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Documents de travail

N° 2024-18 – Juillet 2024

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Pauline GIVORD

Institut national de la statistique et des études économiques

2024/18

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PAULINE GIVORD*

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Département des Études Économiques – Timbre G201
88, avenue Verdier – CS 70 058 – 92 541 MONTROUGE CEDEX – France
Tél. : 33 (1) 87 69 59 54 – E-mail : d3e-dg@insee.fr – Site Web Insee : http://www.insee.fr

* Insee-Dese – Département des études économiques
L'auteure remercie Julien Grenet, Francesco Avvisati, Noémie le Donné, Marco Paccagnella ainsi que les participants au séminaire des études économiques de l'Insee pour leurs commentaires et remarques avisées, et Alejandra Arbelaez pour son aide sur une version antérieure de cette étude. Elle reste seule responsable des erreurs et omissions qui pourraient substituer.

L'influence de l'âge d'entrée à l'école sur les compétences scolaires et socio-émotionnelles : Une étude à partir de PISA

Le fait de commencer l'école à un âge plus jeune affecte-t-il les résultats à long terme des élèves ? Cette étude fournit une analyse des effets de l'âge d'entrée à l'école en utilisant des données des cycles récents du Programme international pour le suivi des acquis des élèves (PISA) dans 16 pays. En utilisant une stratégie de variable instrumentale, les estimations montrent que l'âge d'entrée à l'école influence significativement la performance cognitive des élèves de 15 ans. Ceux qui sont plus jeunes au début de leur scolarité ont plus souvent un vécu scolaire difficile que leurs pairs plus âgés. De plus, l'entrée précoce à l'école a un impact significatif sur les compétences sociales et émotionnelles, comme la confiance en soi, la motivation, la persévérance et l'engagement, qui peuvent avoir des effets sur le long terme. Ces effets sont plus prononcés pour les élèves issus de milieux défavorisés mais varient significativement selon les différents systèmes éducatifs.

Mots-clés : Effets d'âge à l'école, PISA, Variables instrumentales, compétences socio-émotionnelles

Codes JEL : I21, I24, C26

How age at school entry affects future educational and socioemotional outcomes: Evidence from PISA

Does starting school at a younger age affect students' long-term outcomes? This study provides comparative evidence of the impact of school starting age using data from recent Program for International Student Assessment (PISA) cycles across 16 countries. Relying on an instrumental variable strategy, the estimates reveal that the age at school entry significantly influences the cognitive performance of 15-year-old students. Those who are younger at school start tend to face more challenging educational trajectories compared to their older peers. Moreover, early school entry has a substantial impact on social and emotional skills, including self-confidence, motivation, persistence, and engagement, which may have enduring effects on their future life outcomes. These effects are more pronounced for students from disadvantaged backgrounds but vary significantly across different educational systems.

Keywords: Birthday effects, PISA, Instrumental variables, socioemotional skills

JEL Code : I21, I24, C26

1 Introduction

Do the months on which children are born impact their future lives? Yes, sometimes, and this impact is not related to astrology. These effects, often referred to as "birthday effects," occur because all school systems start the school year at roughly the same time, creating cohorts defined by a "cutoff" date. Children born just after this cutoff are almost a year older than those born just before it. As a result, the older students often perform better in assessments due to their greater maturity. However, while this "age at test" effect on school performance is expected to fade with age,[1] evidence suggests that school-starting age effects continue to influence labor outcomes later in life.

These long lasting effects of school starting age may be related to the condition of the children's emotional development at the beginning of their schooling. If younger children are not sufficiently prepared for school, their perception of education and their motivation to learn can be adversely affected. In their initial years of schooling, younger children may struggle more than their older peers, facing risks of falling behind. On the other hand, older, more capable students can either inspire or intimidate their younger classmates, depending on how teaching is adapted to the needs of every students in the class. School systems use different tools, such as grade repetition or additional support, to help younger students catch up, though the effectiveness of these measures remains debated. These dynamics are well-known, and leads to various adaptations by parents across countries; for example, in Germany and the USA, some parents choose to delay school entry for younger children, whereas in France or Italy, it is common to enroll older children early. The existence of lasting effects of school entry age calls into question the ability of educational systems to manage the initial heterogeneity of students: disparities in success according to birth month are difficult to explain by types of socialization that would differ within families, as can be, in part, educational inequalities according to social origin or between girls and boys.

This study uses data from the Program for International Student Assessment (PISA) to provide new comparative evidence on the enduring effects of birth month on 15-year-olds across 16 countries, focusing not only on cognitive outcomes but also on socio-emotional skills. PISA data have several features that make it possible to provide new insights into these topics. PISA data includes measures of cognitive (mathematics, reading, and science performance) and over a large range of socio-emotional skills (self-confidence, motivation, persistence, engagement with others...) that are comparable across a set of countries. PISA also provides a measure of the age at entry and past and future school pathway (grade repetition, educational expectation), as well as information on the regulations regarding school entry (date of the first day of school, and cutoff date, meaning the date at which a child should have reached the theoretical starting age for primary school), making it possible to measure the relative age at entry at school within the cohort. Thus, one may compare the magnitude of the impact of school entry age on cognitive and socio-emotional dimensions when measured at 15 years across countries and across individual characteristics (such as gender or socioeconomic status). The analyses focused on OECD countries that have distinct schooling organizations, notably regarding school starting age and the use of ability-grouping practices in primary schools.[2] Finally, as the PISA sample is age-based, it is representative of students aged approximately 15 years (between 15 years and 4 months to 16 years and 3 months), regardless of the school type and grade.

The identification strategy relies on a quasi-experimental design to measure the impact of relative school starting age. To control for potential endogeneity (for instance, if parents are allowed to delay or advance their child's entry into primary school, depending on their "readiness"

[1] For instance, in school systems where children are supposed to enter primary school at 6, in relative terms the eldest students in the first grade are 15% older than their youngest classmates - while they are only 6% older when they are aged 15.

[2] A common challenge for the identification of birthday effect is that it may causes to three channels, that are linearly related : the age at which students sit tests, the age at which they started school, and the grade in which they are enrolled are linearly related. It makes it impossible in general to identify separately one or another of these channels. One may plausibly assume that the age-at-test effects on cognitive and socio-emotional outcomes would be similar from one country to another, and among children of different socioeconomic statuses within the same country, as they would depend on biological maturity.

to participate in school), this variable is instrumented by the theoretical school starting age. The theoretical age at school entry varies within one country only through the student's birth month and on an administrative cutoff date for eligibility to enroll in school.

The estimates show that in all school systems, age at school entry has a significant and sizeable impact on cognitive outcomes at 15, as measured by the PISA score. The magnitude varies from 0.1 to 0.3 standard error depending on school systems, and is observable in the three main PISA domains (maths, reading, and science). The relative age at entry to a school has an impact on being held back in school: in countries that used grade repetition extensively, being older by one year at entry at school significantly increases the likelihood of having repeated a grade at 15, which may partly mediate the persistence of relative age effect at older age. On average, these birthday effects are higher for students from disadvantaged social backgrounds than for more favored ones, and for boys than for girls.

First and foremost, this study presents new and comprehensive evidence on the impact of the relative age at school entry on social and emotional competencies. Students who enter school relatively old compared to their peers often have better attitudes towards school and positive relationships with their peers and teachers. For instance, students who enter school older than their peers were less frequently exposed to bullying at school, and reported less frequently that they experience some form of unfair treatment by their teachers. On average over the 16 countries analyzed here, being one year older at entry at school increases by 0.1 to 0.2 standard deviation indices of social and emotional skills measured in PISA: persistence, assertiveness, curiosity, emotional control, stress resistance and empathy, as well as intrinsic motivation and self-esteem. As advocated notably by Heckman and Kautz (2012), these "characters" beneficially affect later-life outcomes. Those who were the eldest in their school entry cohort also tended to have more ambitious educational expectations : entering school one year eldest results in expectations of completed tertiary education significantly higher by 5 percentage points on average across the 16 countries analyzed here. The magnitude of these school starting age varies with school systems, though.

This study contributes to the growing body of research on the measurement of birthday effects and the identification of drivers. First documented in the domain of sports, birthday effects on educational outcomes and careers have been observed in almost all countries. Using the Trends in International Mathematics and Science Study (TIMSS) Bedard and Dhuey, 2006 observe enduring birthday effects in all OECD countries, from grade fourth to grade eight. Such effects have been observed in the United Kingdom (Crawford et al., 2014), Italy (Ponzo and Scoppa, 2014), Israel (Attar and Cohen-Zada, 2018), France (Grenet, 2010), Mexico (Peña, 2020), Sweden (Fredriksson and Öckert, 2014), and the United States (e.g., Bedard and Dhuey, 2006 in Florida). Those who were the oldest in their school-entry cohort are overrepresented in leadership positions in both political (Muller and Page, 2016; Tukiainen et al., 2019) and economic fields (Du et al., 2012). A consistent pattern indicates that students entering school early appear to be more likely to be diagnosed with attention deficit hyperactivity disorder (ADHD) (Dhuey and Lipscomb, 2010; Elder and Lubotsky, 2009; Furzer et al., 2020; Dee and Sievertsen, 2018) and special educational needs Balestra et al. (2020). It may be argued that this over-representation of students who are the youngest in their cohort is due to a wrong attribution of a relative lack of maturity as learning difficulties. In addition, Ballatore et al. (2020) observe being students younger than their peers have higher risk of being bullied, and Thompson et al. (2004) that they have often lower degree of self-esteem. Very little is known about the heterogeneity of these effects by socio-demographic characteristics, with the exception of Fredriksson and Öckert (2014) with Swedish data and Bernardi (2014) with French data who observe higher school starting age effects for children with low-educated parents. This may be explained by the theory of "compensatory advantage", meaning that children from advantaged backgrounds may benefit from a higher level of parental investment that helps to soften the negative consequences of prior adverse outcomes. This study adds to the existing literature on school starting age by comparing the magnitude of these birthday effects on several distinct school systems, in both cognitive and non-cognitive dimensions, and in illustrating variation by socio-economic background and gender.

This analysis also relates to recent analysis on the still controversial impact of peer effects, and more notably, on the impact of the rank among peers. Murphy and Weinhardt (2020) show 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. This may explain why the relative age effects are long-lasting. For instance, Crawford et al. (2010) observed that the youngest students in a school cohort reported had a lower view of their own scholastic competence than their older peers, which is not fully explained by actual differences due to their lower age at the time of testing. However, this effect is controversial; for instance, Cascio and Schanzenbach (2016) observe that having older peers in the kindergarten, at a given age, has a positive impact on educational outcomes, at least for the youngest students. To the best of our knowledge, no previous study has compared the relative age effects between distinct school systems.

The remainder of this paper is organized as follows. Section 2 presents the data and the details of the empirical strategy. Section 3 discusses the results of different outcomes, including several robustness checks. Section 4 presents a general discussion of the results.

2 Data and identification strategy

2.1 PISA data and school system regulations

The analysis is conducted using mainly data from the three latest rounds of PISA (2015, 2018, and 2022). PISA is a survey conducted every three years by the Organisation for Economic Co-operation and Development (OECD) in a large set of countries. PISA provides comparable measures of 15-year-old students' school performance in three domains (reading, mathematics, and science). In each round of PISA, one of the academic domains is tested in more detail—with three rounds, the analysis is conducted on the three most accurate measures for the three domains. PISA also provides measures of socio-emotional variables, based on a student-reported questionnaire. These dimensions vary from one cycle to another. Information is also collected from national education authorities using a dedicated questionnaire on system-level variables, such as compulsory school starting age and age of first selection into differentiated education. PISA 2018 also provides information about the regulations regarding school entry: the first day (dd/mm) of the school year at each level of education and the cutoff date (dd/mm) for eligibility to enroll in school. The cutoff date is defined as the date by which a child should have reached the theoretical starting age for primary school, i.e., the age at which the child is eligible to enroll in school (see Table C.2).

The analysis focuses on OECD countries for which we can accurately measure individual age at school entry, the grade at the time of the PISA test, and where regulation regarding school enrollment (cut-off, first day of school) is defined at the federal level.[3] In practice, a set of 16 countries is considered (15 OECD countries for which we have sufficient information, with the addition of Singapore): Austria, Belgium, England and Wales, Denmark, Estonia, Finland, France, Italy, Korea, Japan, the Netherlands, Mexico, Norway, Singapore, and Spain.[4] Comparing various distinct school systems helps to determine whether birthday effects are consistent, or if they vary depending on the contextual factors involved. Most of the countries analyzed here are indeed quite similar in terms of economic development and school enrollment,[5] but their school systems have distinctive features. For instance, the compulsory age for primary school is 7 in Estonia, Finland, and Poland, while it is 5 in England and Wales, and 6 in the other countries. School systems also differ in the use of grade repetition and the age of first selection into differentiated systems (see Table C.1 in the Appendix): In Belgium, France, Spain, the Netherlands, and Mexico, 10% or more of the PISA students reported having repeated a grade in primary school, but in most of the

[3]This excludes for instance Germany, New-Zealand, the United States, Switzerland, and Australia, where the cutoff dates may vary by jurisdiction and thus could not be provided by federal authorities.

[4]In PISA 2018 and 2022, information on school entry is not available for Norway and is imputed to "normal age" for Japan.

[5]For instance, in all countries but Mexico, the upper age limit for compulsory education is above 16 (it is 15 in Mexico), and as a consequence, the coverage of the PISA survey is high: in PISA 2022 the survey respondents represent 63% of the 15-year-old population in Mexico, 79% in the Netherlands, 84% in Denmark and more than 90% in other countries.

other countries, this proportion is lower than 3%. The age of first selection is 10 in Austria, 12 in Belgium and Singapore, 14 in Italy, 15 in Denmark, France, Japan, Korea, and Mexico, and 16 in the other seven analyzed countries.

In all countries, 15-year-old students may be enrolled in distinct grades when they sit the PISA test. This could be the case if students had started primary school later or earlier than the applicable regulations stipulate or if they had repeated or skipped a grade since their entry into school. In addition, one of the specific features of the PISA test is that the sample is age-based, while most existing tests are usually grade-based. The average age is approximately 15 years and 10 months in most countries. The PISA sample is representative of an annual cohort of students. However, this annual cohort does not always align with a theoretical school cohort at the time of school entry, which would be defined by a strict enforcement of school entry regulations. In some countries, such as Austria, Estonia, Finland, and Korea, the PISA sample includes students from two different grade cohorts. This variation arises from differences in the school start dates and the cutoff dates used to determine age eligibility.

In countries where the PISA survey samples two school cohorts, it becomes feasible to estimate the impact of age at school entry while accounting for the grade level of the students at the time of the PISA test. It is crucial to control for grade in such analyses because school performance is expected to vary significantly across grades. Students in higher grades have benefited from more extended schooling, have been exposed to more complex concepts, and are therefore likely to achieve higher scores on the PISA test compared to those in lower grades. Consequently, any estimation of the impact of age at primary school entry must adjust for the effects associated with being enrolled in a higher grade. The consequences for estimations in countries where the survey samples only one school cohort are discussed in the robustness section 3.5.

2.2 Contextual variables and socio-emotional outcomes

PISA measures of literacy are completed through contextual questionnaires, notably providing information about students' backgrounds (for instance, gender, date of birth, and occupations and education of parents), their educational path (age at primary school entry, grade repetition). These variables make it possible to control for individual characteristics (such as the socioeconomic background, measured by relying on the PISA index of economic, social, and cultural status, ESCS, see Avvisati, 2020), but also to identify those students who have repeated a grade and whether the grade repetition occurred in primary school or in middle school.

PISA data make it possible to calculate the theoretical age at primary school entry (using the student's birth month, cut-off dates, and date of first day of the school year), as well as the *actual* age at entry at school. In the student questionnaire, students who sit the PISA test are also asked how old they were when they started primary school. The possible answers range from "4 years" to "9 years or older" (and include "I do not remember"). This information is reported in years, but may be measured in months using the child's birthday and the date of the first day of the school year.

In PISA, students are also asked about their attitudes, beliefs, motivation, and aspirations (for details on the variables used in this article in the Appendix B) and the quality of their relations at school.[6] As discussed by Kautz et al. (2014), these skills (perseverance, motivation, self-esteem, self-control, conscientiousness, and forward-thinking behavior...), that are valued in the labor market, are predictors of later-life outcomes. While all recent PISA cycles have included such measures of social and emotional competencies, the types of skills and instruments used for their measures change from one cycle to another. PISA 2022 introduces a comprehensive array of measures for social and emotional competencies, aligned with the five-factor structure of personality traits known as the 'Big Five model' (see the Appendix for details). These traits include emotional regulation, engagement with others, collaboration, task performance, and open-mindedness. Similar attributes have been assessed in previous PISA cycles, although not as

[6]The answers to these questions are summarized by indices relying on Item response theory (IRT) modeling, notably to confirm the theoretically expected behavior of the indices and to validate their comparability across countries. For details see for instance (OECD, 2019), the PISA 2018 and 2022 Technical Reports OECD (2024).

systematically as in PISA 2022. In addition, PISA surveys introduce variables measuring the quality of the relationships at school (with teachers or peers at school). For these dimensions, only data from PISA 2015 and 2018 are utilized. PISA 2022 coincided with the tail end of the COVID-19 global pandemic, which significantly affected the schooling experience of students due to frequent school closures (OECD, 2023b).

In the study, two main dimensions are explored. A first group of outcomes focuses on the students' social and emotional skills. These include variables regarding task performance skills (persistence, motivation to master tasks), emotional regulation skills (stress-resistance and emotional control); engaging with others skills (assertiveness and cooperation); open-mindedness skills (curiosity) and collaboration skills (empathy). These variables from PISA 2022 are complemented by indices related to self-confidence, such as a measure of self-efficacy (an index estimated from answers to questions such as "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"), whether they enjoy competition and whether they expect to complete tertiary education.

2.3 Identification issues and econometric models

The actual age at school entry of one child may differ from the theoretical starting age for primary education. For instance, in the United Kingdom, while most children are expected to start formal schooling quite early (in September after they turn 4), "summer children" (those born between 1 April and 31 August) may delay school entry by one year (Cirin and Lubwama, 2018).

In contrast, in Italy, for instance, it is quite common that some families favor early entry into primary school, which is perceived as more stimulating than kindergarten (Ponzo and Scoppa, 2014). In any case, it is likely that decisions to postpone or advance school entry are endogenous, as they usually depend on the child's maturity at the time of school entry. For this reason, even though the proportions of late and early entry differ widely from one country to another, at the individual level such decisions usually depend on the relative position of the child in the theoretical school cohort (Givord, 2020): those who start school earlier are more often the children born just after the cutoff (those are the eldest in their theoretical school cohort) and those who start school later are children born just before the cutoff (the youngest in their theoretical school cohort). Because of this endogeneity, OLS estimates of the impact of age at entry on most educational outcomes are expected to be downward biased.

Furthermore, as age at school entry is self-reported, the variable may suffer from measurement error. Some students may have no clear memory of the age at which they entered primary school (for instance, if they had been enrolled in preprimary school before). This would reinforce the attenuation bias of the OLS estimates.

To address these two empirical issues, the impact of school starting age is measured using a 2-stage-least-squares estimation, where the self-reported age at entry is instrumented by the theoretical age at entry, as defined by the strict application of regulations for school enrollment. As a robustness check, additional estimations are provided by correcting the self-reported school entry age, using additional information from the school report (see Section 3.5).

A second issue is whether to control for the actual grade sampled students are enrolled in at the time of the survey. On one side, the actual grade is potentially correlated with the age at entry (the youngest students in a school cohort, as defined by a strict application of the school regulation, are more likely to be enrolled in a lower grade than the oldest students). If the specification does not control for the grade, part of the measured differences between the eldest and the youngest students at school entry may be mediated by the fact that they are enrolled in different grades. On another side, the current grade a student is enrolled in is endogenous, and may thus alter the estimations. In countries where two school cohorts are sampled by design, this issue is solved by instrumenting the actual grade by the theoretical grade the student should be enrolled in, according to his or her birthday if he or she had been "on time". This is simply a dummy that measures whether the month of birth is above or below the cutoff date.[7] This strategy cannot

[7] The estimate of grade impact provides a measure of the "learning gain" of students over one year of schooling,

be used in countries where only one school cohort has been sampled (as there is no variation in the theoretical grade), and for these countries, the estimation of the impact of the age at school entry is not conditional on the current grade. The consequences for estimations are discussed in the robustness section 3.5, by comparing estimates with and without the current grade in the four countries where the corrections can be made.

The main specification is:

$$Y_i = SSA_i\beta + X_i\gamma + u_i \tag{1}$$

$$SSA_i = SSA_i^{th}\alpha_1 + X_i\gamma_1 + v_i \tag{2}$$

with $(v_i, w_i) \perp Y_i \mid X_i$.

In countries where two school cohorts are sampled by design, the equation becomes $Y_i = SSA_i\beta + Grad_i\delta + X_i\gamma + u_i$ and $\mathbb{1}_{m\_birth_i<cutoff}$ is used to instrument $Grad_i$.

In practice, the theoretical age at entry SSA_i^{th} is expressed in years (based on a measure in months, set to one month for students born the month just before the cutoff date and 12 months for those born just after the cutoff date). Defined this way, the variable measures the theoretical relative age of the student within their cohorts as defined by the school regulation. This corresponds to the theoretical relative age at which the student should have started school had the regulations been enforced without exception. It is the largest for the students assumed to be the eldest in their school-entry cohort, and the lowest for the students assumed to be the youngest in their school-entry cohort.

2.4 Validity and interpretation of the IV estimates

The IV estimate provides a measure of an average causal impact of the relative school starting age at school on outcomes provided that the theoretical relative age at entry SSA_i^{th} is a valid instrument. The identification assumption (2.3) means that conditional on observable characteristics, the theoretical starting age and the school cohort the students belong to have no direct effect on educational outcomes except through their effect on respectively actual school starting age and actual grade when they sit the test. This cannot be formally tested, but as the theoretical age at entry is only related to the month of birth, one may plausibly assume that it is unrelated to other unobserved determinants of the outcomes, conditional on observables. These observables include the position in the national distribution of the index of economic, social and cultural status, that combines several variables related to students' family background (parents' education, occupations, and proxies for material wealth and cultural capital). Controlling for these parental background reduces potential threats of validity that may emerge if the seasonality of birth varies with parental background, as observed in the US for instance by (Clarke et al., 2019; Buckles and Hungerman, 2013). Note that in countries analysed here, no significant effect is observed in the average ESCS by month of birth (see Table C.4 the Appendix).

The second condition regarding the validity of the identification strategy is the correlation provided by the first stage equations (2). They relate respectively (1) the actual school starting age with the theoretical age at entry SSA_i^{th}, as defined by a strict application of the school entry regulation and calculated using the birthday and cutoff dates and controlling for the same characteristics and (2) the actual grade a student is enrolled in at the time of the PISA test and the theoretical grade he or she is expected to be enrolled in at the time of the PISA test, if he or she has been enrolled at the normal age and has not repeated a grade (which is identified by the fact of being born before or after the cutoff). The former is identified only in countries where two school cohorts have been sampled by design.

In all countries analyzed here, actual age at school entry is strongly related to theoretical age at entry. In countries where school regulations regarding entry at school are strictly applied, the

as examined in detail in Avvisati and Givord (2021).

coefficient α_1 is expected to be 1. The correlation can be distinct when parents do not always comply with regulations. This is shown in the Figure 1. In most countries, the coefficient is close to one, which is consistent with the fact that in these countries, most students enter school at the expected age (see Givord, 2020 for details). However, in several countries, the coefficients are markedly lower than one. This can be explained by the fact that some children may enter school later (as in Austria and in England and Wales) or earlier (as in Italy) than scheduled, and such a decision usually depends on the maturity of the child: students who are the eldest in their school cohort are more likely to enter school earlier while the youngest students in their cohort are more likely to enter school later. This makes the observed age at entry endogenous to educational outcomes, and this is the reason why naive estimations of the link between the school starting age and outcomes may provide spurious results.

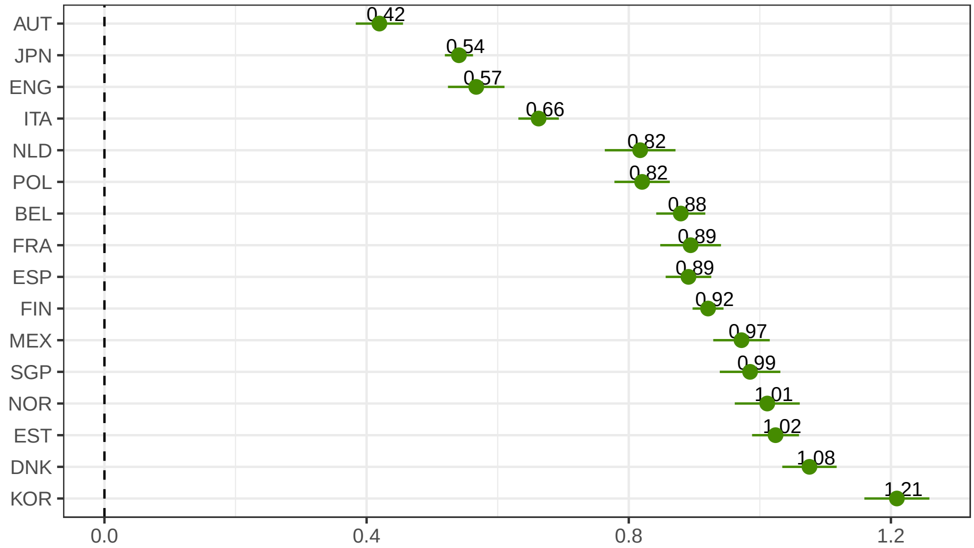

Figure 1: First stage estimate: impact of theoretical age on actual relative age at school entry

Source: PISA 2015, 2018 and 2022, Author's calculation.

Note: Point estimates and 95% Confidence intervals. Models include additional control variables: gender, socio-economic status (4 dummies), immigrant background, PISA cycle dummies.

Angrist and Imbens (1994) provides a useful framework for interpreting the results obtained with an IV strategy. This framework is defined when both the instrument and the endogenous variable (the treatment) are binary, which is not the case in this study. For illustration purposes, one may first adapt the analysis to the binary treatment/instrument case. A binary treatment would be defined as the condition of being amongst the eldest children at school entry, while the assignment to the treatment would be defined as being born just after versus just before the cutoff. One should consider the thought experiment of comparing the observed relative age at entry for a child born in a specific month with the age that child would have started school had he or she been born in a different month of the same year. The interpretation of the IV estimator within the Angrist and Imbens (1994) framework hinges on the 'monotonicity assumption.' In the case analysed here, this assumption implies that being born just after or just before the cutoff has a non-negative impact on the likelihood of being the oldest at school entry. Specifically, it assumes that no parents would opt to anticipate school entry for a child born before the cutoff while delaying it for one born after. The likelihood of encountering 'defiers'—those who act contrary to the direction suggested by the instrument—is low. Non-compliance is likely influenced by the child's maturity, which correlates with their month of birth.

For example, some parents may prefer their child to be among the oldest when starting school, opting to delay school entry if their child is born just before the cutoff, while adhering to regulations if born just after. In Angrist and Imbens (1994)'s terminology, these parents are labelled as 'always takers.' Conversely, parents who prefer their children to be 'stimulated' by older peers will comply if the child is born just before the cutoff, but might accelerate entry if born just after, classifying them as 'never takers.' Most parents, however, are likely to follow school enrollment rules. Under the monotonicity assumption, Angrist and Imbens (1994) demonstrate that the IV estimator measures a "local average treatment effect" (LATE), defined as the average treatment effect for 'compliers,' those whose children are among the oldest at school entry if and only if born just after the cutoff. The external validity of this LATE estimate depends on the degree of heterogeneity in the causal effect of relative school starting age, and on the degree of flexibility given to parents for choosing age at school entry. In school systems where choice is given to parents, it is likely that the maturity of their child is taken into account in the decision: parents will anticipate entry when possible only if the child is "mature enough", and that it is anticipated that they will not be harmed by being the youngest at school (this configuration corresponds to "never takers"), or on the contrary delay for children that may especially suffer from being the youngest at school (this configuration corresponds to "always takers"). It is thus likely when the proportion of children who delay entry, the IV estimate provides a lower bound of the causal impact of being amongst the eldest at school entry, while it corresponds to a higher bound when the proportion of students who anticipate are high. The IV estimate is expected to be close to the average treatment effect when compliance to school regulation is strict.

However, the context of this paper presents additional complexities, as both the treatment (relative age at school entry) and the instrument (month of birth) are continuous variables. If parents strictly adhere to enrollment rules, the relationship between them is expected to be linear (a child born just before the cutoff would be eleven months younger at entry than one born just after). However, with non-compliance, the relationship between treatment and instrument is not strictly monotonic nor linear. For example, if parents delay the school entry for a child born just before the cutoff—but not for one born just after—the child starting school in the latter scenario would be one month older at entry than in the former.Thus, for these students, the relationship is not constant, deviating from the expected patterns for 'never takers' or 'always takers' as described in the Angrist-Imbens framework. As far as we know, no analysis of the properties and interpretation of the IV estimators in this context have been provided before.[8]

The robustness of the main results to deviation from the monotonicity assumption is tested by two polar tests. The first test restricts the sample to children born in "intermediate" months (three or four months away from the cutoff). For these children, non-compliance is very unlikely as the possibility of delaying or anticipating entry at school is usually possible for children born "at the margin" of the cutoff. Assuming that the relationship between the relative age at entry and outcomes is linear, the results should be similar to those obtained in the entire sample.

The second test, on the contrary, uses a regression-on-discontinuity design and restricts the sample to children born just around the cutoff. The estimation will estimate the effect of being amongst the eldest rather than amongst the youngest at entry at school and thus correspond to the LATE defined just above. This robustness check can be conducted only in countries with one school cohort.

3 Results

3.1 Relative age and performance on cognitive tests

Reduced-form estimates correspond to direct estimates of the effect of theoretical age at school entry (the age that would be observed from a strict application of the regulations regarding school

[8]Dahl et al. (2023) show that in some context, the monotonicity assumption may be violated for some estimations of birthday effects when the enrollment rules are not strictly enforced. Their context is, however, distinct from the one analyzed in this paper.

entry). These reduced-form estimates are informative by themselves, as they provide the most direct measure of the birthday effect. They can be interpreted as the difference in outcomes between two children, one born just after the cutoff date and one born almost one year later, but just before the cutoff date - and thus the simple effect of the month of birth on outcomes when the students are aged 15 (whatever the mechanisms that explain these variations). Because of these small birthday differences, the former student is expected to be among the oldest in his or her theoretical school-entry cohort, while the latter is expected to be among the youngest students in this same theoretical school-entry cohort.[9]

As illustrated by Figure 2, the reduced-form estimates show that theoretical school starting age has significant and sizable effects on the cognitive results measured by PISA for 15-year-old students. On average, among the 16 countries analyzed here, being born just after the cutoff increases performance at the PISA test by 16 score points, compared to children born just before the cutoff. Birthday impact significantly varies among countries, though, from around 10 score points (in Austria, Denmark, the Netherlands, and Singapore) to more than 20 score points (in Estonia, Finland, Norway, and Mexico).

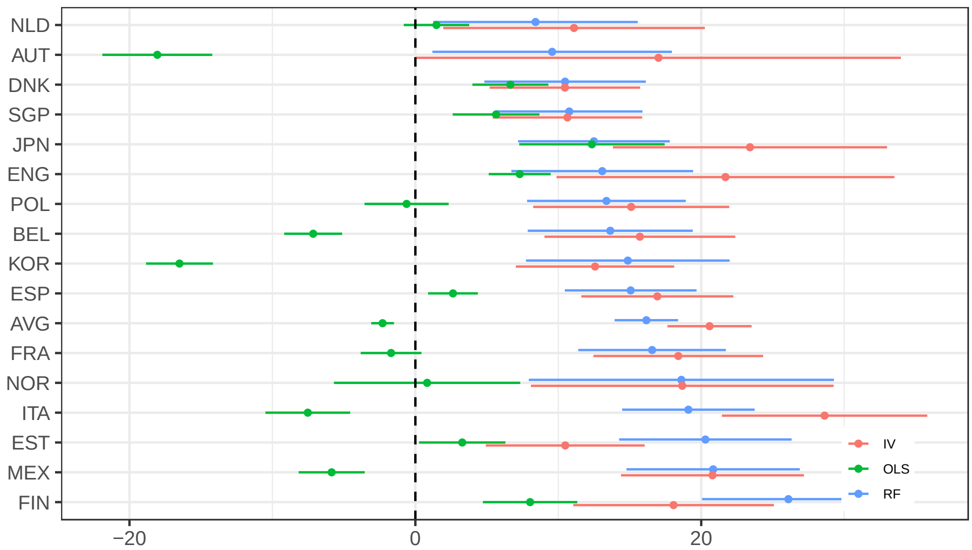

Figure 2: Impact of the relative age at school entry on reading performance: OLS, IV and Reduced-form estimates

Source: PISA 2015, 2018 and 2022, Author's calculation. Note: Point estimate and 95% Confidence Interval of the impact of the relative age at school entry, 2SLS (instrument: theoretical age at entry). Models include as additional controls variables: gender, socio-economic status (4 dummies), immigrant background, PISA dummies. In countries where two school cohorts have been sampled, the specification includes detailed grade, instrumented by the theoretical grade.

The OLS estimates of the impact of actual age at entry on educational outcomes are much smaller, usually not significant and even negative in seven out of the sixteen countries analyzed here (Figure 2). This illustrates that observed age at entry may be endogenous. Some children may be enrolled earlier or later than scheduled, and these decisions are usually based on the observed maturity of the children. Those students who entered school earlier for instance are more likely to have had higher cognitive performance, while being the youngest students in their class; conversely, children who entered school later than scheduled, are more likely to have had lower cognitive performance while being the eldest in their cohort.

The 2SLS estimates, using theoretical age at entry as an instrument for the measured relative

[9]For the sake of simplicity, the reduced-form and OLS estimates are shown only for reading performance, but similar conclusions can be drawn for mathematics and science.

age at entry (and theoretical grade as an instrument for the actual grade), provide a very different picture than the OLS estimates. They show that relative age at entry has a significant impact on performance in almost all countries in the three main domains measured by PISA (reading, mathematics and science, see Figure 3). Being the eldest in one's class at school entry is positively related to performance on PISA. On average, among the 16 countries analyzed here and over the three PISA rounds, a one-year difference in age at school entry is associated with 21 score points on reading performance and 18 score points on math and science performance, as measured by the three last PISA tests. The estimates are the highest in Italy (29 score points in reading, on average over the three last PISA cycles) and Japan (23 score points) and the lowest in Denmark, Estonia, and the Netherlands (around 10 score points in reading). The estimates are not precisely estimated in Austria, England, and Japan, though. In almost all countries, the estimates are of similar magnitude for the three domains and when analyzing separately the different rounds of PISA (see Figure C.1 in the Appendix). Distinct trends appear in a few countries: a net increase in the impact of school entry in Poland, and a decrease in Denmark, France, and Mexico.

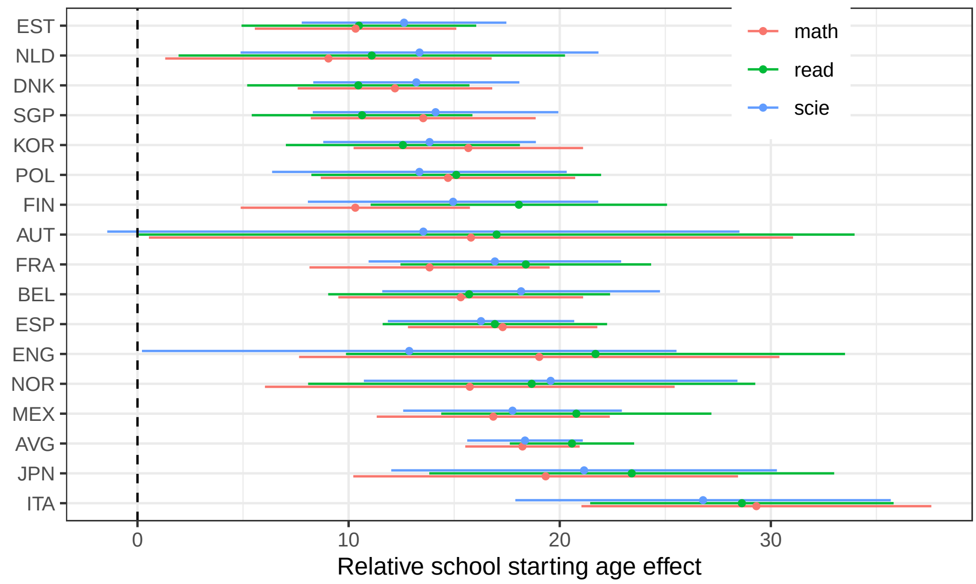

Figure 3: Impact of relative age at entry on reading, mathematics and science performance

Source: PISA 2015, 2018 and 2022, Author's calculation. Note: Point estimate and 95% Confidence Interval of the impact of the relative age at school entry, 2SLS (instrument: theoretical age at entry). Models include as additional controls variables: gender, socio-economic status (4 dummies), immigrant background, PISA dummies. In countries where two school cohorts have been sampled, the specification includes detailed grade, instrumented by the theoretical grade.

For the sake of comparison, these birthday effects can be compared with existing score variations at the country level. On average across OECD countries, the difference in maths performance between students in respectively the first and the fourth quarter of the ESCS distribution in PISA 2022 is around 90 (see for instance OECD, 2023a), gender differences are 9 score points (and 20 score points in reading). The impact of being older by one year at entry at school has the same magnitude of the impact of a year of schooling, as it can be estimated in countries where two school cohorts have been sampled by design (Figure C.2 in the Appendix): in these four countries, the impact of relative school starting age is equivalent from half to one additional year of schooling, depending on the country.

3.2 Relative age and grade repetition

The long-lasting effects of school starting age may be related to the students' schooling experience. Grade repetition may constitute a channel for the impact on score performance. Simply because 15-year-old students who have repeated a grade are enrolled in a lower grade at the time of the PISA test than their no-grade repeaters. In addition, literature suggests that grade repetition may have long-term negative consequences (for a survey see for instance Valbuena et al., 2021): If grade repetition may be viewed as a remedial measure aimed at addressing the learning challenges faced by children, most existing results suggest that it has at most a positive impact on the short-term only, and may have a negative impact on the long-term. The use of grade repetition largely varies amongst countries, as illustrated by the variation in the proportion of students who have reported in PISA 2018 that they had repeated a grade in primary school (see Table C.1 in the Appendix). While in England and Wales, Estonia, Finland, Italy, and Korea, only a few percent of students report that they have repeated a grade in primary school, the proportion is higher than 10% in Belgium, the Netherlands, France, and Spain.

In all countries using extensively grade repetition, relative age at entry is a strong predictor of grade repetition. The estimates suggest that in these countries, being older by one year at school entry reduces the probability of repeating a grade in primary school by as much as 13 percentage points in Belgium (see Figure 4), and 10 percentage points in Austria and France. The impact greatly varies by gender and socio-economic status (see subsection 3.4). The impact of age at entry is much lower when measuring grade repetition in middle school rather than primary school, consistently with the fact that such repetition is mediated by a lack of maturity in the early years of schooling that fades with age, but is still significant in Belgium, France, Italy, and Spain.

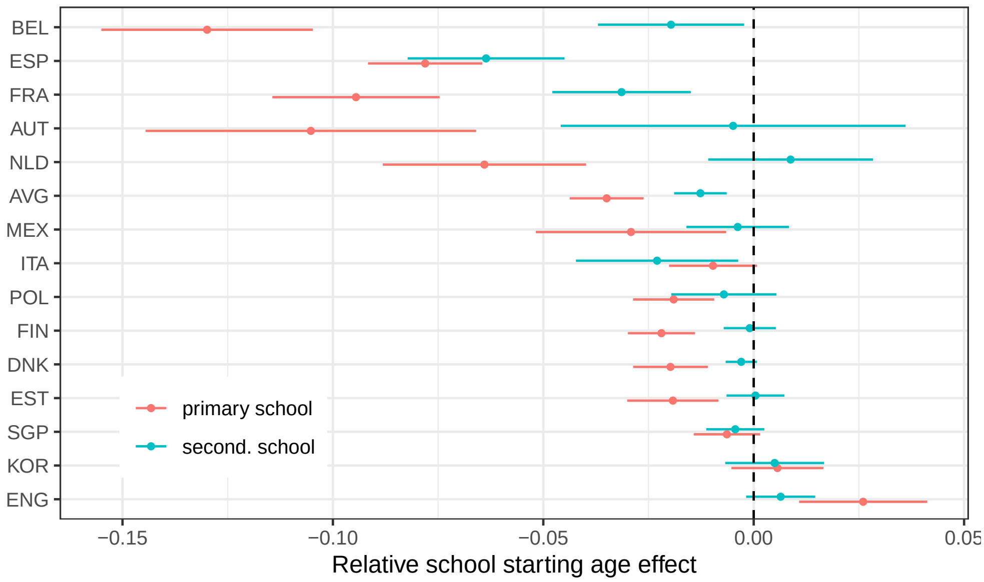

Figure 4: Impact of relative age at entry on grade repetition in primary and secondary school

Source: PISA 2015, 2018 and 2022, Author's calculation. Note: Point estimate and 95% Confidence Interval of the impact of the relative age at school entry, 2SLS (instrument: theoretical age at entry). Models include as additional controls variables: gender, socio-economic status (4 dummies), immigrant background, PISA dummies. In countries where two school cohorts have been sampled, the specification includes detailed grade, instrumented by the theoretical grade.

3.3 Relative Age and Socio-emotional Skills

Previous research has explored whether the age at which children start school influences their initial experiences with formal education. Negative experiences can shape children's perceptions and attitudes toward school, affecting their self-confidence. These effects may have long-lasting impacts on the development of their social and emotional skills and subsequently on their future outcomes.

3.3.1 Social and Emotional Skills

According to PISA 2022 data, being older at the time of school entry positively influences key social and emotional skills (see Figure 5). Across a set of 16 countries, being one year older at school entry significantly increases assertiveness (by 0.15 standard deviations), persistence (0.08 sd), curiosity (0.08 sd), empathy (0.07 sd), emotional control (0.07 sd), stress resistance (0.06 sd), and resistance to stress (0.06 sd). These traits are likely to correlate with positive future outcomes. For example, assertiveness may lead to better communication and healthier relationships. At the country level, estimates of the impact of relative school entry age are consistently positive, though not significant in all countries, possibly due to variations in school systems and the smaller sample sizes used (only one PISA cycle).

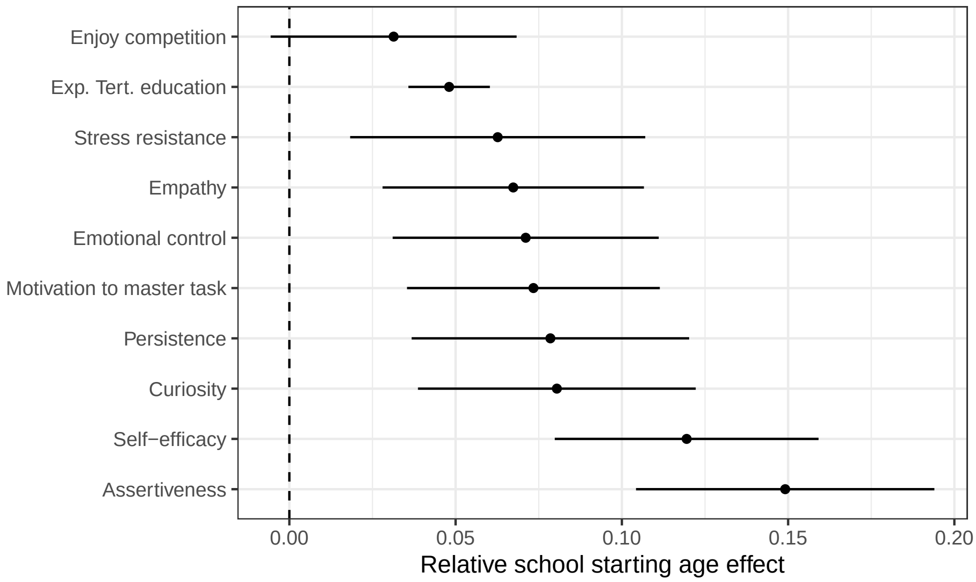

Figure 5: Average impact of the relative age at school entry on social and emotional skills

Source: PISA 2015, 2018, and 2022, Author's calculation. Note: Point estimate and 95% Confidence Interval of the impact of the relative age at school entry, 2SLS (instrument: theoretical age at entry). Models include additional control variables: gender, socio-economic status (4 dummies), immigrant background, PISA dummies. In countries where two school cohorts have been sampled, the specification includes detailed grade, instrumented by the theoretical grade.

Analyses using PISA 2015 and 2018 data related to self-confidence support similar conclusions. Being the oldest at school entry positively affects students' self-efficacy (by 0.12 standard deviation on average) and motivation to master tasks (0.07 sd), with significant estimates observed in several countries, including Denmark, Estonia, England, Wales, Italy, Korea, Poland, and Spain. On average, no significant impact is noted nor in most countries on the propensity to enjoy competition at age 15. However, starting school earlier significantly impacts educational expectations: being one year older at school entry increases expectations of completing higher education by 5 percentage points on average across the sixteen countries, with larger effects observed in England and Wales (11 percentage points), Belgium, Japan, Austria, and Italy (6 percentage points). As educational expectations reflect young individuals' views on their future prospects and their ambitions, lower expectations may lead to lower achievements. This finding underscores how birth month can significantly influence long-term outcomes, as documented by several studies.

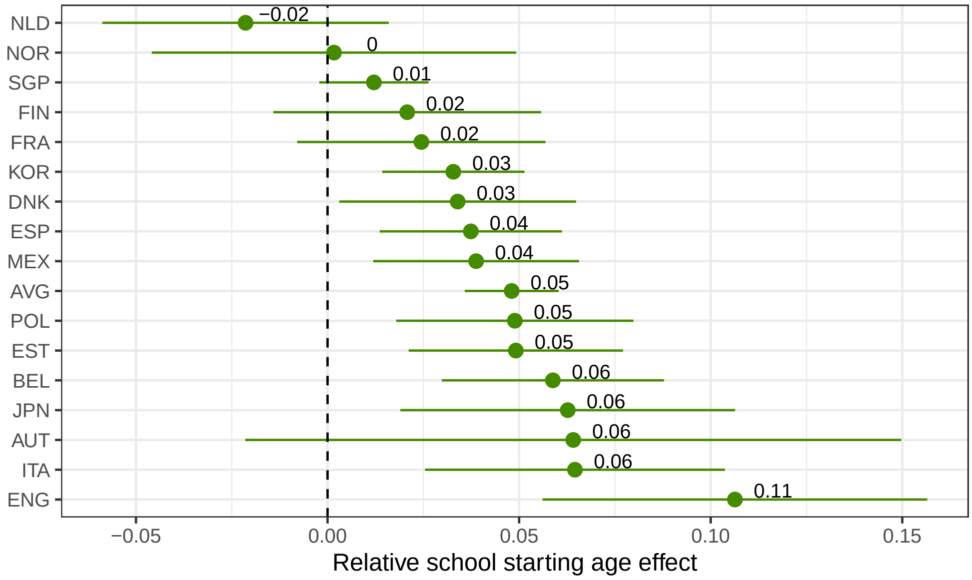

Figure 6: Average impact of the relative age at school entry on expectations to complete a tertiary degree

Source: PISA 2015, 2018, and 2022, Author's calculation. Note: Point estimate and 95% Confidence Interval of the impact of the relative age at school entry, 2SLS (instrument: theoretical age at entry). Models include additional control variables: gender, socio-economic status (4 dummies), immigrant background, PISA dummies. In countries where two school cohorts have been sampled, the specification includes detailed grade, instrumented by the theoretical grade.

The variation in the magnitude of the birthday effect across school systems and among different types of students within countries suggests that these effects measure more than just differences in maturity. They likely reflect the varied experiences children have at school, influenced by the specifics of the school system.

3.3.2 Relationships with teachers and peers

The youngest students in a school cohort may be confronted with difficulties in learning, as they are intellectually less mature; they may struggle with some tasks and thus may receive less frequent positive feedback from their teachers. Consequently, they may feel that their efforts are not adequately rewarded, which may alter their perception of their relationship with their teachers. As they lack self-confidence and are, on average, physically weaker, they may have more challenging relationships with their peers and be more at risk of being bullied.

Estimations confirm these assumptions. Age at primary school entry negatively affects measures of the quality of students' relationships with their teachers and peers (see Figure 7). The eldest students report more often positive relationships than the youngest ones. For instance, students who were the eldest at entry at school were less likely to perceive their teacher as "unfair" (by 0.36 standard deviation on average) and reports more frequently that their teacher is inspiring (by 0.08 sd), and a positive disciplinary climate (by 0.09 sd). A possible explanation for these results may be that if youngest students have negative first experiences with school (for instance, if they felt that they had to work hard in their first classes and received insufficient rewards from their teachers), they may maintain uneasy feelings when they interact with their teachers.

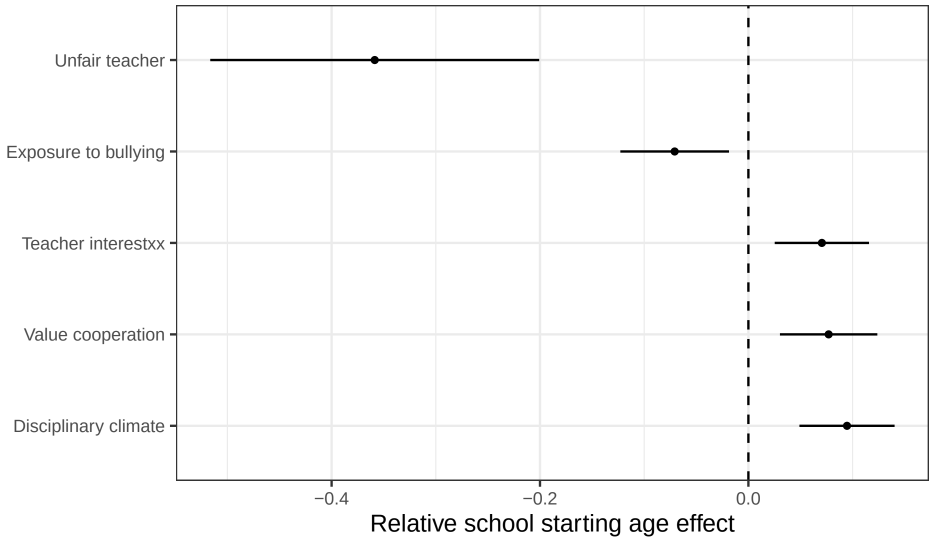

Figure 7: Average impact of the relative age at school entry on social and emotional skills

Source: PISA 2015, 2018 and 2022, Author's calculation. Note: Point estimate and 95% Confidence Interval of the impact of the relative age at school entry, 2SLS (instrument: theoretical age at entry). Models include as additional controls variables: gender, socio-economic status (4 dummies), immigrant background, PISA dummies. In countries where two school cohorts have been sampled, the specification includes detailed grade, instrumented by the theoretical grade.

Such negative perceptions are also observed regarding their relationships with their peers. On average, the students who were the youngest at primary school entry were more exposed to bullying when they were 15 - being one year younger increases the index of exposure to bullying by 0.07 standard-error, but this is only significant in Belgium, France, Italy, and the Netherlands. This effect appears to be higher among boys (see Table C.10 in the Appendix). Physical bullying may be more frequent, especially for boys, and power imbalances due to differences in physical maturity may have direct consequences. Older peers also more often reported valuing relationships with their peers and being engaged in collaborative activities for others' own benefit (they more often reported that they "are good listeners", "enjoy seeing their classmates be successful", "take into account what others are interested in", and "enjoy considering different perspectives"). Students who were the eldest report also more often valuing cooperation (+0.08 sd).

3.4 Heterogeneity of the school starting age by gender and social backgrounds

The impact of relative age at entry varies with the individual characteristics of the students. On average across the 16 countries, the impact appears non-linear - in the three main PISA domains it is small and not significant for students with the most advantaged backgrounds - those in the highest quarter of the distribution of the PISA index of economic, social and cultural status (see left panel in 8), while it is slightly increasing from the three bottom quarters of ESCS, especially in mathematics (the impact of the relative age at school entry is 12 for students in the first quarter of the distribution of ESCS and 22 for those in the third quarter). One may assume that the youngest children in a cohort benefit from greater support to compensate for their initial disadvantage when they come from a high-status background (Bernardi, 2014). At the country level, coefficients are less precisely estimated. Various patterns emerge, but the differences are rarely significant. The most striking differences emerge in Korea, where the impact is significantly higher for the most disadvantaged students than for the more advantaged ones, and in Italy, where the opposite pattern is observed. This may be related to the fact that IV estimates correspond to a "Local average treatment effect" (see subsection 2.4, and that Italian parents can anticipate their children's entry into school (Ponzo and Scoppa, 2014). Givord (2020) observes that 9% of PISA students started primary school earlier than scheduled when they came from an advantaged family, while this proportion is only 5% for students from disadvantaged families. Under the assumption that parents anticipate entry for children for whom the impact of being the youngest at school entry is low (for instance (Fenoll et al., 2023) observe that children who anticipate are those with the highest learning abilities), the IV estimates provide a higher bound of the ATE.

Regarding gender, the impact of relative age on cognitive outcomes is higher for boys than for girls (see right panel in Figure 8), on average. Many studies have observed an early gender gap in achievement in favor of girls (Reilly et al., 2019), and that girls start school with more advanced social and behavioral skills, which may explain why they are less prone to the relative-age effect. However, at the country levels, the differences between the point estimates for boys and girls are mostly not significant (see Figure C.4 in the Appendix).

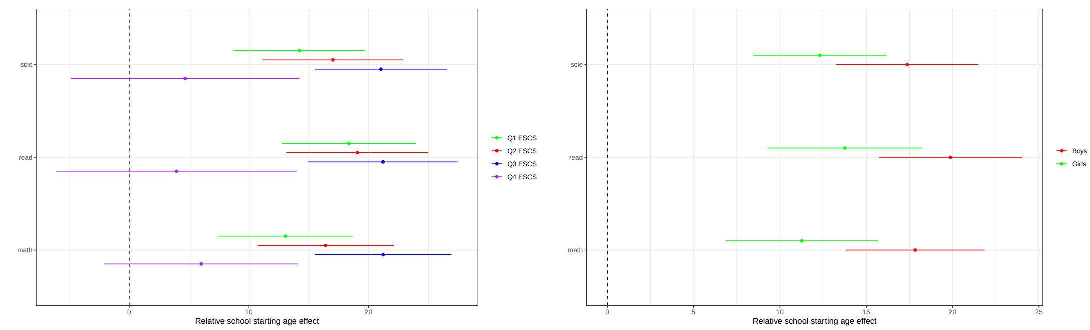

Figure 8: Average impact of relative age at entry on reading, mathematics, and science performance by ESCS and gender

In addition, in several countries, the impact of relative age on schooling experience strikingly varies with parental background (see Figure 9). In countries that use grade repetition extensively, relative age at entry often has a greater impact on grade repetition for disadvantaged students than for advantaged students: for instance, in France, a one-year difference in age at entry increases the likelihood of grade repetition in primary school by 17 percentage points for disadvantaged students, and is not significant for advantaged students (those in the highest quarter of the distribution of this index). In Belgium and Spain, the impact of school starting age is also higher than 15 percentage points for disadvantaged students, and three times lower for advantaged ones. Point estimates are also slightly lower for boys than for girls.

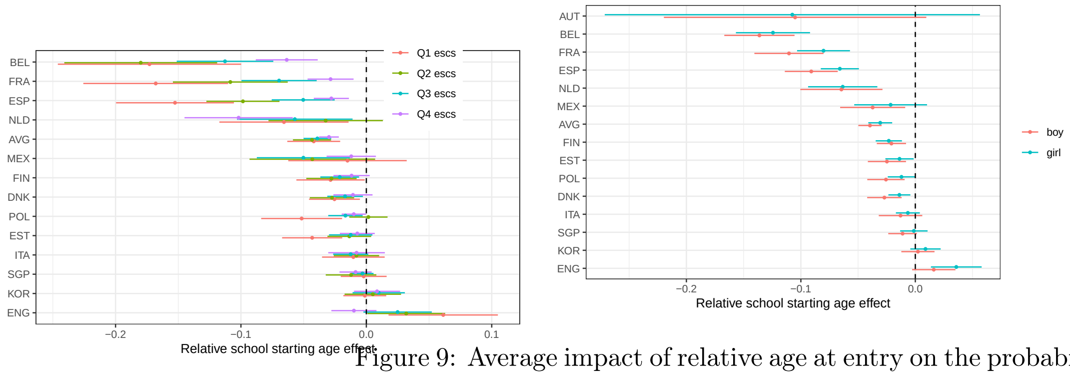

Figure 9: Average impact of relative age at entry on the probability of repeating a grade in primary school by eSCS and gender

3.5 Robustness checks

Several robustness checks have been performed. The first replaces the self-reported measure of age at entry at school, using additional information from the questionnaire. The second tests whether the measure of age at entry captures the impact of being in distinct grades (as it may be correlated with the month of birth). Finally, two tests check the external validity of the estimands, by either restricting the sample to the months just around the cut-off (using a regression discontinuity design), or, on the contrary, by excluding these months (as students born around the cut-off may be less compliant with the school regulations). For the sake of simplicity, tests focus on one outcome (reading performance). All tests provided similar results.

3.5.1 Corrected measure of age at entry

As the variable measuring age at entry in primary school is self-reported by students in the PISA questionnaire, one may question whether it could be not accurate enough. Using additional information available in the data, it is possible to correct for apparent misreports by checking consistency between the grade a student is enrolled in when he/she sits the PISA test, and whether he/she has repeated a grade. Students who are enrolled in the modal grade corresponding to their theoretical school cohort, and who have never repeated a grade, are assumed to have been enrolled at "normal age" at school, even when they report a distinct age. Using this alternative measure of age at entry provides very close estimates to those obtained using directly the reported age at entry without correction (see Figure C.6 in the Appendix).

3.5.2 Separate impact of grade and effect

When the grade is not controlled for, the impact of relative age on performance may be partially mediated by the fact that the month of birth may also affect the grade at which students sit the PISA test. As the youngest students in a school cohort (as defined by a strict application of the school regulation) are more likely to be enrolled in a lower grade than the oldest students, part of the measured differences between the eldest and the youngest students may be because they are enrolled in different grades.

The magnitude of this effect can be reckoned using the set of countries where two school cohorts have been selected, by comparing the estimates of the relative age impact with and without controlling for grade. In the latter case, the sample is restricted to students in the largest school cohort, as defined by the birthday date. This corresponds to a restriction of the sample based on the month of birth that is expected to be random. Sample selection is thus expected to be exogenous.

Four countries have two sampled cohorts in the set of countries analyzed in this study: Austria, Estonia, Korea, and Finland. The point estimates of the impact of relative age entry are very close to those obtained without controlling for grade (Figure 10).

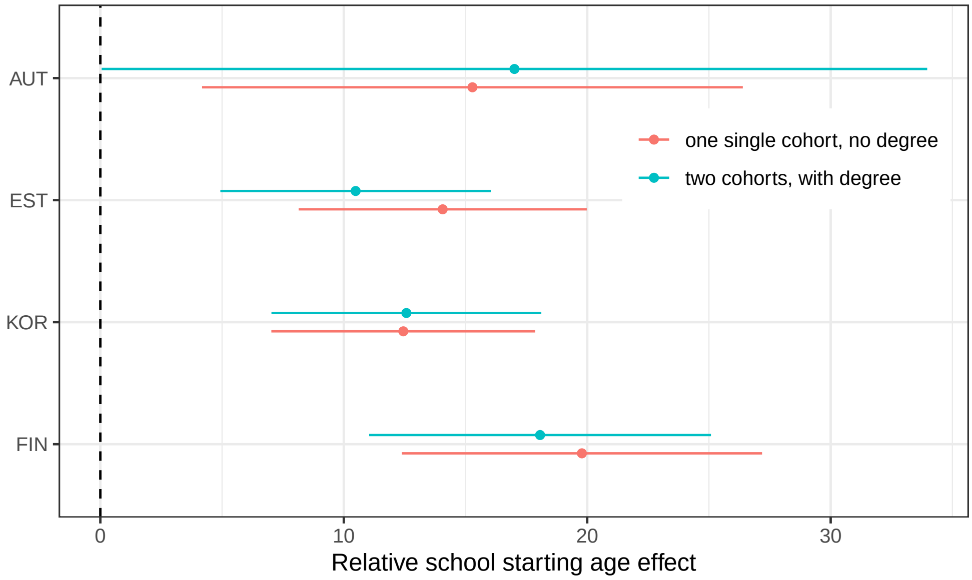

Figure 10: Average impact of the relative age at school entry on reading performance, with and without controlling for grade

Source: PISA 2015, 2018, and 2022, Author's calculation. Note: Point estimate and 95% Confidence Interval of the impact of the relative age at school entry, 2SLS (instrument: theoretical age at entry). Models include as additional controls variables: gender, socio-economic status (4 dummies),immigrant background, PISA dummies. The specification "two cohorts" uses the entire national sample and includes detailed grade, instrumented by the theoretical grade. The specification "one cohort" uses only the main school cohort and does not include grade.

3.5.3 Restrictions to or from the cut-off

The interpretation of the estimates may be complicated by the fact that in several countries, school regulations are not strictly applied. In these countries, flexibility is given to parents for the choice of school entry, and children may enter school earlier or later than is expected, depending on their maturity. As discussed in Subsection 2.4, IV estimates cannot be interpreted as an average treatment effect, but only as a Local Average Treatment Effect (LATE). As shown by Angrist and Imbens (1994) in a binary treatment/binary instrument framework, the IV estimator measures the average impact of the treatment for the "compliers" (those who change their behavior because of the instrument), provided that the instrument has a monotonic impact on the treatment. When school regulations regarding school entry age are not strictly applied, the LATE may differ from the average treatment effect if the impact of school starting age is heterogeneous among children.

However, the framework in this study is more complex, as both the treatment and the instrument are continuous. In addition, the relationship is not fully linear in the case of not perfect compliance. Two polar cases are used as robustness checks. First, a regression discontinuity design, restricting the sample to students born in the few months around the cut-off, makes it possible to analyze results in the classical binary treatment/instrument framework, with monotonous treatment. This provides a "pure" Local Average Treatment Effect of being among the eldest at entry at school. The second polar case excludes, on the contrary, students born around the cut-off: as non-compliance is less likely in this sample, the estimates are expected to be close to the average treatment effect.

In practice, the RDD estimates are conducted by restricting the sample to students born two months just before or after the cut-off. The "treatment" is defined as being among the 20% eldest students at entry at school (defined by the "real" age at entry) compared to being among the 20% youngest students at entry at school. Because of imperfect compliance, the design is "fuzzy," and the instrument is being born in the two months just after the cut-off (being theoretically among the eldest at entry at school), compared to those born two months just before the cut-off. Defined this way, the impact of the instrument is monotonic, even though it does not exclude the presence of always or never takers. This estimation strategy is used only in countries where only one school cohort has been sampled. In countries where two school cohorts have been sampled, students around the cut-off are expected to be enrolled in two distinct grades. It would not be possible to isolate the impact of school starting age.

The RDD estimates are illustrated in Figure 11. They are still positive and significant in all countries, yet less precisely estimated and often higher than the IV estimated using the entire sample.[10] Estimates are highly imprecise in Norway, where the data are available only for one PISA 2015, and in England and Wales.

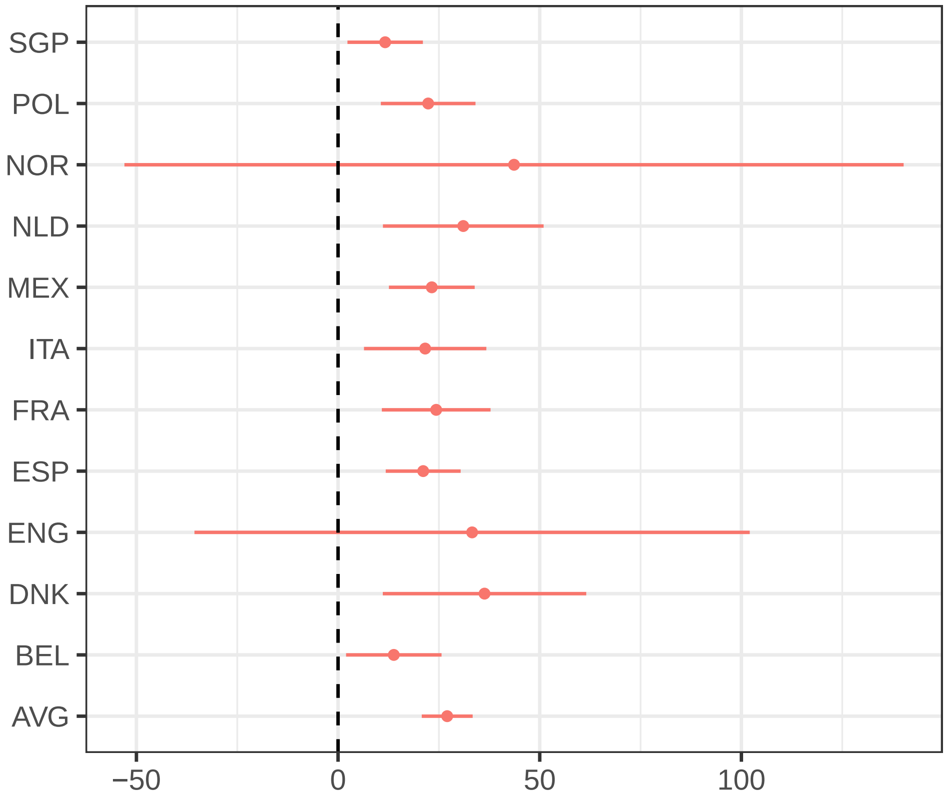

Figure 11: Average impact of the relative age at school entry on reading performance, RDD specification

Source: PISA 2015, 2018, and 2022, Author's calculation. Note: Point estimate and 95% Confidence Interval of the impact of the relative age at school entry, 2SLS (instrument: theoretical age at entry). Models include as additional controls variables: gender, socio-economic status (4 dummies), immigrant background, PISA dummies. Sample restricted to students born just before and after the cutoff.

While they are quite imprecise, RDD estimates provide a local average treatment effect (for the compliers). The proportion of compliers may be especially low around the cutoff. For instance, early entrance is possible in Italy and Austria for students born in the first four months after the legal cutoff,[11] while in England, parents of children born before the cutoff (the "summer

[10]The RDD estimators are not directly comparable to IV estimates. The latter measures the impact of being older by one year, while the former measures the impact of being 10 months older, on average.

[11]In Italy, the cutoff is December 31; only children born from January to April may enter school early (see Fenoll et al., 2023). In Austria, the cutoff is September 1, but children who turn six before December 31 may be allowed

babies") may defer the school entry date until later in the school year. Conversely, for children born sufficiently far from the cutoff, compliance is much more likely. The second polar case thus excludes students born around the cutoff. Under the assumption that the causal effect of maturity is linear, estimates on this subpopulation are expected to be closer to the average impact for the entire population.

In practice, the estimates are conducted by excluding the three months before and after the cutoff in all countries. This choice has been made to maintain a sufficient sample size for the estimations. The estimates are then compared to the measures obtained using the entire sample. The estimates appear quite similar in most countries. On average across the 16 countries, the impact of being older by one year is 19 in the restricted sample (compared to 21 using the entire sample). At the country level, the estimates using the restricted sample are negative in Austria and the Netherlands but very close in other countries.

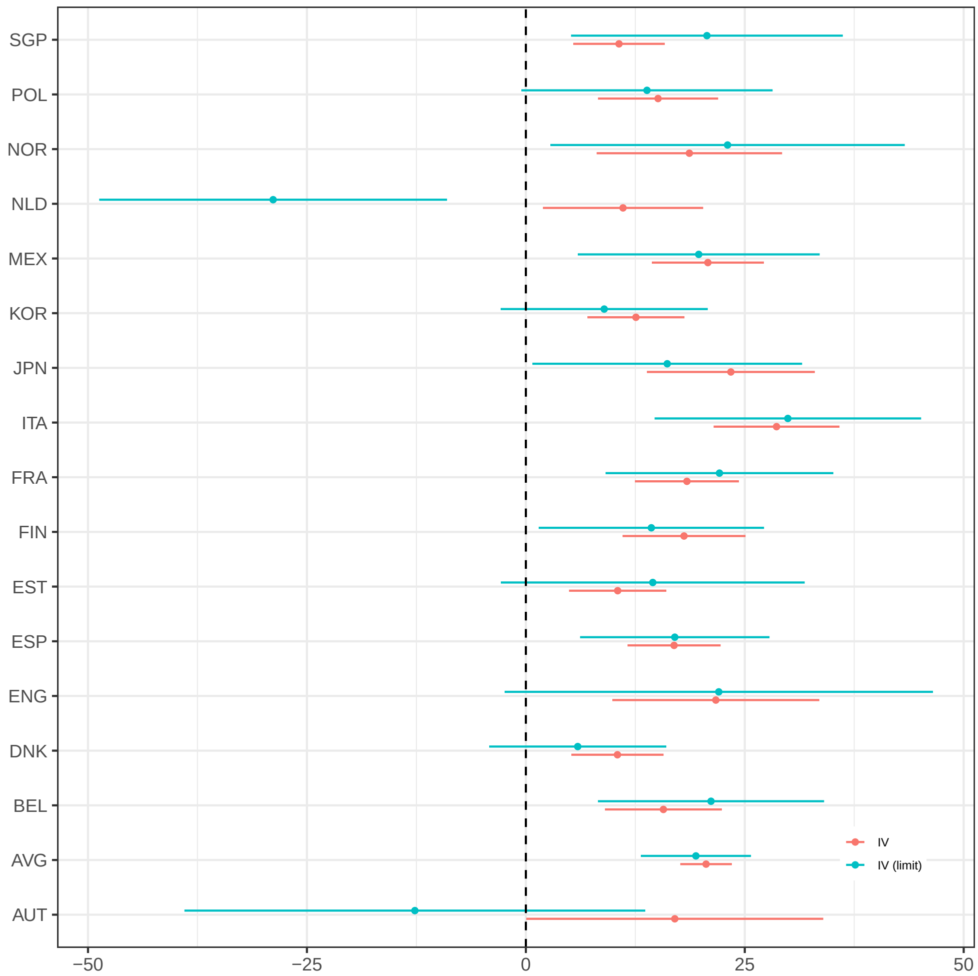

Figure 12: Average impact of the relative age at school entry on reading performance, alternative specifications

Source: PISA 2015, 2018, and 2022, Author's calculation. Note: Point estimate and 95% Confidence Interval of the impact of the relative age at school entry, 2SLS (instrument: theoretical age at entry). Models include additional control variables: gender, socio-economic status (4 dummies), immigrant background, PISA dummies.

to start primary school early.

4 Discussion and concluding remarks

This study on a set of 16 countries confirms the previous results observed in the literature that birthday effects may have sizeable consequences for several outcomes. In this set of countries, despite quite distinctive school systems, the birthday effects on the cognitive outcomes of 15-year-old students are sizeable and significant. On average amongst the set of sixteen countries, the effect of being one year older at entry at school increases the test performance by around 20 score points in the three main domains of PISA (meaning an increase by 0.2 standard deviation). At the country level, it ranges from 10 score points to 25 score points, without a clear link with the school system specificity. Part of these effects may be mediated by early grade repetition, as early entry is strongly associated with retention. In countries where retention is common, being the youngest in a cohort (such as Austria, Belgium, and France) increases the likelihood of being retained in primary school by as much as 10 percentage points.

The existence of birthday effects may be viewed as reflecting the ability of a school system to correct or amplify unequal abilities at school start: unlike gender or social and cultural background, it is unlikely that children are exposed to distinct socialisation at home depending on their month of birth. However, one may observe that in many countries, these birthday effects appear to be higher for disadvantaged students, suggesting that the most advantaged students may benefit from support from their family making it possible to compensate them for the initial disadvantage of being the youngest at school entry.

In addition, the relative school starting age impacts social and emotional skills, that may have long-lasting effects. On average over the 16 countries analyzed here, the relative age at entry significantly increased the main social and emotional skills, as well as the quality of their relation at school. Students who were the youngest at entry not only had lower performance on PISA at age 15 but also expressed negative feelings about their teachers and in some countries are more exposed to bullying. It impacts students' self-esteem or their ability to cooperate with others, with potential long-term consequences. Being the youngest at school entry has in several countries a significant impact on the likelihood of expecting to complete tertiary education.

It is worth emphasizing that these results cannot distinguish among the main reasons behind these birthday effects, specifically whether these effects may be solely explained by maturity ("age at testing") or relative age. However, these two effects may be mutually reinforcing ones, rather than two alternative explanations. While absolute age effects are expected to be quite important in the first years of schooling - and may still explain the differences observed in academic outcomes measured on PISA - emotional development (such as self-esteem or competitiveness) may also plausibly be more sensitive to social comparisons and thus to relative age effects. Because they may be compared to their older peers in an unfavorable way in their first years of schooling, the youngest children may develop lower self-confidence, which may undermine their expectations for the future. However, the features of the school systems may help to mitigate, or on the contrary, may contribute to amplifying these initial differences.

This may call for policies to adequately inform teachers and parents of the penalty suffered by the youngest students in order to avoid unfair comparisons, and to implement practices that are adapted to the needs of the youngest children. Using age-adjustment for assessments in the first years of schooling may help to avoid unfair comparisons between less mature students and their peers (Crawford et al., 2014). Such adjustments could be made for instance for standardized tests (such age-based standardization has been introduced in the last decade in Ireland; see Shiel et al., 2020). Adjustments for age should be recommended specifically for tests that are used as allocation mechanisms, notably in school systems where academic achievement may have consequences on the type of education students may pursue, such as grade repetition or tracking into distinct types of schooling. In addition, age adjustments may be advocated to reduce the overclassification of the youngest children as having learning difficulties or psychiatric conditions, as observed, for instance, by Layton et al. (2018).

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) observed that longer sequences of teaching (a practice referred to as block scheduling, consisting of 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 are also related to greater relative-age effects, as such requirements may necessitate an investment that the youngest students are not mature enough to make. Larger classes are also related to greater relative-age effects, probably because they reduce the capacity of teachers to devote individualized attention to all students, according to their needs.

At the individual level, it would be difficult to infer from the results here that more flexibility should be provided to parents regarding when to enroll their children in school depending on their maturity. While these results suggest caution against the tendency to enroll children earlier than planned in some countries (as in Italy, see Ponzo and Scoppa, 2014), they also do not support the possibility of postponing school entry for less mature children. In the related literature, these practices are highly debated and the evidence is mixed. Dhuey et al. (2019) observe only marginal evidence of a positive impact of red-shirting in Florida's primary schools. In Hungary, Altwicker-Hámori and Köllő (2012) observe a positive impact of delaying school entry for disadvantaged students; but the opposite is observed in Australia, where Suziedelyte and Zhu (2015) report that early entry into school improves cognitive scores, especially for disadvantaged students. A possible explanation for these apparently contradictory findings could be that differences in the impact of delayed entry on future outcomes may depend on whether the child had attended preschool, and on the quality of that experience. However, the PISA data cannot provide sufficiently relevant information on these issues, and this calls for further investigations.

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A Age, school cohort, and relative school starting age in PISA

As discussed extensively in the literature, several reasons may explain the observed birthday effects on educational outcomes.

PISA covers students who are aged between 15 years 3 months and 16 years 2 months at the time of the assessment (see Givord, 2020 for a description of the sample). Depending on their month of birth, some students may be older than others when they sit the PISA test and this "age-at-the-test" effect may make a difference in performance as age may be related to greater maturity.

The age at the test is linearly related to the school starting age, and the duration of schooling. In several countries, the 12-month spread of PISA-sampled students coincides with one and unique school cohort, as defined by the cutoff. If they had started school at the normal age, students who are the eldest when they sit the PISA test were those who are the eldest in their school cohort in primary school. If they have not skipped nor repeated a grade, they are expected to be enrolled in the same grade as their school cohort.

However, in some PISA participating countries, the 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. Amongst the countries analyzed here, this is the case in Austria, Finland, Korea, where 8% of the sample (1 month over 12) is expected to be in a lower grade than the modal one (according to their month of birth, had the regulations regarding school entry strictly applied) and Estonia, where 16% (2 months over 12) are in this case.[12]

In case where the PISA sample encompasses two cohorts, the link between the age at the test and the school starting age is not expected to be continuous. This is illustrated in Figure A.1 for a fictitious case. In this example, Student A is almost one year older than Student B, they are expected to be enrolled in two subsequent grades when they sat the PISA test, but they should have the same school starting age in primary school.

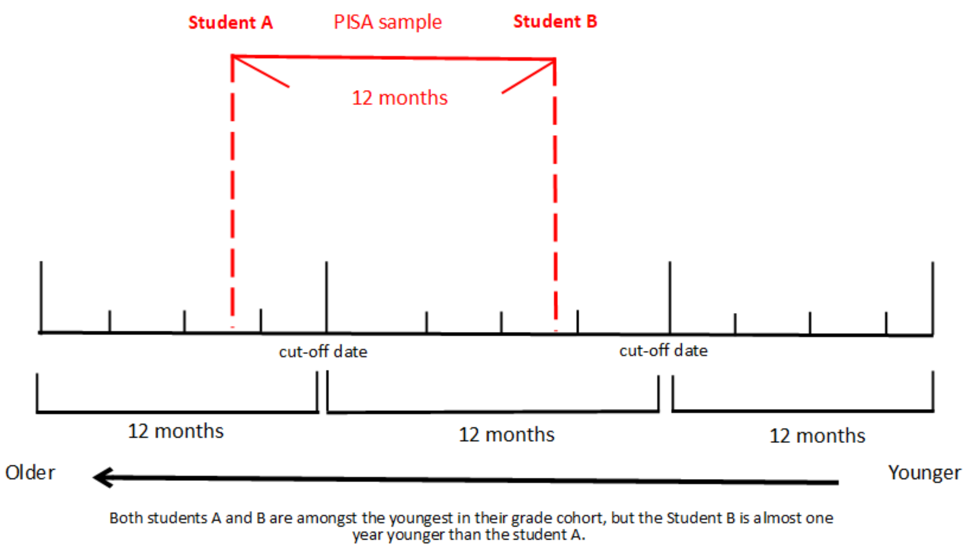


Figure A.1: Structure of the PISA Sample with two theoretical school cohorts

[12] In England and Wales, only 2% of the sample of PISA 2018 (300 students over 10,817) are born in August 2002 and are thus included in a previous school cohort than the main one (the cutoff date for school entry is August 31st). The number of students born in August is surprisingly much lower than those born in other months, and that the performance of these students is much higher on average than that of their younger peers. One may thus suspect that they are not fully representative of students of their age and it has been chosen to exclude these observations.

B Socioemotional Variables

In PISA, students are asked several questions in the context questionnaire that make it possible to construct indices measuring socio-emotional dimensions, notably on motivation and self-esteem. The variables vary from one cycle to another. The variables used in this article are described below.

Exposure to bullying In PISA 2018, students are asked how often (“never or almost never”, “a few times a year”, “a few times a month”, “once a week or more”) during the 12 months prior to the PISA test they had the following experiences in school, including those that happen in social media: “Other students left me out of things on purpose”; “Other students made fun of me”; “I was threatened by other students”; “Other students took away or destroyed things that belong to me”; “I got hit or pushed around by other students”; and “Other students spread nasty rumours about me”. These statements were combined to construct the index of exposure to bullying (variable beingbullied). Positive values on this scale indicate that the student was more exposed to bullying at school than the average student in OECD countries; negative values on this scale indicate that the student was less exposed to bullying at school than the average student across OECD countries.

Teacher enthusiasm PISA 2018 asked (ST213) students whether they agree (“strongly agree”, “agree”, “disagree”, “strongly disagree”) with the following statements about the two language-of-instruction lessons they attended prior to sitting the PISA test: “It was clear to me that the teacher liked teaching us”; “The enthusiasm of the teacher inspired me”; “It was clear that the teacher likes to deal with the topic of the lesson”; and “The teacher showed enjoyment in teaching”. These statements were combined to create the index of teacher enthusiasm (TEACHINT). Positive values in this index mean that students perceived their language-of-instruction teachers to be more enthusiastic than did the average student across OECD countries.

Teacher unfairness In PISA 2015, students are asked (variable ST039) about how often (“Never or almost never”, “a few times a year”, “a few times a month”, “once a week or more”) they had the following experiences at school: "Teachers disciplined them more harshly than other students", "Teachers ridiculed them in front of others", and "Teachers said something insulting to them in front of others". Perception of teachers behaving unfairly refers to students reporting “a few times a month” or “once a week or more” to one of these three statements in their responses to this question.

Disciplinary climate In PISA 2015 and 2018, students are asked how often (“every lesson”, “most lessons”, “some lessons”, “never or hardly ever”) the following happened in their language-of-instruction lessons (ST097): ”Students don’t listen to what the teacher says”; “There is noise and disorder”; “The teacher has to wait a long time for students to quiet down”; “Students cannot work well”; and “Students don’t start working for a long time after the lesson begins”. These statements were combined to create the index of disciplinary climate (disclima). Positive values on this scale mean that the student enjoyed a better disciplinary climate in language-of-instruction lessons than the average student across OECD countries.

Motivation to master tasks PISA 2018 asked students (ST182) to report the extent to which they agree (“strongly disagree”, “disagree”, “agree”, “strongly agree”) with the following statements about themselves: “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”. These statements were combined to create the index of motivation to master tasks (variable workmast). Positive values in the index indicate greater motivation than the average student across OECD countries.

Enjoy competition PISA 2018 asked students (ST182) to report the extent to which they agree ("strongly disagree", "disagree", "agree", "strongly agree") with the following statements about themselves: "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". These statements were combined to create the index of motivation to master tasks (variable compete). Positive values on this scale mean that students expressed more favourable attitudes towards competition than did the average student across OECD countries.

Self-efficacy In PISA 2018, students are asked whether they "Strongly disagree", "Disagree", "Agree" or "Strongly agree" on the following questions: "I usually manage one way or another" (i), "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". The answers to these items are summarised in a single index of self-efficacy (variable resilience) that was standardised to have a mean of 0 and a standard deviation of 1 across OECD countries.

Assertiveness In PISA 2022, students are asked (question ST305) to rate their agreement with statements about a range of behaviours indicative of assertiveness (e.g., "I take initiative when working with my classmates.", "I find it hard to influence people."). The answers to these items are summarised in a single index of Assertiveness (variable ASSERAGR) that was standardised to have a mean of 0 and a standard deviation of 1 across OECD countries.

Curiosity In PISA 2022, students are asked (question ST301) to rate their agreement with statements about a range of behaviours indicative of curiosity e.g., "I like to know how things work.", "I am more curious than most people I know. The answers to these items are summarised in a single index of Curiosity (variable CURIOAGR) that was standardised to have a mean of 0 and a standard deviation of 1 across OECD countries.

Emotional control In PISA 2022, students are asked (question ST313) to rate their agreement with statements about a range of behaviours indicative of Emotional control e.g., "I keep my emotions under control.", "I get mad easily." The answers to these items are summarised in a single index of Emotional control (variable EMOCOAGR) that was standardised to have a mean of 0 and a standard deviation of 1 across OECD countries.

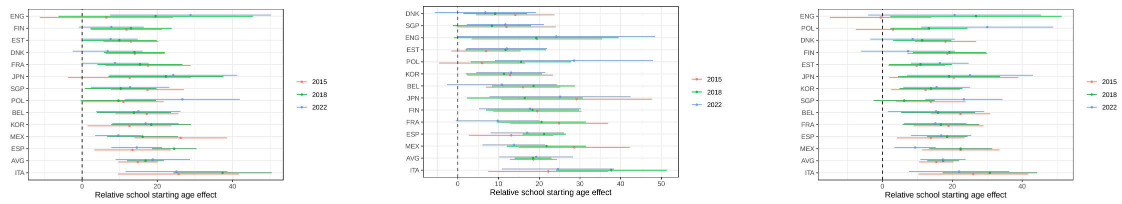
Empathy In PISA 2022, students are asked (question ST311) to rate their agreement with statements about a range of behaviours indicative of empathy e.g., "I predict the needs of others.", "It is difficult for me to sense what others think." The answers to these items are summarised in a single index of Empathy (variable EMPATAGR) that was standardised to have a mean of 0 and a standard deviation of 1 across OECD countries.

Perseverance In PISA 2022, students are asked (question ST307) to rate their agreement with statements about a range of behaviours indicative of empathy e.g., "I keep working on a task until it is finished.", "I give up after making mistakes." The answers to these items are summarised in a single index of Perseverance (variable PERSEVAGR) that was standardised to have a mean of 0 and a standard deviation of 1 across OECD countries.

Stress resistance In PISA 2022, students are asked (question ST345) to rate their agreement with statements about a range of behaviours indicative of empathy e.g., "I remain calm under stress.", "I get nervous easily." The answers to these items are summarised in a single index of Perseverance (variable STRESSAGR) that was standardised to have a mean of 0 and a standard deviation of 1 across OECD countries.

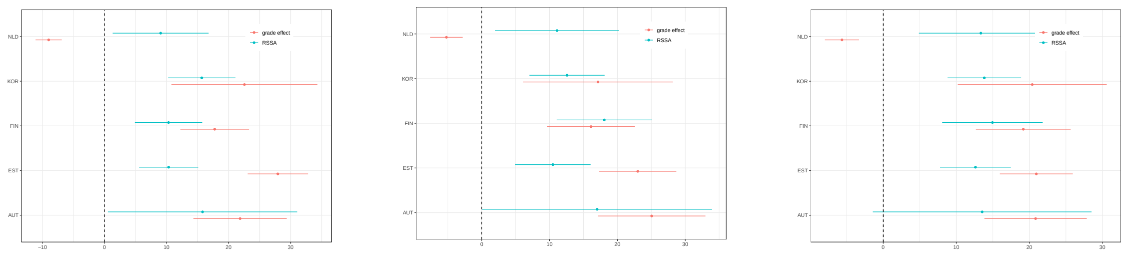
Expectation to complete tertiary education In PISA 2015 and 2018, students were asked (question ST225) which levels of education they expect to complete, using the International Standardised Classification of Education 1997. In this classification, tertiary education corresponds to <ISCED level 5A> and/or <ISCED level 6> (theoretically oriented tertiary and post-graduate).

C Additional Tables and Figures



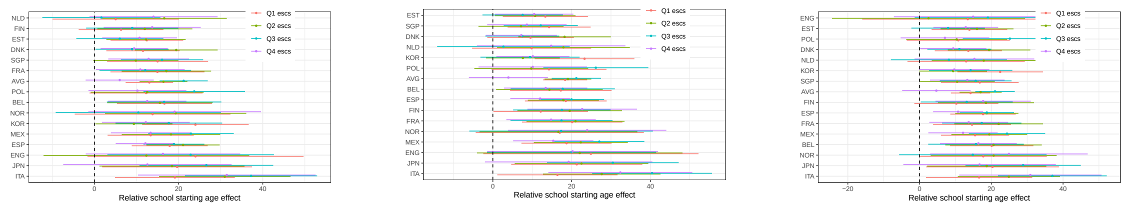
Maths **Reading** **Science**

Figure C.1: Impact of relative age at entry on reading, mathematics, and science performance by PISA cycle



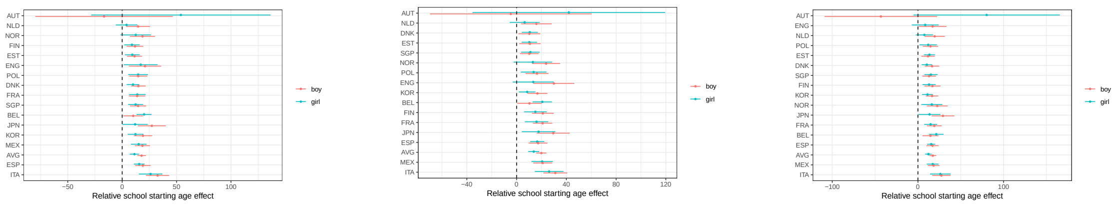
Maths **Reading** **Science**

Figure C.2: Impacts of relative age at entry and of one year of schooling on reading, mathematics, and science performance by PISA cycle



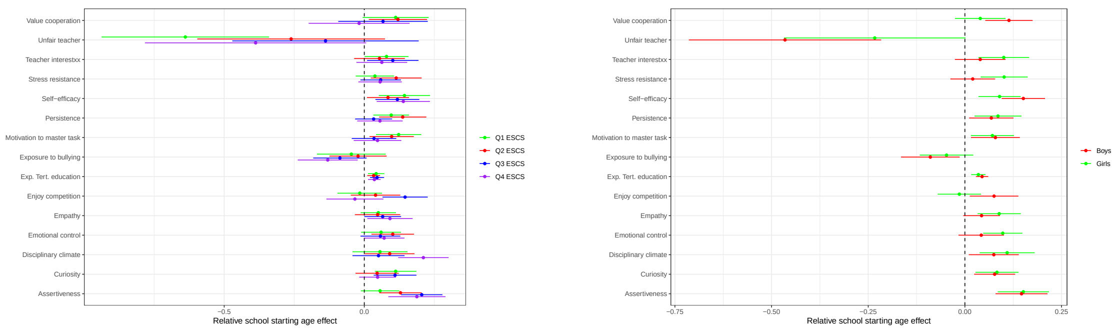
Maths **Reading** **Science**

Figure C.3: Impact of relative age at entry on reading, mathematics, and science performance by ESCS



Maths **Reading** **Science**

Figure C.4: Impact of relative age at entry on reading, mathematics, and science performance by gender



ESCS **Gender**

Figure C.5: Impact of relative school starting age on socio-emotional outcomes by ESCS and gender

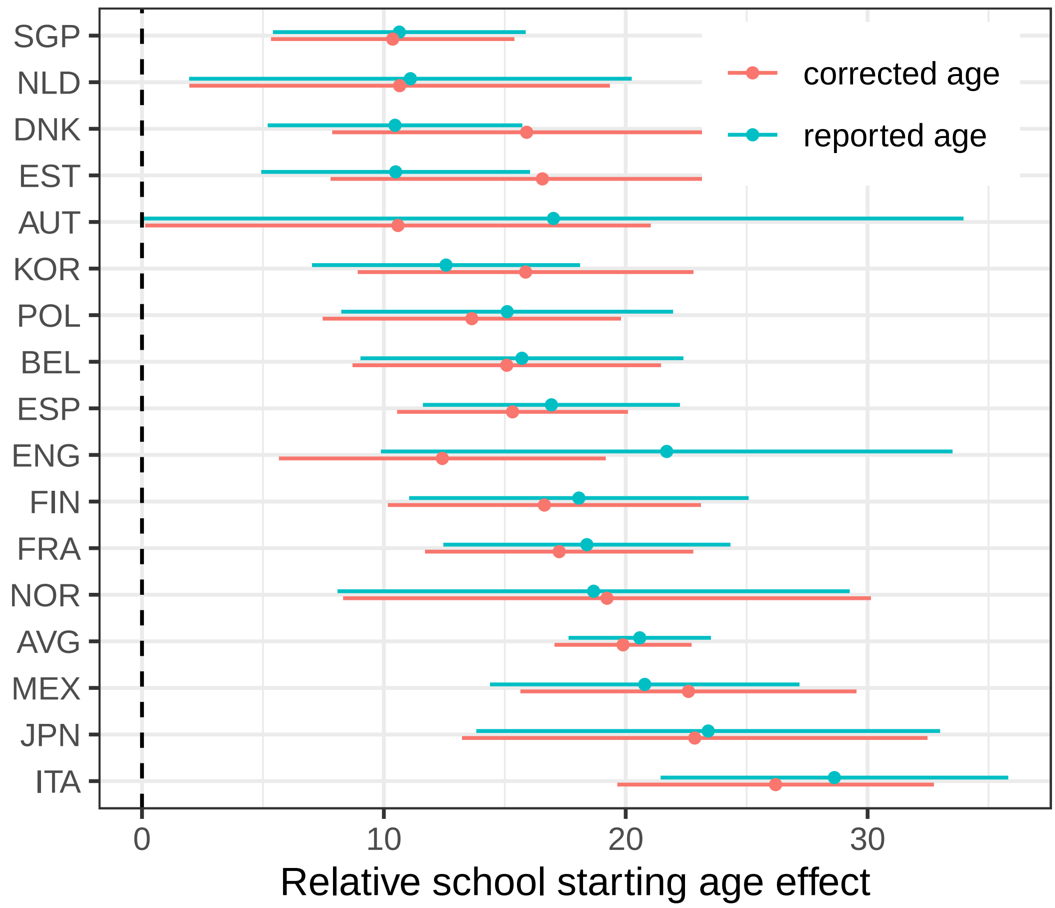


Figure C.6: Impact of relative school starting age on reading performance (self-reported and corrected measure of school starting age)

Table C.1: School systems characteristics

	AUT	BEL	DNK	ENG	ESP	EST	FIN	FRA	ITA	JPN	KOR	MEX	NLD	NOR	POL	SGP
Compulsory school age	6	6	6	5	6	7	7	6	6	6	6	6	6	6	7	6
Cut-off date for school cohort	1/9	31/12	31/12	31/8	31/12	1/10	31/12	31/12	31/12	1/4	31/12	31/12	31/12	31/12	31/12	1/1
Age at first selection	10	12	15	16	16	16	16	15	14	15	15	15	12	16	16	12
Prop. of repeaters (%)	15.1	29.7	3.3	2.4	27.1	3.5	3.0	16.3	12.3	NA	4.2	13.2	20.2	NA	3.9	4.7

Source: PISA 2015, 2018 and 2022, Author's calculations.

Table C.2: Description of the sample

	AUT	BEL	DNK	ENG	ESP	EST	FIN	FRA	ITA	JPN	KOR	MEX	NLD	NOR	POL	SGP
N. Obs 2015	6,928	9,279	6,971	10,396	6,649	5,503	5,789	5,808	11,265	6,507	5,549	7,488	5,251	5,278	4,432	6,084
N. Obs 2018	6,662	8,043	7,401	8,919	33,181	5,189	5,524	5,637	11,417	6,109	6,619	6,406	4,511	NA	5,509	6,590
N. Obs 2022	5,964	4,408	5,771	7,724	29,161	6,277	9,788	6,187	10,367	5,706	6,378	6,217	4,669	NA	5,785	6,554
Modal grade	10	10	9	11	10	9	9	10	10	10	10	10	10	10	9	10
Average age at entry (year)	6.6	6.2	6.4	5.3	6.0	7.3	7.0	6.1	6.2	6.5	6.7	6.3	6.1	6.1	7.1	6.4
Prop. in the main school cohort (%)	8.3	100.0	100.0	0.0	100.0	76.8	91.7	100.0	100.0	100.0	81.7	100.0	100.0	100.0	100.0	100.0
Prop. of repeaters 2015 (%)	15.2	34.0	3.4	2.8	31.3	4.0	3.0	22.1	15.1	NA	4.7	15.8	20.1	NA	5.3	5.4
Prop. of repeaters 2018 (%)	14.4	30.8	3.2	2.3	28.7	2.9	3.3	16.6	13.2	NA	4.5	15.0	17.3	NA	3.3	4.8
Prop. of repeaters 2022 (%)	15.6	21.5	3.5	2.0	21.7	3.6	2.7	10.8	8.6	NA	3.3	9.0	23.3	NA	3.1	3.7
Prop. of repeaters in primary school 2015 (%)	6.0	19.5	2.9	2.1	12.8	2.9	2.6	12.8	1.5	NA	4.3	12.2	14.5	NA	2.2	2.6
Prop. of repeaters in primary school 2018 (%)	6.3	17.7	2.8	1.8	11.4	1.8	2.9	11.3	1.4	NA	4.1	11.7	11.8	NA	1.5	2.2
Prop. of repeaters in primary school 2022 (%)	8.0	14.4	3.1	1.5	10.1	2.5	2.3	7.5	1.0	NA	3.1	5.3	14.3	NA	1.4	1.6

Source: PISA 2015, 2018 and 2022. Author's calculations. Note: Performances averaged over the three cycles. Standard Errors in parenthesis.

Table C.3: Descriptive statistics

	AUT	BEL	DEU	DNK	ENG	ESP	EST	FIN	FRA	ITA	JPN	KOR	MEX	NLD	NOR	POL
Perf. in maths	498.94*** (2.96)	508.07*** (2.26)	500.04*** (2.73)	509.40*** (1.79)	501.48*** (2.74)	481.39*** (1.41)	523.41*** (1.77)	507.30*** (1.97)	495.41*** (2.33)	486.59*** (2.70)	526.97*** (2.35)	525.93*** (3.12)	408.80*** (2.53)	519.23*** (2.51)	500.96*** (2.31)	515.65*** (2.61)
Perf. in reading	484.39*** (2.70)	492.86*** (2.29)	498.28*** (3.07)	501.13*** (1.83)	502.83*** (2.71)	476.54*** (1.59)	523.02*** (1.78)	520.08*** (2.33)	492.61*** (2.32)	476.28*** (2.43)	503.86*** (2.73)	514.05*** (2.96)	420.47*** (2.73)	484.78*** (2.65)	499.45*** (2.24)	511.86*** (2.75)
Perf. in science	489.78*** (2.76)	498.77*** (2.25)	502.99*** (2.90)	492.64*** (1.93)	504.78*** (2.66)	483.25*** (1.54)	530.11*** (1.89)	521.88*** (2.48)	492.98*** (2.22)	468.01*** (2.42)	529.14*** (2.58)	519.01*** (2.85)	419.20*** (2.58)	503.38*** (2.85)	490.41*** (2.25)	511.04*** (2.69)
Assertiveness (2022)	0.01 (0.01)	0.00 (0.01)	0.02 (0.02)	0.08*** (0.01)	−0.02 (0.02)	−0.15*** (0.01)	−0.06*** (0.01)	−0.05*** (0.01)	0.19*** (0.02)	−0.05*** (0.01)	na	0.05** (0.02)	na	−0.01 (0.01)	na	−0.11*** (0.02)
Perseverance (2022)	0.16*** (0.02)	−0.11*** (0.01)	0.05*** (0.02)	0.01 (0.02)	−0.17*** (0.02)	0.14*** (0.01)	−0.15*** (0.01)	0.00 (0.01)	0.01 (0.01)	0.07*** (0.01)	na	−0.05** (0.02)	0.24*** (0.02)	−0.17*** (0.01)	−0.16*** (0.02)	−0.28*** (0.02)
Empathy (2022)	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	na	0.02 (0.02)	na	0.02 (0.02)	na	0.02 (0.02)
Curiosity (2022)	0.02 (0.02)	−0.26*** (0.01)	−0.05*** (0.02)	−0.04** (0.02)	−0.09*** (0.02)	0.14*** (0.01)	−0.18*** (0.01)	−0.19*** (0.01)	0.08*** (0.02)	0.09*** (0.01)	na	0.09*** (0.02)	0.29*** (0.02)	−0.33*** (0.01)	−0.13*** (0.02)	−0.24*** (0.01)
Stress (2022)	0.08*** (0.01)	0.06*** (0.02)	0.05*** (0.02)	0.20*** (0.01)	−0.15*** (0.02)	−0.02*** (0.01)	0.13*** (0.01)	0.19*** (0.01)	−0.09*** (0.02)	−0.22*** (0.02)	na	−0.01 (0.02)	na	0.27*** (0.02)	na	−0.05*** (0.02)
Enjoy cooperation (2015)	0.24*** (0.01)	−0.06*** (0.01)	0.15*** (0.02)	0.01 (0.01)	−0.04** (0.02)	0.19*** (0.02)	0.03* (0.02)	−0.08*** (0.01)	−0.07*** (0.01)	−0.14*** (0.01)	−0.22*** (0.02)	−0.02 (0.02)	0.16*** (0.02)	−0.18*** (0.01)	0.11*** (0.02)	−0.21*** (0.02)
Test anxiety (2015)	−0.10*** (0.02)	−0.16*** (0.01)	−0.33*** (0.01)	0.09*** (0.01)	0.25*** (0.02)	0.40*** (0.01)	−0.22*** (0.01)	−0.41*** (0.01)	−0.10*** (0.02)	0.45*** (0.01)	0.26*** (0.01)	0.10*** (0.01)	0.26*** (0.02)	−0.54*** (0.02)	0.07*** (0.02)	−0.11*** (0.02)
Motivation to master tasks (2018)	−0.03** (0.01)	na	−0.08*** (0.02)	−0.05*** (0.01)	−0.17*** (0.01)	0.17*** (0.01)	−0.31*** (0.01)	−0.31*** (0.02)	−0.24*** (0.01)	0.49*** (0.02)	−0.11*** (0.02)	0.39*** (0.01)	0.37*** (0.02)	−0.40*** (0.02)	0.02 (0.01)	0.10*** (0.02)
Enjoy competition (2018)	0.24*** (0.02)	−0.06*** (0.01)	0.15*** (0.02)	0.01 (0.01)	−0.04** (0.02)	0.19*** (0.01)	0.03* (0.01)	−0.08*** (0.02)	−0.07*** (0.02)	−0.14*** (0.01)	−0.22*** (0.02)	−0.02 (0.01)	0.16*** (0.02)	−0.18*** (0.02)	0.11*** (0.02)	−0.21*** (0.01)
Self-efficacy (2018)	0.08 (0.08)	−0.21 (−0.21)	−0.02 (−0.02)	0.05 (0.05)	−0.18 (−0.18)	0.17 (0.17)	−0.03 (−0.03)	−0.03 (−0.03)	−0.10 (−0.10)	−0.03 (−0.03)	−0.61 (−0.61)	−0.04 (−0.04)	0.36 (0.36)	−0.11 (−0.11)	na	−0.06 (−0.06)
Perc. of teacher unfairness (2015) %	10.14*** (0.06)	9.82*** (0.05)	9.88*** (0.06)	9.72*** (0.05)	10.47*** (0.07)	9.33*** (0.06)	10.77*** (0.06)	9.40*** (0.07)	10.00*** (0.05)	na	8.26*** (0.05)	8.32*** (0.05)	8.38*** (0.05)	8.65*** (0.05)	9.90*** (0.08)	10.00*** (0.07)
Disciplinary climate (2018)	0.29*** (0.03)	−0.21*** (0.02)	0.04* (0.02)	0.19*** (0.03)	0.09*** (0.03)	−0.22*** (0.01)	0.20*** (0.02)	−0.11*** (0.02)	−0.34*** (0.03)	−0.02 (0.02)	0.78*** (0.03)	1.07*** (0.02)	−0.03 (0.02)	−0.20*** (0.02)	0.04* (0.02)	0.04 (0.03)
Teacher interest (2018)	−0.09*** (0.02)	0.04** (0.02)	−0.12*** (0.02)	0.19*** (0.02)	0.24*** (0.02)	0.03** (0.02)	−0.08*** (0.02)	−0.15*** (0.02)	0.03 (0.02)	−0.07*** (0.02)	−0.24*** (0.02)	0.44*** (0.02)	0.26*** (0.02)	−0.18*** (0.02)	0.09*** (0.02)	−0.24*** (0.02)
Exp. to complete tertiary education %	0.48*** (0.01)	0.69*** (0.01)	0.34*** (0.01)	0.64*** (0.01)	0.64*** (0.01)	0.77*** (0.00)	0.70*** (0.01)	0.64*** (0.01)	0.78*** (0.01)	0.61*** (0.01)	0.74*** (0.01)	0.89*** (0.01)	0.83*** (0.01)	0.69*** (0.01)	0.68*** (0.01)	0.57*** (0.01)

Source: PISA 2015, 2018 and 2022. Author's calculation. Note: Performances averaged over the three cycles. Standard Errors in parenthesis.

Table C.4: Average escs by month of birth

cnt	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	max-min
AUT	0.01	0.09	0.07	0.06	0.1	0.09	0.05	0.07	0.11	0.02	0	0.06	0.05
	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)
BEL	0.11	0.14	0.14	0.17	0.18	0.12	0.13	0.16	0.14	0.09	0.09	0.11	0
	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)
DNK	0.46	0.51	0.54	0.53	0.49	0.57	0.54	0.56	0.55	0.52	0.54	0.53	0.07
	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
ENG	0.19	0.19	0.21	0.22	0.24	0.2	0.2	0.21	0.22	0.21	0.17	0.23	0.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)
ESP	−0.21	−0.19	−0.19	−0.17	−0.18	−0.23	−0.26	−0.24	−0.22	−0.25	−0.22	−0.22	−0.01
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
EST	0.06	0.1	0.11	0.07	0.16	0.15	0.11	0.1	0.06	0.06	0.06	0.09	0.03
	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)
FIN	0.26	0.28	0.28	0.23	0.32	0.27	0.29	0.25	0.24	0.27	0.3	0.23	−0.03
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)
FRA	−0.07	−0.04	−0.04	−0.01	−0.05	−0.09	−0.04	−0.08	−0.06	−0.05	−0.04	−0.1	−0.03
	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
ITA	−0.15	−0.14	−0.11	−0.1	−0.12	−0.17	−0.16	−0.13	−0.11	−0.14	−0.11	−0.11	0.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.04)
JPN	−0.07	−0.09	−0.09	−0.11	−0.1	−0.09	−0.13	−0.12	−0.06	−0.06	−0.13	−0.11	−0.04
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
KOR	0.05	0.03	0.01	0.02	0	−0.01	0.02	0	0.02	0.02	0	−0.04	−0.09
	(0.03)	(0.04)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)
MEX	−1.12	−1.13	−1.13	−1.15	−1.13	−1.11	−1.11	−1.03	−1.14	−1.15	−1.15	−1.09	0.03
	(0.04)	(0.05)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.06)
NLD	0.23	0.22	0.22	0.26	0.23	0.22	0.23	0.25	0.26	0.19	0.26	0.19	−0.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)	(0.03)
NOR	0.46	0.47	0.48	0.54	0.48	0.49	0.52	0.48	0.5	0.48	0.43	0.43	−0.03
	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)	(0.05)
POL	−0.22	−0.25	−0.24	−0.21	−0.15	−0.24	−0.21	−0.19	−0.21	−0.25	−0.23	−0.22	0
	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
SGP	0.18	0.15	0.2	0.17	0.16	0.09	0.18	0.14	0.2	0.15	0.18	0.15	−0.03
	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)

Source: PISA 2015, 2018, and 2022, Author's calculations. Standard errors are shown in parentheses.

Table C.5: Impact of relative age at entry on PISA test score

	AVG	AUT	BEL	DNK	ENG	ESP	EST	FIN	FRA	ITA	JPN	KOR	MEX	NLD	NOR	POL	SGP
Reading																	
	20.58***	17.01**	15.71***	10.46***	21.69***	16.93***	10.49***	18.06***	18.39***	28.63***	23.41***	12.57***	20.79***	11.10**	18.67***	15.10***	10.64***
	(1.50)	(8.65)	(3.41)	(2.69)	(6.03)	(2.71)	(2.84)	(3.58)	(3.03)	(3.67)	(4.89)	(2.83)	(3.26)	(4.67)	(5.40)	(3.50)	(2.67)
Interaction with Gender																	
Girl	13.76***	42.03	20.68***	10.62***	13.40	16.58***	10.25***	15.10***	16.05***	26.17***	17.70**	8.51**	20.57***	6.51	13.07*	13.73***	11.09***
	(2.28)	(39.52)	(3.98)	(3.31)	(8.40)	(2.91)	(3.17)	(4.65)	(4.78)	(5.89)	(6.88)	(3.41)	(4.40)	(6.13)	(7.91)	(5.29)	(3.79)
Boy	19.88***	−4.65	10.37**	10.27**	29.99***	17.30***	10.72**	21.10***	20.94***	31.10***	29.49***	16.78***	21.02***	15.93**	23.71***	16.38***	10.22***
	(2.11)	(33.17)	(5.04)	(4.49)	(8.38)	(3.84)	(4.40)	(4.46)	(3.96)	(4.88)	(6.76)	(4.10)	(3.87)	(6.29)	(5.77)	(4.73)	(3.85)
Interaction with ESCS Quartile																	
ESCS Q1	18.35***	48.88	17.26***	9.58*	24.90*	18.52***	13.33**	12.15**	20.15***	16.40**	21.31**	23.29***	18.71***	9.85	17.00	14.26*	14.29***
	(2.85)	(47.86)	(6.58)	(5.61)	(13.94)	(5.30)	(5.52)	(6.13)	(6.51)	(7.79)	(8.50)	(6.46)	(5.84)	(7.72)	(10.89)	(7.45)	(5.38)
ESCS Q4	3.95	−92.97	13.42**	7.22	20.26*	12.00***	10.50**	22.69***	14.78**	32.37***	19.25*	10.17**	15.34***	14.81	23.95**	10.14	8.65*
	(5.12)	(84.38)	(5.40)	(4.61)	(11.07)	(3.86)	(5.07)	(7.10)	(5.80)	(9.33)	(10.85)	(4.74)	(5.20)	(9.62)	(10.26)	(7.03)	(5.15)
Sciences																	
	18.36***	13.54*	18.17***	13.21***	12.87**	16.27***	12.63***	14.95***	16.93***	26.79***	21.15***	13.83***	17.76***	13.36***	19.57***	13.35***	14.12***
	(1.40)	(7.64)	(3.36)	(2.49)	(6.46)	(2.25)	(2.47)	(3.51)	(3.05)	(4.54)	(4.66)	(2.57)	(2.64)	(4.32)	(4.51)	(3.56)	(2.97)
Interaction with Gender																	
Girl	12.31***	80.25*	21.39***	10.49***	8.57	15.53***	13.44***	13.03***	14.89***	26.20***	13.55**	11.21***	17.28***	7.55	16.25***	11.96**	15.22***
	(1.96)	(43.60)	(4.33)	(3.09)	(8.00)	(2.43)	(3.30)	(3.97)	(3.85)	(6.12)	(6.54)	(3.26)	(3.55)	(5.15)	(6.27)	(5.21)	(3.92)
Boy	17.37***	−43.26	14.72***	16.49***	17.18**	17.06***	11.81***	16.98***	19.14***	27.38***	29.24***	16.55***	18.27***	19.63***	22.55***	14.66***	13.09***
	(2.09)	(33.51)	(4.79)	(4.31)	(8.25)	(3.64)	(4.04)	(4.78)	(4.48)	(5.49)	(6.79)	(3.70)	(3.49)	(6.04)	(6.22)	(4.60)	(4.09)
Interaction with ESCS Quartile																	
ESCS Q1	14.21***	32.65	20.11***	13.59***	13.44	17.68***	13.89***	10.25*	14.62***	16.59**	20.34**	22.47***	15.46***	12.98	17.75**	10.79	16.78***
	(2.80)	(42.90)	(5.93)	(4.77)	(15.02)	(4.66)	(5.38)	(5.98)	(5.54)	(7.56)	(9.45)	(6.09)	(4.85)	(8.35)	(9.05)	(7.33)	(5.53)
ESCS Q4	4.68	−48.44	16.40***	9.38**	14.93	10.73***	12.87***	17.72***	13.70**	30.88***	16.72	9.67*	12.11**	15.28*	24.91**	7.07	13.31**
	(4.87)	(71.50)	(5.46)	(4.72)	(11.27)	(3.55)	(4.61)	(6.78)	(5.61)	(10.12)	(10.85)	(5.00)	(4.93)	(8.52)	(11.21)	(6.31)	(5.31)
Mathematics																	
	18.24***	15.80**	15.31***	12.20***	19.03***	17.30***	10.33***	10.32***	13.83***	29.32***	19.33***	15.67***	16.85***	9.04**	15.74***	14.71***	13.53***
	(1.38)	(7.78)	(2.96)	(2.35)	(5.80)	(2.29)	(2.44)	(2.77)	(2.90)	(4.23)	(4.65)	(2.77)	(2.82)	(3.94)	(4.95)	(3.07)	(2.72)
Interaction with Gender																	
Girl	11.26***	53.92	20.14***	9.95***	17.05**	15.66***	9.31***	8.97**	13.93***	26.11***	11.91**	12.31***	15.22***	4.04	12.48*	14.67***	12.36***
	(2.25)	(42.05)	(3.51)	(2.96)	(7.95)	(2.54)	(3.48)	(3.65)	(3.90)	(5.54)	(5.89)	(3.69)	(3.66)	(5.08)	(7.13)	(4.64)	(3.54)
Boy	17.83***	−16.64	10.13**	14.90***	21.01***	19.03***	11.38***	11.77***	13.73***	32.55***	27.24***	19.16***	18.58***	14.63***	18.67***	14.74***	14.63***
	(2.05)	(32.23)	(4.67)	(3.44)	(7.56)	(3.63)	(3.54)	(3.91)	(3.84)	(5.43)	(6.55)	(4.31)	(3.53)	(5.62)	(5.91)	(4.26)	(3.80)
Interaction with ESCS Quartile																	
ESCS Q1	13.06***	22.18	16.64***	11.55***	24.02*	17.90***	12.47***	6.34	14.98***	19.13***	19.65**	24.01***	13.38**	5.06	13.83	12.28*	15.01**
	(2.88)	(46.66)	(5.76)	(4.45)	(13.10)	(4.60)	(4.41)	(5.14)	(5.70)	(7.26)	(9.09)	(6.46)	(5.22)	(7.66)	(9.44)	(6.85)	(6.12)
ESCS Q4	6.02	−17.11	12.56***	9.46**	16.30*	12.12***	10.74**	13.74**	10.91**	31.46***	12.60	12.22**	13.37***	14.05*	19.07*	10.23*	12.88***
	(4.13)	(83.49)	(4.74)	(4.07)	(9.36)	(3.60)	(4.53)	(5.88)	(5.38)	(10.77)	(10.21)	(5.32)	(4.82)	(7.77)	(10.47)	(5.93)	(4.90)

Source: PISA 2015, 2018 and 2022, Author's calculation. Note: Only the 2SLS estimates of the impact of the relative age at school entry (instrument: theoretical age at entry) is reported. Models include as additional controls variables: gender, socio-economic status (4 dummies), immigrant background. In countries where two school cohorts have been sampled (Estonia, Finland, Germany, Korea), the specification includes detailed grade, instrumented by the theoretical grade. Standard Errors in parenthesis.

Table C.6: Impact of relative age at entry on grade repetition

	AVG	AUT	BEL	DNK	ENG	ESP	EST	FIN	FRA	ITA	JPN	KOR	MEX	NLD	NOR	POL	SGP
Primary school																	
	−0.03*** (0.00)	−0.11*** (0.02)	−0.13*** (0.01)	−0.02*** (0.00)	0.03*** (0.01)	−0.08*** (0.01)	−0.02*** (0.01)	−0.02*** (0.00)	−0.09*** (0.01)	−0.01* (0.01)	na	0.01 (0.01)	−0.03** (0.01)	−0.06*** (0.01)	na	−0.02*** (0.00)	−0.01 (0.00)
Interaction with Gender																	
Girl	−0.03*** (0.01)	−0.11 (0.08)	−0.12*** (0.02)	−0.01*** (0.00)	0.04*** (0.01)	−0.07*** (0.01)	−0.01** (0.01)	−0.02*** (0.01)	−0.08*** (0.01)	−0.01 (0.01)	na	0.01 (0.01)	−0.02 (0.02)	−0.06*** (0.02)	na	−0.01** (0.01)	−0.00 (0.01)
Boy	−0.04*** (0.01)	−0.11* (0.06)	−0.14*** (0.02)	−0.03*** (0.01)	0.02* (0.01)	−0.09*** (0.01)	−0.02*** (0.01)	−0.02*** (0.01)	−0.11*** (0.02)	−0.01 (0.01)	na	0.00 (0.01)	−0.04** (0.01)	−0.06*** (0.02)	na	−0.03*** (0.01)	−0.01* (0.01)
Interaction with ESCS Quartile																	
ESCS Q1	−0.04*** (0.01)	−0.05 (0.14)	−0.17*** (0.04)	−0.03** (0.01)	0.06*** (0.02)	−0.15*** (0.02)	−0.04*** (0.01)	−0.03** (0.01)	−0.17*** (0.03)	−0.01 (0.01)	na	−0.00 (0.01)	−0.02 (0.02)	−0.07** (0.03)	na	−0.05*** (0.02)	−0.00 (0.01)
ESCS Q4	−0.03*** (0.00)	−0.14 (0.14)	−0.06*** (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.03*** (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.03*** (0.01)	−0.01 (0.01)	na	0.01 (0.01)	−0.01 (0.01)	−0.10*** (0.02)	na	−0.01** (0.00)	−0.01 (0.01)
Middle school																	
	−0.01*** (0.00)	−0.00 (0.02)	−0.02** (0.01)	−0.00 (0.00)	0.01 (0.00)	−0.06*** (0.01)	0.00 (0.00)	−0.00 (0.00)	−0.03*** (0.01)	−0.02** (0.01)	na	0.00 (0.01)	−0.00 (0.01)	0.01 (0.01)	na	−0.01 (0.01)	−0.00 (0.00)
Interaction with Gender																	
Girl	−0.01*** (0.00)	−0.06 (0.07)	−0.03** (0.01)	−0.00 (0.00)	0.01** (0.00)	−0.03*** (0.01)	0.00 (0.00)	0.00 (0.00)	−0.03** (0.01)	−0.00 (0.01)	na	0.01 (0.01)	−0.00 (0.01)	−0.00 (0.01)	na	0.00 (0.01)	−0.00 (0.00)
Boy	−0.02*** (0.00)	0.05 (0.07)	−0.01 (0.01)	−0.01 (0.00)	0.00 (0.01)	−0.10*** (0.02)	−0.00 (0.01)	−0.00 (0.01)	−0.04*** (0.01)	−0.05** (0.02)	na	0.00 (0.01)	−0.00 (0.01)	0.02 (0.02)	na	−0.01 (0.01)	−0.00 (0.01)
Interaction with ESCS Quartile																	
ESCS Q1	−0.00 (0.01)	0.07 (0.14)	−0.04 (0.02)	−0.00 (0.00)	0.00 (0.01)	−0.08*** (0.03)	0.01 (0.01)	0.01 (0.01)	−0.02 (0.02)	−0.02 (0.03)	na	−0.01 (0.01)	0.01 (0.01)	0.04* (0.02)	na	0.02 (0.02)	−0.01 (0.01)
ESCS Q4	−0.02*** (0.00)	−0.09 (0.22)	−0.00 (0.01)	−0.01* (0.00)	0.00 (0.01)	−0.04*** (0.01)	−0.00 (0.00)	−0.00 (0.01)	−0.01 (0.01)	−0.01 (0.01)	na	0.01 (0.01)	−0.01 (0.01)	−0.01 (0.02)	na	−0.01 (0.01)	−0.01 (0.01)

Source: PISA 2015, 2018 and 2022, Author's calculation. Note: Only the 2SLS estimates of the impact of the relative age at school entry (instrument: theoretical age at entry) is reported. Models include as additional controls variables: gender, socio-economic status (4 dummies), immigrant background. In countries where two school cohorts have been sampled, the specification includes detailed grade, instrumented by the theoretical grade. Standard Errors in parenthesis.

Table C.7: Impact of relative age on social and emotional skills

	AVG	BEL	DNK	ENG	ESP	EST	FIN	FRA	ITA	KOR	MEX	NLD	POL	SGP
Assertiveness														
	0.15^{***} (0.02)	0.13^{**} (0.06)	0.12^{**} (0.06)	0.15^{*} (0.09)	0.14^{***} (0.03)	0.09^{*} (0.05)	0.19^{***} (0.04)	0.06 (0.05)	0.30^{***} (0.07)	0.18^{***} (0.05)	na	0.02 (0.11)	0.14^{*} (0.08)	0.20^{***} (0.04)
Interaction with Gender														
Girl	0.15^{***} (0.03)	0.15^{*} (0.09)	0.09 (0.07)	0.16 (0.14)	0.18^{***} (0.05)	0.04 (0.07)	0.25^{***} (0.06)	0.08 (0.07)	0.28^{**} (0.11)	0.15^{*} (0.08)	na	−0.01 (0.12)	0.03 (0.12)	0.28^{***} (0.07)
Boy	0.15^{***} (0.03)	0.11 (0.08)	0.14^{*} (0.09)	0.15 (0.12)	0.10^{***} (0.04)	0.14^{**} (0.07)	0.13^{**} (0.06)	0.03 (0.10)	0.31^{***} (0.09)	0.22^{***} (0.07)	na	0.04 (0.14)	0.26^{**} (0.11)	0.13^{**} (0.06)
Interaction with ESCS Quartile														
ESCS Q1	0.06 (0.04)	0.20 (0.13)	−0.10 (0.07)	0.00 (0.17)	0.11 (0.07)	−0.01 (0.11)	0.09 (0.10)	-0.22^{**} (0.11)	0.15 (0.12)	0.14^{*} (0.09)	na	0.12 (0.16)	0.03 (0.13)	0.17^{*} (0.09)
ESCS Q4	0.19^{***} (0.05)	0.18^{*} (0.10)	0.30^{**} (0.13)	0.10 (0.17)	0.12^{**} (0.05)	0.03 (0.10)	0.17^{*} (0.10)	0.22^{*} (0.12)	0.48^{**} (0.20)	0.29^{***} (0.11)	na	−0.10 (0.20)	0.24 (0.24)	0.26^{**} (0.10)
Persistence														
	0.08^{***} (0.02)	0.07 (0.05)	0.07 (0.05)	0.09 (0.08)	0.05 (0.03)	0.04 (0.04)	0.16^{***} (0.05)	0.03 (0.05)	0.22^{***} (0.05)	0.11^{**} (0.05)	0.07 (0.05)	−0.07 (0.07)	0.09 (0.08)	0.04 (0.04)
Interaction with Gender														
Girl	0.09^{***} (0.03)	0.10 (0.06)	0.12 (0.07)	0.11 (0.13)	0.06 (0.05)	−0.01 (0.06)	0.16^{**} (0.07)	−0.02 (0.07)	0.26^{***} (0.08)	0.08 (0.06)	0.08 (0.07)	−0.12 (0.10)	−0.03 (0.12)	0.06 (0.06)
Boy	0.07^{**} (0.03)	0.05 (0.07)	0.01 (0.08)	0.06 (0.10)	0.04 (0.04)	0.09 (0.06)	0.17^{**} (0.07)	0.09 (0.09)	0.17^{*} (0.10)	0.14^{*} (0.07)	0.05 (0.06)	−0.02 (0.11)	0.22^{*} (0.11)	0.02 (0.06)
Interaction with ESCS Quartile														
ESCS Q1	0.10^{***} (0.03)	0.29^{***} (0.11)	0.07 (0.08)	0.20 (0.19)	−0.04 (0.08)	0.14 (0.09)	0.27^{***} (0.10)	−0.01 (0.10)	0.15 (0.11)	0.15 (0.10)	0.12 (0.07)	0.03 (0.17)	−0.02 (0.13)	0.01 (0.08)
ESCS Q4	0.06 (0.04)	−0.08 (0.08)	0.14 (0.12)	−0.22 (0.16)	−0.04 (0.05)	0.06 (0.09)	0.18^{*} (0.10)	−0.00 (0.10)	0.38^{**} (0.16)	0.12 (0.07)	0.11 (0.11)	−0.28 (0.21)	−0.01 (0.19)	0.11 (0.10)
Empathy														
	0.07^{***} (0.02)	0.07 (0.05)	0.15^{***} (0.06)	0.07 (0.10)	0.05 (0.04)	0.05 (0.05)	0.19^{***} (0.05)	0.06 (0.05)	0.10 (0.07)	−0.00 (0.04)	na	0.03 (0.09)	0.18^{**} (0.08)	0.08^{*} (0.05)
Interaction with Gender														
Girl	0.09^{***} (0.03)	0.06 (0.07)	0.29^{***} (0.08)	0.11 (0.16)	0.05 (0.06)	0.00 (0.07)	0.27^{***} (0.08)	0.04 (0.07)	0.18^{*} (0.10)	−0.04 (0.05)	na	0.16 (0.13)	0.20^{*} (0.11)	0.15^{**} (0.08)
Boy	0.04^{*} (0.02)	0.08 (0.07)	−0.00 (0.08)	0.03 (0.10)	0.04 (0.04)	0.11^{*} (0.06)	0.10 (0.07)	0.08 (0.08)	0.01 (0.09)	0.03 (0.06)	na	−0.08 (0.11)	0.16 (0.12)	0.01 (0.06)
Interaction with ESCS Quartile														
ESCS Q1	0.05 (0.03)	0.17^{*} (0.10)	−0.02 (0.10)	0.03 (0.20)	0.04 (0.09)	−0.04 (0.11)	0.41^{***} (0.11)	0.05 (0.10)	−0.02 (0.09)	0.03 (0.07)	na	−0.25 (0.21)	0.09 (0.14)	0.11 (0.09)
ESCS Q4	0.09^{**} (0.04)	0.11 (0.11)	0.16 (0.14)	0.12 (0.18)	0.02 (0.08)	−0.02 (0.06)	0.20^{**} (0.10)	0.18 (0.12)	0.13 (0.16)	0.02 (0.08)	na	0.29 (0.22)	0.13 (0.20)	0.06 (0.10)

Source: PISA 2022, Author's calculation. Note: Only the 2SLS estimates of the impact of the relative age at school entry (instrument: theoretical age at entry) is reported. Models include as additional controls variables: gender, socio-economic status (4 dummies), immigrant background. In countries where two school cohorts have been sampled (Estonia, Finland, Germany, Korea), the specification includes detailed grade, instrumented by the theoretical grade. Standard Errors in parenthesis.

Table C.8: Impact of relative age on social and emotional skills

	AVG	BEL	DNK	ENG	ESP	EST	FIN	FRA	ITA	KOR	MEX	NLD	POL	SGP
Curiosity														
	0.08*** (0.02)	0.04 (0.04)	0.05 (0.06)	0.08 (0.10)	0.05 (0.04)	0.07* (0.05)	0.23*** (0.05)	0.08 (0.05)	0.16** (0.07)	0.11*** (0.04)	0.05 (0.04)	0.04 (0.07)	0.12 (0.08)	0.11** (0.05)
Interaction with Gender														
Girl	0.08*** (0.03)	0.02 (0.06)	0.01 (0.06)	−0.06 (0.13)	0.10** (0.05)	0.01 (0.06)	0.25*** (0.07)	0.05 (0.08)	0.35*** (0.09)	0.05 (0.06)	0.06 (0.07)	−0.00 (0.10)	0.09 (0.08)	0.12* (0.07)
Boy	0.08*** (0.03)	0.07 (0.07)	0.08 (0.09)	0.21 (0.13)	0.01 (0.05)	0.14** (0.06)	0.22*** (0.07)	0.11 (0.09)	−0.05 (0.11)	0.18*** (0.06)	0.04 (0.06)	0.08 (0.11)	0.15 (0.12)	0.11* (0.06)
Interaction with ESCS Quartile														
ESCS Q1	0.11*** (0.04)	0.18* (0.10)	−0.11 (0.09)	0.15 (0.25)	0.07 (0.09)	0.00 (0.10)	0.25*** (0.08)	−0.02 (0.10)	0.26** (0.11)	0.15* (0.08)	0.16* (0.09)	−0.03 (0.16)	−0.01 (0.12)	0.06 (0.10)
ESCS Q4	0.05 (0.03)	−0.05 (0.09)	0.01 (0.15)	0.06 (0.15)	−0.03 (0.06)	0.05 (0.07)	0.20** (0.09)	0.06 (0.09)	−0.08 (0.16)	0.15* (0.08)	0.02 (0.10)	0.03 (0.16)	0.13 (0.17)	0.31*** (0.09)
Emotional control														
	0.07*** (0.02)	na	0.04 (0.05)	0.09 (0.10)	0.02 (0.02)	0.05 (0.05)	0.03 (0.05)	0.08 (0.06)	0.09 (0.07)	0.08** (0.04)	0.09** (0.04)	−0.10 (0.08)	−0.08 (0.07)	−0.00 (0.05)
Interaction with Gender														
Girl	0.10*** (0.03)	na	0.03 (0.07)	0.11 (0.16)	0.01 (0.03)	0.03 (0.06)	0.04 (0.07)	0.13* (0.07)	0.17* (0.10)	0.04 (0.05)	0.10* (0.05)	−0.10 (0.10)	0.01 (0.12)	0.03 (0.07)
Boy	0.04 (0.03)	na	0.05 (0.07)	0.07 (0.16)	0.03 (0.03)	0.07 (0.07)	0.01 (0.07)	0.02 (0.09)	0.01 (0.08)	0.12* (0.06)	0.09 (0.06)	−0.09 (0.13)	−0.17* (0.11)	−0.04 (0.06)
Interaction with ESCS Quartile														
ESCS Q1	0.06* (0.04)	na	0.16 (0.11)	−0.02 (0.21)	−0.14* (0.07)	0.03 (0.10)	0.02 (0.08)	0.02 (0.10)	0.10 (0.13)	0.07 (0.08)	0.08 (0.08)	−0.10 (0.18)	−0.07 (0.15)	0.15 (0.09)
ESCS Q4	0.07* (0.04)	na	0.07 (0.10)	0.11 (0.20)	0.02 (0.04)	0.08 (0.09)	−0.04 (0.11)	0.14 (0.10)	−0.30** (0.15)	0.12 (0.08)	0.12 (0.08)	−0.23 (0.17)	0.14 (0.17)	−0.05 (0.08)
Stress resistance														
	0.06*** (0.02)	−0.00 (0.05)	0.02 (0.05)	0.06 (0.11)	0.04 (0.03)	0.07* (0.04)	0.09** (0.04)	0.10* (0.06)	0.07 (0.08)	0.08** (0.04)	na	−0.25*** (0.07)	0.03 (0.06)	−0.03 (0.04)
Interaction with Gender														
Girl	0.10*** (0.03)	−0.08 (0.07)	0.01 (0.07)	0.05 (0.17)	0.03 (0.05)	0.06 (0.06)	0.02 (0.06)	0.23*** (0.07)	0.02 (0.11)	0.11** (0.05)	na	−0.23** (0.10)	0.04 (0.10)	0.00 (0.06)
Boy	0.02 (0.03)	0.09 (0.08)	0.05 (0.08)	0.08 (0.15)	0.05 (0.04)	0.09 (0.05)	0.17*** (0.06)	−0.08 (0.08)	0.13 (0.10)	0.05 (0.05)	na	−0.30*** (0.10)	0.01 (0.10)	−0.05 (0.06)
Interaction with ESCS Quartile														
ESCS Q1	0.04 (0.04)	−0.04 (0.14)	0.02 (0.09)	0.01 (0.25)	−0.07 (0.09)	0.19 (0.13)	0.13 (0.08)	−0.07 (0.09)	0.09 (0.10)	−0.03 (0.07)	na	−0.19 (0.17)	0.02 (0.12)	0.07 (0.07)
ESCS Q4	0.06 (0.04)	−0.01 (0.12)	0.16 (0.13)	−0.20 (0.18)	0.04 (0.06)	0.02 (0.08)	0.09 (0.08)	0.15 (0.10)	0.02 (0.15)	0.18** (0.07)	na	−0.32* (0.18)	0.16 (0.17)	−0.07 (0.08)
Co-operation														
	−0.02 (0.02)	na	−0.05 (0.05)	−0.09 (0.08)	−0.03 (0.03)	0.03 (0.04)	0.11** (0.05)	0.07 (0.06)	0.07 (0.07)	−0.03 (0.04)	−0.08 (0.05)	−0.12 (0.09)	0.05 (0.07)	−0.02 (0.05)
Interaction with Gender														
Girl	−0.02 (0.03)	na	−0.05 (0.06)	−0.15 (0.15)	−0.02 (0.05)	−0.07 (0.06)	0.11 (0.07)	0.15** (0.07)	0.11 (0.09)	−0.02 (0.05)	−0.13** (0.06)	−0.23* (0.13)	0.09 (0.10)	−0.02 (0.06)
Boy	−0.03 (0.03)	na	−0.04 (0.06)	−0.04 (0.11)	−0.03 (0.04)	0.13** (0.06)	0.10 (0.08)	−0.04 (0.10)	0.02 (0.11)	−0.03 (0.05)	−0.02 (0.07)	−0.01 (0.12)	0.01 (0.11)	−0.03 (0.07)
Interaction with ESCS Quartile														
ESCS Q1	−0.02 (0.04)	na	0.00 (0.08)	−0.09 (0.19)	−0.05 (0.08)	0.02 (0.10)	0.11 (0.10)	−0.00 (0.12)	−0.03 (0.12)	−0.06 (0.07)	−0.06 (0.07)	0.06 (0.18)	0.14 (0.15)	0.00 (0.09)
ESCS Q4	−0.05 (0.04)	na	−0.27*** (0.10)	−0.10 (0.14)	−0.04 (0.06)	0.02 (0.07)	0.07 (0.09)	0.11 (0.09)	0.04 (0.14)	0.01 (0.07)	−0.16* (0.09)	−0.30 (0.19)	0.09 (0.18)	−0.08 (0.10)

Source: PISA 2022, Author's calculation. Note: Only the 2SLS estimates of the impact of the relative age at school entry (instrument: theoretical age at entry) is reported. Models include as additional controls variables: gender, socio-economic status (4 dummies), immigrant background. In countries where two school cohorts have been sampled (Estonia, Finland, Germany, Korea), the specification includes detailed grade, instrumented by the theoretical grade. Standard Errors in parenthesis.

Table C.9: Impact of relative age on the quality of teacher/students relationships

	AVG	AUT	BEL	DNK	ENG	ESP	EST	FIN	FRA	JPN	KOR	MEX	NLD	NOR	POL	SGP
Perc. of teacher unfairness (2015)																
	−0.36*** (0.08)	−0.82* (0.48)	−0.51*** (0.17)	0.01 (0.17)	−0.27 (0.33)	−0.14 (0.17)	−0.69*** (0.20)	0.27 (0.22)	−0.45** (0.19)	−0.14 (0.22)	0.03 (0.16)	−0.77*** (0.19)	−0.45** (0.21)	−0.15 (0.21)	−0.06 (0.23)	−0.06 (0.16)
Interaction with Gender																
Girl	−0.23* (0.12)	−1.38* (0.74)	−0.58*** (0.21)	0.00 (0.18)	−0.53 (0.45)	0.08 (0.24)	−0.41* (0.25)	0.35 (0.28)	−0.44 (0.28)	−0.16 (0.26)	−0.08 (0.18)	−0.72*** (0.23)	−0.26 (0.23)	−0.14 (0.30)	−0.15 (0.34)	−0.08 (0.21)
Boy	−0.47*** (0.13)	−0.42 (0.68)	−0.43 (0.31)	0.02 (0.28)	−0.02 (0.55)	−0.38 (0.28)	−0.95*** (0.31)	0.21 (0.35)	−0.47* (0.28)	−0.11 (0.35)	0.13 (0.27)	−0.82*** (0.30)	−0.67** (0.32)	−0.16 (0.31)	0.02 (0.32)	−0.03 (0.27)
Interaction with ESCS Quartile																
ESCS Q1	−0.64*** (0.15)	−1.18 (1.49)	−0.20 (0.37)	0.56* (0.29)	0.13 (0.61)	−0.84*** (0.30)	−1.06** (0.43)	0.43 (0.41)	−1.17** (0.50)	0.06 (0.57)	−0.21 (0.31)	−1.46*** (0.30)	−0.89** (0.41)	0.55 (0.40)	−0.03 (0.51)	−0.31 (0.31)
ESCS Q4	−0.39* (0.20)	−0.59 (0.99)	−0.68** (0.31)	0.01 (0.30)	−0.88 (0.75)	0.10 (0.27)	−0.22 (0.34)	0.01 (0.45)	0.06 (0.36)	−0.49 (0.54)	0.32 (0.31)	−0.63 (0.40)	0.04 (0.30)	−0.70* (0.36)	−0.48 (0.48)	−0.24 (0.30)
Teacher Enthusiasm																
	0.07*** (0.02)	−0.03 (0.10)	0.08 (0.05)	−0.04 (0.03)	0.35*** (0.13)	0.13*** (0.03)	0.02 (0.05)	0.18*** (0.05)	0.04 (0.06)	0.09 (0.09)	0.06 (0.04)	0.03 (0.05)	−0.06 (0.07)	na	0.09 (0.06)	−0.03 (0.04)
Interaction with Gender																
Girl	0.10*** (0.03)	0.09 (0.14)	0.07 (0.06)	−0.04 (0.05)	0.34* (0.18)	0.10** (0.04)	0.02 (0.06)	0.24*** (0.07)	0.14* (0.08)	0.12 (0.12)	0.07 (0.04)	0.05 (0.07)	−0.04 (0.10)	na	0.14* (0.08)	−0.01 (0.06)
Boy	0.04 (0.03)	−0.18 (0.17)	0.08 (0.07)	−0.03 (0.06)	0.36** (0.17)	0.16*** (0.05)	0.03 (0.07)	0.12* (0.07)	−0.06 (0.08)	0.07 (0.13)	0.05 (0.07)	0.01 (0.06)	−0.10 (0.12)	na	0.05 (0.08)	−0.04 (0.07)
Interaction with ESCS Quartile																
ESCS Q1	0.08** (0.04)	−0.16 (0.19)	0.09 (0.09)	0.02 (0.08)	0.44 (0.28)	0.09 (0.08)	0.01 (0.10)	0.09 (0.11)	−0.02 (0.09)	0.19 (0.16)	−0.02 (0.08)	0.10 (0.08)	−0.05 (0.16)	na	0.18* (0.10)	−0.03 (0.09)
ESCS Q4	0.06 (0.05)	0.23 (0.20)	0.02 (0.08)	−0.00 (0.06)	0.17 (0.33)	0.12** (0.06)	−0.02 (0.12)	0.15* (0.08)	−0.02 (0.12)	0.10 (0.18)	−0.01 (0.09)	−0.01 (0.07)	0.14 (0.17)	na	0.12 (0.14)	−0.05 (0.09)
Disciplinary climate																
	0.09*** (0.02)	0.07 (0.11)	0.05 (0.04)	0.02 (0.04)	0.18 (0.13)	0.04 (0.03)	−0.03 (0.05)	0.12** (0.05)	−0.02 (0.06)	0.18** (0.07)	0.08* (0.05)	0.11*** (0.03)	0.09 (0.06)	na	0.08 (0.06)	0.08 (0.05)
Interaction with Gender																
Girl	0.11*** (0.04)	0.03 (0.13)	0.07 (0.07)	−0.02 (0.05)	0.17 (0.17)	0.05 (0.04)	−0.02 (0.07)	0.11 (0.08)	0.10 (0.09)	0.20* (0.12)	0.01 (0.06)	0.09 (0.06)	0.11 (0.09)	na	0.01 (0.07)	0.07 (0.06)
Boy	0.07** (0.03)	0.12 (0.18)	0.03 (0.07)	0.07 (0.06)	0.20 (0.24)	0.03 (0.05)	−0.04 (0.08)	0.13* (0.08)	−0.13* (0.07)	0.16 (0.11)	0.17** (0.08)	0.14** (0.05)	0.08 (0.08)	na	0.15* (0.09)	0.08 (0.07)
Interaction with ESCS Quartile																
ESCS Q1	0.06 (0.05)	−0.14 (0.16)	0.07 (0.09)	−0.08 (0.08)	0.11 (0.29)	0.00 (0.08)	0.11 (0.11)	0.03 (0.11)	−0.01 (0.08)	0.10 (0.17)	0.08 (0.09)	0.14** (0.07)	0.09 (0.11)	na	−0.18 (0.14)	0.07 (0.09)
ESCS Q4	0.21*** (0.05)	0.43** (0.19)	−0.03 (0.08)	0.05 (0.06)	0.56** (0.26)	0.05 (0.05)	−0.12 (0.10)	−0.02 (0.09)	0.20* (0.11)	0.57*** (0.17)	0.10 (0.10)	0.13 (0.08)	−0.00 (0.12)	na	0.05 (0.12)	0.08 (0.11)

Source: PISA 2015 and 2018, Author's calculation. Note: Only the 2SLS estimates of the impact of the relative age at school entry (instrument: theoretical age at entry) is reported. Models include as additional controls variables: gender, socio-economic status (4 dummies), immigrant background. In countries where two school cohorts have been sampled (Estonia, Finland, Germany, Korea), the specification includes detailed grade, instrumented by the theoretical grade. Standard Errors in parenthesis.

Table C.10: Impact of relative age on social relations at school

	AVG	AUT	BEL	DNK	ENG	ESP	EST	FIN	FRA	JPN	KOR	MEX	NLD	NOR	POL	SGP
Exposure to bullying																
	-0.07^{***}	-0.20^{*}	-0.09^{*}	-0.03	0.02	-0.04	-0.07	-0.03	-0.20^{***}	0.05	na	-0.09	-0.20^{***}	na	0.02	-0.09^{*}
	(0.03)	(0.11)	(0.05)	(0.04)	(0.11)	(0.03)	(0.05)	(0.06)	(0.06)	(0.09)		(0.06)	(0.06)		(0.07)	(0.05)
Interaction with Gender																
Girl	-0.05	-0.29^{**}	-0.06	-0.08	0.20	-0.02	-0.08	-0.06	-0.13	-0.02	na	-0.11	-0.16^{***}	na	0.02	-0.19^{***}
	(0.04)	(0.14)	(0.06)	(0.06)	(0.16)	(0.04)	(0.09)	(0.08)	(0.08)	(0.09)		(0.08)	(0.06)		(0.09)	(0.06)
Boy	-0.09^{**}	-0.11	-0.11	0.05	-0.20	-0.06	-0.06	0.01	-0.27^{***}	0.11	na	-0.07	-0.24^{***}	na	0.02	0.02
	(0.04)	(0.17)	(0.07)	(0.06)	(0.20)	(0.05)	(0.09)	(0.10)	(0.08)	(0.13)		(0.09)	(0.09)		(0.11)	(0.07)
Interaction with ESCS Quartile																
ESCS Q1	-0.05	-0.26	-0.02	-0.11	-0.09	-0.08	-0.07	0.01	0.06	0.04	na	-0.21	-0.10	na	0.25^{*}	-0.12
	(0.06)	(0.17)	(0.08)	(0.09)	(0.28)	(0.07)	(0.11)	(0.14)	(0.17)	(0.14)		(0.15)	(0.12)		(0.14)	(0.10)
ESCS Q4	-0.13^{**}	-0.24	-0.08	-0.04	0.06	-0.05	-0.11	-0.12	-0.25^{**}	-0.03	na	-0.12	-0.23^{*}	na	0.02	-0.12
	(0.05)	(0.19)	(0.08)	(0.07)	(0.26)	(0.06)	(0.09)	(0.10)	(0.11)	(0.16)		(0.10)	(0.12)		(0.13)	(0.09)
Enjoy cooperation (2015)																
	0.08^{***}	0.12	0.10^{**}	0.06	-0.04	-0.04	0.09^{**}	0.23^{***}	0.10^{**}	0.14	0.07^{*}	0.09	0.05	0.06	0.12^{**}	0.08^{*}
	(0.02)	(0.13)	(0.04)	(0.04)	(0.09)	(0.05)	(0.04)	(0.06)	(0.05)	(0.09)	(0.04)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)
Interaction with Gender																
Girl	0.04	0.11	0.08	0.05	0.02	-0.03	0.02	0.22^{***}	0.04	0.05	-0.01	0.06	0.01	0.11	0.24^{***}	0.09
	(0.03)	(0.22)	(0.06)	(0.05)	(0.12)	(0.07)	(0.07)	(0.08)	(0.07)	(0.12)	(0.06)	(0.08)	(0.07)	(0.08)	(0.08)	(0.07)
Boy	0.11^{***}	0.11	0.13^{*}	0.08	-0.09	-0.04	0.15^{***}	0.24^{***}	0.16^{**}	0.24^{**}	0.15^{**}	0.13	0.10	0.02	0.02	0.08
	(0.03)	(0.17)	(0.07)	(0.07)	(0.12)	(0.07)	(0.06)	(0.07)	(0.07)	(0.12)	(0.07)	(0.08)	(0.08)	(0.08)	(0.07)	(0.07)
Interaction with ESCS Quartile																
ESCS Q1	0.11^{*}	0.72^{*}	0.19^{**}	0.05	-0.05	-0.07	0.21^{**}	0.15	0.17	0.40^{**}	0.12	-0.06	0.11	0.03	0.18^{*}	-0.00
	(0.06)	(0.41)	(0.09)	(0.08)	(0.16)	(0.10)	(0.10)	(0.12)	(0.11)	(0.20)	(0.08)	(0.14)	(0.11)	(0.09)	(0.11)	(0.08)
ESCS Q4	-0.02	-0.22	0.20^{***}	0.07	-0.02	-0.01	0.15	0.21^{*}	0.07	0.13	0.16^{*}	0.03	-0.02	0.08	0.10	0.09
	(0.09)	(0.27)	(0.07)	(0.05)	(0.16)	(0.09)	(0.11)	(0.11)	(0.11)	(0.19)	(0.08)	(0.14)	(0.10)	(0.11)	(0.13)	(0.11)

Source: PISA 2015 and 2018, Author's calculation. Note: Only the 2SLS estimates of the impact of the relative age at school entry (instrument: theoretical age at entry) is reported. Models include as additional controls variables: gender, socio-economic status (4 dummies), immigrant background. In countries where two school cohorts have been sampled (Estonia, Finland, Germany, Korea), the specification includes detailed grade, instrumented by the theoretical grade. Standard Errors in parenthesis.

Table C.11: Impact of relative age on self-confidence

	AVG	AUT	BEL	DNK	ENG	ESP	EST	FIN	FRA	JPN	KOR	MEX	NLD	NOR	POL	SGP
Self-efficacy																
	0.12*** (0.02)	0.19 (0.12)	0.05 (0.05)	0.11** (0.05)	0.34*** (0.11)	0.14*** (0.03)	0.13*** (0.04)	0.04 (0.06)	0.05 (0.05)	0.15** (0.07)	0.13*** (0.04)	0.09 (0.06)	0.11 (0.07)	na	0.16*** (0.05)	0.03 (0.04)
Interaction with Gender																
Girl	0.09*** (0.03)	0.25* (0.13)	−0.03 (0.07)	0.08 (0.06)	0.23 (0.15)	0.15*** (0.04)	0.17*** (0.06)	0.05 (0.08)	0.03 (0.08)	0.07 (0.08)	0.13** (0.05)	0.06 (0.07)	0.20*** (0.07)	na	0.11* (0.06)	−0.00 (0.05)
Boy	0.15*** (0.03)	0.13 (0.21)	0.13 (0.09)	0.15** (0.07)	0.46** (0.19)	0.12*** (0.04)	0.09 (0.07)	0.02 (0.08)	0.07 (0.08)	0.24** (0.11)	0.13* (0.08)	0.13 (0.08)	−0.01 (0.12)	na	0.22*** (0.08)	0.06 (0.06)
Interaction with ESCS Quartile																
ESCS Q1	0.14*** (0.05)	0.24* (0.15)	−0.05 (0.13)	0.09 (0.09)	0.48* (0.27)	0.09 (0.06)	0.03 (0.11)	0.08 (0.10)	0.03 (0.10)	0.43** (0.18)	0.09 (0.08)	0.10 (0.12)	0.10 (0.15)	na	0.08 (0.10)	0.06 (0.08)
ESCS Q4	0.14*** (0.05)	0.51** (0.23)	0.03 (0.09)	0.19** (0.09)	0.64** (0.32)	0.15** (0.07)	0.21** (0.10)	0.07 (0.13)	0.01 (0.11)	0.12 (0.19)	0.05 (0.08)	0.10 (0.10)	0.24* (0.15)	na	0.29** (0.11)	0.14** (0.06)
Ambitious learning goals																
	0.07*** (0.02)	0.06 (0.09)	0.03 (0.04)	−0.05 (0.03)	0.30** (0.12)	0.12*** (0.04)	0.00 (0.05)	0.06 (0.05)	−0.02 (0.06)	0.08 (0.08)	0.12** (0.05)	0.07 (0.04)	−0.10 (0.07)	na	0.22*** (0.05)	−0.03 (0.04)
Interaction with Gender																
Girl	0.07** (0.03)	0.07 (0.11)	0.04 (0.06)	−0.03 (0.04)	0.39** (0.17)	0.14*** (0.05)	−0.04 (0.08)	0.02 (0.07)	−0.07 (0.08)	0.01 (0.10)	0.21*** (0.06)	0.09 (0.06)	−0.00 (0.08)	na	0.29*** (0.07)	−0.02 (0.05)
Boy	0.08** (0.03)	0.05 (0.13)	0.03 (0.05)	−0.07 (0.06)	0.18 (0.18)	0.10* (0.06)	0.05 (0.07)	0.10 (0.07)	0.02 (0.07)	0.14 (0.12)	0.00 (0.07)	0.05 (0.07)	−0.22* (0.13)	na	0.16** (0.07)	−0.04 (0.06)
Interaction with ESCS Quartile																
ESCS Q1	0.12*** (0.04)	−0.08 (0.15)	0.11 (0.08)	−0.10 (0.08)	0.37 (0.25)	0.16** (0.08)	0.06 (0.09)	0.09 (0.11)	−0.01 (0.10)	0.24 (0.16)	0.19* (0.10)	0.17* (0.09)	−0.18 (0.16)	na	0.13 (0.11)	−0.08 (0.07)
ESCS Q4	0.05 (0.04)	0.27 (0.20)	−0.05 (0.07)	0.01 (0.07)	0.62** (0.26)	0.15* (0.08)	−0.08 (0.09)	0.17* (0.09)	0.04 (0.10)	0.08 (0.16)	−0.00 (0.11)	−0.03 (0.09)	−0.15 (0.16)	na	0.23** (0.10)	−0.05 (0.07)
Enjoy Competition																
	0.03* (0.02)	0.10 (0.12)	0.12*** (0.04)	0.01 (0.05)	0.40*** (0.13)	0.09*** (0.03)	0.06 (0.05)	−0.04 (0.05)	0.07 (0.06)	−0.15 (0.09)	0.01 (0.04)	0.05 (0.06)	−0.04 (0.07)	na	0.01 (0.04)	−0.04 (0.03)
Interaction with Gender																
Girl	−0.01 (0.03)	0.06 (0.15)	0.02 (0.06)	0.01 (0.06)	0.32** (0.16)	0.06* (0.04)	0.10 (0.06)	−0.09 (0.07)	−0.02 (0.08)	−0.29** (0.14)	0.02 (0.04)	−0.01 (0.08)	0.00 (0.09)	na	0.07 (0.06)	0.02 (0.05)
Boy	0.08** (0.03)	0.15 (0.19)	0.21*** (0.07)	0.01 (0.08)	0.50** (0.20)	0.12*** (0.05)	0.01 (0.07)	0.01 (0.08)	0.15* (0.08)	−0.01 (0.13)	−0.01 (0.07)	0.13* (0.08)	−0.08 (0.12)	na	−0.05 (0.08)	−0.10** (0.05)
Interaction with ESCS Quartile																
ESCS Q1	−0.02 (0.04)	−0.06 (0.19)	0.04 (0.12)	0.02 (0.09)	0.44* (0.25)	0.04 (0.07)	0.03 (0.10)	0.11 (0.12)	0.02 (0.11)	−0.17 (0.16)	0.07 (0.08)	−0.03 (0.11)	−0.00 (0.15)	na	0.06 (0.09)	−0.08 (0.09)
ESCS Q4	−0.03 (0.05)	0.01 (0.25)	0.20** (0.08)	0.15* (0.09)	0.34 (0.36)	0.02 (0.07)	0.03 (0.08)	−0.05 (0.10)	−0.03 (0.10)	−0.42** (0.18)	−0.14 (0.09)	−0.06 (0.12)	−0.05 (0.13)	na	−0.01 (0.09)	−0.02 (0.08)
Test anxiety (2015)																
	−0.02 (0.02)	−0.23 (0.15)	−0.00 (0.04)	0.05 (0.03)	0.04 (0.09)	−0.03 (0.04)	−0.01 (0.05)	−0.06 (0.05)	0.04 (0.06)	0.03 (0.07)	−0.14*** (0.05)	−0.06 (0.06)	−0.04 (0.05)	−0.03 (0.05)	−0.01 (0.05)	−0.05 (0.05)
Interaction with Gender																
Girl	−0.03 (0.04)	−0.35** (0.18)	0.01 (0.05)	0.10** (0.05)	−0.04 (0.12)	0.01 (0.05)	0.07 (0.07)	−0.07 (0.07)	0.09 (0.08)	0.17 (0.11)	−0.12* (0.07)	−0.06 (0.07)	0.06 (0.07)	0.02 (0.07)	−0.04 (0.07)	−0.08 (0.06)
Boy	−0.02 (0.04)	−0.14 (0.20)	−0.02 (0.06)	−0.01 (0.05)	0.12 (0.12)	−0.07 (0.06)	−0.09 (0.06)	−0.04 (0.06)	−0.01 (0.08)	−0.12 (0.11)	−0.15** (0.07)	−0.05 (0.08)	−0.16** (0.08)	−0.08 (0.07)	0.02 (0.08)	−0.02 (0.07)
Interaction with ESCS Quartile																
ESCS Q1	−0.08 (0.06)	−0.01 (0.36)	−0.08 (0.08)	0.10 (0.07)	−0.05 (0.15)	0.04 (0.08)	−0.03 (0.11)	−0.02 (0.12)	0.14 (0.12)	−0.07 (0.16)	−0.10 (0.11)	−0.27*** (0.10)	−0.20** (0.10)	0.14 (0.09)	0.17 (0.12)	−0.03 (0.08)
ESCS Q4	0.03 (0.07)	−0.19 (0.32)	0.04 (0.07)	0.10 (0.07)	0.11 (0.16)	−0.02 (0.08)	0.01 (0.09)	0.09 (0.10)	0.13 (0.11)	0.32* (0.17)	−0.09 (0.09)	−0.14 (0.10)	0.10 (0.09)	−0.07 (0.10)	−0.20** (0.10)	−0.08 (0.09)

Source: PISA 2015 and 2018, Author's calculation. Note: Only the 2SLS estimates of the impact of the relative age at school entry (instrument: theoretical age at entry) is reported. Models include as additional controls variables: gender, socio-economic status (4 dummies), immigrant background. In countries where two school cohorts have been sampled, the specification includes detailed grade, instrumented by the theoretical grade. Standard Errors in parenthesis.

Table C.12: Impact of relative age at entry on the expectation to complete tertiary education

	AVG	AUT	BEL	DNK	ENG	ESP	EST	FIN	FRA	ITA	JPN	KOR	MEX	NLD	NOR	POL	SGP
	0.05***	0.06	0.06***	0.03**	0.11***	0.04***	0.05***	0.02	0.02	0.06***	0.06***	0.03***	0.04***	−0.02	0.00	0.05***	0.01*
	(0.01)	(0.04)	(0.01)	(0.02)	(0.03)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)
Interaction with Gender																	
Girl	0.03***	−0.02	0.05***	0.04**	0.11***	0.03*	0.03	−0.01	0.01	0.10***	0.06**	0.03**	0.05***	−0.04	−0.01	0.07**	0.00
	(0.01)	(0.12)	(0.02)	(0.02)	(0.04)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.01)	(0.02)	(0.03)	(0.03)	(0.03)	(0.01)
Boy	0.04***	0.13	0.07***	0.02	0.10***	0.05***	0.07***	0.05**	0.04**	0.03	0.06**	0.04**	0.03	−0.01	0.02	0.03	0.02**
	(0.01)	(0.10)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.01)
Interaction with ESCS Quartile																	
ESCS Q1	0.04***	0.21	0.02	0.01	0.11**	0.05*	0.08**	0.06	0.01	0.03	0.10*	0.08***	0.07**	0.00	−0.05	0.05	0.00
	(0.01)	(0.17)	(0.03)	(0.03)	(0.05)	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)	(0.06)	(0.02)	(0.03)	(0.04)	(0.05)	(0.03)	(0.02)
ESCS Q4	0.04***	−0.07	0.06***	0.02	0.12**	0.03**	0.03	0.00	0.06**	0.08*	0.04	0.02	0.02	0.00	0.02	0.06*	−0.00
	(0.01)	(0.35)	(0.02)	(0.03)	(0.04)	(0.01)	(0.02)	(0.03)	(0.03)	(0.04)	(0.03)	(0.01)	(0.02)	(0.04)	(0.04)	(0.03)	(0.01)

Source: PISA 2015, 2018 and 2022, Author's calculation. Note: Only the 2SLS estimates of the impact of the relative age at school entry (instrument: theoretical age at entry) is reported. Models include as additional controls variables: gender, socio-economic status (4 dummies), immigrant background. In countries where two school cohorts have been sampled, the specification includes detailed grade, instrumented by the theoretical grade. Standard Errors in parenthesis.

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