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Maturity and School Outcomes in an Inflexible System: Evidence from Catalonia

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Abstract

Having a unique cut-off to determine when children can access school induces a large heterogeneity in maturity to coexist in a classroom. We use rich administrative data of the universe of public schools in Catalonia to show that: 1) Relatively younger children do significantly worse both in tests administered at the school level and at the regional level, and they experience greater retention; 2) Younger children in our data exhibit higher dropout rates and chose the academic track in secondary school less often; 3) The effect is homogeneous across SES and significant across the whole ability distribution; 4) Younger children are more frequently diagnosed with learning disabilities.

JEL Codes: I21, I28, H75.

Keywords: Human capital, educational economics, kindergarten cutoff.

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1 Introduction

The fact that a unique school cut-off date determines when a child can enter school induces large heterogeneity in the age at which a child enters school and large heterogeneity of ages encountered in classrooms, with the older children being up to 20% older than their youngest peers. Older children will be substantially more mature than their younger peers, which will lead them to initially perform better. Work by Heckman and coauthors shows that early child development is complementary to later learning – see Cunha, Heckman, and Lochner (2006) for a review. Bedard and Dhuey (2006) use international data to show that this early relative maturity effects propagate through the human capital accumulation process and have long run effects for adults. Several papers look at the effects within a country: Fredriksson and Öckert (2014) for Sweden, Puhani and Weber (2007) for Germany, Schneeweis and Zweimüller (2014) for Austria, Black, Devereux, and Salvanes (2011) for Norway, Crawford, Dearden, and Meghir (2010) for England, McEwan and Shapiro (2008) for Chile, Ponzo and Scoppa (2014) for Italy, and Elder and Lubotsky (2009) for the US.

We use very detailed administrative data of the universe of public schools in Catalonia for children between age 6 and 18 for the academic years 2009/2010 - 2013/2014 to provide evidence that being younger in the class affects performance in different ways. The case of Catalonia deems particularly interesting as children are generally not allowed to postpone entrance to primary school. We first confirm that relatively younger children perform worse as measured by their performance in tests administered both at the school level and at the regional level; moreover they are retained more often and are less likely to enroll in the academic track for high school. Contrary to what others have found for other countries, younger children in Catalonia drop out more often.[1] We also find that the effect is decreasing as children get older, although significant throughout. In particular the gap between younger and older children is about 0.6 standard deviations when they are in second grade, and still 0.2 standard deviations in middle school. The effect is significant and

[1] In Catalonia children get their degree at the end of the academic year where most students turn 16, which is the age until which education is compulsory. As we discuss later in the text incentives to finish the degree may be slightly stronger in Catalonia than in other countries.

sizeable for all ability levels, as confirmed by quantile regressions.

Particularly stark are the results on retention: while a small fraction of students are retained in primary school (about 3.1% during the first two years) those born at the end of the year are more than two times more likely to be retained than the average child.

Younger children are more frequently diagnosed with learning disabilities such as ADD and ADHCD, also suggesting a role for teachers in handling heterogeneous maturities in the classroom. The probability of being diagnosed for a child born at the end of the year is three times higher than for an otherwise identical child born at the beginning of the year.

Finally, being younger increases the probability of dropout by about 2 percentage points. When children finish middle school, at age 16, they can choose a vocational or an academic track. About 50% of students overall enroll in the academic track, but the probability of choosing it is 5 p.p lower for the youngest.

In the literature there is also evidence that maturity effects may be larger for children coming from families with high socioeconomics (SES). For instance, Elder and Lubotsky (2009) argue that pre-school experience changes with SES and hence the impact of spending one more year at home or in preschool is particularly benefiting for children coming from high SES. In the US, for instance, the impact of maturity is larger for high SES than for low SES. On the other hand high SES could also help fill the gap during school years, by providing support and additional training to the relatively younger who are facing greater challenges. In the case of Catalonia SES of the parents affects performance directly, by increasing performance in school, but does not interact with maturity effects. This may be because more than 97% of the students enroll in preschool at the age of 3, and a vast majority of them attend childcare before that.[2] This means that the extra year out of school for older children is spent in homogeneous preschools for all children, and hence, there

[2]Guaranteed universal and free access to public education in Spain, and in Catalonia in particular, starts at age 3. The spring of the year that children become three parents are asked to choose school for their children. That will be the same school that children will be in at least until the end of primary school. In our data we can observe transition from preschool to primary school only for children enrolled in public schools. Only 4.5% of children who attended a public preschool switch to a different institution for primary education. These figures compare well with statistics described in Calsamiglia and Güell (2014) or Calsamiglia, Fu, and Güell (2014), for both public and semi-public school in Barcelona, where 95% of the children attend school at age 3 and less than 5% change school in primary school.

is less heterogeneity due to the experience acquired in that additional year.

The rest of the paper is organized as follows. Section 2 describes the Catalan educational system and enrollment rules. Section 3 presents the data and the descriptive statistics. Section 4 presents the analysis of the maturity effects on school outcomes in primary and middle school. Finally, Section 5 concludes.

2 Catalan educational system and enrollment rules

Primary school (*Educació primaria*, EPRI) is the first stage of compulsory education in Catalonia; normally a child begins primary school in September of the year in which he or she turns 6 years old. This enrollment rule is quite sharp and exceptions are extremely rare. Until 2008, they required the approval of the department of Education, *Departament d'Ensenyament*.[3] A reform of compulsory education approved in September 2008 introduced a slightly more flexible transition from preschool to primary school. The general rule is the same, but exceptions are managed by the school, together with the family instead of the department of Education.[4] However, as discussed in next session and confirmed by the statistics in table 2, also in more recent years the overwhelming majority of children comply with the rule: more than 99% of them enroll in primary school at 6 years old.

Before primary school children can attend preschool (*Educació infantil*) for three years (from September of the year in which they turn 3). Attendance is not compulsory, but in practice almost all families enroll their children.[5] Normally primary education takes 6 years, followed by 4 years of middle school (*Educació secondaria obligatòria*, ESO). Students are legally required to stay in

[3]Decree 94/1992, issued on April, 28 (in Diari Official de la Generalitat de Catalunya (DOCG), núm. 1593 - 13/05/1992).

[4]Decret 181/2008, issued on September, 9 (in DOGC núm. 5216 - 16/9/2008), and Order EDU/484/2009, issued on November 2, (in DOGC núm. 5505 - 13/11/2009)

[5]In our data about 97% of children enrolled for the first time in primary school in 2012 or 2013 were enrolled in preschool the year before. Some of the remaining 3% may have been enrolled in a semi-private or private school (only enrollment data for public preschools are available to us).

school until they turn 16 or until they graduate. After successfully completing lower secondary education, students can enroll in upper secondary education for two more years. Upper secondary education is either academic (*Batxillerat*) or vocational (*Grau Mitjà*). Only students who graduated from Batxillerat can aim at enrolling in a 4-year bachelor degree in a University. The rates of completion of middle school and enrollment in further education is low in Catalonia (and in Spain), in comparison with other European countries. According to Eurostat in years 2011-2013 about 25% of the population aged 18 to 24 in Catalonia were early leavers from education, namely they attained at most lower secondary education and have not been involved in further education or training.[6]

Students who do not obtain sufficient evaluations can be retained and spend one more year in the same grade both in primary and secondary school. By law, children can be retained at most once in primary school and at most twice in middle school.[7] Exceptions are allowed only for children with special educational needs and are extremely rare in practice.[8] However, as discussed in section 3.2, retention is relatively infrequent in primary school and pretty common in middle school.

3 Data

Our analysis focuses on students enrolled in public schools in Catalonia from school year 2009/2010 to school year 2013/2014. Each year about 79.000 children enroll for the first time in the first grade in one of the primary schools of the region. 67% of them attends a public school. 30% of the students attend a semi-private school, and the remaining a private school outside of the public school

[6]Statistics "Early leavers from education and training by sex and NUTS 2 regions" (edat_lfse_16) available on ec.europa.eu/eurostat

[7]For primary school: Decret 142/2007, issued on June, 26 (in DOGC núm. 4915 - 26/6/2007). For secondary school: Decret 143/2007, issued on June, 26 (in DOGC núm. 4915 - 26/6/2007)

[8]Our data confirm that retention rules are enforced. For instance among children born in 2003 (who normally enter primary education in 2009 and are in grade 5 by year 2013), only 30 (0.05%) were retained twice during the first two cycles of primary education. Among those born in 2001 (who typically complete the second and the third cycle of primary school before 2013), only 27 (0.04%) were retained twice in the time period spanned by our sample. Similarly for middle school, only 13 children born in 1997 and 22 children born in 1996 were retained three times from 2009 to 2013.

system.[9]

3.1 Data sources

We exploit data from different sources that provide us with detailed information on enrollment, school progression, academic outcomes and socio-demographic characteristics of Catalan students. The *Departament d'Ensenyament* (regional ministry of education in Catalonia) provided enrollment records for the schools in the region, from preschool to high school. The IT infrastructure that supports the automatic collection of data have been progressively introduced since the school year 2009/2010. By year 2010/2011 almost all schools have already adopted it, while we have data for about 60% of them in 2009/2010.[10]

Basic information (age of the children, school and class attended) are available for all types of schools, but more detailed socio-demographic characteristics (such as gender, nationality, special needs) are collected only for public schools. Moreover for children enrolled in public school we observe the internal evaluations that they receive at the end of each school cycle (2-years period in primary school, 1-year period in the secondary school) for each subject they have undertaken. These final evaluations are assigned by teachers taking into account the progression of the child and her performance in several tests administered during the cycle.

The *Consell d'Avaluació de Catalunya* (public agency in charge of evaluating the educational system) provided us with the results of standardized tests taken by all the students in the region attending the last year of primary school (6^{th} grade) and the last year of middle school (11^{th} grade). Such tests are administered during spring since 2009/2010 for primary school and since 2011/2013 for middle school. They assess basic competences in Maths, Catalan, Spanish and English and have a purely statistical purpose: they do not affect in any way the students' final evaluations or progress to the next grades. We will refer to the results in these tests, whose grading is blind, as *external evaluations*, in contrast with the final evaluations given by the school, that we will call *internal*

[9] Semi-private schools (*Concertadas*) are run privately and funded via both public and private sources

[10] Some schools initially report data only for their lower grades, covering the entire pool of students only after two or three years. Therefore the sample used to study the outcomes in the lower grades is slightly larger.

evaluations.

Finally we collect information on the student's family background, more specifically on parental education from the Census (2002) and local register data (*Padró*).[11] We couldn't identify any parents for 4.5% of children in our sample; those students are excluded from the analyses that incorporate parental background variables.

All data sources have been merged and anonymized by the Institut Català d'Estadistica (IDESCAT).

3.2 Summary statistics

Table 1 summarizes basic socio-demographic characteristics of students enrolled in first grade of primary school and in first grade of middle school in public institutions of the region.[12] Birthdays are almost equally distributed across the year and, if anything, children are slightly more likely to be born in the last months of the year. About half of the students in the sample are female, and there is a slight increase in the share of not Spanish citizens attending public school from primary to middle school (from 14% to 18%).[13] 36% of parents of children enrolled in primary school have at most obtained a middle school diploma, while 28% of children have at least one parent with tertiary education.

Table 2 provides evidence that in all school years from 2009/2010 to 2013/2014 more than 99% of 6-year-old students are enrolled in first grade of primary school. Moreover there isn't any evident trend that suggests an increasing attitude to postpone (or anticipate) entrance.[14]

We do not know the enrollment status at age 6 for children that were older when data collection started, therefore we cannot infer the share of non compliers for the previous school years. How-

[11] When the information could be retrieved from both sources, we imputed the highest level of education, presumably the most up-to-date information. In the analyses we use an index of "parental background" based on the average level of education of parents. The index takes 5 values, from 0 (both parents are early school leavers) to 4 (both parents hold a tertiary education degree). For single-parent family the index is based on the level of education of the single parent.

[12] Statistics are comparable in the subsequent grades.

[13] For simplicity from now on we will refer to students whose nationality is not the Spanish one as "immigrant". However some of them may be second generation immigrants, i.e. they may be born in Spain from parents who migrated there.

[14] For postponed enrollment the share is slightly higher in 2012/2012, but the following year it drops back to 2011/2012 level. It is also worth noting that the statistics for 2009/2010 may be not fully comparable with the following years because the sample of schools involved is much smaller.

ever, although we cannot assess the exact change due to the increased flexibility introduced by the decree issued in 2008, the overall effect of the change in law on enrollment behavior appears to be null or extremely small. Finally it is worth noting that a part of "immigrant" students may have started their education abroad in a country with different enrollment rules, both for the cutoff date and for the flexibility of the system. We cannot directly control for this fact, but the analysis in section 4.3.1 shows that we can identify a larger maturity effect for Spanish students.

Table 3 summarizes academic outcomes at the end of each cycle of primary school and the end of first and second grade of secondary school. The first four columns show average results in the core subjects: Mathematics, Catalan, Spanish, English. In middle school grades are assigned using a 0-10 scale, while in primary school the available evaluations are "Insufficient", "Sufficient", "Good", "Very good", "Excellent", that we convert in numeric values using the same scale of middle schools grades.[15] In the empirical analyses (section 4) we will take z-scores of the evaluations, so that the units of measure of the estimated coefficients are standard deviations.[16]

Fourth column of table 3 reports the share of children that repeated the cycle; while retention rate is low in primary school, it increases substantially in middle school (about 10% a year). At the end of second grade more than one fourth of children have been retained at least once in the past. Last column of table 3 shows the share of children who have special educational needs of any kind, representing around 4% of the sample.[17]

Graphs 1 and 2 provide a first visual insight of how large the age gap at the beginning of primary school is. Figure 1 plots the average GPA in second grade by month of birth: performances appear to be a linear decreasing function of the month of birth. Similarly, figure 2 shows that the empirical probability of retention is increasing in month of birth, being 4 times higher for children

[15] In middle school both numeric grades and the same 5 marks are assigned, thus each word correspond to an interval of numeric grades between 0 and 10. Using the same conversion scheme, we assign to each evaluation in primary school the midpoint of its interval; thus "Insufficient" is interpreted as 3, "Sufficient" as 5, "Good" as 6, "Very good" as 7.5 and "Excellent" as 9.5. An alternative approach would be to just use numbers from 1 to 5. If the analyses discussed next section are replicated using this second approach results are extremely similar.

[16] External evaluations are standardized at the subject – year level. Internal evaluations are standardized at the subject–year–school level.

[17] Special needs assignation and is regulated by Llei Orgànica d'Educació LOE 2/2006 (articles 71 and 72).

born in December than for children born in January.

Finally graph 3 gives a first sense of the persistence of the maturity gap over time. It plots the empirical probability of undertaking academic upper secondary education by month of birth: on average younger children are less likely to choose it.

4 Analysis

4.1 Methodology

We study the effect of maturity at enrollment in primary school on children' achievement throughout compulsory education and on their future educational choices.

As Elder and Lubotsky (2009) point out, entrance age may have lasting effects on human capital for two reasons. First, all children in a class are exposed to the same educational methods and contents, but they may have different learning capabilities due to different levels of maturity. Second, even if at some point their current production functions are identical, their level of human capital may be different due to their past history, and therefore they may end up with different human capital in the following period. To clarify this point, let A be the age at enrollment, X^t other individual characteristics that contribute to human capital formation at time t (for instance parental investments), and consider the following simple model of human capital:

$$H^t = \beta H^{t-1} + \left(a^t A + X^t b^t\right) \tag{1}$$

$$H^0 = a^0 A + X^0 b^0 \tag{2}$$

H^t depends on past human capital and current inputs. If $a^t > 0$, maturity has *direct* effect on human capital accumulation in period t. In other words we can say that children born in different months have access to different technology to produce human capital. If $\beta > 0$, then there will be an *indirect effect* of producing differential levels of human capital through the accumulation process. In particular, if $a^t = 0$, A has only an *indirect* effect on H^t trough past human capital

H^{t-1}. Replacing H^{t-1} backward in (1) we obtain the following equivalent expression:

$$H^t = \left(a^t + \sum_{k=0}^{t-1} \beta^{t-k} a^k \right) A + \left(\sum_{k=0}^{t} \beta^{t-k} X^k b^k \right) \tag{3}$$

Equation 3 is close to our empirical specification. We do not observe contemporaneous inputs, with the exception of the institute in which the child is enrolled, therefore we rely on individual and family characteristics which are constant over time. The specifications we use in the analysis have the following structure:

$$Y_i^t = \alpha^t \text{EA}_i + X_i \gamma^t + c_i^t + s_i^t + \epsilon_i^t \tag{4}$$

where Y_i^t is any school outcome achieved in grade t (for instance GPA), X_i are covariates realized before the child enroll in school (gender, immigrant status, parental education...), c_i^t and s_i^t are respectively cohort and school fixed effect. As evident from a comparison with previous equation 3, α^t in equation 4 captures the cumulative effect of maturity up to grade t plus the direct effect of the particular year. Although we cannot perfectly disentangle the direct and indirect effect of maturity in grade t, a comparison of the estimated α^t across grades is informative of the prevailing effect: a decreasing sequence of $\widehat{\alpha^t}$ suggests that the main channel in the long run is the *indirect* effect, and that the direct effect is only relevant in the initial years. In particular, if β is sizeable, then a^t must be almost insignificant in the future, only the past accumulation process being relevant in explaining the long run gap.[18]

Rather than age A, we use the "expected entrance age" EA, namely the age the child would have when enrolling in primary school if she complies with the rule of enrolling in the year in which they turn 6. Although the very large majority (more than 99%) of children do comply with the rule, a small share of them postpone the entrance. Moreover, for outcomes measured in more

[18] Several works of Cunha, Heckman and other co-authors study life cycle skill formation, showing that skill attainment at one stage of the life cycle raises skill attainment at later stages of the life cycle. Their finding support the hypothesis that β is positive and sizeable. See Cunha et al. (2006) for a review.

advanced grades, the actual age of children depends on whether they have been retained in the past. Thus the actual age is endogenous and an instrumental variable approach is required: as usual in this literature we use the expected age at the enrollment.[19] Unfortunately we do not observe the actual enrollment age for most of the students, thus we rely on the "reduced form" approach given by 4. Appendix A compares results of the reduced form model with a proper two stage least square approach on the subset of students whose date of enrollment is directly observed. Given the extremely high rate of compliance the two approaches are virtually identical.

The assumption that EA is uncorrelated with unobserved characteristics that impact school's outcomes ensures that α^t is consistently estimated.

Given the limited time span of our sample we cannot follow students over time, but we rather use different cohorts of students to estimate α^t for grade t. As a robustness check we can however restrict the estimation to students that we observe in two consecutive levels; for instance for those born in 2003 or 2004 we have evaluations for both first and second cycle of primary education. We can then estimates specifications for first and second cycle only on this subsample and compare the results with those obtained with the general specification. This simple robustness check always confirms the validity of our approach.[20]

The richness of our dataset allows us to observe evaluations of retained students both in the year in which they fail and in the year in which they gain access to the following grade. As discussed in section 3.2 and confirmed in following section 4.4, younger children are more likely to be retained relatively to their older counterparts, the difference being larger at the initial grades. On the one hand if the youngest have a less favorable production function, taking again a given school level should put them in the same position as the oldest children of the following cohort. Moreover, concluding their education with one year of delay would impact relatively less their future wealth, because when entering the labor market they would be about the same age of the oldest children in their cohort that were not retained. Then we adopt the most conservative approach and in our

[19] For simplicity we normalize expected age in the interval $[0, 1]$: a student born on January, 1 has expected age of 1, while a student born on December, 31 has expected age of 0

[20] Results of this robustness check are not shown and are available upon requests.

analysis we always use the last available outcome for retained children. That is, if a child has been retained in sixth grade we analyze her outcomes the second time she takes the exams in sixth grade. Replicating the analysis using the outcome before retention makes our results slightly stronger.

4.2 Sample Selection

In section 4.3 we estimate the effect of maturity on academic performance, as measured by internal evaluations over time. External evaluations are used when they are available to verify the robustness of the results. The pool of students used for each regression include children in public school who attends a class with at least 6 other children.[21] Moreover two important refinements define the sample of the analysis. First, we include only cohorts for which we can observe (at least) students with a regular progression or one year behind in primary school and up to two years behind in secondary school. Therefore regressions whose dependent variable is an evaluation in primary school exploit four cohorts of students, while those whose dependent variable is an evaluation in secondary school include three cohorts. For instance, when we study outcomes in second grade of primary school, we use students born from 2002 to 2005, while we do not include those who were born in 2001 (we would observe only students who are one or more year behind, but not those with a regular progression) or born in 2006 (we would observe only students in a regular progression, but not those retained the year before).[22] This choice is aligned with the regulation of enrollment and progression in primary and secondary school: students can be retained at most once during the entire cycle of primary school, and at most twice in secondary school. Exceptions to these general rules require *ad hoc* arrangements and are very rare in practice.

Second, as explained in section 4.1, when a student undertakes the same grade twice only the most recent evaluation is included in the analysis. Consider for instance a student who attended the second grade of primary school in year 2010, was retained and repeated the same grade in 2011, being

[21] This restriction exclude less than 1% of the sample. Estimates are neither sensitive to the choice of a stricter threshold nor to including everyone in the analysis.

[22] While for the oldest cohorts we can observe also students who are more than one year behind, this is not possible for 2005 cohorts. Given that the number of students who are two or more year behind or one year in advance is negligible, we ignore this difference. Further reducing the sample leaves the estimates unchanged

finally promoted. The evaluation obtained in 2011 is included, while the other is discarded. With very good approximation this approach gives us the evaluation that the student obtained when she is admitted to the following level. When the final observation coincides with student's last year in the sample we do not have direct evidence that the student was promoted; however the regulation ensures that the student has to be promoted, except for very special cases. As a robustness check (not shown) we performed the same set of analysis exploiting one less cohort and imposing the further restriction that students are included in the sample only if we can observe them in a higher grade the following year. Results were completely equivalent to those discussed below.

When analyzing the external evaluations at the end of secondary school we have a selection problem: children aged 16 can drop out of school without finishing secondary school. Given the retention rules discussed in previous section, all children conclude at least the second grade, but they may dropout before concluding the fourth or even the third grade. This means that the sample of students for which we can observe evaluations in the two last years of middle school is not fully representative of the initial population of children. This selection issue is discussed extensively in section 4.5, where we analyze the effect of maturity on dropout. We still include our results for third and fourth grades in the analysis discussed thereafter, in order to provide some illustrative evidence of the long lasting effect of maturity on performance, but we acknowledge that we cannot exclude either positive or negative biases due to selection.

4.3 Maturity on Evaluations

We studied the effect of maturity on final evaluations in Mathematics, Spanish, Catalan, English and their GPA.[23]. Table 4 presents the results for different specifications using internal evaluations obtained at the end of second grade of primary school. Column (1) shows coefficients of a simple regression of GPA on maturity and a constant, while additional regressors are progressively intro-

[23]Due to missing evaluations, the sample size is slightly different across specification. Results are unchanged when restricting the analysis to the subsample of students who have all the evaluations filled.

duced from column (2) to (4). In column (2) individual and family characteristics (gender, migrant status, parental education) are added, together with a vector of dummies for the year of birth (i.e. cohort fixed effects). Column (3) includes school fixed effects. Column (4) allows for a non linear effect of maturity: quadratic and cubic orthogonal components of expected age are added to the specification. The remaining columns regress the evaluations in each subject using the same specification of column (3). Table A-1 in appendix A replicates column (3) for the subsample of children for whom we can observe the enrollment age, and compares results with a two stage least square model with fixed effects. Not surprisingly, given that most of the children are compliers, the estimates are very similar.

Table 5 shows the effect of maturity over school progression, from second grade of primary school to fourth grade of middle school: GPA is regressed on expected age, other individual and family characteristics, cohort and school fixed effects.[24] As explained in section 4.2, not all children arrive at third or fourth grades of middle school, therefore the regressions are performed on the subset of the population that stay in school at least until those grades.

For sixth grade of primary school and fourth grade of middle school we also use as dependent variable the GPA in external evaluations (columns (ext.)) for comparison with the effect estimated trough internal evaluations (columns (int.)).

Table 4 provides compelling evidence that maturity is a very important determinant of students' outcomes at the beginning of their school career: *ceteribus paribus* being born at the beginning of January rather than at the end of December increases the GPA of 0.58 standard deviations. This effect is much larger than both the gender gap and the native-immigrant gap. It is also larger than the effect of having both parents with high school diploma rather than with only primary education. Estimations are similar using as dependent variable evaluations in the four subjects used to compute the average score. Comparison of column (1) and (2) with column (3) shows that the

[24]First column is identical to column (3) in table 4 and it is reported for convenience.

effect of age is orthogonal to socio-economics as well as to school characteristics.[25] The pattern is identical using the subjects rather than GPA.[26] Although there may be differences in the distribution of birth across socio-economics, for instance because working mothers prefer to deliver in summer, these results are definitely reassuring that household with a better parental background do not specifically target the early months of the year.

Finally, column (4) in table 4 provides evidence that the effect of maturity is linear: adding higher polynomial terms in age do not change the estimates, moreover the additional terms are highly insignificant.[27]

Table 5 confirms that the age effect is highly persistent over time, although decreasing in magnitude: in middle school being one year older is still associated with 0.2 standard deviations increase in the GPA. Although the worst performing students, who (as we showed) are disproportionately born in the last months of the years, may have been retained and drop out before reaching the fourth grade, age effect is still significant at 1% level at the end of middle school.

Columns (ext.) confirm that results are not driven by the particular evaluation procedure used in schools: the estimated effect is the same or larger using the test scores obtained by the students in their external evaluations. The fact that the effect of maturity on school outcomes decreases over time supports the hypotheses that younger children create a lower stock of human capital in the earlier stage of their academic career, but later on they do not cumulate human capital at a lower rate for a given level of human capital from previous period (otherwise the gap should be increasing rather than decreasing). However the initial disadvantage is so large that the negative effects

[25]To compute the school fixed effects each student is assigned the school she was attending when the dependent variable was measured. Although less than 4% of the students change schools, for those that have attended a different school in the past the specification is not fully accurate since the previous school may have affected the educational outcome as well. Including a dummy that captures the change in school does not change the results discussed in this paragraph. Its coefficient is significant and negative, suggesting that pupils who switch from one school to another are probably experiencing some learning difficulties. However we do not do that because the choice of changing school is endogenous. For instance a child born in December may have a hard time in first year of primary school and her parents may decide to move her in another school, attributing her difficulties to the pedagogical methods of the initial school.

[26]For the sake of space we do not show specifications (1),(2) and (4) for the subjects. Results are available upon request.

[27]We use orthogonal components rather than simply the square and the cube of the expected age because the three terms would be highly correlated and the estimation of each one of them very imprecise. Conversely using the orthogonal components allow us to get rid off the correlation and directly test that there aren't non linear effects.

propagate over time and the gap is not closed at the end of lower secondary education.

4.3.1 Heterogeneous effects

We next explore whether the maturity effect on school performance is heterogeneous across students' characteristics such as gender or parental background, and across the distribution of ability. To test heterogeneity due to exogenous characteristics we augment the baseline model with all the possible interactions among discrete regressors and the continuous measure of age at enrollment. In other words we allow the age effect on evaluations to be heterogeneous across 12 groups defined by of gender, nationality, and parental education; moreover a different intercept is estimated for each group.[28]

Table A-2 in the appendix shows estimated maturity effect for each group over school progression. Figure 4, that plots predicted internal evaluations by maturity in grade 2 and 6 for each group, facilitates the interpretation of the results. While students with different set of characteristics have on average different predicted evaluations, the maturity effect is remarkably similar across groups: most of the lines are almost perfectly parallel. Difference between native and immigrant students from grade 4 of primary school on constitutes the main exception: the advantage of older students is reduced among immigrants of both genders with low or middle educated parents, and the gap between the estimated coefficient for native and immigrant is typically larger in more advanced grades. [29] One plausible explanation for this finding is that some non Spanish students are recent immigrants, who may have experienced a different school system for the first part of their education, with different cutoff dates or simply more flexibility, therefore they may be less affected by our measure of maturity at enrolment. Although this is a speculation we cannot directly test, it is supported by the evidence that the difference widen in more advanced grades, where recent

[28] In this specification we aggregate parental education in three categories (low, middle, and high) to ensure that final groups contain enough students for a meaningful estimate. Parental education is classified as low if both parents have at most a middle school diploma, while it is high if at least one parent completed tertiary education and the other obtained a high school diploma, other cases are classified as middle.

[29] Conversely, estimates for immigrant children with high educated parents are similar to the Spanish counterpart. They are however extremely under represented in the population: among Spanish students each category of parental education contain at least 30% of the data, while less than 6% of immigrant students have high educated parents.

immigrants have been exposed to relatively more education abroad than in Spain.

Maturity effect is quite homogeneous by gender or parental education; differences are small in magnitude and not significant in most cases.[30] The finding that maturity effect and parental education are orthogonal is particularly interesting because it contrasts with Elder and Lubotsky (2009), who find that in US the effect is increasing in children's SES. One possible explanation comes from the differences in preschool systems in Spain and US. Preschool quality is quite heterogeneous in US and a substantial fraction of children do not attend preschool regularly. Parental contribution is therefore fundamental to determine the human capital level of the child at the beginning of formal education. Younger children start school having spent less time with their parents, and *ceteris paribus* the gap is larger among high SES, given that they have foregone more parental inputs when starting school. Conversely in Spain almost every child is enrolled in preschool, for which there is free and universal access starting at age three. Even if the gap that we observed in primary school can be even larger in preschool, the quality of the time spent out of school before age 6 depends less on their SES.

We perform quantile regressions to explore heterogeneous effects across ability distribution. Figure 5 displays the estimated coefficients for quantile regressions on the effect of maturity on internal and external evaluations in sixth grade of primary school (from 0.1 to 0.9 quantile). It is relevant to stress that with both measures the estimated effect of maturity is sizeable and significant throughout the entire distribution of ability. This is an important confirmation that we should be concerned about the negative effect of being younger at the time of enrollment for all children, not only for those who exhibit particular characteristics.

The shape of the curves that describe the relative importance of maturity effects across the distribution is different in the two specifications. Using as outcomes internal evaluations, the gap is smaller at the bottom tail, and increasing for most of the distribution, with a small drop at the

[30] The estimated coefficient is slightly larger for female than for male only among Spanish with low educated parents, in grade 2 and 4 of primary school. The estimate is significant at 5% level but the size of the difference is small (0.05 standard deviation).

upper tail. The shape of an analogous curve for internal evaluations in previous grade is extremely similar. In middle school the gap is also increasing in ability, but without the drop for the top tail.[31] Conversely the effect is decreasing in ability when external evaluations are used as outcome.[32] Difference between internal and external evaluations might come from the specific way in which teachers evaluate children in class. It may also be affected by the fact that internal and external do a better job in discriminating children's ability in different part of the distribution.[33]

4.3.2 Peer effects

After providing evidence that maturity at the enrolment as well as other individual characteristics are important determinants of school's outcomes, we explore the effect of peers' characteristics. To do so we augment the specifications discussed throughout section 4 by including characteristics of children attending the same school and grade in the same year. We use this level of aggregation rather than measuring peers at the class level because anecdotal and empirical evidence suggests that some middle schools may sort children across classes based on their ability: to the extent that ability – as measured by school performances – is correlated with other individual characteristics, a regression that exploits peers' at the class level would be biased.[34]

Table 6 replicates table 5 including peers' regressors: average of exogenous regressors and the share of peers that are older than the regular age for the grade under analysis, i.e. who have been retained in one or more of the previous years.

Coefficients in table 6 of own regressors are virtually unaffected by the introduction of the new regressors, while peers' average age and other characteristics affect differently internal and exter-

[31] Results available upon request.

[32] This result is in line with Arellano and Weidner (2016). Using as outcome the results in TIMSS (Trends in International Mathematics and Science Study) for a sample of Canadian students, they find that age effects are decreasing in ability.

[33] External evaluations are meant to test basic knowledge, therefore they can discriminate better children at the bottom part of the distribution rather than at the top tail. On the other hand internal evaluations allow to discriminate better the middle-high part of the distribution: only one grade is available for insufficient performance in primary school; in middle school in principle numbers from 1 to 4 can be used, but 3 and 4 are much more frequent in practice. However the increasing and decreasing effects respectively in the middle part of the distribution are very robust when performing censored quantile regressions that consider bottom or top outcomes as censored.

[34] See Calsamiglia and Loviglio (2016) for a more detailed discussion of children's allocation to classes in primary and middle schools in Catalonia.

nal evaluations. On one hand peers' characteristics are mainly insignificant (with the exception of the share of female) when using external evaluation as dependant variable. Peers' expected age effect is positive and marginally significant (p-value 0.24) in grade 6. This is aligned with previous works that find positive or null effects of peers' quality on standardized tests.[35]

On the other hand internal evaluations show a quite consistent pattern: they typically have the opposite sign of the corresponding coefficient of individual characteristics. Effects are not large in magnitude, in comparison with the corresponding effect of own characteristics, but always significant in primary school and mainly significant in the initial years of middle school.[36] Allowing for heterogeneous effects across children with different characteristics (for instance younger or older than their peers, or born in different terms of the year) leave the results unchanged: a change in peers' characteristic affects all individuals internal grades in a similar manner.[37]

These findings suggest that teachers evaluate their students in relative terms, at least to some extent: being with older students, as well as with children that have more educated parents, may decrease performances as measured by internal evaluations, due to comparison with an increased average level of performances. However this does not imply that children are learning less in a class with more advantaged peers: as shown using external evaluations they do as well or slightly better than similar children with weaker peers when they are blindly evaluated.

In a recent paper Lavy and Sand (2015) shows that teachers' perceptions and biases can affect children's expectations, choices and outcomes in the longer run. Calsamiglia and Loviglio (2016) analyze how individual grades are harmed by peer quality, also emphasizing the fundamental role that teachers perceptions can have on individual's self-perception and performance over time.

[35] See Sacerdote (2011) for a review of the literature on peer effects. Elder and Lubotsky (2009) and Ciccone and Garcia-Fontes (2012) find that having older peers is not detrimental for performances as measured by a standardized test. Cascio and Schanzenbach (2007) find that exposure to more mature kindergarten classmates improves school outcomes in the following years.

[36] Variation of peers' characteristics is relatively small within school. For instance an increase of 0.1 in peers' expected age (which is much larger than one standard deviation) would decrease the GPA in second grade of primary school of 0.05, about one third of the effect of increasing individual age of 3 months (i.e. about one standard deviation in expected age).

[37] Results are available upon requests

4.4 Maturity on Retention

We add one further piece of evidence on the effects of maturity by exploring the effect of age on probability of being retained in primary school and in middle school. Results are shown in table 7. For primary school the dependent variable is a dummy that takes values 1 if the child has been retained in any of the two years of the cycle. We exploit only cohorts for which we can observe both students who are behind and students that are progressing at the regular pace up to the end of the cycle. Note, however, that retention is very rare in primary school. For secondary school we measure retention yearly; we include in the analysis only cohorts for which it is possible to observe both students that are progressing regularly, students who started middle school later (typically because retained in primary school), and students who have already been retained once in one of the previous grades in middle school.

We use a linear probability model, with cohort and school fixed effects. Probit or logit model based on the same specification deliver fully aligned results.

Being one year younger increases probability of retention in the first cycle of primary school of about 4 percentage points, a huge effect given that the average retention rate is less than 3%. Although the worst performing children have been already retained in previous years, the effect is still sizeable and significant also for second and third cycle, even if smaller in size. This result appears particularly striking considering that children born in the last months of the year are over represented among those retained in the first cycle. Despite the "lower tail" have probably already been retained at the beginning, it is still more likely for younger children to be retained throughout primary school.

Children who were younger when starting primary school are more likely to be retained also several years later in middle school. The estimated effect is about 3 percentage points and does not decrease over time.

Previous analyses in section 4.3 already highlighted that retention does not close the gap between older and younger children: we used the last evaluation for a given grade, but students with an earlier birthday are still performing better on average. Clearly this does not mean that retention is

completely ineffective: it may improve outcomes of children who have been retained, however this intervention on the lower tail of the distribution of ability does not close the average gap between younger and older children.

4.5 Dropout and enrollment in Batxillerat

As discussed above, the age effect is persistent and still sizeable in middle school, but the trend is somehow decreasing over time. However in the year in which they turn 16 students have to take decisions that will have long lasting consequences on their labor market outcomes. First, if they turn 16 before graduation they can dropout without concluding lower secondary education. Second, after completing middle school, they can enroll in further education, of either academic or vocational type. It is of uttermost importance to understand if the maturity effect is strong enough to affect their decisions: if the the younger children make on average different choices than their elder counterparts, it becomes evident that the initial gap in age has long term consequences. Thus our goal in this section is to explore whether age at the beginning or primary school affects the probability of completing lower secondary education, and then the probability of enroling in the academic rather than in the vocational track.

We can expect two opposed effects on probability of graduating from middle school. To the extent that low performers are more likely to dropout, we can expect age to have a positive effect on the probability of graduation. On the other hand, older students face a larger time period in which they can dropout therefore they may have higher incentives to leave school before graduation. Which effect prevails is an empirical question.

The limited time span covered by our data imposes some restrictions on the sample used for the current analysis. We focus on students born in 1995 and enrolled in public school in 2009, and determine whether they graduate from a public school in the following years, and whether they enroll in higher education.[38]

[38]More precisely, we are identifying the effect of maturity on the probability of concluding middle school within the public system. We cannot follow students when they leave the public school and obtain a diploma through a private institution. However we do observe enrollment in both public and private high school. We do not find graduation

Although all children should attend school for at least some months before they turn 16 and can dropout, they may not be included in the records if schools transfer their data to the central system at the end rather than at the beginning of the years. Indeed while at earlier grades the probability of disappearing from the data in the following year is orthogonal with age, in the year in which they turn 14 children born at the beginning of the year are significantly more likely to disappear. Given this selection issue, to avoid bias in our favor in the estimates we analyze outcomes of 14 years old rather than 15 years old.[39]

Table 8 summarizes the school progression of 14-year-old students in 2009, namely of children born in 1995. 73% of them are enrolled in third grade of middle school, while 24.7% are one year behind and 2.3% two years behind.[40] While students attending third grade can graduate at the end of the following year (i.e. in 2010), students who are one year behind will graduate on time if they graduate in two years, and student who are two years behind will require three more years to graduate if they graduate on time. We say that an individual born in 1995 will graduate on time if, given the grade that he or she is in in 2009 graduation happens without any further delay. Hence a student is considered graduated "on time" if she completed the remaining of middle school after 2009 without further delay (i.e. in 2010 for those enrolled in third grade, in 2011 for those in second grade, and in 2012 for those in first grade). We say that she graduated with "one year of

for 371 students that are then registered in batxillerat (1% of the sample under analysis). Given that middle school diploma is a compulsory requirement for enrollment in batxillerat they should have obtained it in some unobservable way. We also observe 1722 students who enroll in vocational training without having completed middle school in the public system. However this fact does not provide sufficient evidence that they obtained a middle school diploma, because, after turning 17, students who previously dropout have the possibility to access vocational education after the successful completion of some preparatory courses (another event that we cannot track in the data). Given that counting as graduated only the students enrolled in batxillerat would slightly bias the results in our favor (older children are more likely to perform better and enroll in the academic track), we do not incorporate this information in our initial measure.

[39]Results we obtained replicating table 10 for 15 years old are qualitatively similar, but higher in magnitude. The coefficient of the regressor might spuriously capture the fact that the lower tail of distribution of ability of older children is not in the sample, thus older children in the sample had on average a better outcome. On the other hand our estimates in table 7 may be downward biased because of higher measurement error: some of the 14 years old that we count as dropout may be truly leaving our sample of interest at 15 because moving out of the Catalan education system.

[40]We drop from the analysis 28 children who are one year ahead, i.e. in fourth grade. Nothing changes in the estimations if they are included.

delay" if she needed one additional year (i.e. she finished in 2011 if she was in third grade in 2009, she finished in 2012 if she was in second grade in 2009, and so on). Columns of table 8 show the share of students for each group that graduates on time, with one year of delay and with two years of delay. Last line reports aggregate statistics for the entire cohort of students born in 1995. For the small subgroup of students who attended first grade in 2009 we cannot observe whether they graduate with two years of delay, however only 13 of them where still enrolled in middle school in 2013, therefore we ignore this limitation in our analyses. Moreover it is evident from table 8 that allowing for one year of delay substantially increases the possibility of observing graduation, while very few students graduate with two years of delay. Overall, 74% of students in our sample managed to complete lower secondary education in the time span we can observe.

The dummies we just described are the dependent variables in first three columns of table 10. The usual set of regressors and school fixed effects are included.

We follow the same logic when analyzing enrollment in high school. Table 9 shows descriptive statistics of the probability of enrollment in high school by grade attended at age 14. Dependent variables for columns 4 to 6 in table 10 are built following the same logic but for high school.[41]

Maturity has a significant effect on the probability of graduating on time: ceteribus paribus 14-year-old children born at the beginning of January have 3.5 percentage points higher probability of completing middle school in the minimum possible time than children born at the end of December (the average rate is 64% using our first measure). The estimate is positive but smaller for the measures that allow for delay; the p-value for the coefficient in the third column is only 0.1. This finding suggests that maturity affects the probability of completing middle school. But when the student does not progress normally (typically because she is retained in fourth year of middle school or before) other factors may be important in deciding whether to continue in school or not. Moreover the result shows that as far as dropout is concerned, the "negative" effect of being younger (due to average worst academic outcomes) completely offsets the "positive" effect due to

[41] Obviously given that the enrollment in high school happens at least the year after graduation, we can allow for at most one year of delay.

longer time of compulsory education. This is in contrast with previous studies that exploit US data. The seminal work by Angrist and Krueger (1991) shows that younger children are more likely to stay in school. In a recent paper Cook and Kang (2016) find that, although older children obtain on average better evaluations before turning 16, they are then more likely to dropout and be engaged in criminal activities when adult. The peculiarity of the Spanish system, in which students who stay in school can achieve an official qualification few months after they turn 16, may explain part of the difference in results: older children have more incentives to stay in school, therefore the "negative" effect of being younger is prevalent in our analysis.

Remaining columns of table 10 show that maturity has a sizeable and significant effect on the probability of enroling in further academic education: being one year older increases the chance of enroling in batxillerat by 5 percentage points (on average 50% of students enroll). On the other hand, youngest children are more than 2 percentage points more likely to enroll in vocational education (24% enroll on average).

4.6 Diagnoses of learning disabilities

In public school children with special education needs may be granted additional support during compulsory education. About 4% of students in our data are classified as "special needs" children, and this assignment is a quite persistent: 90% of students who were labeled as special needs in a given year have the same label the following period. While physical disabilities should be straightforward to identify, behavioral or learning diseases (such as attention deficit or mild intellectual disability) are typically diagnosed within schools, with teachers being instrumental in its detection and diagnose. After the condition is confirmed, the child is formally classified as needing special education arrangements.

Our concern here is that teachers' perceptions may be partially clouded by children's maturity: additional immaturity of a younger child may be confounded with a learning disability. We provide evidence in support of this hypothesis testing whether expected age affects the probability of being labeled with a "special needs" code related to learning disorder (development and be-

havioral disorders, mild intellectual disability, and other conditions whose detection may require some subjective judgment of the educator). As placebo test we perform the same analysis using as dependent variable a dummy for physical disability (blindness, deafness, mobility issues, whose diagnosis should be relatively objective). Results are reported in table 11. The first two columns refer to the first cycle of primary school, while the other refer to first grade of middle school.
Being one year older reduces the probability of being diagnosed with learning disorder in the first part of primary school by 1.6 percentage points. The effect is pretty much stable over time, the estimated coefficient being 1.4 percentage points in middle school. On the other hand expected age has no effect on the probability of being attributed physical disability.[42]

5 Conclusions

This paper shows that an inflexible system that allows for no postponing of the entrance of children and little retention early on may lead to maturity effects to have long lasting effects. We use a very rich data set including internal and external evaluations to confirm the persistence of the disadvantage for younger children over time and across the ability distribution. The effect is not only leading to worse performance over time, but to their choices as to whether to continue their education and what career to pursue to be significantly different. The fact that the effect is decreasing over time suggests that having a flexible system that better adapts individual maturity levels to specific grades early on would better adapt the initial heterogeneity, allowing for a better progression over time.

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[42]The share of the students with special needs related to learning is 2.7% in primary school and 3.1% in middle school. The correspondent figures for physical disabilities are 0.47% and 0.35% respectively.

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6 Tables

Table 1: *Students characteristics*

	Period of birth			Parents' education			Female	Immigrant
	Jan-Apr	*May-Aug*	*Sep-Dec*	*low*	*medium*	*high*		
EPRI I	32%	33%	35%	36%	37%	27%	48%	14%
ESO I	33%	33%	34%	43%	36%	22%	49%	18%

Statistics computed on students born in 2003-2006 (EPRI I) and born in 1997-2000 (ESO I)

Table 2: *Delayed or early enrolment in primary school*

School year	*Share who ...*		*N students*
2009/2010	*delayed*	0.78%	
	anticipate	0.064%	23449
2010/2011	*delayed*	0.84%	
	anticipate	0.045%	48980
2011/2012	*delayed*	0.83%	
	anticipate	0.036%	52646
2012/2013	*delayed*	0.92%	
	anticipate	0.056%	53432
2013/2014	*delayed*	0.82%	
	anticipate	0.049%	53156
Total	*delayed*	0.84%	
	anticipate	0.048%	231663

For each year the table shows the share of 6 years old who are still in preschool or are already in second grade). Last column shows the number of 6 years old in each year.

Table 3: *Students school outcomes*

School grade	*Maths*	*Catalan*	*Spanish*	*English*	*Retained*	*Special Needs*
EPRI II	6.95 (1.77)	6.62 (1.78)	6.74 (1.62)	6.97 (1.72)	3.1%	4%
EPRI IV	6.56 (1.90)	6.47 (1.83)	6.52 (1.75)	6.74 (1.94)	2.2%	4%
EPRI VI	6.23 (1.97)	6.20 (1.87)	6.21 (1.82)	6.35 (2.05)	1.9%	4.5%
ESO I	5.63 (1.98)	5.67 (1.79)	5.70 (1.81)	5.78 (2.04)	10.0%	4%
ESO II	5.32 (2.10)	5.48 (1.88)	5.50 (1.90)	5.59 (2.16)	10.6%	4%

Share of retained in primary school refers to the cycle (two-year period). Standard deviation in parenthesis.

Table 4:

Internal evaluations in primary school, grade 2

	GPA				Maths	Spanish	Catalan	English
	(1)	(2)	(3)	(4)				
expected age	0.578	0.574	0.583	0.583	0.544	0.538	0.512	0.497
	(0.009)**	(0.008)**	(0.008)**	(0.008)**	(0.008)**	(0.009)**	(0.008)**	(0.008)**
female		0.169	0.172	0.172	-0.083	0.252	0.231	0.232
		(0.005)**	(0.005)**	(0.005)**	(0.005)**	(0.005)**	(0.005)**	(0.005)**
immigrant		-0.210	-0.318	-0.318	-0.256	-0.390	-0.346	-0.177
		(0.011)**	(0.010)**	(0.010)**	(0.010)**	(0.010)**	(0.009)**	(0.010)**
parents' education		0.168	0.212	0.212	0.195	0.169	0.204	0.193
		(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.002)**
exp. age square				0.001				
				(0.002)				
exp. age cube				-0.003				
				(0.002)				
Constant	-0.261	-0.567	-0.625	-0.625	-0.462	-0.564	-0.600	-0.606
	(0.004)**	(0.007)**	(0.006)**	(0.006)**	(0.006)**	(0.006)**	(0.006)**	(0.006)**
R^2	0.03	0.12	0.15	0.15	0.12	0.12	0.14	0.11
N	167,399	160,434	160,434	160,434	162,044	161,870	161,906	160,778

+ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$

Cohort FE included from col. (2). School FE from col. (3).

Standard errors clustered by school

Table 5:
GPA over time

	EPRI II	EPRI IV	EPRI VI (int.)	EPRI VI (ext.)	ESO I	ESO II	ESO III	ESO IV (int)	ESO IV (ext)
expected age	0.583	0.415	0.337	0.340	0.225	0.183	0.158	0.141	0.203
	(0.008)**	(0.008)**	(0.009)**	(0.009)**	(0.010)**	(0.010)**	(0.010)**	(0.011)**	(0.020)**
female	0.172	0.222	0.296	0.131	0.341	0.341	0.343	0.328	0.060
	(0.005)**	(0.005)**	(0.005)**	(0.006)**	(0.007)**	(0.007)**	(0.008)**	(0.008)**	(0.012)**
immigrant	-0.318	-0.325	-0.328	-0.307	-0.304	-0.286	-0.318	-0.378	-0.632
	(0.010)**	(0.010)**	(0.010)**	(0.011)**	(0.012)**	(0.012)**	(0.012)**	(0.012)**	(0.023)**
parents' education	0.212	0.228	0.233	0.190	0.223	0.217	0.192	0.161	0.194
	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.005)**
Constant	-0.648	-0.593	-0.623	-0.623	-0.393	-0.426	-0.333	-0.264	-0.485
	(0.007)**	(0.006)**	(0.009)**	(0.010)**	(0.008)**	(0.008)**	(0.009)**	(0.009)**	(0.015)**
R^2	0.15	0.15	0.15	0.10	0.16	0.14	0.12	0.11	0.15
N	160,434	148,378	136,131	117,621	105,887	102,007	96,022	86,022	24,465

+ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$
Cohort and School FE included.
Standard errors clustered by school

Table 6:

GPA over time, including peer effect

Standardized evaluations

	EPRI II	EPRI IV	EPRI VI (int.)	EPRI VI (ext.)	ESO I	ESO II	ESO III	ESO IV (int.)	ESO IV (ext.)
expected age	0.578	0.411	0.333	0.339	0.218	0.176	0.152	0.139	0.194
	(0.008)**	(0.008)**	(0.009)**	(0.009)**	(0.010)**	(0.010)**	(0.010)**	(0.011)**	(0.022)**
peers exp. age	-0.490	-0.274	-0.176	0.103	-0.196	0.060	-0.157	0.268	0.101
	(0.027)**	(0.033)**	(0.035)**	(0.088)	(0.150)	(0.211)	(0.217)	(0.167)	(0.736)
peers share behind	0.731	0.790	0.800	0.117	0.889	1.478	1.422	1.137	2.353
	(0.050)**	(0.050)**	(0.045)**	(0.095)	(0.125)**	(0.141)**	(0.127)**	(0.103)**	(0.371)**
female	0.170	0.220	0.293	0.131	0.338	0.337	0.338	0.325	0.057
	(0.005)**	(0.005)**	(0.005)**	(0.006)**	(0.007)**	(0.007)**	(0.008)**	(0.008)**	(0.013)**
peers share female	-0.150	-0.208	-0.257	0.086	-0.414	-0.320	-0.289	-0.195	0.329
	(0.015)**	(0.020)**	(0.021)**	(0.051)+	(0.085)**	(0.118)**	(0.126)*	(0.096)*	(0.387)
immigrant	-0.318	-0.324	-0.326	-0.307	-0.302	-0.283	-0.313	-0.375	-0.607
	(0.010)**	(0.010)**	(0.010)**	(0.011)**	(0.012)**	(0.012)**	(0.012)**	(0.012)**	(0.024)**
peers share immigrant	0.308	0.410	0.434	0.058	0.516	0.431	0.078	0.137	0.609
	(0.025)**	(0.029)**	(0.031)**	(0.074)	(0.123)**	(0.152)**	(0.177)	(0.138)	(0.505)
parents' education	0.211	0.225	0.230	0.189	0.221	0.213	0.189	0.159	0.187
	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.005)**
peers mean parents edu	-0.205	-0.212	-0.233	0.019	-0.338	-0.354	-0.341	-0.371	-0.115
	(0.006)**	(0.007)**	(0.008)**	(0.019)	(0.033)**	(0.047)**	(0.046)**	(0.038)**	(0.151)
Constant	-0.099	-0.212	-0.199	-0.850	0.057	-0.264	-0.150	-0.235	-1.380
	(0.020)**	(0.024)**	(0.026)**	(0.067)**	(0.111)	(0.143)+	(0.155)	(0.130)+	(0.504)**
R^2	0.15	0.15	0.16	0.16	0.15	0.13	0.11	0.10	0.05
N	160,438	148,472	136,281	117,752	106,707	102,960	96,170	86,025	24,465

+ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$

Cohort and School FE included.

Standard errors clustered by school

Table 7:

Retention

	Primary school			Middle school			
	1st cycle	2nd cycle	3rd cycle	1st grade	2nd grade	3rd grade	4th grade
expected age	-0.040	-0.020	-0.011	-0.029	-0.030	-0.026	-0.035
	(0.002)**	(0.002)**	(0.002)**	(0.004)**	(0.004)**	(0.004)**	(0.006)**
female	-0.007	-0.003	-0.004	-0.051	-0.039	-0.044	-0.079
	(0.001)**	(0.001)**	(0.001)**	(0.003)**	(0.003)**	(0.003)**	(0.004)**
immigrant	0.032	0.015	0.016	0.046	0.047	0.079	0.223
	(0.003)**	(0.002)**	(0.002)**	(0.005)**	(0.005)**	(0.005)**	(0.008)**
parents' education	-0.011	-0.007	-0.005	-0.028	-0.027	-0.023	-0.036
	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
Constant	0.067	0.042	0.031	0.168	0.166	0.158	0.237
	(0.002)**	(0.001)**	(0.001)**	(0.003)**	(0.004)**	(0.004)**	(0.005)**
R^2	0.02	0.01	0.01	0.04	0.03	0.03	0.11
N	98,142	90,265	84,478	69,476	67,089	59,944	38,480

+ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$
Cohort and School FE included.
Standard errors clustered by school

Table 8: *ESO completion rate for 14-year-old students in 2009*

	on time	1 year delay	2 years delay	N students
in ESO I at 14	14.8%	16.1%		795
in ESO II at 14	34.5%	42.6%	42.8%	8284
in ESO III at 14	76.1%	86.1%	86.7%	24517
All 14 years old	64.4%	73.7%	74.2%	33596

14 years old with a regular progression are enrolled in ESO III, those who were retained in lower grades. First column of the table reports share of students who completed ESO without further delay (in 2010 for those in ESO III, in 2011 for those in ESO II, etc.). Following columns allow for one or two years of additional delay.

Table 9: *Enrolment in higher secondary education. 14-year-old students in 2009*

	Academic education		Vocational edication		N students
	on time	1 year delay	on time	1 year delay	
in ESO I at 14	3.0%		11.9%		795
in ESO II at 14	11.1%	13.0%	22.4%	30.8%	8284
in ESO III at 14	59.8%	64.0%	11.3%	22.2%	24517
All 14 years old	46.4%	50.0%	14.0%	24.0%	33596

Table 10:

Probability of completing ESO and undertaking further education.

Children born in 1995

	ESO graduate			enrol in batx.		enrol in voc.	
	on time	1 year delay	2 years delay	on time	1 year delay	on time	1 year delay
expected age	0.035	0.017	0.013	0.050	0.048	-0.020	-0.028
	(0.009)**	(0.008)*	(0.008)	(0.009)**	(0.008)**	(0.007)**	(0.008)**
female	0.116	0.103	0.102	0.138	0.145	-0.039	-0.076
	(0.005)**	(0.005)**	(0.005)**	(0.005)**	(0.005)**	(0.004)**	(0.005)**
immigrant	-0.184	-0.178	-0.174	-0.193	-0.186	-0.010	-0.031
	(0.008)**	(0.009)**	(0.009)**	(0.008)**	(0.008)**	(0.006)+	(0.007)**
parents' education	0.065	0.052	0.051	0.098	0.099	-0.026	-0.040
	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.002)**
Constant	0.528	0.652	0.660	0.292	0.323	0.203	0.346
	(0.006)**	(0.006)**	(0.006)**	(0.006)**	(0.006)**	(0.005)**	(0.005)**
R^2	0.10	0.09	0.09	0.16	0.16	0.01	0.03
N	33,596	33,596	33,596	33,596	33,596	33,596	33,596

+ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$

School FE included.

Standard errors clustered by school

Table 11:

Diagnosis of disabilities

	EPRI cycle I		ESO grade I	
	learning	physical	learning	physical
expected age	-0.016	-0.000	-0.014	0.001
	(0.002)**	(0.001)	(0.002)**	(0.001)
female	-0.019	-0.001	-0.019	-0.000
	(0.001)**	(0.000)+	(0.001)**	(0.000)
immigrant	0.001	0.000	0.007	0.000
	(0.002)	(0.001)	(0.002)**	(0.001)
parents' education	-0.006	-0.000	-0.010	-0.000
	(0.000)**	(0.000)+	(0.001)**	(0.000)+
Constant	0.064	0.007	0.058	0.003
	(0.002)**	(0.001)**	(0.002)**	(0.000)**
R^2	0.01	0.00	0.01	0.00
N	119,960	119,960	110,595	110,595

+ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$
Cohort and School FE included.
Standard errors clustered by school

7 Figures

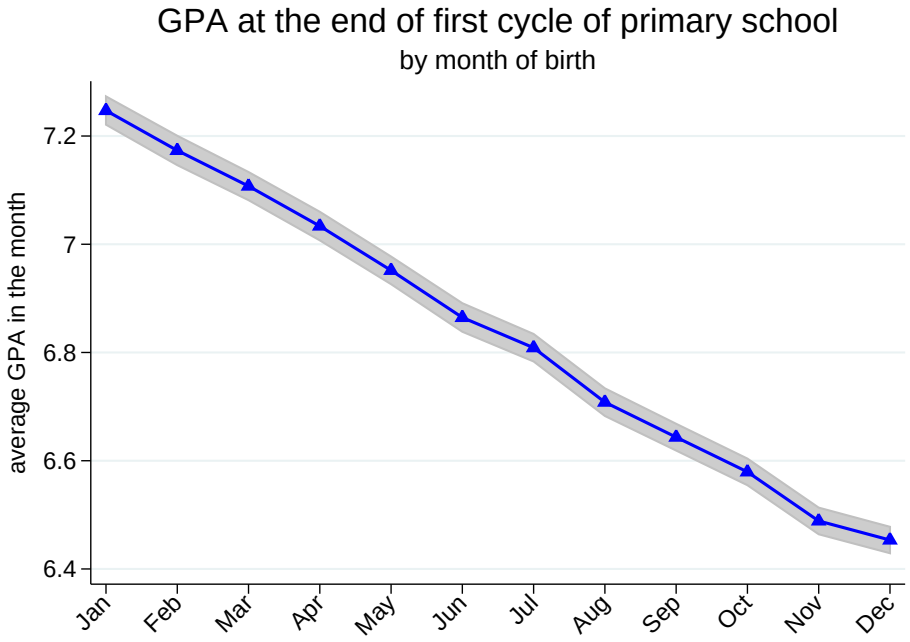

Figure 1: Average of final internal evaluations in Maths, Spanish, Catalan, English in second grade of primary school. Computed on children born from year 2002 to year 2005.

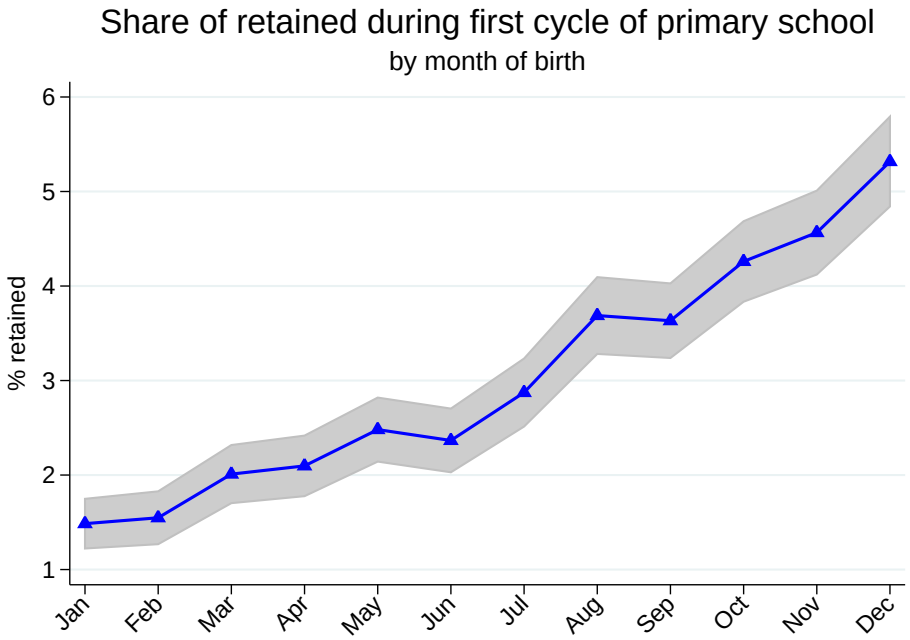

Figure 2: Share of children retained during first cycle of primary school (either in first or second grade). Computed on children born from year 2004 to year 2005.

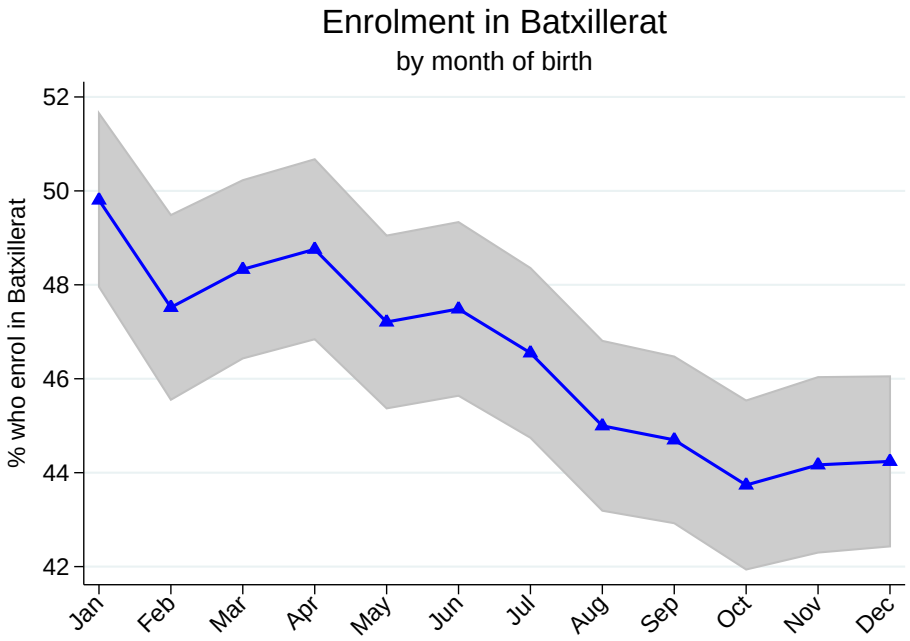

Figure 3: Share of 14 year old born in 1995 who will enroll in Batxillerat in the following years. We count both children who complete ESO without any further retention or who complete it one year later.

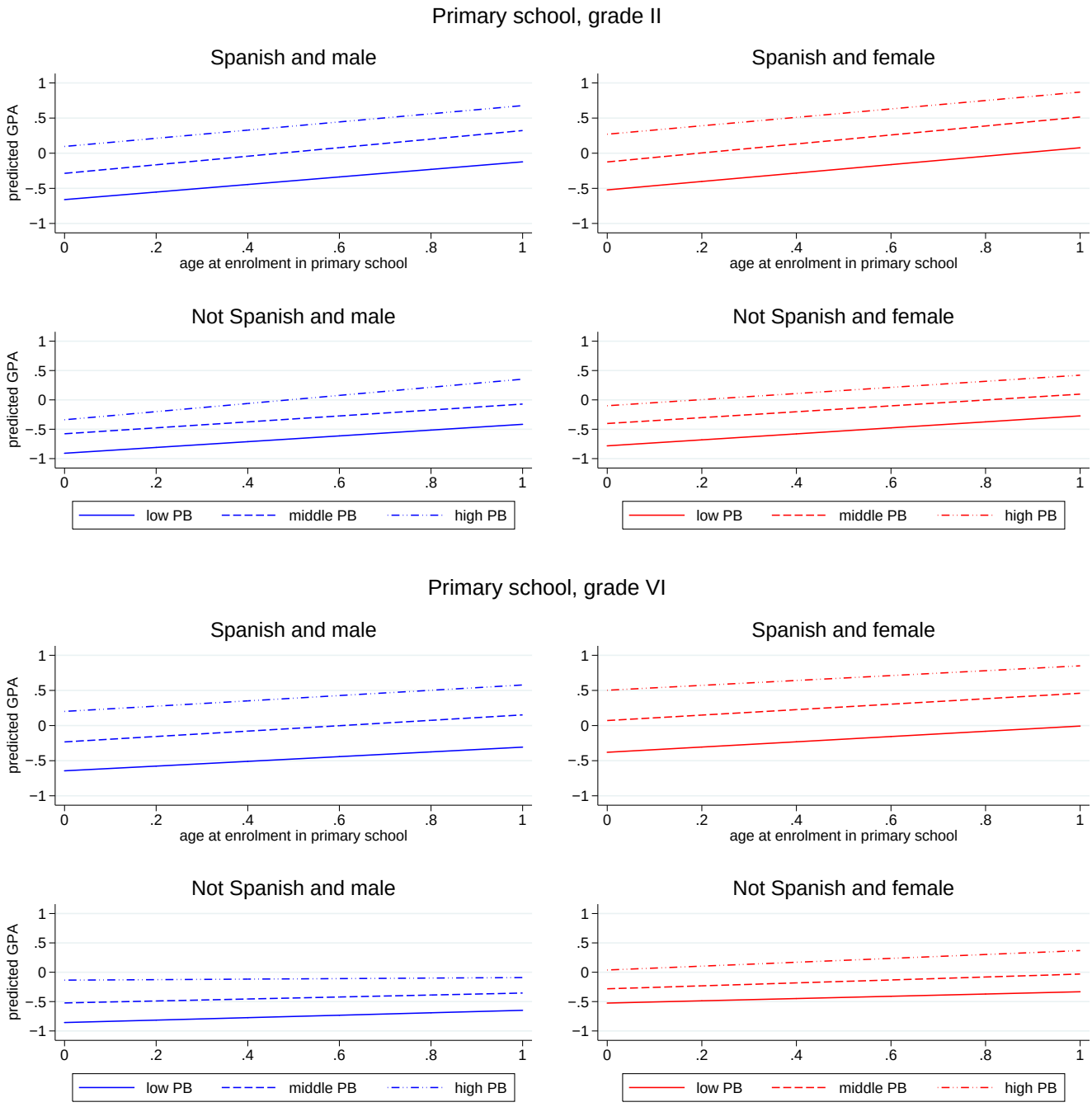

Figure 4: Predicted internal evaluations (mean of Maths, Spanish, Catalan, English) in second and sixth grade of primary school. Predicted value are computed using the average school fixed effect. (Expected) age at enrolment is rescaled in the interval 0-1: a child born on December, 31st has age 0, a child born on January, 1st has age 1.

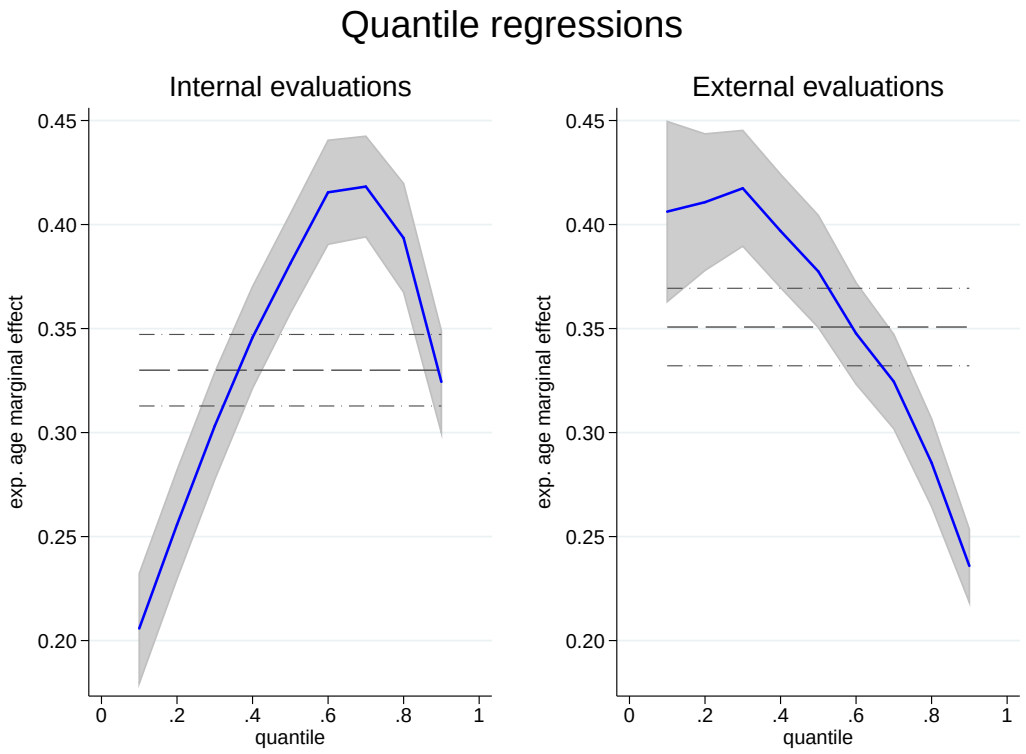

Figure 5: The graph plots the coefficients of expected age estimated performing quantile regressions at 0.1,0.2,...,0.9 quantile. Lines parallel to x-axis are the correspondent ols estimates with their confidence interval. We use internal and external GPA for students enroled in sixth grade of primary school and born from 1998 to 2001.

A Two stage least square regressions and additional tables

As explained in section 4 in general we cannot perform a proper instrumental variable regression. However, a subset of students (those born between 2003 and 2005) is observed both when they begin primary school and when they are evaluated at the end of their second year. We exploit this subset of children to compare 2SLS estimates with our reduced form approach.

First column of table A-1 replicates the reduced form regression in column (3) of table 4 for this subsample. The second column estimates 2SLS regression: the actuale age of enrolment is instrumented with the expected age. Third colum reports the first stage estimates (the dependent variable is actual age). As shown in the table, the age of enrolment and its instrument are highly correlated: any increase in the expected age of enrolment is reflected in an almost equal increase int the actual age. This is not surprising, given that 99% of children comply with the rule of enroling at age 6.[43]

Using the same notation of section 4, and calling A_i the actual age of enrolment for individual i, the appropriate specification for our model is:

$$Y_i = aA_i + X_i b + c_i + s_i + u_i, \qquad cor(u_i, A_i) \neq 0 \tag{A-1}$$

$$A_i = \gamma EA_i + X_i \delta + v_i, \qquad cor(v_i, EA_i) = 0, \quad cor(u_i, EA_i) = 0 \tag{A-2}$$

The two stage least squares estimation estimates first $\widehat{\gamma}$ and $\widehat{\delta}$ in equation (A-2) and then replaces age in equation (A-1) with $\widehat{A_i} + \widehat{v_i} = \widehat{\gamma} EA_i + X_i \widehat{\delta} + \widehat{v_i}$. Given that $\widehat{A_i}$ is uncorrelated with the error $(u_i + v_i)$, this makes possible a consistent estimation of a.

The reduced form approach consists in replacing age in equation (A-1) with the RHS of equation

[43] The first stage detects also some significant correlation of actual age with other covariates, even if they are all very small in size. in particular immigrant seem slightly more likely to be older.

(A-2):

$$Y_i = a\gamma EA_i + X(b + a\delta) + c_i + s_i + \alpha v_i + u \tag{A-3}$$

$$= \alpha EA_i + X\beta + c_i + s_i + \epsilon_i, \qquad cor(\epsilon_i, EA_i) = 0 \tag{A-4}$$

α can be consistently estimated, but in general it is different from a if $\gamma \neq 1$. In our case however γ is really close to 1, thus we can expect $\widehat{\alpha}$ to deliver a good approximation of a, even if slightly smaller. The intuition is confirmed by results in table A-1: the estimated effect of maturity is just slightly lower under reduced form than under instrumental variable.[44] To conclude, we can regard our estimations obtained by reduced form as a lower bound of the true effect.

[44] We obtain comparable results when using as outcomes the final evaluations in the various subjects rather than the GPA.

Table A-1:

Two stage least square estimation
GPA in second grade of primary school

	Reduced form	IV	
		2sls	first stage
expected age	0.586		0.980
	(0.009)**		(0.001)**
actual age		0.598	
		(0.009)**	
female	0.166	0.169	-0.005
	(0.006)**	(0.005)**	(0.001)**
immigrant	-0.285	-0.299	0.024
	(0.011)**	(0.009)**	(0.001)**
parents' education	0.215	0.217	-0.002
	(0.002)**	(0.002)**	(0.000)**
Constant	-0.650	-4.030	5.719
	(0.008)**	(0.059)**	(0.001)**
N	114,830	114,830	114,830

+ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$
Cohort FE included from col. (2). School FE from col. (3).
Standard errors clustered by school

Table A-2: Effect of maturity at enrollment on GPA

	EPRI II	EPRI IV	EPRI VI (int.)	EPRI VI (ext.)	ESO I	ESO II	ESO III	ESO IV (int.)	ESO IV (ext.)
Spanish, male, low p.e.	0.538	0.386	0.337	0.356	0.224	0.153	0.113	0.097	0.220
	(0.022)**	(0.022)**	(0.022)**	(0.028)**	(0.025)**	(0.024)**	(0.025)**	(0.028)**	(0.059)**
Spanish, male, middle p.e.	0.609	0.474	0.384	0.360	0.231	0.201	0.223	0.160	0.171
	(0.019)**	(0.021)**	(0.022)**	(0.024)**	(0.023)**	(0.024)**	(0.025)**	(0.028)**	(0.050)**
Spanish, male, high p.e.	0.581	0.411	0.376	0.330	0.252	0.211	0.222	0.162	0.158
	(0.021)**	(0.024)**	(0.026)**	(0.023)**	(0.029)**	(0.030)**	(0.033)**	(0.038)**	(0.050)**
Spanish, female, low p.e.	0.600	0.455	0.374	0.395	0.253	0.216	0.171	0.132	0.237
	(0.022)**	(0.023)**	(0.024)**	(0.026)**	(0.027)**	(0.027)**	(0.027)**	(0.026)**	(0.054)**
Spanish, female, middle p.e.	0.640	0.488	0.388	0.372	0.236	0.210	0.221	0.212	0.213
	(0.019)**	(0.021)**	(0.022)**	(0.022)**	(0.025)**	(0.026)**	(0.027)**	(0.028)**	(0.048)**
Spanish, female, high p.e.	0.600	0.384	0.347	0.310	0.316	0.264	0.180	0.219	0.157
	(0.021)**	(0.023)**	(0.025)**	(0.024)**	(0.029)**	(0.032)**	(0.032)**	(0.031)**	(0.047)**
Immigrant, male, low p.e.	0.493	0.315	0.208	0.286	0.072	0.006	0.002	0.041	0.115
	(0.037)**	(0.035)**	(0.033)**	(0.047)**	(0.036)*	(0.035)	(0.042)	(0.046)	(0.119)
Immigrant, male, middle p.e.	0.505	0.293	0.169	0.255	-0.003	0.026	0.068	-0.018	0.283
	(0.054)**	(0.053)**	(0.050)**	(0.061)**	(0.051)	(0.052)	(0.057)	(0.062)	(0.154)+
Immigrant, male, high p.e.	0.691	0.302	0.044	0.117	0.328	0.263	0.093	0.433	0.557
	(0.108)**	(0.115)**	(0.112)	(0.125)	(0.134)*	(0.142)+	(0.157)	(0.152)**	(0.403)
Immigrant, female, low p.e.	0.511	0.268	0.193	0.222	0.099	0.076	0.012	0.049	0.208
	(0.040)**	(0.037)**	(0.034)**	(0.047)**	(0.036)**	(0.038)*	(0.039)	(0.045)	(0.111)+
Immigrant, female, middle p.e.	0.500	0.365	0.251	0.275	0.198	0.158	0.025	0.113	0.429
	(0.058)**	(0.057)**	(0.052)**	(0.059)**	(0.054)**	(0.058)**	(0.058)	(0.062)+	(0.127)**
Immigrant, female, high p.e.	0.521	0.270	0.331	0.166	0.465	0.333	0.436	0.186	0.389
	(0.129)**	(0.116)*	(0.117)**	(0.124)	(0.151)**	(0.147)*	(0.137)**	(0.160)	(0.350)

+ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$

Each column shows coefficient of expected age at enrolment interacted with exogenous characteristics listed in the first column. Regressions include also dummies for gender, nationality (Spanish or immigrant), parental education (low, middle, or high), all their interactions, cohort and School FE. Standard errors are clustered by school.