Maturity and school outcomes: a role for teachers?*

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Abstract

Having a unique cutt-off to determine when children can access school induces a large heterogeneity in maturity to coexist in a classroom. We use very rich data on perfomance in internal and external evaluations in public schools in Catalonia to show that: 1) Relatively younger children do significantly worse both in internal and external evaluations and experience greater retention, although the effect is decreasing as children become older; 2) Younger children in our data exhibit higher dropout rates and chose the academic track in secondary school less often; 3) The effect is significant across the whole ability distribution; 4) Age of peers in the classroom has two different effects: having older peers affects external evaluations positively (although not significantly), but affects internal evlauations negatively, suggesting that teachers evaluate children on a curve; 5) Similarly, younger children are more frequently diagnosed with learning disabilities also suggesting that maturity can affect teachers' perception of the ability of the child.

JEL codes: I21, I28, H75.

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 the heterogeneity of ages encountered in classrooms, with the older chidren 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 acumulation 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, 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.

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We use very detailed administrative data on internal and external grades in school of the universe of public schools in Catalunya 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 Catalunya deems particularly interesting as children are generally not allowed to postpone entrance to primary school. Hence, the analysis offers a good description of the cost of an inflexible system. We first confirm that relatively younger children perform worse as measured by their performance in tests, are retained more often and are less likely to enrol 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 in their internal evaluations when they are in second grade, and still 0.2 standard deviations in middle school. 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. 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 enrol in the academic track, but the probability of choosing it is 5 p.p lower for the youngest.

There is little evidence on the heterogeneous effects that age has on children of different abilities. We perform quantile regressions to provide evidence on the potentially heterogeneous effects along the underlying ability distribution and find different results for internal and external evaluations. Internal evaluations are given by the teachers in the schools who know and follow the students over time and within a school. External evaluations include the results of an exam designed and graded by the government. For both types of evaluations the effect is significant and sizeable for all ability levels; moreover the estimates for the average child are very similar. However external and internal evaluations exhibit a different pattern across the distribution of ability. For external evaluations the effect is decreasing with ability, the disadvantage of being relatively younger being smaller for those with higher underlying ability. On the other hand for internal evaluations the comparative statics are the opposite: the effect becomes larger along the underlying ability distribution. This suggests that being younger in the class does not harm the learning process as much if the individual has relatively higher ability. But teachers' perceptions and grading seem to be particularly disadvantegeous for the young with relatively higher ability.

We analyze the impact of having older peers in the classroom. The effect estimated using external evaluations is positive, small and insignificant, suggesting that having older peers does not particularly harm individual performance. This is aligned with finding of Elder and Lubotsky (2009) using standardized tests in US. However, using internal evaluations provided by teachers in schools, we surprisingly find that the effects of average peers' age reverse, being negative and significant. This suggests that teachers give lower grades to students when peers are older and hence, that teachers do grade curving. Similarly, younger children are more frequently

[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 incetives to finish the degree may be slighlty stronger in Catalonia than in other countries.

diagnosed with learning disabilities such as ADD and ADHCD, also suggesting a role for teachers in handling heterogenous 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. Teachers' perception of students is important for childrens' self-perception and expectations. In a recent paper Lavy and Sand (2015) show that teachers' perceptions and biases can affect childrens' expectations, choices and outcomes in the longer run.

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 pre schools 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 the school year, by providing support and additional training to the relatively younger who are facing greater challenges. In the case of Catalunya 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 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 enrolment 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 discusses the results and concludes.

2 Catalan educational system and enrolment 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 enrolment 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

[2] Guaranteed universal and free acces to public education in Spain, and in Catalunya 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.

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

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 enrol 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 enrol 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 school until they turn 16 or until they graduate. After successfully completing lower secondary education, students can enrol 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 enrolment 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 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 enrol 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

[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 enrolment data for public preschools are available to us).

[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.

the public school system.[9]

3.1 Data sources

We exploit data from different sources that provide us with detailed information on enrolment, school progression, academic outcomes and socio-demographic characteristics of Catalan students.

The *Departament d'Ensenyament* (regional ministry of education in Catalonia) provided enrolment 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 (6th grade) and the last year of middle school (11th 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 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 analysis that incorporate parental background variables.

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

[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.

[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 analysis 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.

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 enrolment 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. However, 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 enrolment behaviour appears to be null or extremely small.

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. The fourth column 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.[15]

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 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.

[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 enrolment 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.

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

4 Analysis

4.1 Methodology

We study the effect of maturity at enrolment 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 enrolment, 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 in 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:

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

where Y_i^t is any school outcome achieved in grade t (for instance GPA), X_i are covariates realized before the child enrol in school (gender, immigrant status, education of parents...), 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 direct 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.[16]

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 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 enrolment.[17] Unfortunately we do not observe the actual enrolment 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 enrolment 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.

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 favourable 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 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

[16]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.

[17]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

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.[18] 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).[19] This choice is aligned with the regulation of enrolment and progression in primary and secondary school: students can be retained at most once during the entire cycle of primary school, and once per grade for at most two time 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 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

[18] This restriction exclude less than 1% of the sample. Estimates are not sensible neither to chose a stricter threshold nor to include everyone in the analysis.

[19] 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

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.[20]. Table 4 presents the results for different specifications using 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 introduced 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 12 in appendix A replicates column (3) for the subsample of children for whom we can observe the enrolment 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. [21] 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 effect of age is orthogonal to socio-economics as well as to school character-

[20]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.
[21]First column is identical to column (3) in table 4 and it is reported for convenience.

istics.[22] The pattern is identical using the subjects rather than GPA.[23] 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.[24]
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 disproportionally 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 propagate over time and the gap is not closed at the end of lower secondary education.

We next explore whether the maturity effect on school performance is heterogeneous across individual characteristics such as gender or parental background. To test the heterogeneity we augment regressions in table 5 with interaction terms between expected age and the other regressors (female, immigrants and dummies for parental education categories). Not only the effects are not significantly different among them, but differences are also negligible in magnitude. We can therefore conclude that maturity effect is quite homogeneous with respect to other characteristics that affect childrens' development. This results contrast with Elder and Lubotsky (2009), who find that 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

[22] 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.

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

[24] 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.

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 spend out of school before age 6 depends less on their SES.

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 6. 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 rentention 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 being 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 enrolment 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 enrol 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 affect the probability of completing lower secondary education, and then the probability of enrolling 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 negative 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 enrol in higher education.[25]

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 not appearing any more in 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 favour in the estimates we analyze outcomes of 14 years old rather than 15 years old.[26]

[25] 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 enrolment in both public and private high school. We do not find graduation 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 enrolment in batxillerat they should have obtained it in some unobservable way. We also observe 1722 students who enrol in grau mitja 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 favour (older children are more likely to perform better and enrol in the academic track), we do not incorporate this information in our initial measure.

[26] Results we obtained replicating table 9 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 6 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.

Table 7 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.[27] 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 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 7 show the share of students for each group that graduate 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 7 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 9. The usual set of regressors and school fixed effects are included.
We follow the same logic when analyzing enrolment in high school. Table 8 shows descriptive statistics of the probability of enrolment in high school by grade attended at age 14. Dependent variables for columns 4 to 6 in table 9 are built following the same logic but for high school.[28]

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

[27]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.

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

the "positive" effect due to longer time of compulsory education. This is in contrast with previous studies that exploit US data. The seminal work by Angrist and Keueger (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 9 show that maturity has a sizeable and significant effect on the probability of enrolling in further academic education: being one year older increases the chance of enrolling in batxillerat by 5 percentage points (on average 50% of students enrol). On the other hand, youngest children are more than 2 percentage points more likely to enrol in vocational education (24% enrol 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 labelled 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 behavioural disorders, mild intellectual disability, and other conditions whose detection may require some subjective judgement of the educator). As placebo test we perform the same analysis using as dependent variables a dummy for physical disability (blindness, deafness, mobility issues, whose diagnosis should be relatively easy and objective). Results are reported in table 10. 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.[29]

[29] 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.

4.7 Peer effect

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 the characteristics of children attending the same school and grade in the same year. 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. We show that peers' age may affect differently external evaluations (blindly graded) and internal evaluations (possibly affected by teachers' judgement).
Table 11 replicates table 5 including peers' regressors. We also account for 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.

An important feature in determining the potential role for peer effects in school is understanding how children are allocated into classrooms. Although there is no specific regulation on how children should be allocated we show that classes in primary school are particularly designed to be homogenous in the observables. Therefore average peers' characteristics at the school level are quite representative of average peers' characteristics at the class level. [30] Conversely, as explained in appendix B, in middle school there is evidence of a substantial sorting of children across classes of the same school 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. In fact the share of peers with a given characteristics, e.g. age or parental background, would be endogenous, because it would depend on the class to which the child has been assigned on the basis of her previous history. Thus the coefficient of the regressor would spuriously capture the probability of belonging to a "better" rather than to a "worse" class and thus the individual unobserved ability which is part of the error term: coefficients of peers' characteristics associated with good school outcomes would be upward biased, while coefficients of peers' characteristics associated with bad school outcomes would be downward biased.

Coefficients in table 11 of own regressors are virtually unaffected by the introduction of the new regressors, while the estimated effects of peers' characteristics on internal evaluations show a quite consistent and interesting 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.[31] In other words having

[30] We replicated first four columns of table 11 computing peers' regressors at the class level and we obtained almost identical results. Results are available upon request.

[31] 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).

"better" peers, as measured by their expected outcomes, seems to be detrimental for the individual score. 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.[32]
On the other hand, peers' characteristics are mainly insignificant (with the exception of the share of female) when using external evaluation as the dependant variable. Peers' expected age effect is positive and marginally significant (p-value 0.24) in grade 6.
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 evaluated objectively.

Focusing on the effect of peers' maturity, the effect is clearly important at the beginning of primary school than later on in the school progression.[33] This may be due to the fact peers' measure at the school level may do a poor job in capturing the average composition of the group of peers that a child is exposed to in middle school because of the sorting happening across classes.[34] In fact, as explained at the beginning of this section, in primary school classes are formed making them as homogeneous as possible, therefore average peers' characteristics at the school level are quite representative of average peers' characteristics at the class level.

We also replicated tables 6 and 10 adding peers' covariates. For disabilities diagnosis, only the share of female among peers' have a positive and significant effect at 5% level on the probability of being diagnosed learning disability at the beginning of primary school.[35] All the other coefficients are insignificant and negligible in size. Similarly analysis for retention do not highlight any important effect of peers' regressors.

4.8 Quantile

Figure 4 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 enrolment for all children, not only for those who exhibit particular characteristics.

[32] Results are available upon requests

[33] As explained in section 4.1 the composition of the class is affected by a large selection from third grade of middle school, because several children dropout before making it in those grades. The estimated coefficients of peers' regressors capture this selection and are difficult to interpret.

[34] Again, see appendix B

[35] If on average females behave better in class, this may make more striking the misbehaviour of a child possibly affected by attention deficit or hyperactivity disorder. Clearly this is just one possible explanation.

However the shape of the curves that describe the relative importance of maturity effects across the distribution is quite 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 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. Conversely the effect is decreasing in ability when external evaluations are used as outcome.

One possible explanation for part of this difference is that 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. This suggests that the difference between external and internal might come from teachers' perception of the students, that appear to be particularly detrimental for those in the medium-high part of the distribution of ability.

Estimated effects for other coefficients follow a similar U-shaped pattern for other regressors in internal evaluations, and exhibit a similar decreasing effect (in magnitude) for external evaluations. Peers' expected age has an about constant effect across the distribution.

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. We also find that teachers' perceptions may play an important role in making this initial gap persist.

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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 (for EPRI I) and born in 1997-2000 (for ESO I)

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

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

For each year the table shows the share of 6 years old who delayed the enrolment in primary school (they are still in preschool) or anticipate it (they 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%

Standard deviations of internal evaluations 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		ESO I	ESO II	ESO III	ESO IV	
			(int.)	(ext.)				(int)	(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:

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

	in 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 8: *Enrolment in higher secondary education. 14-year-old students in 2009*

	Academic education		Vocational edication		N students
	in time	1 year later	in time	1 year later	
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 9:

Probability of completing ESO and undertaking further education.
Children born in 1995

	ESO graduate			enrol in batx.		enrol in voc.	
	in time	1 year delay	2 years delay	in time	1 year delay	in 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 10:

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

Table 11:

GPA over time, including peer effect
Standardized evaluations

	EPRI II	EPRI IV	EPRI VI		ESO I	ESO II	ESO III	ESO IV	
			(int.)	(ext.)				(int.)	(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

7 Figures

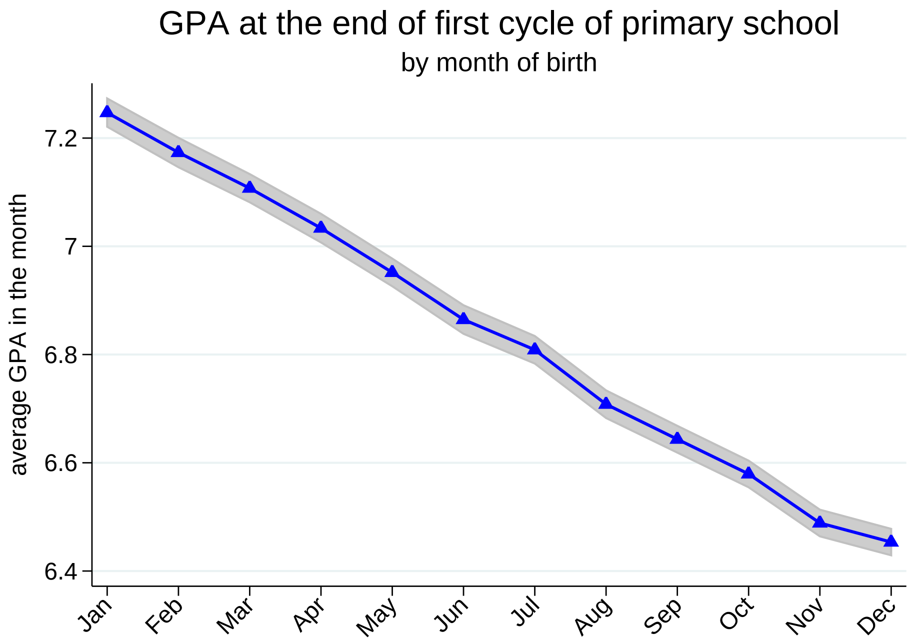

Figure 1: Average of final internal evaluations in Maths, Spanish, Catalan, English in second grade of primary school. Computed on children born from year 2002 to year 2005.

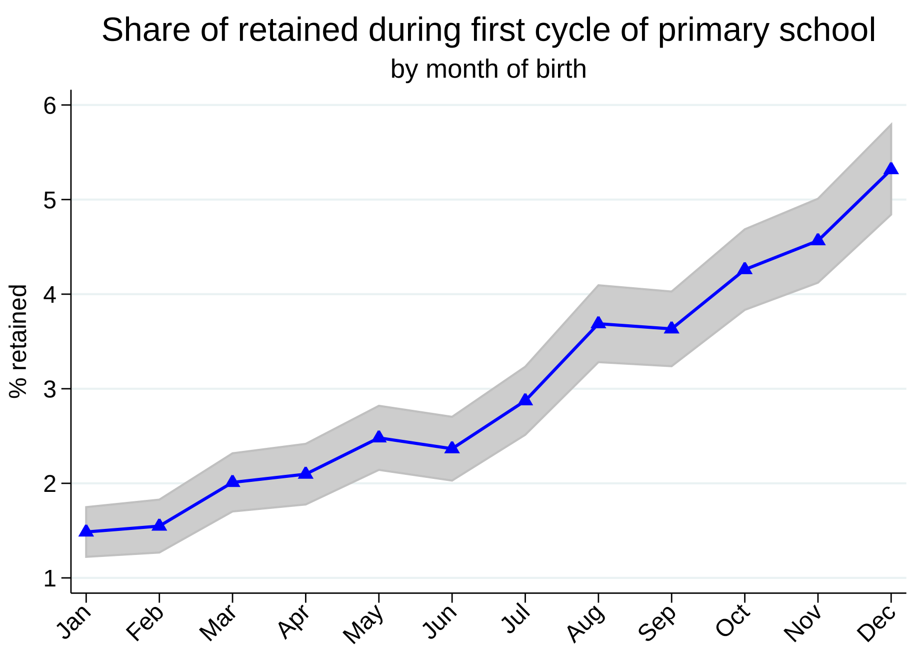

Figure 2: Share of children retained during first cycle of primary school (either in first or second grade). Computed on hildren born from year 2004 to year 2005.

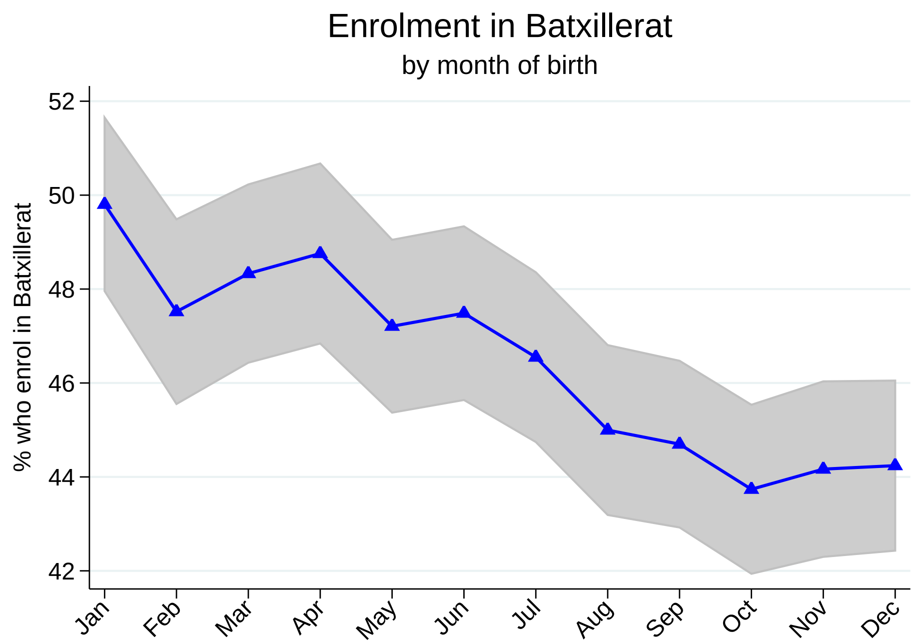

Figure 3: Share of 14 year old born in 1995 who will enrol in Batxillerat in the following years. We count both children who complete ESO without any further retention or who complete it one year later.

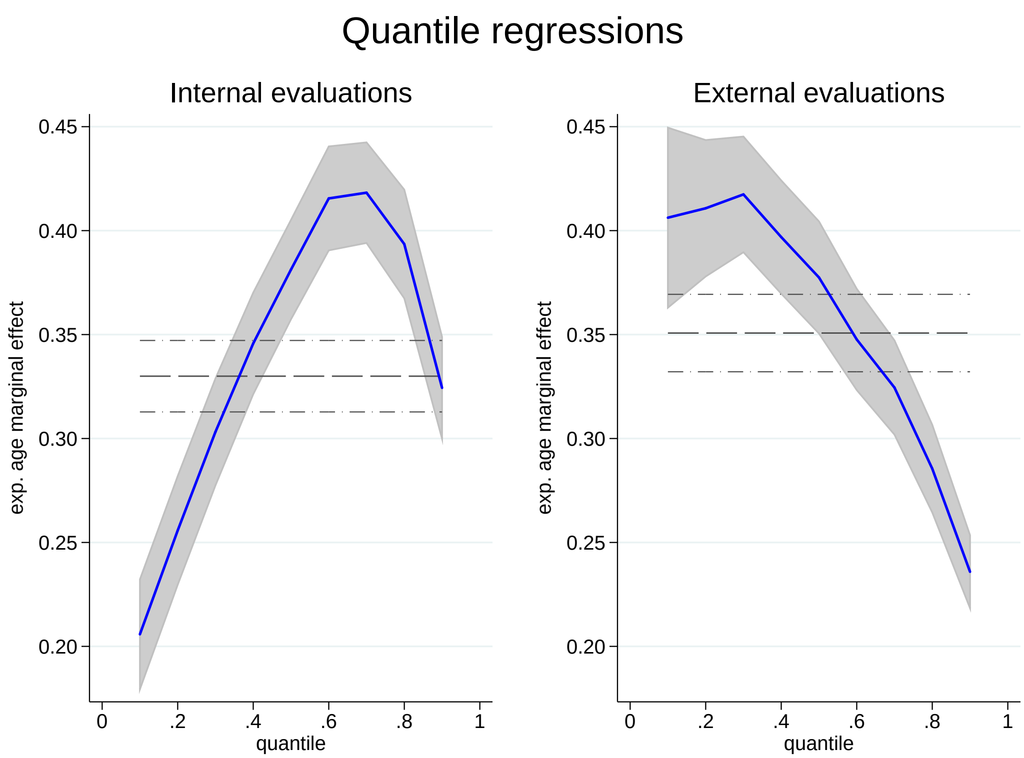

Figure 4: The graph plots the coefficients of expected age estimated performing quantile regressions at 0.1,0.2,...,0.9 quantile. Lines parallel to x-axis are the correspondent ols estimates with their confidence interval. We use internal and external GPA for students enrolled in sixth grade of primary school and born from 1998 to 2001.

A IV

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 12 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 enrolling at age 6.[36]

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:

$$Y_i = aA_i + X_i b + c_i + s_i + u_i, \qquad cor(u_i, A_i) \neq 0 \tag{5}$$

$$A_i = \gamma EA_i + X_i \delta + v_i, \qquad cor(v_i, EA_i) = 0, \quad cor(u_i, EA_i) = 0 \tag{6}$$

The two stage least squares estimation estimates first $\widehat{\gamma}$ and $\widehat{\delta}$ in equation (6) and then replaces age in equation (5) 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 (5) with the RHS of equation (6)

$$Y_i = a\gamma EA_i + X(b + a\delta) + c_i + s_i + \alpha v_i + u \tag{7}$$

$$= \alpha EA_i + X\beta + c_i + s_i + \epsilon_i, \qquad cor(\epsilon_i, EA_i) = 0 \tag{8}$$

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 12: the estimated effect of maturity is just slightly lower under reduced form than under instrumental variable.[37] To conclude, we can regard our estimations obtained by reduced form as a lower bound of the true effect.

[36] 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.

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

Table 12:

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

B Allocation of students in classes within school

B.1 Sorting in lower secondary education

Anecdotal evidence suggests that the assignment of children to classes when they start middle school is not random. While school's enrolment is highly regulated and based on well know priority criteria, schools are free to chose how to allocate their students across classes. In particular, when students begin lower secondary education their academic records and other information from their previous primary school are available to the administrators of the middle school. Hence they may decide to sort students based on the information they have on their ability, creating separate classes for above average or below average students.

The objective of this section is to test whether the differences in average ability (as proxied by previous internal or external evaluations) across classes of the same school that we observe in the data are compatible with a random allocation of students. To do so we perform a Monte Carlo simulation using students enrolled in first grade of middle schools in our sample. First, taking from the data the assignment of students to schools and the number of classes of each school, the method randomly allocates the students to classes. Then statistics are computed for each class, and the minimum and maximum values are determined for each statistic. In particular for every class we compute the average GPA in internal evaluations and in external evaluations obtained during last year of primary school. We can therefore identify for each school the "best" and "worst" class in terms of average value of our measure of ability. Finally we compute the average values of minima and maxima across the entire pool of schools in our sample. The algorithm just described is iterated 2000 times, to determine the distribution for the expected value of average ability in the "best" and in the "worst" class of a school. In particular we can compute the expected value and its 95% (or 99%) confidence interval and verify whether the actual averages in our data for "best" and "worst" classes belong to the confidence intervals. Results of the simulation are summarized by figure 5: histograms plot the distribution of ability measures in "best" and "worst" classes and red lines plot the actual mean values in our data. We can always reject the null hypothesis that within school allocations into classes is random. In particular on average in the "worst" classes students have previous performances well below their expected value if the allocation were random. Symmetrically, in "best" classes students exhibit on average much higher previous performances than the random benchmark.

B.2 Planning in primary education

We have evidence that also the allocation of children at the beginning of primary school is not random, even if for very different reasons. In fact it seems that at that level administrators "correct" random allocations in the attempt of creating classes that are homogeneous among them. While no official evaluation is available for children that are just starting compulsory education, primary school administrators are in contact with preschool teachers that may share their judgements about children ability and maturity. Moreover they can make sure that classes

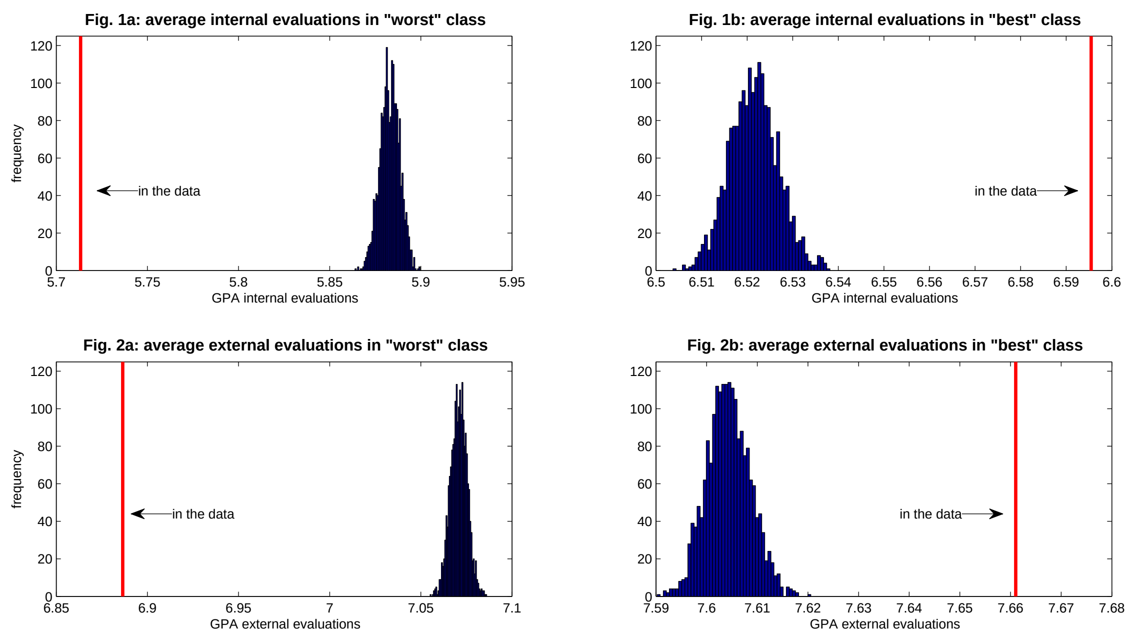

Figure 5: Monte Carlo simulation performed using 971 groups of students enrolled in first grade of lower secondary education in a Catalan public school (each group is composed by all students enrolled in first grade of a middle school in 2012/2013 or 2013/2014). Fig. 1a and 1b plot simulated distribution of expected average internal evaluations in the class with the lowest average evaluation (panel a) and in the class with the highest average evaluation (panel b). Fig. 2a and 2b replicate the same exercise using external evaluations rather than internal as measure of students' ability.

are balanced in term of gender or other observable characteristics. If classes' allocation in primary school tend to follow this logic of planning assignments in order to smooth differences, we should observe in the data that differences across classes of the same school are smaller than what expected from random assignments.

We replicate Monte Carlo simulation described in section B.1 for first grade of primary schools in our data. In this case we classify classes based on individual characteristics such as expected age, gender and parents' education. Results in figure 6 provide evidence that allocation in primary school is not random and on average aim at homogenizing classes. Indeed the average minimum value for share of female, expected age or parents' education is well above its expected value if the distribution were random. The other way round for the maximum.

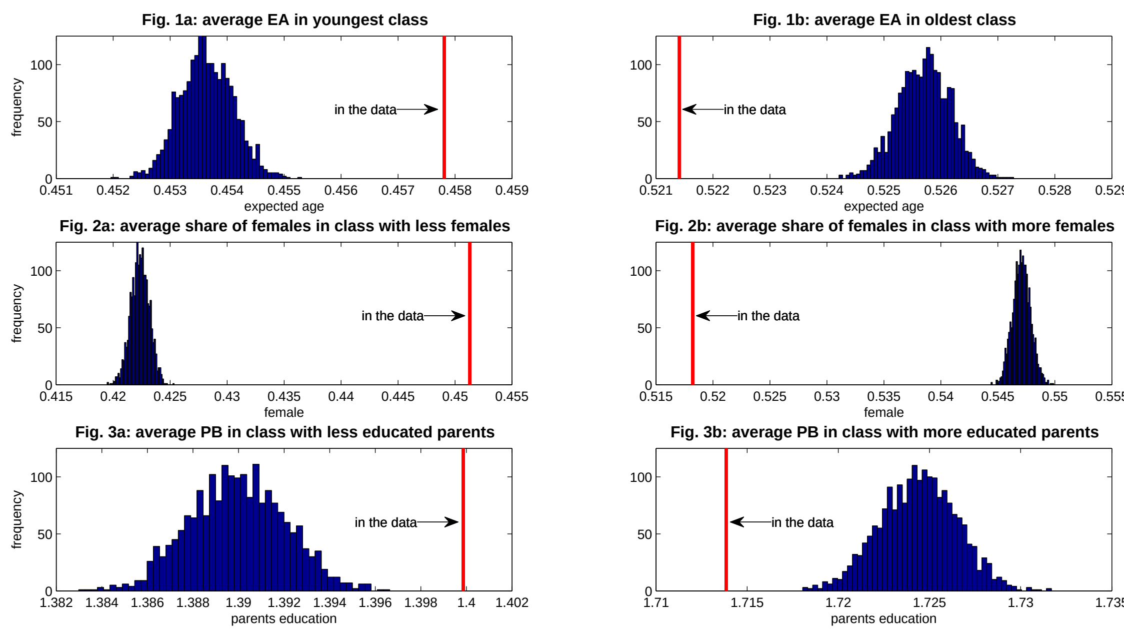

Figure 6: Monte Carlo simulation performed using 3250 groups of students enrolled in first grade of primary education in a Catalan school (each group is composed by all students enrolled in first grade of a school in one of the years from 2010/2011 to 2013/2014). Fig. 1a and 1b plot simulated distribution of expected average age (EA) in the youngest class (panel a) and in the oldest class(panel b). Fig. 2a-2b and 3a-3b replicate the same exercise using share of females and the index for parents' education.