. In fact, if all students had complied perfectly with age-at-entry regulations and had had a regular progression throughout primary and secondary schooling, then the grade-effect could be measured in a simple regression analysis of performance on grade that accounts for age-at-entry (in years and months). However, in practice, many students were held back during their school career, skipped grades, or did not perfectly comply with regulations about the age at entry into school. All of these decisions, taken by students' families or teachers, may themselves have been based on factors that predict performance at age 15 (such as students' health or cognitive maturity), and that cannot be observed. The apparent effects of grades may therefore be confounded by these other factors. True grade effects may still be identified in an instrumental-variables regression, which exploit the variation in grade that stems solely from regulations.

These analyses are presented in Table A A.12 (reading), Table A A.13 (mathematics) and Table A A.14 (science) (Specification 4). According to these analyses – and excluding countries where the expected grade is different from the modal grade only for a small fraction of the student population (less than 25%, see Table A A.15) – the typical difference in reading and science scores between the two grades varied between around 10 score points or less in Albania, Baku (Azerbaijan), Belarus, Ireland, Philippines, Qatar and the United Arab Emirates, to about 20 points in Austria, Brazil, Estonia, Germany, Luxembourg and Slovak Republic. The sometimes stark differences between countries may be influenced by the particular grades included in the comparison; indeed, within any country, the typical score gain from grade 9 to grade 10 may be different from the score gain in lower or upper grades.

Moreover, the estimation of grade equivalents using instrumental variables relies on the assumption that relative-age effects are linear, meaning, for instance, that compared to students who were born in the fifth month of the 12-month period defining a school cohort, the advantage of being born in the first month (i.e., being four months older) is of the same magnitude as the disadvantage of being born in the ninth month (i.e., being four months younger). If the relative-age effect is non linear (for instance, if only the youngest students in a class are affected by their relative age), then the grade-coefficient in this specification may not correspond to a grade effect, but may capture some aspects of the non-linear shape of relative-age effects. In addition, if selection into the sample varies by age (e.g. because compulsory schooling ends at age 16, and few students who are 16 or close to 16 may be selected) or by grade (e.g. because some types of education in the upper grades, such as distance education, are not covered by PISA), then the instrumental-variables approach may not be sufficient to remove all biases.

Because of the limitations of this measure, one may consider alternative measures of the grade effects, such as using extensions of the PISA sample that include multiple birth cohorts. See for instance, for France, Keskpaik and Salles (2013[34]) or a longitudinal study following PISA students in the transition from their current grade to the next grade, as those

for Germany (Prenzel et al., 2006[35]; Ehmke et al., 2017[36]), Italy (Bratti and Checchi, 2016[37]) and Poland.

Grade repetition

The impact of the "birthday effect" on grade repetition has been well documented in the literature (Huang, 2014[38]; Corman, 2003[39]; Solli, 2017[40]; Elder and Lubotsky, 2009[13]). Children who are relatively young for the grade in which they are enrolled often experience a disproportionately greater risk of repeating a grade. When a child is younger than his or her prospective classmates and considered not "mature" enough, either socially or academically, parents and/or teachers may decide to hold the child back a year. One should thus expect that a higher relative age in the cohort will reduce the likelihood of a student repeating a grade, especially in the lower grades.

Through PISA's contextual questionnaire, students were asked whether they had ever repeated a grade, and whether this happened in primary, lower secondary or upper secondary school. It is thus possible to measure the impact of relative age in the cohort at various stages of the progression through education.

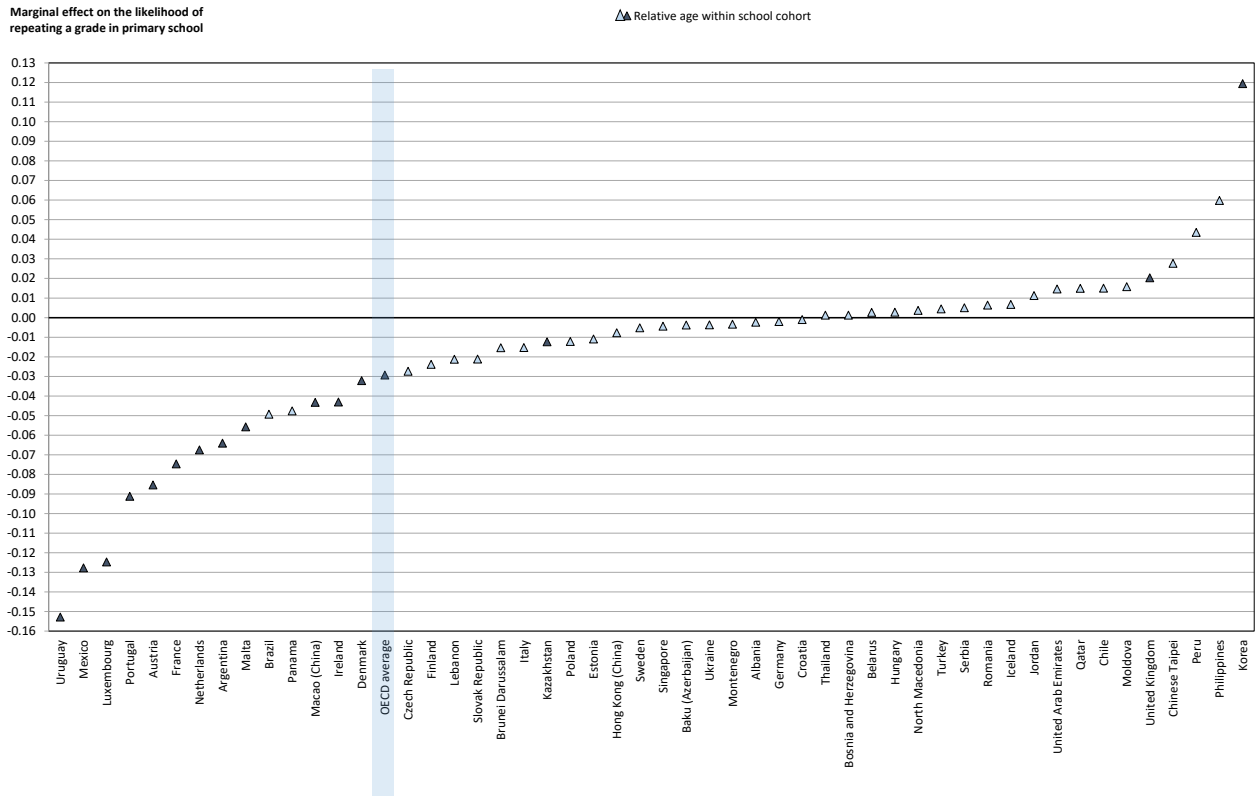
On average, 7% of students across OECD countries reported that they had repeated a grade in primary school – ranging from 21% of students in Colombia to less than 2% of students in Estonia, Iceland, Italy, Lithuania, Poland, Slovenia, Turkey and the United Kingdom. According to the estimates, in several school systems, being amongst the eldest in the grade cohort significantly decreases the probability of being held back in primary school. Across the 25 OECD countries with available data, a difference of one year in the age at entry into school (meaning the difference between – being the youngest in the grade cohort, i.e. born the month just before the cut-off date, and being the eldest, i.e. born just after the cut-off date) reduced by 3 percentage points the probability of repeating a grade in primary school (Figure 8). Amongst OECD countries where more than 5% of pupils had repeated a grade in primary school, only in Chile, Germany and Ireland was the estimated impact of the relative age in the grade cohort not statistically significant. The difference in probability was as large as 13 percentage points in Mexico. The estimated impact was, in decreasing order, 9 percentage points in Luxembourg, 8 percentage points in Spain, 7 percentage points in France and the Netherlands, 5 percentage points in Ireland, and 3 percentage points in Austria.[11] However, in the United Kingdom, a significant, positive relationship was observed; and the pattern was less clear across the 16 partner countries/economies with available data. A significant negative relationship between grade repetition and relative age within the cohort was also observed in Argentina, Macao (China) and Uruguay, but it was not significant in other countries. The impact of grade cohort on repeating a grade in primary school is stronger than the impact on repeating a grade in lower secondary school.

[11] These numbers correspond to estimates when students' characteristics were taken into account, but not their theoretical grades (second column of the Specification 1 in the Table A A.16). This is not expected to have an impact on these estimates. However, in a few cases, such as Korea, the estimates differ when one takes the theoretical grade into account. In addition, in some school systems the theoretical grade was also significantly related to the probability that a student had repeated a grade (once the relative age is taken into account), while this should not be expected. This may be because these two variables are closely related in this country, and it may be difficult to isolate each impact or the nonlinear impact of the theoretical age on this probability.

This may be related to differences in maturity within a grade cohort, and thus the relative disadvantage experienced by the youngest students decreases over time. In addition, one may assume that the most "at risk" students had already repeated grade in primary school and thus are less likely to repeat a grade later on.

Amongst the 9 OECD countries with available data and where at least 5% of students in the PISA sample had repeated a grade, the estimated impact of the relative age at entry into school on the likelihood of having repeated a grade in lower secondary school is significantly negative only in Luxembourg (-13 percentage points), Spain (-5 percentage points) and Chile (-3 percentage points). It is not significant in Austria, Colombia, France, Germany, the Netherlands and Switzerland (Table A A.17). On average across the OECD countries where around 5% of students reported that they had repeated a grade in lower secondary school, being born the month just before the cut-off date reduces the risk of repeating a grade in lower secondary school by 2 percentage points compared to those born just after the cut-off date. Across the 12 partner countries/economies with available data, the estimated impact of the relative age is significantly negative only in Argentina and Brunei Darussalam.

Figure 8. Grade repetition in primary school and relative age in the school cohort



Note: Statistically significant differences are marked in a darker tone.
Countries and economies are ranked in ascending order of the marginal effect of the relative age within school cohort on the likelihood of repeating a grade in primary school, after accounting for socio-economic status, immigrant background and gender.
Source: OECD, PISA 2018 Database, Table A A.16.

The student's age at the time of the PISA test should not have any impact on the likelihood that he or she had repeated a grade. However, the PISA 2018 results show that in several

school systems older students were less likely to have repeated a grade because this is confounded by the relative age at entry into school (Table A A.18). This illustrates the difficulty, discussed earlier, in disentangling the impact – on any outcome – of the age when a student sat the PISA test from the impact of the relative age in the grade cohort. This is especially true in school systems, such as those in the OECD countries France, Mexico, the Netherlands and Spain, where only one grade cohort was sampled for the PISA 2018 test. In these countries, the estimated impact of a student's age when he or she sat the test equals the estimated impact of the relative age in the grade cohort. In these countries, older students are those who are relatively older in their grade cohort, which reduces the likelihood that they had repeated a grade.

Advanced or delayed entry into primary school

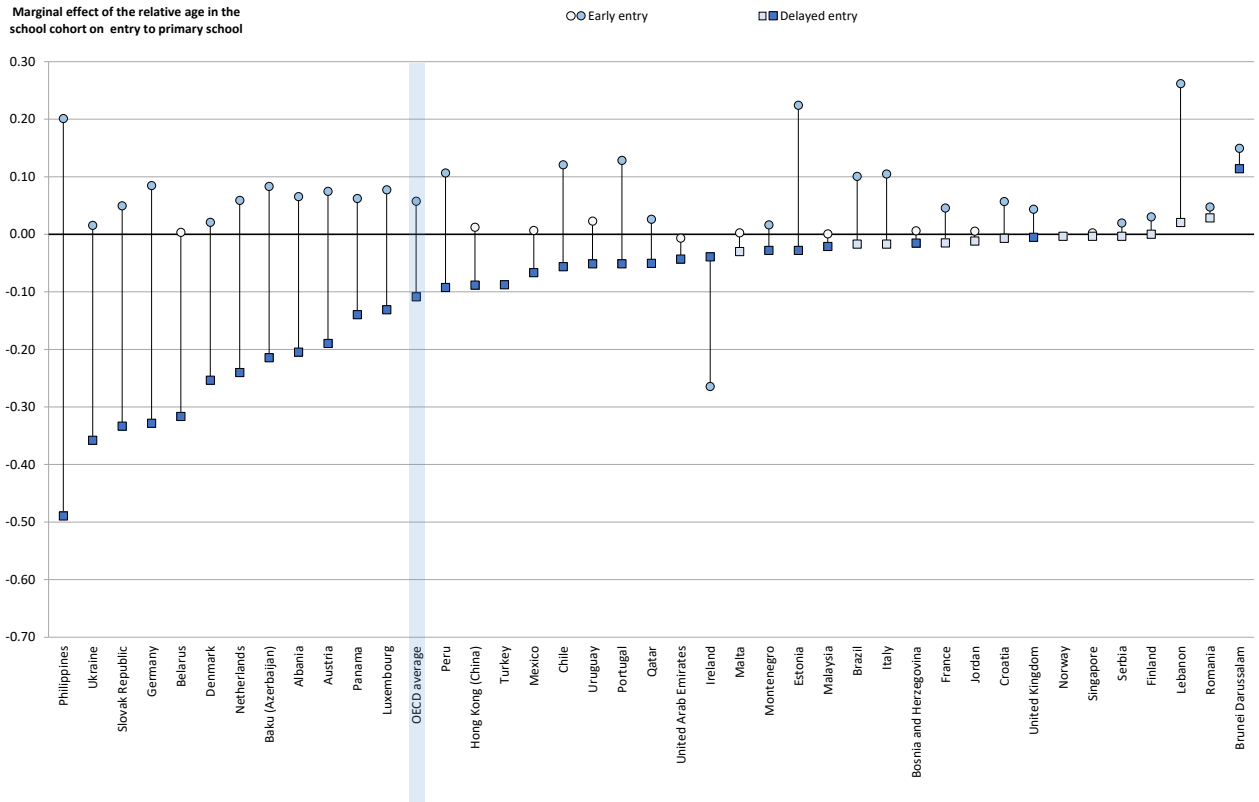
The month a child is born can also affect the probability of delaying or advancing entry into school, and may result in considerable differences in maturity when the school year begins. For instance, a child born just before the cut-off date used for defining eligibility to enter primary school would be younger by almost one year than his or her peers born just after the cut-off date. Families or teachers may thus decide to delay school entry for those who may be considered "not ready" for school.

In 19 of the 23 countries and economies with available data on school regulations and where at least 5% of students reported that they had started school later than expected, by at least one year, the relative age at entry into school was negatively related to the probability of delaying entry into school by at least one year (Figure 9). On average across the 10 OECD countries with available data, being born the month just before the cut-off date decreased by 22 percentage points the probability of entering primary school later than expected, once the effects of gender and socio-economic status were taken into account.[12] Only in Brazil, Brunei Darussalam, Lebanon and Romania was there a positive correlation between the relative age within the grade cohort and the probability of having started school later than expected.

Likewise, the relative age within the grade cohort was positively related to the probability of early entry into school (Figure 9). This is the case in 16 of the 19 countries/economies where at least 5% of students reported that they had started school earlier than official regulations required. Across the eight OECD countries with available data, the estimated effect of one year's difference in the theoretical relative age would be to increase the probability of early entry into primary school by four percentage points. The only exception was Hungary, where the sign was negative. This may be related to the fact that Hungary, in addition to the Czech Republic and Serbia, is one of the rare school systems where the cut-off date for determining entry into school is much earlier in the same year than the date of the start of the primary school year. Parents may be more likely to choose to enrol students who were born after the end of May (the theoretical cut-off date) but who had turned six before the beginning of the school year in September. Those students would be, in theory, the youngest in their grade cohort, which may explain the negative correlation with relative age and the probability of early entry into school.

[12] All marginal effects are estimated using a boy of average socio-economic status as reference.

Figure 9. Relative age in the school cohort and advanced or delayed entry into primary school



Note: Statistically significant differences are marked in a darker tone.
Countries and economies are ranked in ascending order of the marginal effect of the relative age in the school cohort on early entry into primary school, after accounting for age, socio-economic status and immigrant background.
Source: Source: OECD, PISA 2018 Database, Table A A.5 and Table A A.6. In some school systems, relative age in the grade cohort is related to some socio-emotional outcomes

Perceived competence and difficulty in reading

Students' self-concept, or their belief in their own abilities, is an important outcome of education and strongly related to successful learning (Guo et al., 2016[41]; Marsh and O'Mara, 2008[42]). Self-concept is expected to increase with maturity, since greater maturity has a positive impact on performance, and also because if the older students in a class perform better, they may develop greater self-esteem. Longitudinal studies of self-concept and achievement show that these two outcomes are mutually reinforcing over time (Martin and Marsh, 2006[43]; Niepel, Brunner and Preckel, 2014[44]; Arens, Schmidt and Preckel, 2019[45]). This means that students who were amongst the youngest in their grade cohort in the early grades may have developed a lower self-concept because of their relative immaturity compared to their peers in the same grade.

PISA 2018 measured students' self-concept in reading, summarised in two indices: one measuring the perception of competence and the other measuring the perception of difficulty

with reading.[13] Both indices were standardised to have a mean of 0 and a standard deviation of 1 across OECD countries.

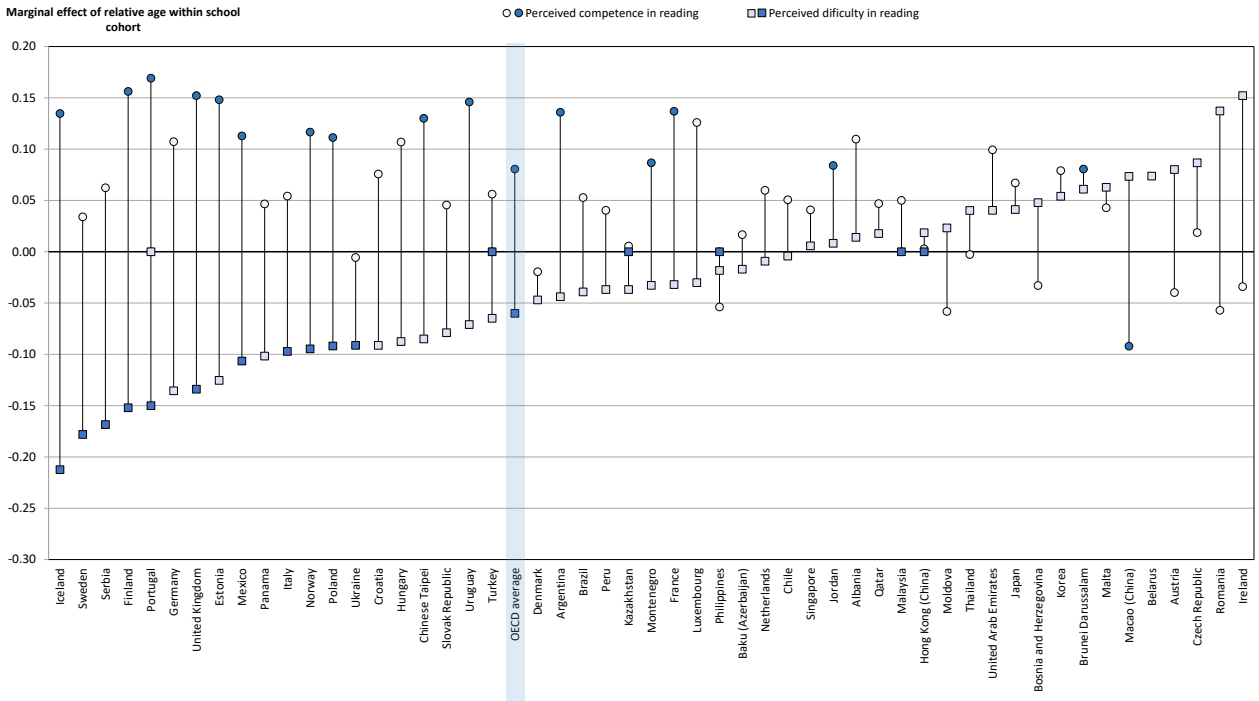
On average across the 25 OECD countries with available data, being amongst the eldest in a grade cohort was related to a 0.08 of a standard deviation increase in the index of perceived competence in reading, and a 0.06 of a standard deviation decrease in the index of perceived difficulty in reading (Figure 10). Amongst these OECD countries, a similar pattern was observed in Finland, Iceland, Mexico, Norway, Poland, Portugal, Spain and the United Kingdom, with correlations often twice as large as the OECD average. In Estonia and France, a significant correlation was observed only between perceived competence and relative age, while in Italy and Sweden, only perceived difficulty in reading was measured.

Amongst the countries where the sampling included two cohorts, only in Estonia and Uruguay did the correlation between relative age and self-concept appear to change after taking into account the theoretical grade cohort. This suggests that self-concept is only partially linked to the amount of knowledge acquired during school. Yet, the fact that the relative age in a cohort is positively related to self-concept may be partly because the oldest students in a cohort perform better, on average, than the youngest students, so it is not surprising that they feel more confident. However, even when the observed performance in reading is taken into account, in a few countries, the impact of relative age is still either significantly positively related to perceived competence in reading (Argentina, Portugal and the United Kingdom) or negatively related to perceived difficulty in reading (Iceland, Serbia and Sweden). That the youngest students in their grade cohort have a lower self-concept than their oldest peers suggests that without appropriate support, the self-confidence, or lack of it, that students develop when they are young persists for years afterward.

Again, one cannot isolate what comes from the initial disadvantage of the youngest students in early grades from their lower levels of maturity when they sat the PISA test. In 8 OECD countries, students' age at the time they sat the test was significantly positively related with self-perceived competence in reading (with an average correlation of 0.08 of a standard deviation in the index); in 10 OECD countries it was significantly negatively related with self-perceived difficulty in reading (with an average correlation of 0.06 of a standard deviation in the index). In four countries/economies, namely Croatia, Finland, Hong Kong, China (China) and Chinese Taipei, being enrolled in the higher grade in the sample cohort was positively related to self-perceived difficulty in reading. One possible explanation would be that these students were confronted with more difficult tasks in higher grades, making them more likely to doubt their skills.

[13] The index is based on students' responses to the following six statements: "I am a good reader"; "I am able to understand difficult texts"; "I read fluently"; "I have always had difficulty with reading"; "I have to read a text several times before completely understanding it"; "I find it difficult to answer questions about a text".

Figure 10. Self-perceived competence and difficulty in reading, and relative age in the school cohort



Note: Statistically significant differences are marked in a darker tone.
Countries and economies are ranked in ascending order of the marginal effects of the relative age within the school cohort on the index of perceived difficulty in reading, after accounting for socio-economic status, immigrant background and gender.
Source: OECD, PISA 2018 Database, Table A A.19 and Table A A.20.

Motivation to achieve and attitudes towards competition

Motivation is probably the most important factor that educators can target in order to improve learning. Motivation may be defined in many ways, but it can be seen as the drive and incentive that push individuals to invest sufficient effort to achieve their goals. What fosters motivation is complex and differs across individuals. Motivation may increase with age, as more mature students may have a clearer view of what they hope to do and why it may be worth working to achieve their objectives. In addition, motivation and achievement may be mutually reinforcing, as achievement may increase students' sense of self-efficacy. Having already experienced success in school may reinforce students' self-esteem, and make it easier for them to set ambitious goals and devote sufficient efforts to achieve them. By contrast, having experienced failure in the early stages of development may lead students to be self-protective and thus avoid challenging situations and opportunities that are essential for learning and development (Conroy, Kaye and Fifer, 2007[46]; De Castella, Byrne and Covington, 2013[47]).

As students who are amongst the youngest in their cohort are more likely to have attained disappointing results in the early years of schooling, they may develop the feeling that it is not worthwhile to compete with others. For instance, the results of a controlled experiment in high schools across two Australian states suggest that the relatively older students tended to have a stronger preference for competition than their younger peers (Page, Sarkar and Silva-

Goncalves, 2017[48]). This is also consistent with the results of a study, mentioned in the introduction, of the over-representation of those born just after the commonly used cut-off date for entry into primary school (thus the eldest in their grade cohort) amongst CEOs and high-level politicians in the United States (Muller and Page, 2016[23]; Du, Gao and Levi, 2012[24]).

PISA 2018 makes it possible to measure students' different attitudes towards learning and motivation to achieve. Specifically, the questionnaire makes it possible to create an index of motivation to master tasks, defined as the dispositional desire to work hard to achieve a goal,[14] an index of attitudes towards competition, defined as the dispositional desire to outperform others.[15] All these indices were standardised to have a mean of 0 and a standard deviation of 1 across OECD countries.

Only in a limited number of countries and economies did the relative age within a grade cohort appear statistically significantly related to these indicators. Still, on average across the 25 OECD countries with available data, being the eldest in the theoretical grade cohort at entry into primary school was statistically positively related to the index of task mastery (one year older in relative age was associated with an increase of 0.06 of a standard deviation in the index), even after taking into account the effects of individual characteristics and the students' theoretical grade cohort (Table A A.21). The same positive correlation was observed, on average across OECD countries, between relative age and the index of competitiveness: one year older in relative age was associated with an increase by 0.05 of a standard deviation in the index (Table A A.22).

Relative age seemed to matter significantly in the motivation to master tasks in Austria, Baku (Azerbaijan), Brunei Darussalam, Croatia, Iceland, Korea, Malaysia, Poland, Spain, the United Kingdom and Uruguay. It was significantly positively related to having a positive attitude towards competition in Brazil, Malaysia, Peru, Spain and the United Kingdom.[16] Even though the estimated correlation was statistically significant in only a few school systems, in no case were the estimations negative, making it unlikely that the positive significant correlations observed were due to mere chance. This suggests that in some school systems, the relative penalty experienced by the youngest students in their grade cohort may have long-term repercussions on their self-esteem, undermining their motivation to achieve.

Self-efficacy and fear of failure

Self-confidence may also determine how students behave in the face of difficulty, and whether they tend to avoid situations where they may fail. In 2018, PISA asked students about their belief in their own ability, especially when facing adverse circumstances, and how they apprehend failure. The answer to these questions made it possible to construct an index of

[14] The index is based on students' responses to the following four statements: "I find satisfaction in working as hard as I can"; "Once I start a task, I persist until it is finished"; "Part of the enjoyment I get from doing things is when I improve on my past performance"; and "If I am not good at something, I would rather keep struggling to master it than move on to something I may be good at".

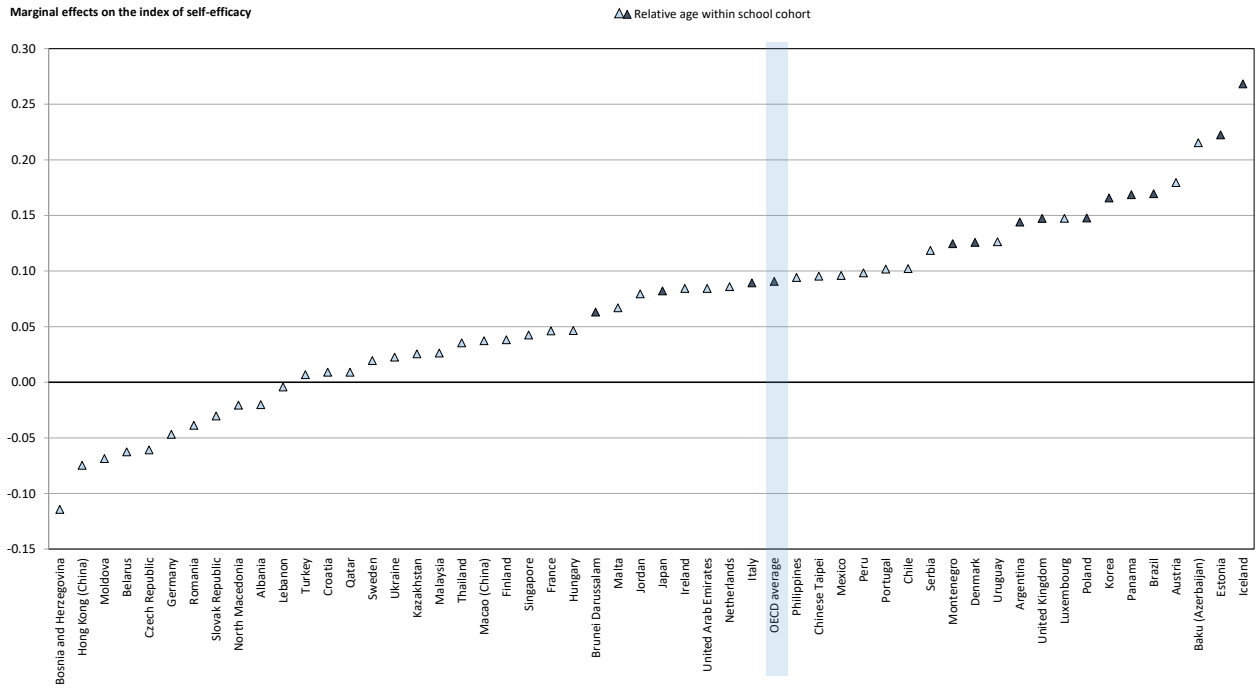
[15] The index is based on students' responses to the following three statements: "I enjoy working in situations involving competition with others"; "It is important for me to perform better than other people on a task"; and "I try harder when I'm in competition with other people".

[16] Similar conclusions were observed when considering students' age at the time of the PISA test, instead of relative age (Table A A.23).

self-efficacy, defined as whether students believe in their own ability to engage in certain activities and perform specific tasks in the face of adversity,[17] and an index of fear of failure.[18]

In several countries, it appeared that students who were amongst the eldest in their grade cohort benefitted from greater self-confidence. On average across the 25 OECD countries with available data, the estimated difference between the eldest and the youngest in their grade cohort was associated with an increase of 0.09 of a point in the index of self-efficacy, once gender, socio-economic status and theoretical grade were taken into account (Figure 11). Such a positive impact was observed in nine OECD countries, namely Denmark, Estonia, Iceland, Italy, Japan, Korea, Poland, Spain and the United Kingdom. By contrast, the index of fear of failure appeared weakly related to the relative age of students (Table A A.24). Of the countries and economies with available information, only in Belarus, Iceland and Kazakhstan was the relative age in the grade cohort statistically related to the index of fear of failure – in a negative way.

Figure 11. Self-efficacy and relative age in the school-entry cohort



Note: Statistically significant differences are marked in a darker tone.
Countries and economies are ranked in ascending order of the marginal effect of the relative age within school cohort on the index of fear of failure, after accounting for socio-economic status, immigrant background and gender.
Source: OECD, PISA 2018 Database, Table A A.25.

[17] The index is based on students' responses to the following five statements: "I usually manage one way or another"; "I feel proud that I have accomplished things"; "I feel that I can handle many things at a time"; "My belief in myself gets me through hard times"; and "When I'm in a difficult situation, I can usually find my way out of it".
[18] The index is based on students' responses to the following three statements: "When I am failing, I worry about what others think of me"; "When I am failing, I am afraid that I might not have enough talent"; and "When I am failing, this makes me doubt my plans for the future".

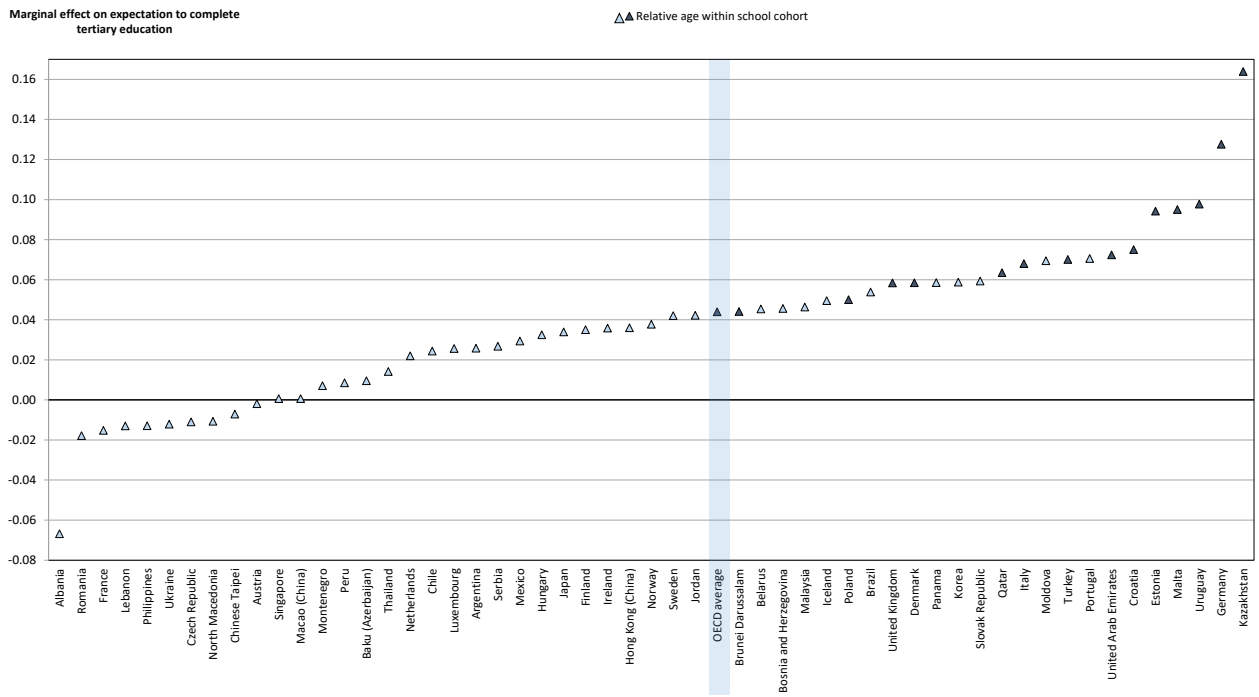
Expectation to complete tertiary education

In many school systems, 15-year-olds are close to the end of compulsory schooling, and are considering the type of education and degree they want to pursue to prepare for their future working lives. PISA 2018 asked students which education level they expect to complete. Consistent with the general increase in educational attainment, in almost all OECD countries, except Austria and Germany (where strong vocational systems facilitate entry into the labour force, even when lacking a tertiary degree), the majority of students expected to earn a tertiary degree. On average across OECD countries, more than two in three students so reported (OECD, 2019[33]).The decision to complete higher education is expected to be related to academic performance, and also to self-confidence and motivation to achieve. Since being younger in a grade cohort may have an impact on these two indicators, one may also ask whether being younger in a grade cohort may influence the expectation to complete tertiary education.

According to the estimates, the relative age within the grade cohort was positively related to the expectation to complete post-secondary education. Being born the month just before the cut-off date increased the probability of expecting to complete tertiary education by four percentage points compared to students born just after the cut-off date (thus the youngest in their grade cohort). This correlation was statistically significant in 8 of the 25 OECD countries with available information, namely Denmark, Estonia, Germany, Italy, Poland, Spain, Turkey and the United Kingdom, and in 7 partner countries, namely Brunei Darussalam, Croatia, Kazakhstan, Malta, Qatar, the United Arab Emirates and Uruguay (Figure 12). As discussed, this positive correlation may reflect the fact that, over their schooling, the youngest students in their cohort scored lower than their peers. However, in some countries, such as Germany and Turkey, being older within a grade cohort at entry into school has a positive impact on the expectation to complete tertiary education, even when performance in PISA is taken into account.

One can assume that students in higher grades may be more informed about further education. Indeed, in several countries where the PISA sample covers two grades, one can observe that students who are enrolled in the higher grade because of their date of birth are often more likely to expect to complete tertiary education. For the same reason, in those countries where a positive relationship was observed with the relative age within the grade cohort, the age at which the student sat the PISA test was significantly and positively related to the probability of expecting to pursue further education (Table A A.26). However, relative age within a grade cohort may have a significant impact on its own, as it may affect self-confidence.

Figure 12. Expectation of completing tertiary education and relative age in the school cohort



Note: Statistically significant differences are marked in a darker tone.
Countries and economies are ranked in ascending order of the marginal effect of the relative age within school cohort on the expectation to complete tertiary education, after accounting for socio-economic status, immigrant background and gender.
Source: OECD, PISA 2018 Database, Table A A.27.

Exposure to bullying

Another variable that could influence the impact of relative age on performance and self-esteem is related to bullying. Bullying is a specific type of aggressive behaviour that involves unwanted, negative actions in which someone intentionally and repeatedly harms and discomforts another person who has difficulty defending himself or herself (OECD, 2019[49]). It is characterised by a systematic abuse of power and an unequal power relationship between the bully and the victim. While the emergence of cyberbullying has received much attention in recent years, more frequently observed are physical forms of bullying. As younger students in a class, especially in the earliest grades, are often physically weaker and shorter than their older peers, they may be more at risk of being victims of violent acts. For instance, a study of fifth-graders in Italy observes that those students who are the eldest in their grade cohort are less likely to be bullied (Ballatore, Paccagnella and Tonello, 2020[50]).

Since 2015, PISA has asked students to respond to statements about their experiences with bullying-related behaviours at school.[19] The responses to these statements were combined to create an index of exposure to bullying. In several countries, being the eldest in a grade cohort significantly reduced the likelihood of being exposed to bullying. On average across the

[19] The index was constructed using student responses ("never or almost never", "a few times a year", "a few times a month", "once a week or more") to three statements about students' experience with bullying: "Other students left me out of things on purpose"; "Other students made fun of me"; and "I was threatened by other students".

25 OECD countries with available information on school-entry regulations, being born just after the cut-off date was related to a decrease in the index of exposure of bullying by 0.08 of a standard deviation in the index compared to those born just before the cut-off date, once gender, immigrant background and socio-economic status were taken into account (Table A A.28). In a few countries where the PISA sample covers two grades, being in the older grade cohort decreases the likelihood of being bullied and more generally, a similar negative correlation was observed between the student's age at the time of the PISA test and the probability of having been bullied (Table A A.29).

School-system specificities and effect of age on performance

Previous analysis suggests that the impact of relative age within a grade cohort at the time of entering school on further development may be substantial. However, the magnitude of this impact varies markedly from one country to another. The relative age at entry into primary school appears to influence a much broader range of indicators in some countries. While the impact on performance was observed in the majority of the school systems, the impact on socio-emotional dimensions appeared significant in only a limited set of countries. Yet, amongst OECD countries, in Austria, Iceland, Italy, Korea, Poland, Spain and the United Kingdom, the observed relative age seemed positively related to two of the three indices, namely self-concept, self-efficacy, and attitudes towards competition. In Denmark, Estonia, Italy, Poland, Spain, Sweden and the United Kingdom, it was significantly related to the probability of expecting to complete post-secondary education in the future. These are dispositions that are likely to have long-lasting consequences.

That the impact of relative age was more generalised for academic outcomes than for socio-emotional ones may be related to the results obtained in a comprehensive study on this topic that focused on the state of Florida (Dhuey et al., 2019[26]). Using exhaustive administrative data, the authors observed that the magnitude of the causal impact of relative age at entry into primary school on cognitive outcomes does not vary by groups, categorised by mother's education, poverty at birth, race/ethnicity and school quality, while the impact on other outcomes, such as disability status, and the selection of courses in middle school and high school, are much more heterogeneous, depending on the group.

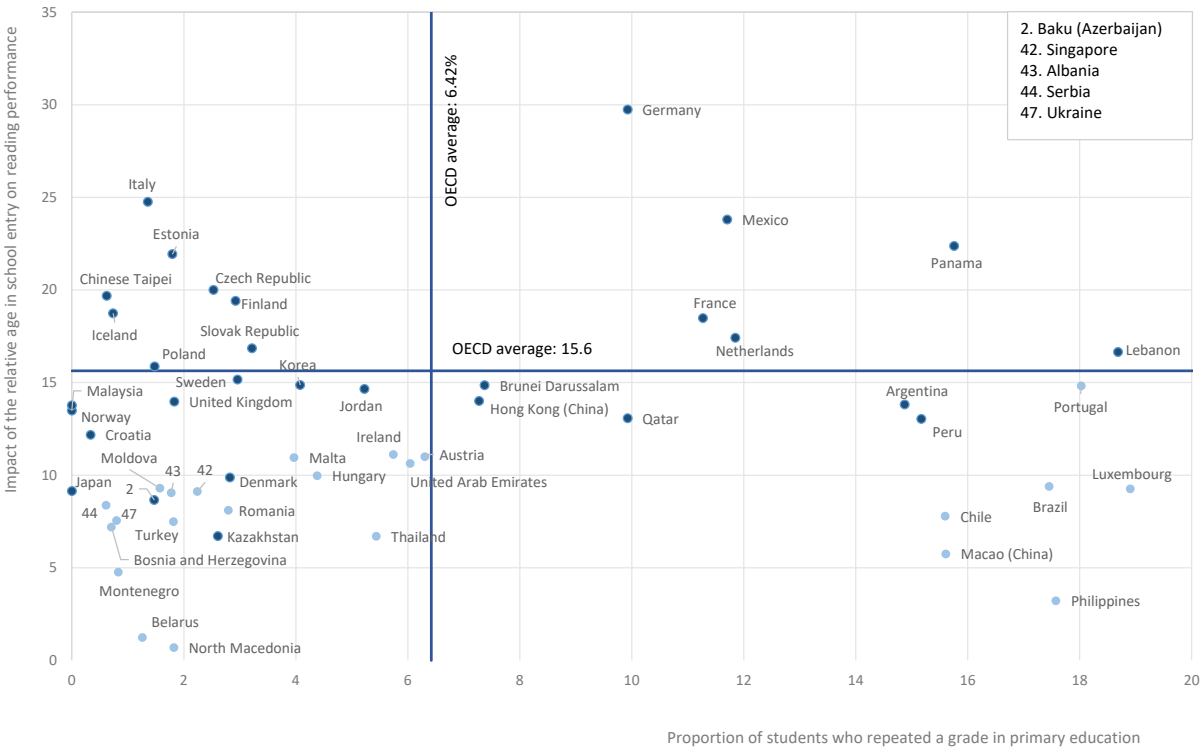
Several factors may be related to these variations. For instance, the relative maturity between the youngest and the oldest in a cohort may be more or less pronounced, depending on the age at entry into primary school. The flexibility given to parents to delay or advance their child's entry into school, depending on their readiness, and the prevalence of preschool, which may prepare students for school, may also explain why this effect varies.

Whether initial relative impact makes a difference when students are 15 years old may depend on the way school systems deal with heterogeneity in performance. The initial relative penalties experienced by the youngest children are more likely to have long-lasting effects in school systems where early academic performance determines the type of schooling a child will experience. For instance, in school systems that rely on stratification by ability (either by early tracking or grade repetition), the youngest in a cohort are more likely to be held back or tracked into a low-ability track if educators do not evaluate the children in relation to their place in the age distribution, and mistake maturity with ability.

Using PISA data, one may try to relate some specificities of the school system to the magnitude of the impact of the relative age within a grade cohort. For instance, these may be related to grade repetition or tracking into distinct schools in the early grades. As suggested by some researchers (Dhuey et al., 2019[26]), grade repetition may constitute a remediation

tool for those students who are lagged behind in the first years of primary school simply because they were not ready for schooling when they entered primary school. However, early grade repetition may also have negative consequences on future schooling (Özek, 2015[51]). PISA data suggest that the correlation between the impact of the relative age within the grade cohort on performance and the prevalence of grade repetition in the early grades (i.e. the proportion of students who reported that they had repeated a grade in primary school) is positive (Figure 13). However, the strength of the relationship is weak and large variations are observed in the magnitude of school-age effects between countries with the same prevalence of grade repetition.

Figure 13. Impact of the relative age in school entry on reading performance and proportion of students who repeated a grade in primary education

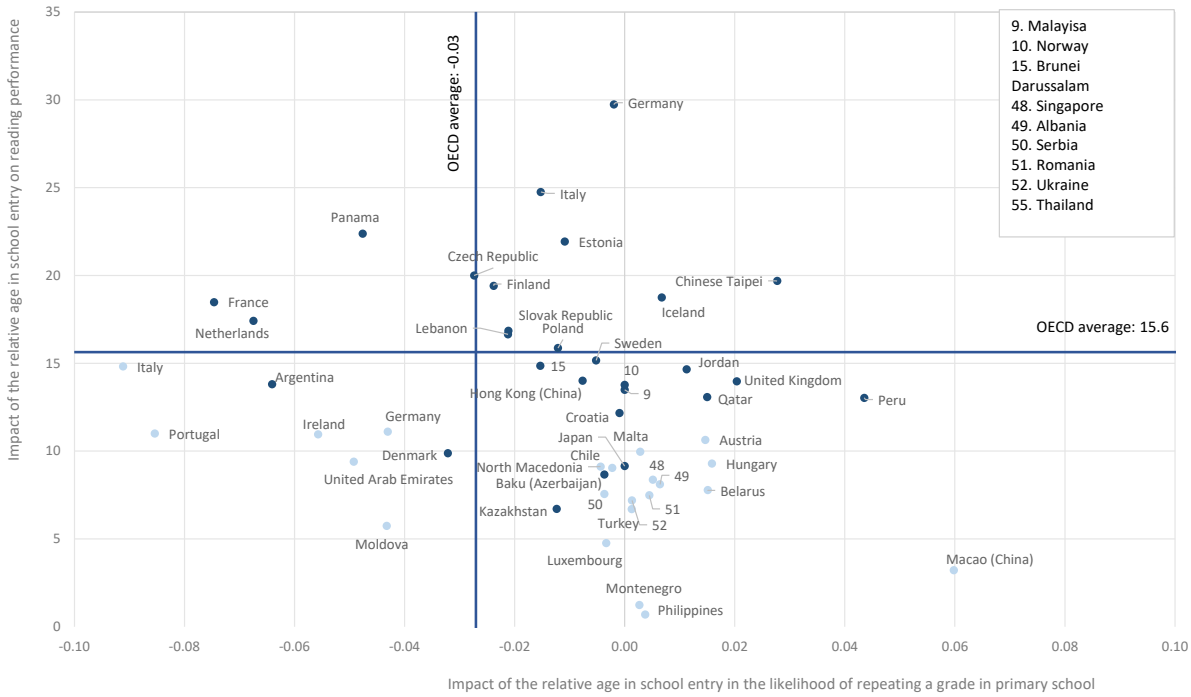


Note: Countries show in darker tone are those for which the estimated impact of the relative age on reading performance is significant.
Source: OECD, PISA 2018 Database & Table A A.12

For instance, in Germany where around 10% of students reported that they had repeated a grade in primary school, the estimated impact of relative age at entry on performance on the PISA reading test is almost 30 score points. In France and the Netherlands, where more than 11% of students reported that they had repeated a grade in primary school, this effect is smaller by more than 10 score points.

Another way to look at this effect is to compare the impact of the relative age within a grade cohort on the probability that the student had repeated a grade, on one hand, and on reading performance, on the other. Estimates suggest that countries where relative age at entry into school has a greater effect on grade repetition in the early grades are often those where relative age has a significant and sizeable impact on PISA reading performance (Figure 14).

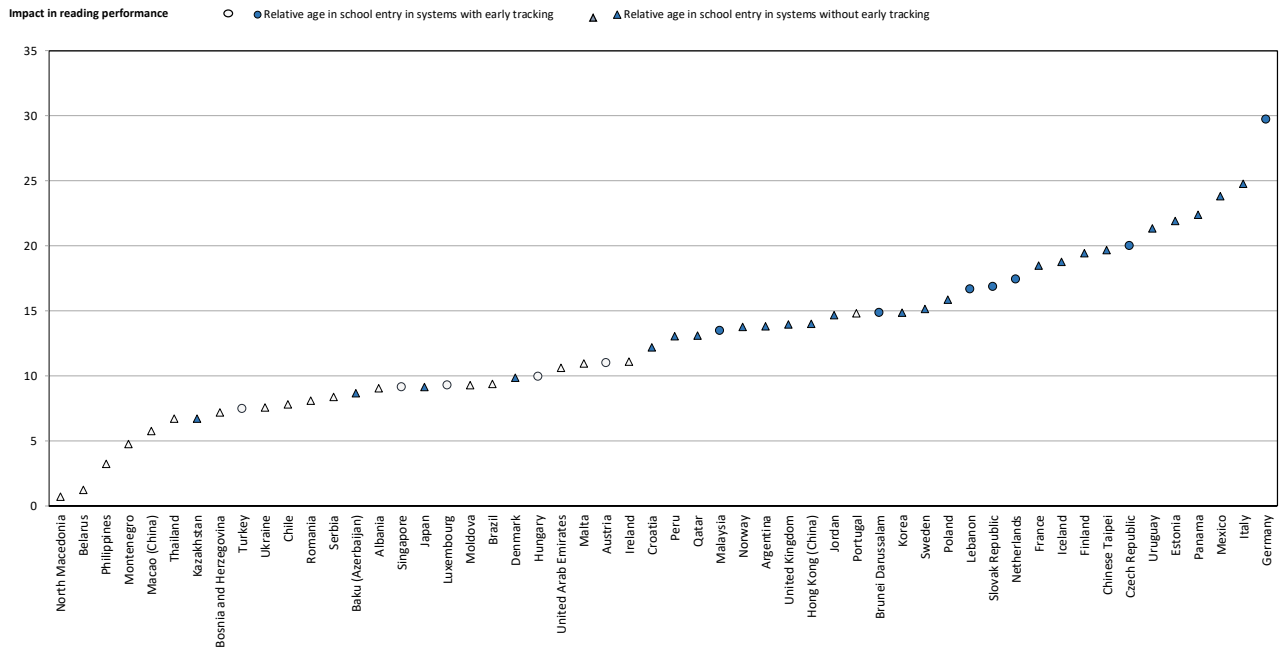
Figure 14. Impacts of the relative age in school entry in the likelihood of repeating a grade in primary school and on reading performance



Notes: Countries show in darker tone are those for which the estimated impact of the relative age on reading performance is significant.
Source: OECD, PISA 2018 Database & Table A A.12

While the relative age effect is expected to disappear as students grow older, it may be preserved or even reinforced when students are separated into different tracks early in their school career (Schneeweis and Zweimüller, 2014[52]). Again, evidence from PISA does not offer a definitive answer. In 7 of the 12 countries and economies where students are tracked for the first time before the age of 12, the relative age at entry has a significant impact on PISA reading performance (Figure 15). This is the case in only 34 of the 43 countries where students are tracked later into distinct schools or streams. In some countries that use early tracking, the impact of relative age on performance may be mitigated if there is enough permeability between the tracks so that students who were initially assigned to the lower track because of an age-related disadvantage manage to move to the higher track when they grew older. Such an effect is observed (Schneeweis and Zweimüller, 2014[52]) in Austria, where students are tracked very early – at the age of 10 (i.e. in grade 5) – but are tracked again at the age of 14 (i.e. in grade 9). However, for Germany, where students are also tracked very early and the age effect in track selection is strong (relatively young students being only two-thirds as likely to be assigned to an academic track), the age-at-school-entry effect on track selection appears only partially mitigated by the possibility that students can change track when they are 16 years old (Mühlenweg and Puhani, 2010[53]). If PISA data show that the relative age at entry has an impact on the probability of being enrolled in a lower grade at age 15 amongst some groups of students (primarily disadvantaged boys), this effect is much weaker than that of the age at first tracking. Relative age did not appear to have significant impact on reading performance in PISA 2018.

Figure 15. Impact of the relative age in school entry on reading performance and early tracking



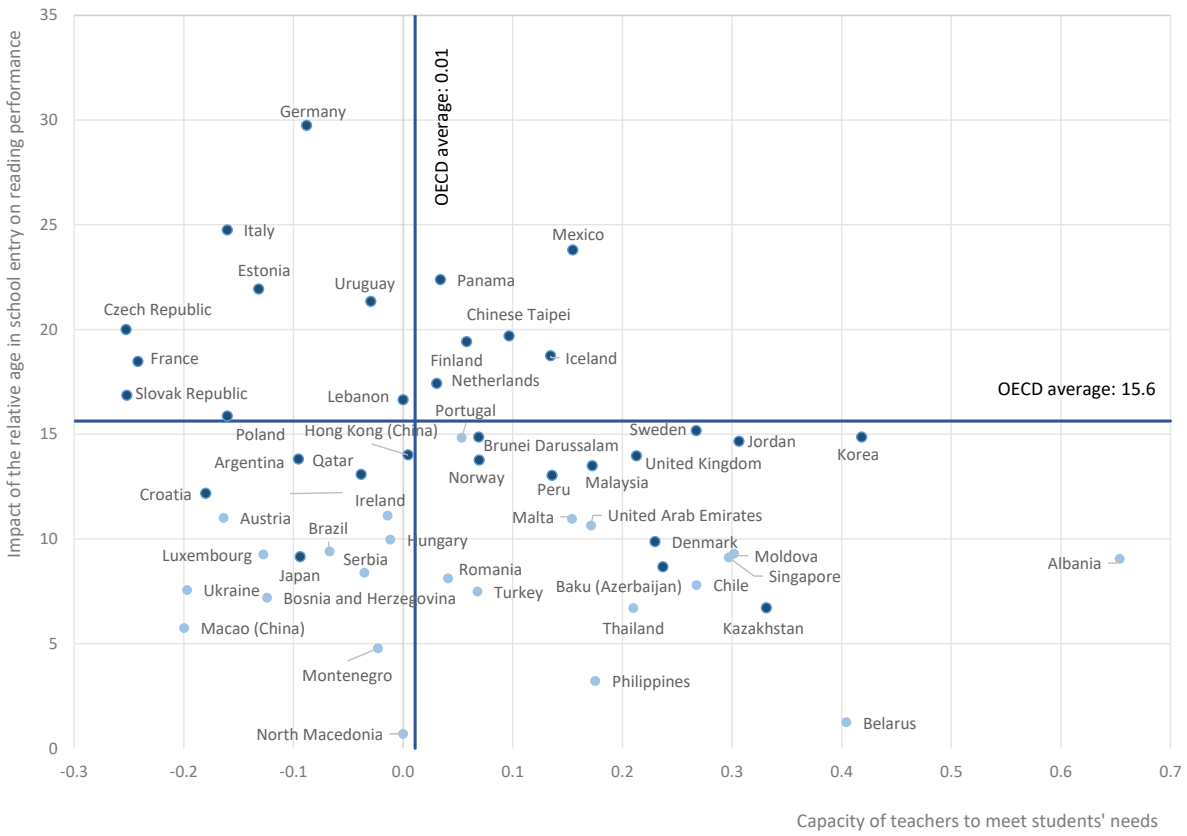
Note: Statistically significant differences are show in darker tone
Countries are ranked in ascending order of the impact of the relative age in school entry on reading performance.
Source: OECD, PISA 2018 Database & Table A A.12

Finally, teaching practices may also help mitigate the impact of the relative age effect, particularly if teachers are aware of their students' relative age and if they have been trained to deal with diversity. Being prepared to teach classes of students with diverse levels of ability may help support all students in overcoming their initial disadvantage or lack of self-confidence. While this cannot be measured directly using PISA data, it may be proxied by the index of teachers' adaptive instruction, as reported by students in PISA.[20] As illustrated by the Figure 16, the correlation of relative age and reading performance decreases with the index of adaptive instruction, as perceived by the students.

Cross-country analyses cannot provide sufficient causal evidence of what specific policies or practices help reduce the age-related effects on students' performance and dispositions later on – even into adulthood. Yet, the results described in this paper suggest that the range of results observed indicates that some school systems provide students with sufficient support to mitigate and even eliminate the initial disadvantage of being the youngest in class during the first years of schooling.

[20] The index of adaptive instruction was constructed using students' responses to a trend question about how often ("every lesson", "most lessons", "some lessons", "never or hardly ever") the following things happen in their language-of-instruction lessons: "The teacher adapts the lesson to my class's needs and knowledge"; "The teacher provides individual help when a student has difficulties understanding a topic or task"; and "The teacher changes the structure of the lesson on a topic that most students find difficult to understand". Positive values on this scale mean that students perceived their language-of-instruction teachers to be more adaptive than did the average student across OECD countries.

Figure 16. Impact of the relative age in school entry on reading performance and average index of adaptive instruction



Note: Countries show in darker tone are those for which the estimated impact of the relative age on reading performance is significant.
Source: Source: OECD, PISA 2018 Database, Table A A.12

Concluding remarks and policy recommendations

No one can choose his or her birthday; yet the results discussed above suggest that in a large majority of countries, the month of birth has a sizeable and significant impact on cognitive and non-cognitive outcomes. As examined extensively in this document, it will always be difficult to disentangle the distinct reasons behind age-related effects. However, one may assume that the difference in maturity between students of the age cohort when they are around 15 years old is small. At 15, some students may be 6% older than their youngest peers in this age cohort; but when these children started school years before, the difference in their maturity was much greater and may even have had an impact on their self-confidence and attitudes towards learning and school. One of the most striking results of this analysis is that, in a few countries, the relative age in a grade cohort may have consequences for the likelihood of expecting to complete post-secondary education – and thus for children's future. In some countries, this result holds even amongst students who perform comparably in PISA. Being held back in the first years of schooling may harm children's self-confidence and thus undermine their expectations for the future. Several recommendations have been made to reduce this month-of-birth effect (for a complete survey, see, for instance, Sharp et al. (2009[54])). The results reported here indeed suggest that differences in maturity at an early age may have long-term consequences, notably on students' self-esteem. Educators and parents should be aware of the initial disadvantage experienced by the youngest students during their first years of schooling, in order to avoid unfair comparisons with other students. In class, teachers may try to make students aware of their achievements rather than comparing them to older classmates. In order to increase their awareness of this age effect, teachers may arrange register in order of date of birth (Gledhill, Ford and Goodman, 2002[55]), and give feedback to students that account for their age.

More systematically, school systems could introduce an adjustment for age in their standardised tests. These tests may help teachers and parents assess students more objectively and adapt teaching to the specific needs of students. These tests may not only be based on grade (the standardised test is conducted for all students enrolled in the same grade), but based on age (the test is conducted for all students of the same age, by month). Such age-based standardised tests were used for several years in Ireland (Shiel, Kellaghan and Moran, 2010[56]; O'Leary et al., 2019[57]). With adequate reporting, this age-adjustment may help teachers and parents identify the normal rate of children's development, particularly in the first years of schooling. Adjustment for age should be specifically recommended for tests that are used for allocation mechanisms, notably in school systems where academic achievement may have consequences on the type of education students may pursue. In England, the Statutory Assessment Tests, sat in grades 2 and 6 by students in primary school, as well as the 11-plus examination sat by some pupils in their last year of primary school in order to get into a grammar school.[21] In addition, the age-adjustment may be advocated to reduce the over-classification of the youngest children as having learning difficulties or psychiatric conditions, observed, for instance, by (Layton et al., 2018[58]).

Other policy recommendations have been proposed to tackle the penalty of being the youngest children in the first years of schooling, but with little or mixed evidence on their efficiency. While grouping children in classes based on month of birth may be advocated by some, the

[21] See for instance https://www.elevenplusexams.co.uk/advice/standardised-scores-an-explanation and https://www.alcentres.co.uk/sats-explained-part-1/

longer-lasting consequences of separating by ability may be negative if the pace of learning is slower in classes with the youngest children. Indeed, having elder peers may also have a positive impact on the learning of the youngest children, as suggested, for instance, by (Peña, 2016[59]; Black, Devereux and Salvanes, 2011[60]; Cascio and Schanzenbach, 2016[9]). For the same reason, caution is advised when considering the common-sense claim that postponing entry into school of the youngest children may give them sufficient time to prepare. Indeed, evidence from school systems where parents can easily delay their child's entry into school if the child is not yet ready is mixed. Dhuey et al. (2019[26]) observed only marginal evidence of a positive impact of redshirting in Florida's primary schools. Depending on whether or not the child had attended preschool, and on the quality of that experience, the impact of early entry in school may be positive. For instance, in Hungary, (Altwicker-Hámori and Köllő, 2012[61]) observe a positive impact of delaying school entry for disadvantaged students; but the opposite is observed in China (Chen, 2017[62]) and in Australia, where (Suziedelyte and Zhu, 2015[63]) observed that early entry into school improves cognitive score, especially for disadvantaged students.[22]

Policy aimed to adapt school to the needs of the youngest children may be more successful than trying to adapt children to school. Some school practices have been shown to be less suitable for the youngest students, and thus increase those children's initial penalty in the first years of schooling. For instance, in Florida primary schools, (Dhuey et al., 2019[26]) observed that longer sequences of teaching (a practice referred to as block scheduling, consisting in fewer but longer classes) are associated with a stronger impact of relative age on achievement. This may be because the youngest students may lack the maturity to concentrate over a long period of time. Similarly, summer-school requirements for grade advancement is also related to greater relative age effect, as it may require an investment that the youngest students are not mature enough to make. Larger classes are also related to greater relative age effect, probably as they reduce the capacity of teachers to devote specific attention to all students, depending to their needs.

[22] However, they also observe that early entry decreases no cognitive scores for both advantaged and disadvantaged students.

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Annex A. Tables

Excel spreadsheets with Tables and Figures are available on the PISA homepage on the following address: http://www.oecd.org/pisa/publications/wkp-month-of-birth.htm.

Table A A.1 Theoretical starting age and theoretical duration (2015)

Table A A.2 Cut-off birthdate for eligibility for school enrolment and first day of the school year (2018)

Table A A.3 Age at entry into primary school and advanced/delayed entry (before and after correction)

Table A A.4 Age at entry into primary school and advanced/delayed entry (details)

Table A A.5 Students who had advanced entry into primary school, by student characteristics

Table A A.6 Students who had delayed entry into primary school, by student characteristics

Table A A.7 PISA students, by quarter-year of age and socio-economic status

Table A A.8 Real relative age at entry into primary school and theoretical relative age in the grade cohort

Table A A.9 Age and percentage of PISA students, by relative age in school entry cohort and socio-economic status

Table A A.10 Percentage of students who sat the 2018 PISA test, by month of test

Table A A.11 Reading performance and age at the time of the PISA test

Table A A.12 Reading performance and relative age within a cohort

Table A A.13 Mathematics performance and relative age within a cohort

Table A A.14 Science performance and relative age within a cohort

Table A A.15 Theoretical cohort grade and observed grades

Table A A.16 Students who had repeated a grade in primary school and relative age within a cohort

Table A A.17 Students who had repeated a grade in lower secondary school and relative age in the school cohort

Table A A.18 Students who had repeated a grade in primary school and age at the PISA test

Table A A.19 Self-perceived competence in reading and relative age in the school cohort

Table A A.20 Self-perceived difficulty in reading and relative age in the school cohort

Table A A.21 Motivation to master tasks and relative age in the school cohort

Table A A.22 Attitudes towards competition and relative age in the school cohort

Table A A.23 Motivation to master tasks and age at the PISA test

Table A A.24 Fear of failure and relative age in the school cohort

Table A A.25 Self-efficacy and relative age in the school cohort

Table A A.26 Students who expect to complete tertiary education and age at the PISA test

Table A A.27 Expectation to complete tertiary education and relative age in the school cohort

Table A A.28 Exposure to bullying and relative age in the school cohort

Table A A.29 Exposure to bullying and age at the PISA test