

Stuck in the Middle: Impacts of Grade Configuration in Public Schools

Jonah E. Rockoff
Columbia Business School and NBER

Benjamin B. Lockwood
Columbia Business School

August, 2009*

Abstract

We examine the implications of separating students of different grade levels across schools for the purposes of educational production. Specifically, we find that moving students from elementary to middle school in 6th or 7th grade causes significant drops in academic achievement. These effects are large (about 0.15 standard deviations), present for both math and English, and persist through grade 8, the last year for which we have achievement data. We instrument for students' movements using the grade range of their schools in grade 3, and employ specifications that control for student fixed effects. This leaves only one potential source of bias—correlation between grade range of a student's grade 3 school and unobservable characteristics that cause decreases in achievement precisely when students are due to switch schools—which we view as highly unlikely. The effects of moving to middle schools are similar for boys and girls, but stronger for students with low levels of initial achievement. We find little evidence that placing public school students into middle schools during adolescence is cost-effective.

* Correspondence should be sent to jonah.rockoff@columbia.edu. We thank Phil Cook and Brian Jacob for very helpful comments and suggestions. Any errors are our own.

One of the most basic issues in the organization of public education is how to group students efficiently. While schools have placed students of similar ages into grade levels since the mid-1800s, grade configurations of public schools have varied considerably over time. At the start of the 20th century, most primary schools in the U.S. included students from kindergarten through grade 8, while the early 1900s saw the rise of the “junior high school,” typically spanning grades 7–8 or 7–9 (Juvonen et al., 2004). More recently there has been a shift toward placing upper elementary students in “middle schools,” which typically span grades 6–8 or 5–8.¹ Interestingly, the use of middle schools and junior high schools to educate students during early adolescence has never gained popularity among private schools.²

The impact of grade configuration has received little attention by economists relative to issues such as class size or teacher quality. There are a few studies which provide evidence that the transition to middle school is associated with a loss of academic achievement, elevated suspension rates, and reduced self esteem (Alspaugh (1998a, 1998b), Weiss and Kipnes, (2006), Byrnes and Ruby (2007), Cook et al. (2008)). There is also a large body of work by educational researchers and developmental psychologists documenting changes in attitudes and motivation as children enter adolescence (Eccles et al. (1984)), and some have hypothesized that instructional differences in middle schools contribute to these changes. However, these studies examine differences between middle school and elementary school students using cross-sectional data,

¹ Between the school years 1969–1970 and 1999–2000, the number of middle schools in the U.S. rose from 1,526 to 11,521, displacing both junior high schools and other types of elementary schools (U.S. Department of Education (1973, 2007)). Over the period from 1987–2007, the fraction of 6th graders in K–6 schools fell from roughly 45 percent to 20 percent, caused mainly by the growth in schools serving grades 6–8. Similarly, the fraction of 7th graders enrolled in junior high schools (i.e., serving grades 7–8 or 7–9) shrank from around 40 percent to 20 percent, again in favor of middle schools. The fraction of 6th and 7th graders attending K–8 schools remained roughly 10 percent over this time period. (Source: National Center for Education Statistics, Common Core of Data, 1987, 2007).

² In 1989, the earliest year for which data is available, 88 percent of 6th graders and 84 percent of 7th graders in private schools attended a school that started in Kindergarten, but only about 1 percent of each group attended a school serving grades 6–8 or 7–8. In 2007, the fraction of 6th and 7th graders in private schools also serving Kindergarten students had risen to 90 and 86 percent, respectively, while private schools serving grades 6–8 or 7–8 served just 1.5 and 2 percent of, respectively, 6th and 7th graders in private schools. (Source: National Center for Education Statistics, Private School Universe Survey, 1989, 2007).

and therefore are unable to reject the hypothesis that differences across students, rather than differences in grade configuration, are responsible for divergent educational outcomes.³

In this study, we use panel data in New York City to measure the effects of alternative grade configurations using variation in achievement within students over time. Specifically, we focus on how student achievement is affected by movement into middle schools. Elementary schools in New York City typically serve students until grade 5 or grade 6, while a smaller portion extend through grade 8; thus most students move to a middle school in either grade 6 or grade 7, while some never move to a middle school. We find that achievement falls substantially (about 0.15 standard deviations in math and English) the year after students move to middle school, relative to their peers who do not move. Importantly, these negative effects persist through grade 8, the highest grade level on which test data are available.

In order to estimate the causal effects of moving to middle school, we use instruments based on the terminal grade of a student's school in grade 3. Thus, our identification assumption is that there are no unobservable factors that cause a drop in student achievement at precisely the same time as students must leave the elementary schools they attended in grade 3. While we cannot rule out the existence of such factors, we cannot think of a plausible alternative story that would explain our findings. Our results suggest that moving adolescent students to middle schools imposes a significant cost in terms of lower achievement, and the continued use of middle schools may be inefficient if they provide no compensating benefit (e.g., cost savings).

The paper proceeds as follows. In Section 2 we describe our data and present statistics on variation in student and school characteristics by grade configuration. In Section 3 we present

³ One exception is work by Bedard and Do (2005); using panel data on U.S. school districts, they find a small negative relationship between changes in the fraction of 6th graders enrolled in middle schools and changes in high school completion rates seven years later. Additionally, using a pseudo-longitudinal analysis, Cook et al. (2008) provide evidence that students moving to middle schools in their sample are not systematically different.

our methodology and our main findings on the impact of movement to middle schools on student achievement, and in Section 4 we present complementary results from surveys of parents and students. Section 5 contains a cost-benefit analysis, and Section 6 concludes.

2. Data and Descriptive Statistics

The primary data set used in our analysis contains information on the enrollment, academic achievement, and demographics of students in New York City in grades 3 through 8. This data spans the school years 1998–1999 through 2007–2008. The data set includes student characteristics such as ethnicity, gender, language spoken at home, and free lunch status, as well as academic and behavioral indicators, including annual standardized test scores in math and English, suspensions, and absences. We exclude students who ever attended a school that exclusively serves those with disabilities—these schools typically do not administer standardized exams in math and English.

In order to pursue our instrumental variables strategy—using the school attended in grade 3 to instrument for middle school attendance—we focus on students whom we can observe in both grade 3 and, potentially, in middle school. Thus, we restrict our sample to the five cohorts that entered grade 3 between the fall of 1998 and the fall of 2002, and exclude students who attended DOE schools for less than six years. By restricting our sample to these students, we also avoid any changes in sample composition that could affect our estimates.⁴ We also drop a small number of students who, according to these data, were retained for more than two years, skipped a grade level or (in a few cases) moved down a grade level.

⁴ These restrictions limit our sample to roughly 75 percent of the students who entered grade 3 in the relevant years. A regression of sample inclusion on math test scores among third graders in these cohorts suggests that a one standard deviation increase in test scores raises the probability of inclusion by just 0.16 percent. While this effect is statistically significant (p-value = 0.02), it is very small and does not, in our view, indicate an important relationship between persistence in the New York City public schools and student achievement in 3rd grade.

Among grade 3 students in our sample, 63 percent were in a K–5 school, 23 percent were in a K–6 school, and 7 percent were in a K–8 school. The small fraction of remaining students attended K–3, K–4 or K–7 schools. Although we can use these additional grade spans as instruments for school changes at grades 4, 5, or 8, in practice the samples are too small for us to obtain reasonably precise estimates of these effects, and we therefore focus on movement into middle schools in grades 6 and 7.

Among schools serving grade 8, 19 percent served grade 3, while 79 percent had a minimum grade of 5, 6, or 7. Thus, as a stylized fact, New York City students typically attend either a school serving all elementary grades (K–8), or a school serving early elementary grades (K–5 or K–6) followed by a middle school (6–8 or 7–8).⁵

We also examine results from city-wide surveys of students in grades 6 and higher and parents of students in all grades. These surveys were conducted at the end of the school years 2006–2007 and 2007–2008, and asked parents and students for their agreement with various statements about the school.⁶ Parent and student survey results can be linked to the data on student enrollment, allowing us to differentiate between students in grades 6 to 8 who attended different types of schools in grade 3 and to link survey responses across years for students and parents who completed both surveys.

We restrict our focus to questions that were asked in both years. We first selected items that focused on three topics covered in both parent and student surveys: safety (e.g., “my child is

⁵ For simplicity, we do not distinguish between schools whose grade range differences lie outside grades 3–8. For example, we treat schools serving grades K–5 the same as schools serving grades 1 to 5, and schools serving grades 6 to 8 the same as school serving grades 6–12. In practice, 98 percent of schools serving grade 3 also serve kindergarten students, and 80 percent of schools serving grade 8 do not serve students in higher grades.

⁶ The surveys were part of New York City’s new school accountability system (see Rockoff and Turner (2008)). See <http://schools.nyc.gov/Accountability/SchoolReports/Surveys/default.htm> for copies of the survey instruments. It is worth noting that response rates for parents were much lower than for students in both survey years. This is likely due to the fact that student surveys were to be administered during school hours, whereas parent surveys were sent by mail.

safe at school”; “I feel safe in my classes”), academic rigor (e.g., “the school has high expectations for my child”; “I need to work hard to get good grades at my school”), and adult pro-social behavior (e.g., “there is an adult at the school whom my child trusts and can go to for help with a school problem”; “the adults at my school look out for me”). We also selected items from the student survey that focused on student prosocial behavior (e.g., “most students in my school help and care about each other”) and items from the parent survey on satisfaction with school quality and teacher quality.⁷ Responses were given on a four point scale, and we average responses within each respondent to create an index for each topic, and normalize the indices to have a mean of zero and a standard deviation of one.

Last, we use two publicly available data sets on school resources. The first contains school-level expenditures from 1999 to 2007. The second contains average class sizes in 2006, 2007, and 2008, by school and grade level.⁸

Our identification strategy is based on the fact that whether (and when) students attend middle school is strongly related to the grade range of the schools they attend in grade 3. While our estimation strategy includes student fixed effects, it is worthwhile to examine differences in the characteristics of 3rd graders in our sample across schools with different grade ranges (K–5, K–6, or K–8). Relative to students in K–6 and K–8 schools, we find that grade 3 students in K–5 schools are somewhat less likely to be Black, to receive free or reduced price lunch, and have somewhat higher test scores (Table 1).⁹

⁷ A list of the actual survey questions constituting each measure is provided in Appendix Table A1.

⁸ These data can be found at <http://schools.nyc.gov/Offices/DBOR/SBER/default.htm> and <http://schools.nyc.gov/AboutUs/data/classsize/classsize.htm>.

⁹ Much of this difference is driven by the fact that elementary schools in Staten Island—the borough of New York with the greatest percentage of White students and smallest percentage of students on free lunch—are nearly all K–5. However, our results are, if anything, slightly stronger if we drop Staten Island from our estimation sample.

One issue which is important to the interpretation of our findings is whether there are observable differences between middle schools and elementary schools other than the grades they serve. In Table 2, we present summary statistics on measures of school resources and teacher quality, as well as cohort size and changes in peer composition. Average per pupil expenditures are nearly identical in K–5 and 6–8 schools (\$10,144 and \$10,094), while per pupil expenditures are lower on average in K–6 schools than 7–8 schools (\$9,680 vs. \$11,082) and expenditures in K–8 schools are \$10,950. Thus, there is little evidence that *financial* resources are higher in elementary schools. Turning to class size, we see that students in grade 6 have similar average class sizes in schools serving grades K–6 (24.8), K–8 (25.4), and 6–8 (25.3). Among students in grade 7, classes are slightly larger in schools serving grades 6–8 (26.7) relative to those serving K–8 (25.4), but lowest in schools serving grades 7–8 (23.9). Overall, this suggests that variation in class size across school types would have little impact on student achievement.

There is also little indication that variation in observable dimensions of teacher quality can explain our findings. The fraction of teachers with no prior experience is lower in K–5 and K–6 schools (6.8 and 8.3 percent) than in schools serving grades 6–8 or 7–8 (11.1 and 10.1 percent), though comparisons of teacher absences go slightly in the opposite direction. Estimates of the difference in effectiveness between new and experienced teachers range from 0.03 to 0.1 standard deviations (e.g., Rivkin et al. (2005), Kane et al. (2008)), so an additional 4 percent chance of being taught by an inexperienced teacher would be expected to reduce test scores by only 0.001 to 0.004 standard deviations. We also find that students in grades 6 and higher attending a K-7 or K-8 school closely resemble their middle school peers with regard to teacher assignment. That is, they are typically assigned subject-specific teachers, and these teachers are

typically licensed in the subject they teach, rather than in general elementary education. In contrast, grade 6 students in K-6 schools strongly resemble elementary school students along these dimensions.

The two measures on which we do see great divergence between students in elementary schools and those in middle school are cohort size and “peer instability” (i.e., the fraction of a student’s school-grade peers who were not school-grade peers in the prior year). Average cohort size is about 75 students in K–8 schools, 100 students in K–5 and K–6 schools, and over 200 students in schools serving grades 6–8 or 7–8.¹⁰ Not surprisingly, peer instability is substantially higher among 6th graders in 6–8 schools (77 percent) than among 5th graders in K–5 schools (23 percent), and higher among 7th graders in 7–8 schools (64 percent) than 6th graders in K–6 schools (23 percent). Meanwhile, peer instability does not vary greatly among students in grades 5 through 7 attending K–8 schools. While there is little research from which we can gauge the impact of cohort size or peer instability, the divergence of elementary and middle schools on these two dimensions provide motivation for further investigation, and we return to this issue in our analysis.

Since middle schools typically draw students from multiple elementary schools, one might also hypothesize that middle schools are less segregated in terms of student background characteristics. To examine this issue, we calculate dissimilarity indices (a measure of segregation) based on student ethnicity and poverty, by type of school and grade level. This indices, which range from zero to one, can be interpreted as the percentage of students who would have to switch schools to equalize the proportions in each ethnic (or poverty) group across schools, divided by the percentage who would have to transfer if groups were completely

¹⁰ School enrollments tend to be about the same across schools with different grade ranges, so that average cohort size and grade range are inversely proportional.

segregated (Reardon and Firebaugh (2002)). In line with our priors, these indices are lower in middle schools than elementary schools, but the differences are quite small. For example, if we compare 5th graders in K-5 schools to 6th graders in 6-8 schools, ethnic dissimilarity falls from 0.6 to 0.55, implying a small decrease in the fraction of students that would have to move in order to equalize ethnic representation among all schools.

Last, we use data from surveys of grade 7 and 8 students and their parents regarding course participation and course offerings to investigate whether middle schools, due to their specialization, are able to provide a greater variety of courses, e.g., art, music, or theater. Despite this attractive idea, in practice we find similar levels of course participation/offering across school structures, with most differences falling in favor of K-8 schools (Table 3). While we lack achievement data for subjects other than math and English, this survey evidence does not support the notion that middle schools focus more on non-tested subjects.

3. Methods and Results

As mentioned above, few studies of the impact of grade configuration have used an empirical strategy that adequately controls for differences in student populations across school type. Using panel data, we base our estimates solely on variation within students over time and instrument for middle school entry using the grade span of the school attended in grade 3. Thus, differences in student characteristics across grade configurations will not influence our results provided that the impact of those differences on academic outcomes is not correlated with their grade 3 enrollment and coincident with the timing of their movements into middle schools.

In addition to estimating the initial effect on student achievement and behavioral outcomes of entering middle school, we want to test whether entering middle school affects

outcomes in subsequent years, and whether effects differ depending on the grade in which the student entered middle school. In our conceptual model, we posit that an outcome Y for student i in grade g can be represented by Equation 1:

$$(1) Y_{ig} = \alpha_i + \delta_g + \beta_g M_i^G + \varepsilon_{ig}$$

In this model, α_i is a student fixed effect, δ_g is a grade fixed effect, and M_i^G is an indicator for whether student i entered middle school in grade G . We allow the coefficient on M_i^G to vary across grades for two reasons. First, we are interested in how the effect of entering middle school persists over time (β_g for $g > G$). Second, these coefficients (β_g for $g < G$) allow us to test whether students who switch to middle schools have different patterns of outcomes prior to changing schools. If students who entered middle school in grade 6 saw declines in achievement in grade 5, it would be difficult to argue that this represented a causal effect of switching to middle school. The final term, ε_{ig} , is a residual that includes unobserved time-varying individual characteristics and other factors that affect academic outcomes, along with any measurement error. In this specification, the grade fixed effects (δ_g) estimate patterns of achievement over grades for students that never enter a middle school.

One concern with estimating the specification in Equation 1 via OLS is that the choice to attend middle school in an upper elementary grade is endogenous and may be related to time varying factors that we do not observe. For example, consider a 5th grader attending a school serving grades K–8, and suppose that in the following year the student moves to a school serving grades 6–8. This choice might be driven by changes in the student’s life—e.g., a bad experience in the previous school, a residential move—that impact academic achievement and have nothing to do with the movement to a middle school. In order to minimize this concern, we use a two stage least squares regression specification, in which we instrument for middle school entry in

grade 6 or 7 using the terminal grade of the school a student attended in grade 3. Specifically, we instrument for entering middle school in grade 6 (grade 7) with an indicator for attending a K–5 school (K–6 school) in grade 3. These instrumental variables are strongly related to actual entry into middle school in grades 6 and 7, since many 3rd graders remain in their elementary schools until they are forced to transfer and then move to middle schools. The estimated coefficients on instruments for entry into middle school in 6th and 7th grades are both about 0.7, with t-statistics around 500 (Table 4).

Another potential concern is that the type of school a student attends in grade 3 may be related to grade retention. We therefore control for whether a student was held back in the year in question, and also for whether the student was held back in any prior year. Our results are remain very similar if we omit these controls, or if we drop retained students entirely.

We first estimate the impact of attending middle school on student achievement in math and English. For ease of interpretation, and to remove variation from changes to the test, scores are normalized within year and grade to have a mean of zero and a standard deviation of one. Recall that our coefficients of interest are the interactions between grade level and entering a middle school in grade 6 or grade 7 (β_g). These coefficients indicate whether the trajectories of student achievement for students entering middle schools are different than for students who never attend a middle school. Coefficients for these estimates are plotted in Figure 1, and these estimates and standard errors (clustered by the school the student attended in grade 3) are shown in Appendix Table A2. There are no significant effects of eventually entering middle school on students' achievement trajectories from grade 3 to grade 4, and these students are estimated to make somewhat *more* progress from grade 4 to grade 5 than their counterparts who never enter middle school. However, in both subjects, we see achievement fall dramatically in grade 6 for

students who enter middle school in that grade. In contrast, students who enter middle school in grade 7 continue to improve relative to their peers in grade 6, but then fall dramatically upon entering middle school in grade 7.

The negative effects of entering middle school are large (about $-.15$ standard deviations), and, importantly, these do not appear to be temporary shocks. Rather, middle school students continue to underperform their K–8 peers at the end of grade 8. Moreover, students who entered middle school in grade 6 underperform relative to students who entered middle school in grade 7. These differences are economically important; relative to students who never entered middle school, students entering in grade 6 are estimated to underperform by 0.16 standard deviations (significant at the 1% level), and students entering in grade 7 are estimated to underperform by 0.09 standard deviations, though the difference is only marginally statistically significant (with p-values of .124 and .033 for math and English, respectively). An F test reveals that the difference in achievement between students who entered middle school in grade 6 or grade 7 is significant at the 1% level in grades 7 and 8.

The main threat to the validity of our results is if students who attend a K–5 (K–6) school in grade 3 differ in such a way that will cause their achievement to dip sharply in grade 6 (grade 7), even after showing somewhat greater progress in earlier grades.¹¹ This possibility seems exceedingly unlikely. To further bolster our findings, we can extend our analysis to include the small fraction of students who attended a K–4 school in grade 3, and use them to estimate the impact of moving to a middle school in grade 5. Although these estimates are much less precise, they display a similar drop in achievement in the year after students move to middle school, with

¹¹ Another possibility is that sample attrition coincident with a predicted transition to middle school is related to the trajectory of student achievement over time. We believe this is unlikely, and to the degree it occurs, would probably bias against our findings. For example, parents who send their children to a K-5 school but believe they will do poorly in a middle school may opt to send them to a private school in grade 6.

particularly clear effects for math (see Appendix Figure A1). Thus, we consider these results to provide strong evidence that entering middle school has a negative and enduring impact on student achievement, and that these effects are greater for students who enter middle school earlier in adolescence.

A number of recent studies find larger impacts of educational interventions and school quality on girls (e.g., Hastings et al. (2006), Angrist et al. (2009), Jackson (2009)), and, in light of these studies, we estimate the impact of middle school entrance on achievement separately by gender. However, the results for girls and boys are remarkably similar (Figure 2). We also estimate impacts separately by whether a student's grade 3 test score was above or below the city-wide median. Although we find similar patterns for both sets of students, we find some evidence that movement into middle schools has larger negative effects on the achievement of initially low achieving students (Figure 3).¹²

We perform similar analyses of student absences and suspensions, and find estimates consistent with our results on student achievement (Figure 4 and Appendix Table A3). Both absences and suspensions rise upon students' entry into middle school, and absences for middle school entrants are significantly higher in grade 8 than for students that never enter middle school.¹³ Although estimated suspensions in grade 8 are about the same for students who enter middle school in grades 6 and 7, absences in grade 8 are higher for students that enter middle school in grade 6, and the difference is statistically significant at the 1% level.

Overall, our estimates suggest that movement of students from elementary to middle schools has a large and persistent negative effect on achievement in math and English. However,

¹² The coefficient estimates used for these figures and their standard errors are available upon request.

¹³ If middle schools are more likely to suspend students for behavioral infractions, our results may overstate the impact of entering middle school on student behavior. However, given the consistency of our findings across outcomes, we doubt that this can explain all of the increase in suspensions.

there are several ways in which these findings might be interpreted. First, it may be that educational quality is lower on average in middle schools. Feldlaufer and Eccles (1988) argue that middle school teachers provide instruction to many more students than elementary school teachers and see each student for short periods of time, and they present evidence that middle school students receive less individualized instruction from their teachers. Second, it may be that the mere act of switching schools during adolescence has long and lasting negative consequences, regardless of whether a student moves from elementary to middle school.

From the perspective of educational production, both interpretations suggest that the separation of adolescent students into middle schools is costly. Still, while one might try to improve education quality in middle schools, their existence is inextricably tied to school switching, making the difference in interpretation potentially important. One way to test these two interpretations would be to compare students leaving K–5 or K–6 schools that are exogenously more likely to move into a K–8 school as opposed to a middle school. However, this is not possible with our data. Even if we set aside exogeneity, only 3.5 percent of students who leave K–5 or K–6 schools at the terminal grade move into a K–8 school.¹⁴

A third potential interpretation of our results is that relative age in school matters. When a student moves from a K–5 to 6–8 school (or from K–6 to 7–8), they switch from the oldest cohort to the youngest cohort in their school. There is little research that would suggest this is an important determinant of student achievement. While there is considerable work demonstrating that older children *within a grade* typically have higher levels of achievement (e.g., Bedard and Dhuey (2006)), Cascio and Schanzenbach (2007) present evidence based on random classroom assignment that this effect is due to biological age, not relative age among peers. Nevertheless, it

¹⁴ We looked to see if this small percentage might belie a small number of neighborhoods where transitions to K–8 schools were common. We found just 10 cases where over 50 percent of exiting K–5 or K–6 students switched to a K–8 school and only 3 where more than 80 percent made such a transition.

is not unfathomable that relative age within a school can matter, and we can attempt to address this issue. We take advantage of the fact that roughly 54 percent of students who move out of a school serving grades K–6 enter a school serving grades 6–8 while 30 percent move to a school serving grades 7–8, generating variation in relative age within a school conditional on having moved to a middle school in grade 7.¹⁵ When we allow the impact of entering middle school in grade 7 to depend on whether the student also entered in the youngest cohort of the middle school, we find that the impact of middle school entry is quite similar regardless of relative age at entry. These estimates are available upon request.

4. Differences in Educational Environment

In order to provide further evidence on the experiences of students who enter middle schools, we analyze survey evaluations of a school’s educational environment by students and parents. By matching survey responses with students’ enrollment histories, we can again identify the effects of middle school entry based on variation in the grade span of the school attended in grade 3. However, because we only have two years of survey data, we make three significant changes to our analysis. First, we cannot implement the two-stage least squares estimation procedure because we cannot observe actual middle school attendance for some students. For example, we have good reason to believe (based on the results in Table 4) that students in grade 3 during the school year 2007–2008 who attend a K–5 school will move to middle school in grade 6, but this event is not due to happen until 2010. We therefore present results based on specifications that regress survey outcomes on the instrumental variables for

¹⁵ The same is true of students moving from schools serving K–5 to schools serving 6–8 or 5–8, but, in practice, very few students in New York make the latter transition.

middle school attendance interacted with grade level.¹⁶ Second, we do not restrict our sample to students who were continuously enrolled for six years—again, our observation window for many survey respondents is far shorter—so the sample contains some students who were not included in the analysis of test scores, suspensions, and absences. Finally, we present results that do not include student (parent) fixed effects, which allows us to use variation in responses from those students (parents) who filled out the survey in only one year. This also allows us to compare student survey results in grade 6 for students that attended schools with different grade spans in grade 3. In practice, the inclusion of fixed effects does not change the basic conclusions from this analysis, and these estimates are available upon request.

Our findings are largely consistent with the notion that parents and students perceive a significant worsening of school environment upon entrance into middle schools. Panel A of Figure 5 compares (parents of) students who attended K–5 schools in grade 3 with those that attended K–8 schools, by students’ current grade levels.¹⁷ Parental evaluations of safety, academic rigor, adult prosocial behavior and school quality for those whose children attended a K–5 school in grade 3 are significantly lower for parents of children in grade 6 (who are likely to be in middle school) than for parents of students in grade 5 (who are likely still in elementary school). The student results are somewhat less clear cut. Students who attended a K–5 school provide lower evaluations of safety, academic rigor, and adult prosocial behavior than those that attended K–8 schools in grades 6, 7, and 8. However, they provide slightly higher evaluations of student prosocial behavior in grades 6 and 7.

¹⁶ If the first stage results on the sample used to measure achievement effects generalize to the sample of students (and their parents) who responded to the surveys, then these coefficients should be about 70 percent as large as they would be if we could implement the two-stage least squares regression.

¹⁷ Point estimates used to construct Figure 5 and standard errors are shown in Appendix Table A4.

Panel B of Figure 5 displays estimates that compare (parents of) students who attended a K–6 school in grade 3 (who are likely to move to middle school in grade 7) with those that attended K–8 schools (and are unlikely to move to middle school). The parental results for safety and adult prosocial behavior are quite consistent with the achievement results—evaluations are similar or even higher when students are in grades 3 to 6 but drop considerably when students are in grade 7 and remain low in grade 8. For academic rigor and school quality, the patterns through grade 6 are similar and there is a noticeable drop at grade 7, followed by another drop at grade 8. Among students, evaluations are higher on all four dimensions for 6th graders who attended a K–6 school relative to those who attended a K–8 school, and evaluations fall for the K–6 group relative to the K–8 group in grade 7. However, evaluations of safety and student prosocial behavior are still higher for the K–6 group in grade 7, and fall to an even greater extent (relative to K–8 attendees) in grade 8. Thus, while student evaluations do worsen after grade 6 for students who are likely to switch to middle school at that time, only the pattern of estimates for adult prosocial behavior fall neatly in line with the achievement effects documented above.

On the whole these estimates suggest that students who move to middle schools experience a significant worsening of their school environment. Additionally, we can find support for this notion by looking at parent and student observations of the school environment in high school. If students who attended a K–5 or K–6 school in grade 3 do not attend high schools with worse educational environments than those who attended a K–8 school, then negative opinions we observed for these groups of students in the middle school grades should

disappear once they (and their K–8 counterparts) all move on to high school.¹⁸ This is indeed what we find. Table 5 reports the results from regressions of student and parent evaluations measured for students in grades 7 through 12 on an indicator for student attendance of a K–5 or K–6 school in grade 3, an interaction of this variable with an indicator for current attendance in grades 9–12, and grade level by year fixed effects. While the effect of having attended a K–5 or K–6 elementary school on evaluations of school environment in grades 7 and 8 is always negative, the coefficient on the interaction of this variable and high school attendance is always positive and of similar magnitude. Thus, most or all of the difference in evaluations of school environment between the groups of students (and parents) dissipates after the movement to high school.

5. Cost-Benefit Analysis

Krueger (2003) estimates the present value of the benefits to earnings increases from class size reductions in Kindergarten, using evidence from the Tennessee STAR class size experiment. We follow his methodology and assumptions to arrive a similar calculate for the costs, in terms of lost future earnings, of placing adolescent students in middle schools instead of using K-8 schools. Our baseline estimates (Appendix Table 4) suggest the use of middle schools reduces average math and reading achievement by about 0.12 standard deviations at the end of grade 8. To allow for the possible convergence of achievement during high school, we also calculate costs using reductions of 0.08 and 0.04 standard deviations. Following Kreuger, we

¹⁸ This is also a helpful robustness check; if students who attended a K–5 or K–6 school in grade 3 end up in low quality high schools, one might speculate that our results are driven by a general decline in school quality in some neighborhoods as students move to higher grade levels.

assume a one standard deviation rise in test scores raises future earnings by 8 percent.¹⁹ We update Krueger's age-earnings profile using the 2008 Current Population Survey March Supplement, and, like him, assume a 1 percent growth rate for real wages and productivity.

Our calculations suggest that the future earnings costs of attending middle schools are substantial (Table 6). If the effects seen in grade 8 fully persist and we assume a discount rate similar to the current yield on inflation protected U.S. bonds (2 percent), we find present value costs of roughly \$25,000 in lost earnings per student. Under these parameters, there is little chance that middle schools could generate enough cost savings to achieve efficiency. Under quite modest parameters (a loss of 0.04 standard deviations and a discount rate of 5 percent), we find costs of \$2,940 per student. Thus, even in this case, middle schools would have to be substantially less expensive in order to be cost-effective. For example, if annual costs per student in elementary and K-8 schools were \$10,000, then annual costs per student in middle schools (serving grades 6-8) would need to be less than \$9,000. Currently, there is little evidence that educational provision is significantly less expensive in middle schools, either in New York City or nationwide.²⁰

6. Conclusion

The issue of grade configuration has been the topic of substantial debate by educational researchers and policy-makers who have challenged the notion that separating adolescents into middle schools is a more economical way to provide education tailored to their needs (Carnegie Council on Adolescent Development (1989, 1996), Bickel et al. (2000), Juvonen et al. (2004)).

¹⁹ We update Krueger's age-earnings profile using the 2008 Current Population Survey March Supplement, and, like him, assume a 1 percent growth rate for real wages and productivity.

²⁰ National school level data on expenditure is unfortunately unavailable, but pupil-teacher ratios for public primary and middle schools averaged 15.2 and 15.3, respectively, in the school year 2006-07 (author's calculations, National Center for Education Statistics, Common Core of Data, 2007)).

Already, middle school reforms are underway in states such as Massachusetts, Pennsylvania, Ohio, Tennessee, Oklahoma, Maryland, and New York, including the large urban districts of Cincinnati and Cleveland, Philadelphia, and Baltimore. Moreover, at least eight other states across the nation are looking to convert their middle schools into K–8 schools. (Hough (2005), Pardini (2002), Reising (2002)). Our analysis suggests that such attention is warranted.

Using panel data and instrumental variables, we estimate that students' academic achievement falls by about 0.15 standard deviations in math and English when they move from elementary schools to middle schools. These effects are economically important, and similar to estimates from the literature on raising teacher effectiveness by one standard deviation (Rivkin et al. (2005), Rockoff (2004)) or moving to a school with one standard deviation higher average test scores (Hastings and Weinstein (2008)). Moreover, the effects of movement to middle school persist through grade 8, and the loss for students who enter middle school in grade 6 is greater than for those who enter in grade 7.

These results are consistent with the findings of Cook et al. (2008), who conclude that entering middle school in 6th grade leads to more behavioral infractions than entering in 7th grade. They hypothesize that this difference may be due to a negative impact of older students on younger peers, and that 6th graders are more sensitive to this effect than 7th graders. The fact that K–8 students perform relatively worse than K–5 students in 5th grade, and worse than K–6 students in both 5th and 6th grade, may support this hypothesis. Still, it appears the temporary benefit of being the oldest student in one's school in 5th or 6th grade is more than negated upon entering middle school.

We find two plausible interpretations for why moving to a middle school is detrimental to student outcomes. First and foremost, a number of factors common to middle schools may make

educational production less efficient. For example, cohort sizes are much larger, students arrive from elementary schools with potentially diverse educational climates, and, at least in New York City, students are slightly more socio-economically diverse. Moreover, adolescent children exhibit increased negativity, low self-esteem (Eccles et al. (1984)), poor ability to judge risks and consequences of their actions (Lewis (1981), Halpern-Felsher and Cauffman (2000)), and other traits that may make them difficult to educate when they are together in large groups.

Alternatively, it may be that any move to a new school has long lasting negative impacts on student achievement. Given the limitations of our data and the types of structures currently used in New York City, we cannot estimate the impacts of switching schools at other grade levels, nor can we estimate the impact of exogenous movement by upper elementary students into K–8 schools. While further research is necessary to evaluate the merits of this interpretation, a large and persistent negative effect of moving adolescents to a new school still has important implications for how public school districts determine school grade configurations.

Despite causing a significant and persistent loss in student achievement in math and English, the use of middle schools could still be optimal. However, while further work should explore this issue further, the evidence we present here rules out several likely sources of compensating benefits, such as cost reduction, wider course offering, or greater parental or student satisfaction with school quality. Additionally, our analysis suggests the achievement costs of middle schools are greater for students lower in the achievement distribution, lending no support for their use on the basis of equity.

References

- Alspaugh, John W. (1998a) "Achievement Loss Associated With the Transition to Middle School and High School" *The Journal of Educational Research*, Vol. 92, No. 1, pp. 20–25.
- Alspaugh, John W. (1998b) "The Relationship of School-to-School Transitions and School Size to High School Dropout Rates" *High School Journal*, Vol. 81, No. 3, pp. 154–160.
- Angrist, Joshua, Daniel Lang, and Philip Oreopoulos (2009) "Incentives and Services for College Achievement: Evidence from a Randomized Trial," *American Economic Journal: Applied Economics* 1(1): 136–163.
- Bedard, Kelly and Chau Do (2005) "Are Middle Schools More Effective? The Impact of School Structure on Student Outcomes" *The Journal of Human Resources*, Vol. 40, No. 3, pp. 660–682.
- Bedard, Kelly and Elizabeth Dhuey (2006) "The Persistence of Early Childhood Maturity: International Evidence of Long-Run Age Effects," *Quarterly Journal of Economics* 121(4): 1437–1472.
- Bickel, Robert, Craig Howley, Tony Williams, and Catherine Glascock (2000) "Will the Real 'Texas Miracle in Education' Please Stand Up? Grade Span Configuration, Achievement, and Expenditure per Pupil" Education Resources Information Center No. ED447995, November 2000.
- Byrnes, Vaughan and Allen Ruby (2007) "Comparing Achievement between K–8 and Middle Schools: A Large-Scale Empirical Study," *American Journal of Education* 114(1): 101–135.
- Carnegie Council on Adolescent Development (1989) *Turning Points: Preparing American Youth for the 21st Century*. New York: Carnegie Corporation.
- Carnegie Council on Adolescent Development (1996) *Great Transitions: Preparing Adolescents for a New Century*. New York: Carnegie Corporation.
- Cascio, Elizabeth and Diane Whitmore Schanzenbach (2007) "First In the Class? Age and the Education Production Function" NBER Working Paper 13663.
- Cook, Philip J., Robert MacCoun, Clara Muschkin, and Jacob Vigdor (2008). "The Negative Impacts of Starting Middle School in Sixth Grade" *Journal of Policy Analysis and Management*, Vol. 27, No. 1, pp. 104–121.
- Eccles, Jacquelynne, Carol Midgley, and Terry F. Adler (1984) "Grade Related Changes in the School Environment: Effects on Achievement Motivation," In J. G. Nicholls (Ed.), *Advances in Motivation and Achievement: Vol. 3. The Development of Achievement Motivation*. Greenwich, CT: JAI.
- Feldlaufer, Harriet and Jacquelynne S. Eccles (1988) "Student, Teacher, and Observer Perceptions of the Classroom Environment Before and After the Transition to Junior High School," *Journal of Early Adolescence*, 8(2): 133–156.

- Halpern-Felsher, Bonnie L. and Elizabeth Cauffman (2000) “Costs and Benefits of a Decision: Decision-making Competence in Adolescents and Adults,” *Applied Developmental Psychology* 22(3): 257–273.
- Hastings, Justine S., Thomas J. Kane, and Douglas O. Staiger (2006) “Gender and Performance: Evidence from School Assignment by Randomized Lottery,” *American Economic Review Papers and Proceedings* 96(2): 232–236
- Hastings, Justine S. and Jeffrey M. Weinstein (2008) “Information, School Choice, and Academic Achievement: Evidence from Two Experiments,” *Quarterly Journal of Economics*, 123(4): 1373–1414.
- Hough, David L. (2005) “The Rise of the ‘Elemiddle’ School,” *School Administrator*, 62(3): 10–14.
- Jackson, C. Kirabo (2009) “Ability-grouping and Academic Inequality: Evidence from Rule-Based Student Assignments,” NBER Working Paper 14911.
- Juvonen, Jaana, Vi-Nhuan Le, Tessa Kaganoff, Catherine Augustine, and Louay Constant (2004) *Focus on the Wonder Years: Challenges Facing the American Middle School* (Santa Monica, CA: RAND Corporation).
- Kane, Thomas J., Jonah E. Rockoff, Douglas O. Staiger (2008) “What Does Certification Tell Us About Teacher Effectiveness? Evidence from New York City,” *Economics of Education Review*, 27(6): 615–631.
- Kreuger, Alan B. (1999) “Experimental Estimates of Education Production Functions,” *Quarterly Journal of Economics*, 114(2): 497–532.
- Lewis, Catherine C. (1981) “How Adolescents Approach Decisions: Changes Over Grades Seven to Twelve and Policy Implications,” *Child Development*, 52: 538–544.
- Pardini, Priscilla (2002) “Revival of the K–8 School,” *School Administrator*, 59(3): 6–13.
- Reardon, Sean F. and Glenn Firebaugh (2002) “Measures of Multigroup Segregation” *Sociological Methodology*, 32: 33–67.
- Reising, Bob (2002) “Middle School Models,” *Clearing House*, 76(2): 60–61.
- Rivkin, Steven G., Eric Hanushek, and John F. Kain (2005) “Teachers, Schools and Academic Achievement,” *Econometrica* 73(2): 417–458.
- Rockoff, Jonah E. (2004) “The Impact of Individual Teachers on Student Achievement: Evidence from Panel Data,” *American Economic Review, Papers and Proceedings* 94(2): 247–252.
- Rockoff, Jonah E., and Lesley J. Turner (2008) “Short Run Impacts of Accountability on School Quality,” NBER Working Paper 14564.
- Weiss, Christopher C. and Lidsay Kipnes (2006) “Reexamining Middle School Effects: A Comparison of Middle Grades Students in Middle Schools and K–8 Schools” *American Journal of Education*, Vol. 112, No. 2, pp. 239–272.

Table 1: Summary Statistics on 3rd Graders by Grade Range

Panel A: All 3rd Graders in New York City			
	School Grade Range		
	K-5	K-6	K-8
White	17%	9%	14%
Black	31%	40%	42%
Hispanic	39%	36%	38%
Asian	11%	14%	6%
Free or Reduced Lunch	83%	86%	88%
Special Education	6%	6%	6%
English Language Learners	10%	9%	9%
Math Achievement	0.04	-0.05	-0.10
English Language Arts Achievement	0.05	-0.07	-0.08

Panel B: Students With Reported Test Scores in Grades 3-8			
	School Grade Range		
	K-5	K-6	K-8
White	19%	9%	15%
Black	34%	44%	45%
Hispanic	35%	33%	33%
Asian	12%	13%	6%
Free or Reduced Lunch	82%	86%	87%
Special Education	4%	4%	3%
English Language Learners	2%	1%	2%
Math Achievement	0.04	-0.09	-0.08
English Language Arts Achievement	0.04	-0.09	-0.07

Note: Sample includes all students who attended grade 3 between the school years 1998-1999 and 2002-2003.

Table 2: Summary Statistics on School Inputs and Cohort Composition by Grade Range

	School Grade Range				
	K-5	K-6	K-8	6-8	7-8
Per-Student Expenditure	\$10,144	\$9,680	\$10,950	\$10,094	\$11,082
Percentage of Rookie Teachers	6.8%	8.3%	8.6%	11.1%	10.1%
Teacher Absences	7.9	8.0	7.4	7.7	8.0
Class Size					
5th Grade	24.2	24.6	24.2	N/A	N/A
6th Grade	N/A	24.8	25.4	25.3	N/A
7th Grade	N/A	N/A	25.4	26.7	23.9
Cohort Size					
5th Grade	118.4	103.3	78.4	N/A	N/A
6th Grade	N/A	93.9	75.4	235.5	N/A
7th Grade	N/A	N/A	74.6	271.6	202.7
Peer Group Instability					
5th Grade	23%	27%	33%	N/A	N/A
6th Grade	N/A	23%	44%	77%	N/A
7th Grade	N/A	N/A	32%	36%	64%
Dissimilarity Index: Ethnicity					
5th Grade	0.595	0.580	0.582	N/A	N/A
6th Grade	N/A	0.577	0.560	0.547	N/A
7th Grade	N/A	N/A	0.563	0.548	0.502
Dissimilarity Index: Free Lunch Status					
5th Grade	0.582	0.512	0.511	N/A	N/A
6th Grade	N/A	0.500	0.532	0.530	N/A
7th Grade	N/A	N/A	0.504	0.514	0.452

Note: Data on class size is only available for the school years 2006–2007 to 2008–2009. Expenditure data covers the years 1999–2000 to 2007–2008. Dissimilarity indices are calculated using the number of students by type within school-grade-year cells.

Table 3: Course Variety and School Structure

<i>Panel A: Grade 7 and 8 Students</i>	School Type	
	K–8	Middle School
Art	75%	64%
Music	61%	57%
Dance	47%	46%
Theater	37%	39%
Foreign Language	68%	62%
Computer Skills/Technology	79%	58%

<i>Panel B: Grade 7 and 8 Parents</i>	School Type	
	K–8	Middle School
Art	50%	37%
Music	38%	32%
Dance	18%	16%
Theater	9%	10%
Foreign Language	43%	43%
Computer Skills/Technology	60%	38%

Note: These data come from responses to citywide surveys of students in grades 7 and 8 and their parents; see the text for more details. For students, we report the fraction stating that they either participated in or were offered the chance to participate in these courses either before, during, or after school. For parents, we report the fraction who said that their child participated in these courses before, during, or after school.

Table 4: School Structure as a Predictor of Middle School Entrance

	Enter Middle School in Grade 6	Enter Middle School in Grade 7
Attended a K-5 School in Grade 3	0.698 [0.001]**	
Attended a K-6 School in Grade 3		0.69 [0.001]**
Number of Observations		
R ²		

Note: Standard errors (in brackets) clustered by school. * significant at 5%; ** significant at 1%

Table 5: Effect of Middle School Attendance on High School Survey Responses

	Student Survey Responses			
	Safety	Adult Prosocial Behavior	Academic Rigor	Student Prosocial Behavior
Middle School Students	-0.06 [0.026]*	-0.108 [0.021]**	-0.067 [0.016]**	-0.035 [0.027]
High School Students Who Attended Middle School	0.046 [0.025]	0.051 [0.025]*	0.041 [0.020]*	0.035 [0.025]

	Parent Survey Responses			
	Safety	Adult Prosocial Behavior	Academic Rigor	Overall Quality
Middle School Students	-0.085 [0.026]**	-0.075 [0.022]**	-0.127 [0.028]**	-0.107 [0.026]**
High School Students Who Attended Middle School	0.091 [0.027]**	0.04 [0.025]	0.062 [0.029]*	0.058 [0.029]*

Note: All regressions include year-grade fixed effects. Standard errors (in brackets) clustered by school.

* significant at 5%; ** significant at 1%

Table 6: Estimated Cost of Middle School Enrollment

Present Value of Loss in Future Income			
Assuming Persistent Achievement Difference of:			
Discount Rate	0.12 SD	0.08 SD	0.04 SD
0.02	-\$25,848	-\$17,232	-\$8,616
0.03	-\$17,749	-\$11,833	-\$5,916
0.04	-\$12,405	-\$8,270	-\$4,135
0.05	-\$8,819	-\$5,879	-\$2,940

Note: This table shows the estimated cost of sending a child to a sequence of K-5 and 6-8 schools relative to a K-8 school. Our baseline estimates suggest the use of middle schools reduces achievement by .12 standard deviations (SD), but we calculate costs using .08 and .04 SD to allow for the possible convergence of achievement during high school. Following Kreuger (2003), we assume a 1 standard deviation rise in test scores yields an 8% increase in each year of future earnings. We use the 2008 Current Population Survey March Supplement to find the current age-earnings profile, and we assume real wages grow at 1%.

Table A1: Survey Questions Used to Construct Satisfaction Indices

Student Indices

Safety

- I feel welcome in my school.
- I stay home because I don't feel safe at school.
- Students threaten or bully other students at school.
- Students get into physical fights at my school.
- Adults at my school yell at students.
- There is conflict in my school based on: race, culture, religion, sexual orientation, gender, or disabilities.
- Students use alcohol or illegal drugs while at school.
- There is gang activity at my school.

Academic Rigor

- I need to work hard to get good grades at my school.
- Someone in my school helps me develop challenging goals for learning more in school.
- My teachers expect me to continue my education after high school.

Adult Prosocial Behavior

- Most of the adults I see at school every day know my name or who I am.
- The adults at my school look out for me.
- The adults at my school help me understand what I need to do to succeed in school.
- My teachers encourage me to succeed.
- How comfortable are you talking to teachers and other adults at your school about a problem you are having in a class?
- How comfortable are you talking to teachers and other adults at your school about something that is bothering you?
- Teachers in my school treat students with respect.

Student Prosocial Behavior

- Students who get good grades in my school are respected by other students.
- Most students in my school treat teachers with respect.
- Most students in my school help and care about each other.
- Most students in my school just look out for themselves.
- Most students in my school treat each other with respect.

Parent Indices

Safety

- My child is safe at school.
- Students threaten or bully other students.

Academic Rigor

- The school has high expectations for my child.
- The school clearly communicates its expectations for my child's learning to me and my child.
- My child is learning what he or she needs to know to succeed in later grades or after graduating from high school.

Adult Prosocial Behavior

- There is an adult at the school whom my child trusts and can go to for help with a school problem.

Overall Quality

- My child's teacher(s) give helpful comments on homework, class work, and tests.
 - How satisfied are you with the quality of your child's teacher(s) this year?
 - How satisfied are you with the education your child has received this year?
-

Table A2: Regression Results for Achievement

	Normalized Achievement Scores, Relative to Students in K-8 Schools	
	Math	English
Students Entering Middle School in Grade 6		
Grade 4	-0.012 [0.034]	-0.014 [0.030]
Grade 5	0.053 [0.028]	0.075 [0.028]**
Grade 6	-0.147 [0.041]**	-0.102 [0.035]**
Grade 7	-0.149 [0.045]**	-0.118 [0.037]**
Grade 8	-0.175 [0.056]**	-0.158 [0.041]**
Students Entering Middle School in Grade 7		
Grade 4	0.009 [0.037]	-0.004 [0.033]
Grade 5	0.063 [0.031]*	0.082 [0.032]**
Grade 6	0.118 [0.045]**	0.095 [0.039]*
Grade 7	-0.041 [0.049]	-0.049 [0.041]
Grade 8	-0.091 [0.059]	-0.095 [0.044]*

Note: All regressions include student fixed effects, as well as controls for grade, for whether the student was held back that year, and for whether the student was held back in any previous year. Standard errors (in brackets) clustered by school. * significant at 5%; ** significant at 1%

Table A3: Regression Results for Absences and Suspensions

	Relative to Students in K-8 Schools	
	Absences	Suspensions
Students Entering Middle School in Grade 6		
Grade 4	0.145 [0.135]	-0.002 [0.004]
Grade 5	0.362 [0.215]	0 [0.004]
Grade 6	1.002 [0.246]**	0.003 [0.007]
Grade 7	1.23 [0.360]**	0.004 [0.010]
Grade 8	1.882 [0.464]**	-0.001 [0.015]
Students Entering Middle School in Grade 7		
Grade 4	-0.072 [0.163]	0.003 [0.005]
Grade 5	-0.139 [0.233]	0 [0.004]
Grade 6	0.066 [0.303]	-0.014 [0.007]
Grade 7	0.64 [0.421]	-0.01 [0.012]
Grade 8	1.159 [0.508]*	-0.002 [0.017]

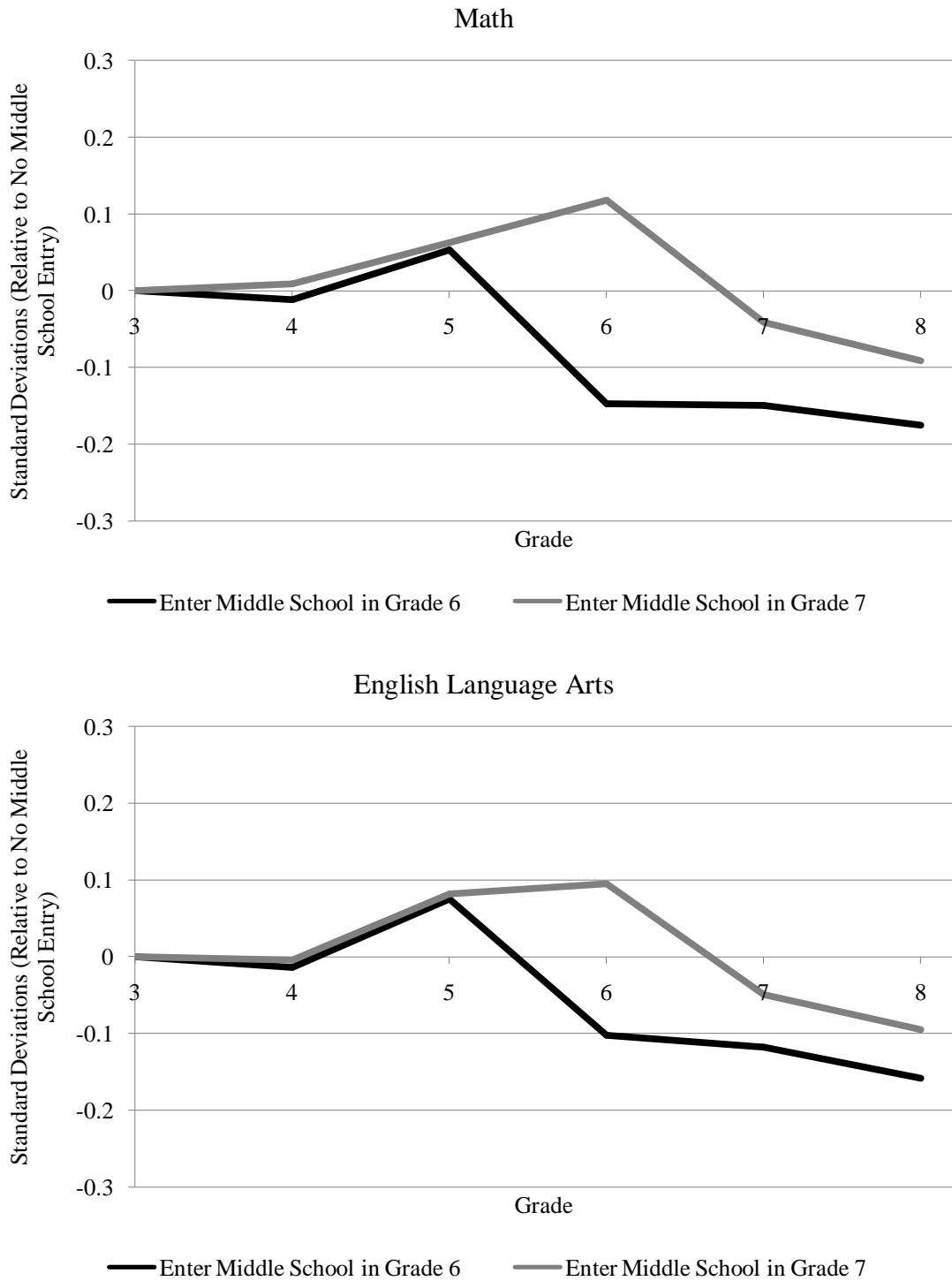
Note: All regressions include student fixed effects, as well as controls for grade, for whether the student was held back that year, and for whether the student was held back in any previous year. Standard errors (in brackets) clustered by school. * significant at 5%; ** significant at 1%

Table A4: Effect of Entering Middle School on Student and Parent Opinions of School Quality

	Student Survey Responses				Parent Survey Responses			
	Safety	Adult Prosocial Behavior	Academic Rigor	Student Prosocial Behavior	Safety	Adult Prosocial Behavior	Academic Rigor	Overall Quality
Enters Middle School in Grade 6	-0.026 [0.031]	-0.066 [0.022]**	-0.059 [0.015]**	0.024 [0.033]	0.134 [0.024]**	0.002 [0.020]	0 [0.026]	0.023 [0.024]
Grade 4					0.064 [0.018]**	0.041 [0.019]*	0.031 [0.021]	0.039 [0.027]
Grade 5					0.114 [0.019]**	0.093 [0.022]**	0.107 [0.023]**	0.142 [0.027]**
Grade 6					-0.178 [0.023]**	-0.034 [0.025]	-0.03 [0.028]	-0.056 [0.031]
Grade 7	-0.01 [0.018]	-0.017 [0.020]	0.028 [0.018]	-0.02 [0.021]	-0.208 [0.027]**	-0.066 [0.027]*	-0.089 [0.029]**	-0.096 [0.030]**
Grade 8	-0.073 [0.024]**	-0.049 [0.023]*	-0.043 [0.023]	-0.106 [0.027]**	-0.223 [0.029]**	-0.079 [0.027]**	-0.159 [0.032]**	-0.164 [0.033]**
Enters Middle School in Grade 7	0.045 [0.038]	0.033 [0.029]	0.014 [0.021]	0.155 [0.042]**	0.027 [0.032]	-0.065 [0.025]*	-0.098 [0.031]**	-0.115 [0.032]**
Grade 4					0.102 [0.026]**	0.024 [0.030]	0.043 [0.030]	0.103 [0.037]**
Grade 5					0.149 [0.033]**	0.076 [0.032]*	0.132 [0.032]**	0.204 [0.035]**
Grade 6					0.13 [0.032]**	0.091 [0.033]**	0.123 [0.037]**	0.185 [0.039]**
Grade 7	-0.035 [0.030]	-0.159 [0.032]**	-0.057 [0.025]*	-0.13 [0.033]**	-0.124 [0.041]**	-0.035 [0.037]	-0.014 [0.040]	0.052 [0.040]
Grade 8	-0.142 [0.037]**	-0.196 [0.038]**	-0.138 [0.031]**	-0.235 [0.040]**	-0.144 [0.043]**	-0.033 [0.036]	-0.111 [0.041]**	-0.07 [0.042]

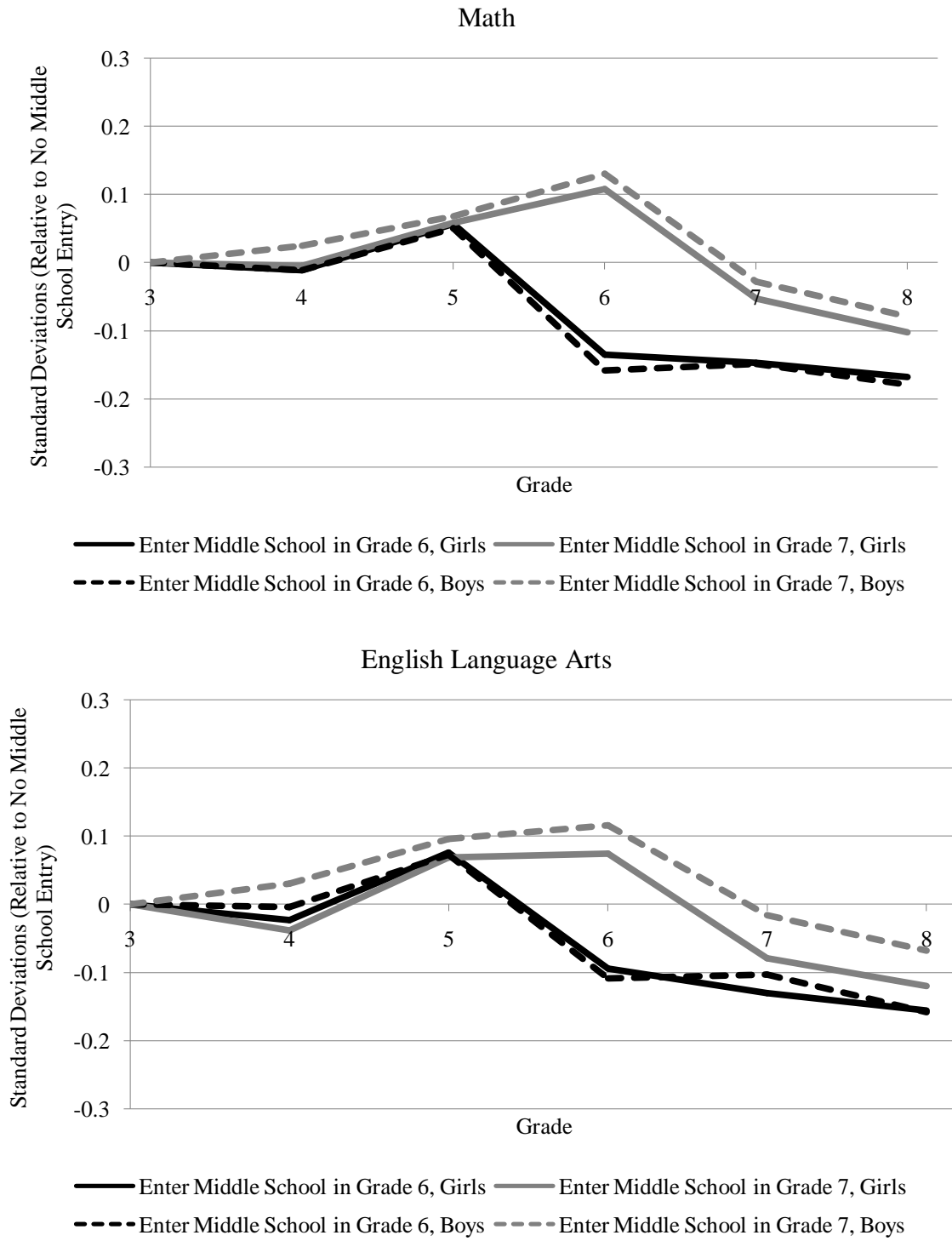
Note: All regressions include year and grade fixed effects. Standard errors (in brackets) clustered by school. * significant at 5%. ** significant at 1%

Figure 1: Estimates of the Impact of Entering Middle School on Student Achievement



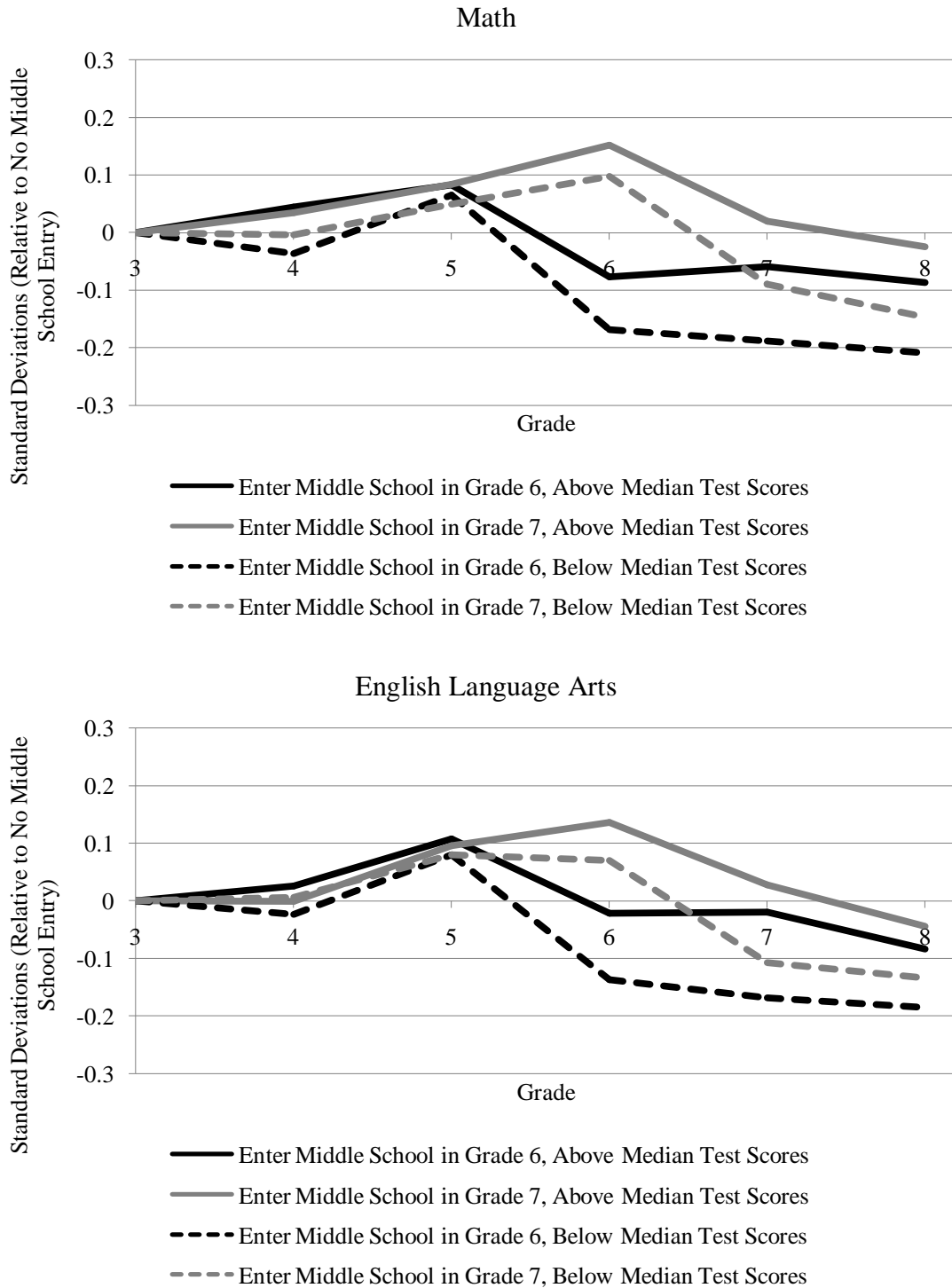
Note: These figures plot coefficient estimates for grade interacted with an indicator for the year in which a student enters middle school. The plotted coefficients and their standard errors are given in Appendix Table A2. All regressions include student fixed effects, as well as controls for grade, for whether the student was held back that year, and for whether the student was held back in any previous year.

Figure 2: Impact of Entering Middle School on Student Achievement, By Gender



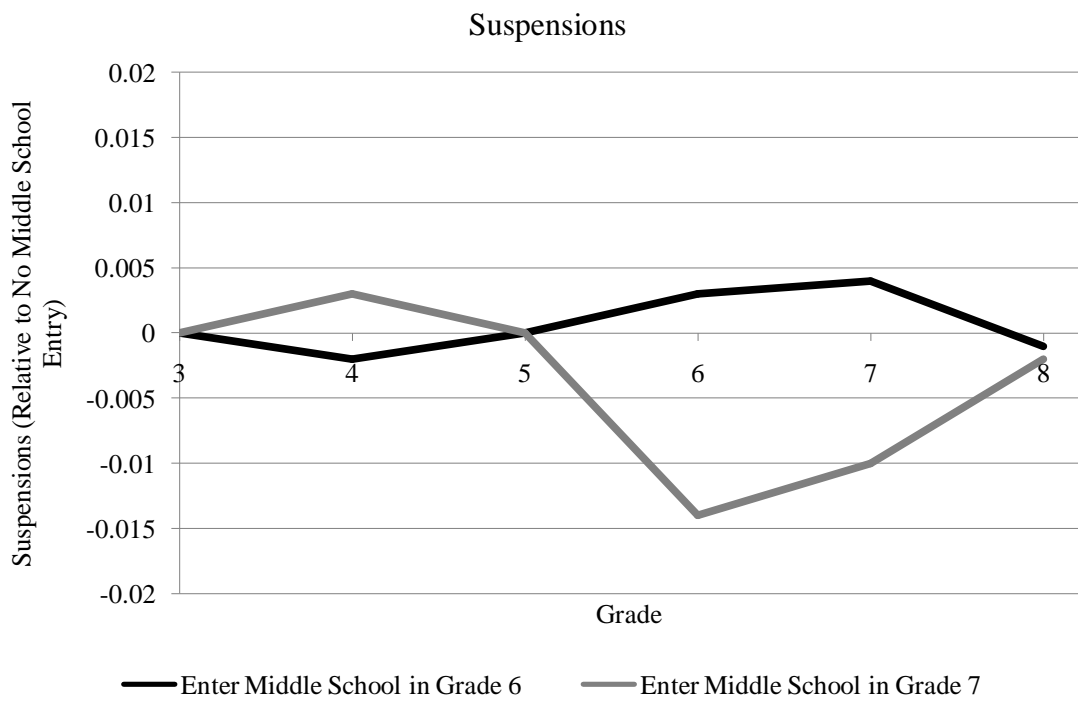
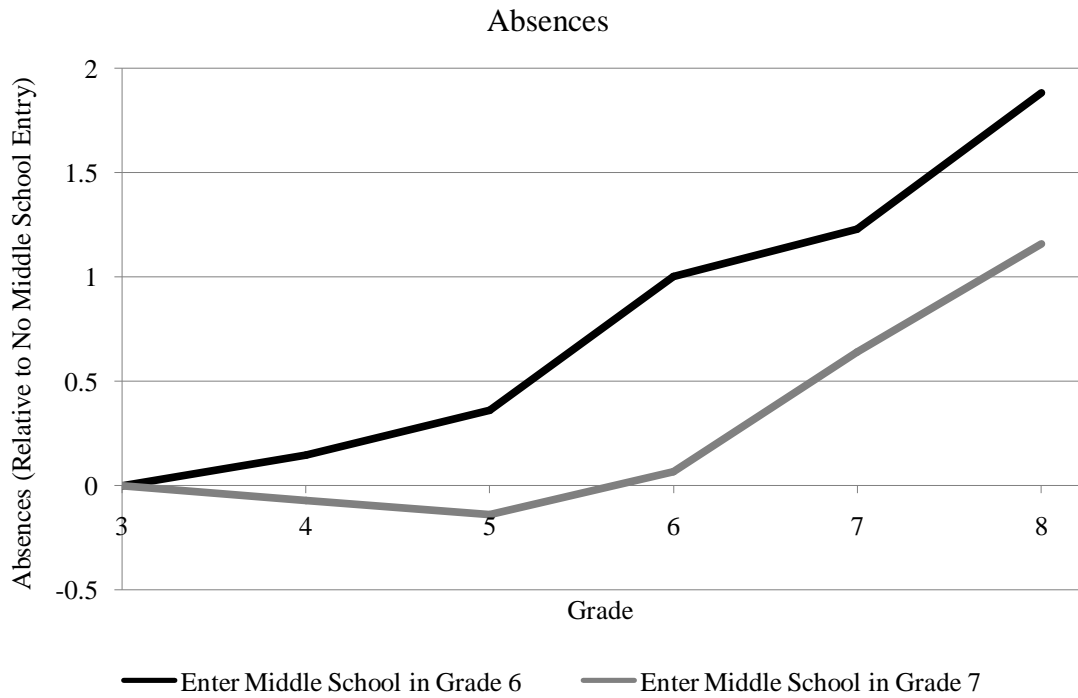
Note: These figures plot coefficient estimates for grade interacted with an indicator for the year in which a student enters middle school. Coefficients and standard errors for these regressions are available upon request. All regressions include student fixed effects, as well as controls for grade, for whether the student was held back that year, and for whether the student was held back in any previous year.

Figure 3: Impact of Entering Middle School on Student Achievement, Separated Into Above and Below Median 3rd Grade Test Scores



Note: These figures plot coefficient estimates for grade interacted with an indicator for the year in which a student enters middle school. Coefficients and standard errors for these regressions are available upon request. All regressions include student fixed effects, as well as controls for grade, for whether the student was held back that year, and for whether the student was held back in any previous year.

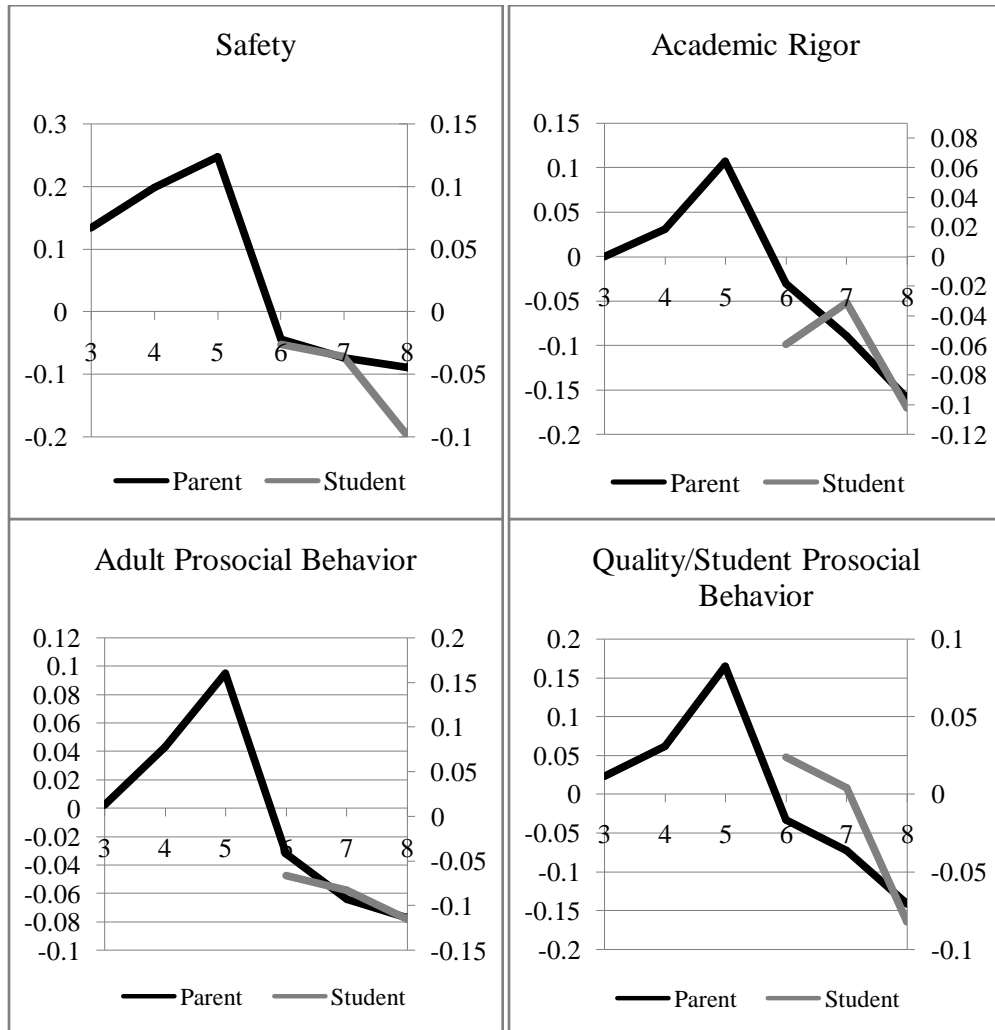
Figure 4: Estimates of the Impact of Entering Middle School on Student Behavior



Note: These figures plot coefficient estimates for grade interacted with an indicator for the year in which a student enters middle school. The plotted coefficients and their standard errors are given in Appendix Table A3. All regressions include student fixed effects, as well as controls for grade, for whether the student was held back that year, and for whether the student was held back in any previous year.

Figure 5: Entering Middle School and Parent and Student Opinions of School Quality

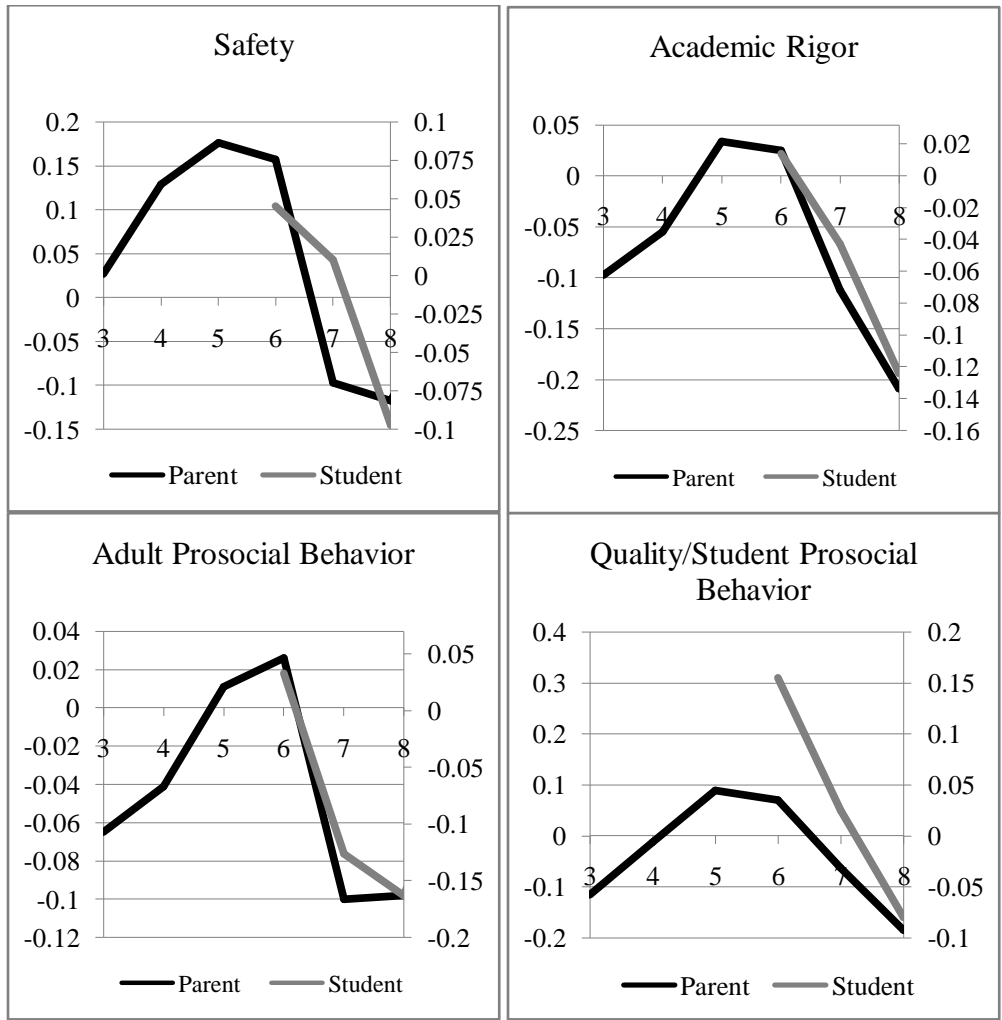
Panel A: Estimated Impacts of Entering Middle School in Grade 6



Note: These figures plot coefficient estimates for grade interacted with an indicator for the year in which a student enters middle school. The plotted coefficients and their standard errors are given in Appendix Table A4. All regressions include grade and year fixed effects.

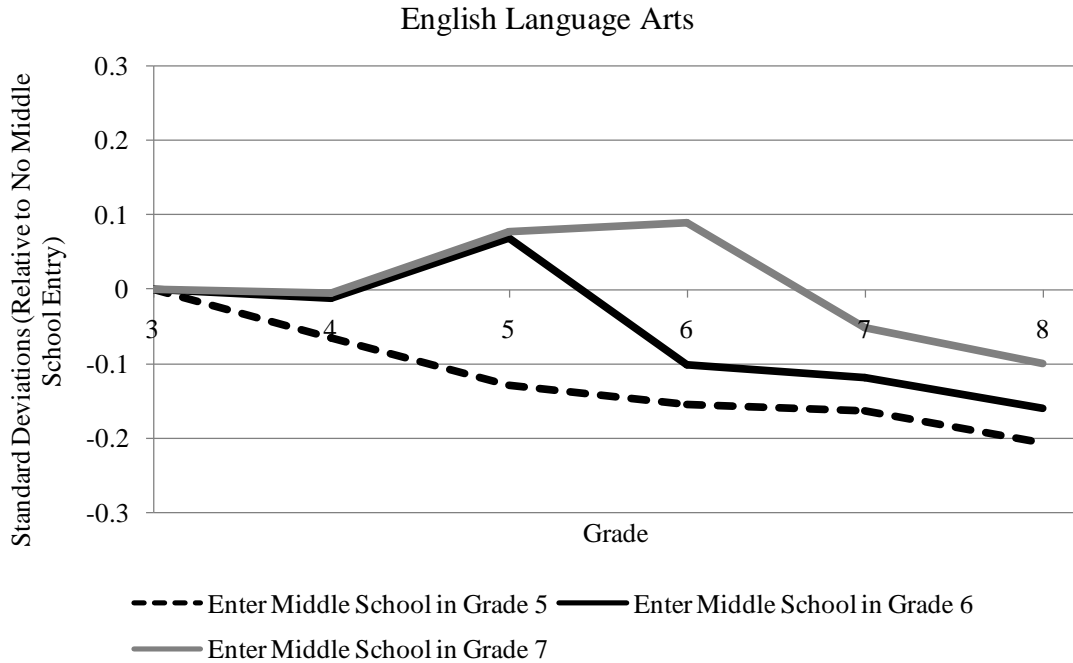
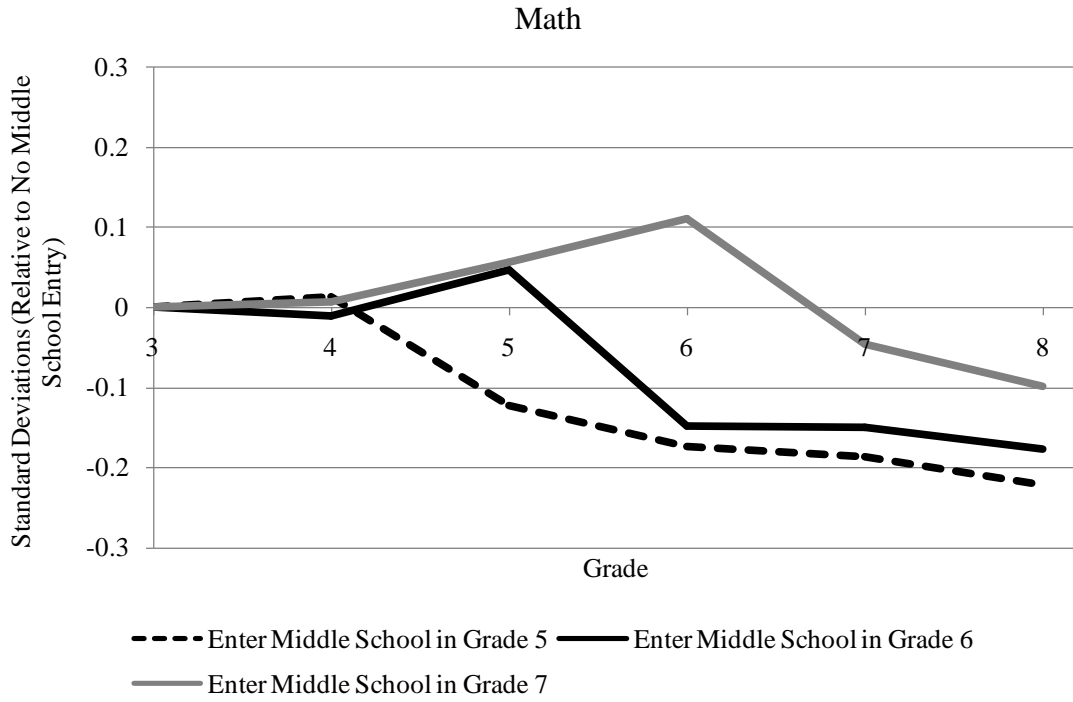
Figure 5: Entering Middle School and Parent and Student Opinions of School Quality

Panel B: Estimated Impacts of Entering Middle School in Grade 7



Note: These figures plot coefficient estimates for grade interacted with an indicator for the year in which a student enters middle school. The plotted coefficients and their standard errors are given in Appendix Table A4. All regressions include grade and year fixed effects.

Figure A1: Estimates of the Impact of Entering Middle School on Student Achievement, Including Students Entering Middle School in Grade 5



Note: These figures plot coefficient estimates for grade interacted with an indicator for the year in which a student enters middle school. All regressions include student fixed effects, as well as controls for grade, for whether the student was held back that year, and for whether the student was held back in any previous year.