The Road Less Traveled: Impacts of Alternative Grade Configurations through Middle and High School*

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Preliminary version

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Abstract

We use statewide administrative data from Florida to estimate the impact of attending public schools with different grade configurations on student achievement through grade 10. To identify the causal effect of school transitions, we use student fixed effects and instrument for middle and high school attendance based on the terminal grade of the school attended in grades 3 and 6, respectively. Consistent with recent evidence from other settings, we find that moving students from elementary to middle school in grades 6 or 7 causes substantial drops in student achievement. We extend this evidence by confirming that these achievement drops occur outside of urban areas and persist through grade 10, by which time most students have transitioned into high school. We also find that switching to high school in grade nine causes a smaller one-time drop in achievement but does not alter students' performance trajectories.

JEL Codes: H52, I21, I28

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1. Introduction

A basic question facing any education system is how best to group students in different grades across schools. Interestingly, school systems around the world have answered this question in very different ways. In Germany, for example, students attend one school through grade 4 before moving to the school in which they will complete their secondary education. Finnish students, known for their strong performance on international assessments of student achievement, attend a single school from grades 2 to 10. The choice of grade configuration determines the number of school transitions students make, the age at which they make school transitions, and the relative age of the peers to whom they are exposed at various ages. While all of these factors could plausibly influence student outcomes, the literature on differences in student achievement across countries (Hanushek and Woessmann 2011) has largely ignored the issue of grade configuration.

In the U.S., the vast majority of students switch from elementary school to middle school in grade 6 or 7 before entering high school in grade 9. However, alternative paths through primary and secondary schooling were more common historically and remain available in many areas. Some American students attend K-8 or even K-12 public schools, while others move after elementary school into schools covering both middle and high school grades. The extent of this variation, which is cross-nationally exceptional, makes the U.S. a valuable potential source of evidence on the role of grade configuration in education production.

Recent evidence from New York City (Rockoff and Lockwood 2010) indicates that moving to a middle school causes a sharp drop in student achievement, suggesting that a return to K-8 grade configurations may be beneficial in that setting. However, it remains unclear whether this pattern is evident in other settings and whether the negative effect of middle school attendance on student achievement persists into high school. The latter consideration is critical, as a key rationale for the creation of middle schools was to equip students for the transition to high school. Moreover, having experienced a previous school transition may make students more resilient to any negative consequences of subsequent transitions. It is also unclear from existing evidence whether the transition to high school in grade 9 causes similarly detrimental effects.

We investigate these questions using statewide administrative data covering all students in Florida public schools from grades 3 to 10 for the school years 2000–2001 through 2008–2009. To isolate the causal effect of entering middle school in grade 6 or 7 and of entering

high school in grade 9, we use student fixed effects and instruments for middle and high school entry based on the grade span of the school each student attended in grades 3 and 6. Our identifying assumption is that selection into schools with different terminal grades prior to a potential transition to middle or high school is not correlated with unobserved student characteristics that cause a change in performance coincident with the transition.

We find that students entering middle school in grade 6 or 7 make larger achievement gains prior to middle school entry than those who do not enter middle schools. Moving to middle school, however, causes a substantial drop in their relative performance. Specifically, math achievement falls by 0.124 (0.221) standard deviations and reading achievement falls by 0.086 (0.148) standard deviations for transitions at grade 6 (grade 7). These students' relative performance in both subjects continues to decline in subsequent middle school grades. Although the negative effects of middle school attendance appear to be largest in urban settings, they are also substantial in small towns and rural areas. We find little evidence that students who attended middle school make larger achievement gains in grades 9 and 10, by which time most students have made another transition into a high school. In addition, students who attended middle schools are 1-1.4 percentage points (i.e., 10-18 percent) more likely not to be enrolled in a Florida public school in grade 10 after having attended in grade 9 (a proxy for having dropped out by this grade).

Investigating the transition to high school in grade 9, we find that students who will eventually enter high school make larger gains in math and reading between grades 6 and 8 than students who do not switch to a high school in grade 9. From grade 8 to 9 they suffer a small drop in relative achievement: 0.026 standard deviations in math and 0.043 standard deviations in reading. However, their relative achievement trajectories become positive again after this immediate drop at the transition to high school.

The achievement drops we observe as students move to both middle and high schools indicate that school transitions (or being in the youngest cohort in a school) adversely impact student performance. The magnitude and persistence of the middle school effect, however, suggests that transitions are particularly costly for adolescent students or that middle schools provide lower quality education than K-8 schools for students in grades 6 to 8. While an initial inspection of available administrative and survey data provide little indication that middle schools in Florida receive fewer resources or use different educational practices, the education available in middle schools may be of lower quality if adolescents are easier to

educate in settings that also contain younger students. [1] While further research is needed to isolate the mechanisms by which grade configuration influences student outcomes, our results confirm that Florida students taking "roads less travelled" through primary and secondary school benefit from doing so.

The paper proceeds as follows. In Section 2 we review the history of grade configuration in the US and previous literature on the effects of middle school attendance. Section 3 describes our data, while Section 4 presents our methodology and main findings concerning the effects of grade configuration on student achievement. Section 5 considers the robustness of these results, heterogeneity in the effects of grade configuration on student achievement, and effects on attendance and school dropout by grade 10. Section 6 evaluates possible explanations for our results and concludes.

2. Background and evidence on grade configuration in the U.S.

Conventional wisdom on the optimal grade configuration in the U.S. has evolved over time in response to enrollment pressures and the emergence of new pedagogical theories. Historically, the vast majority of U.S. public school districts had a single elementary school serving grades K-8 and, later, a secondary school serving grades 9-12. Beginning in the early 1900s, many districts responded to growing enrollments by creating junior high schools serving grades 7-9 (or 7-8). Advocates of this approach argued that junior highs made it possible to prepare adolescent students for the rigors of high school without exposing them to the influence of substantially older students (Juvonen et al 2004).

By the late 1960s, a loose coalition of reformers argued that by grade 6 (or even grade 5), students had unique social, psychological, and academic needs that were best served by placing them into separate schools (National Middle Schools Association 1995). In "one of the largest and most comprehensive efforts at educational reorganization in the history of American schooling" (George and Oldaker 1985, p. 79), the middle school serving grades 6-8 (or 5-8) rapidly displaced the junior high school starting in grade 7 as the dominant model for adolescent students attending American public schools. (See figure 1.) Although a definitive explanation for this change is lacking, it does not appear to have been driven by parental demand: Fewer than 5 percent of 6th and 7th graders in American private schools currently attend middle or junior high schools (Rockoff and Lockwood 2010).

[1] A detailed analysis of observable differences between school types in Florida will be added to the next version of this paper.

Recently, concerns about the performance of middle schools have led several urban school districts to experiment with a return to the traditional K-8 model (Hough 2005). Evidence suggesting that the relative performance of American students declines in the middle grades has also contributed to a broader reconsideration of the performance of school serving adolescent students (see, e.g., Schmitt et al 1999, Juvonen et al 2004). However, most of research on grade configuration has focused narrowly on the question of whether students in grade 6 should remain in an elementary school or attend a middle school (see, e.g. Cook et al 2008, Bedard and Do 2005), ignoring the once common K-8 alternative.

The most convincing evidence on the effects of entering middle school is Rockoff and Lockwood (2010), who develop the identification strategy that we apply in our empirical analysis.[2] In particular, they instrument observed middle school entry in public schools in New York City by the terminal grade of the school that students attended in grade 3. Their results indicate that, in New York City, moving to a middle school in grade 6 or grade 7 causes a large drop in student achievement that persists through the end of grade 8. It remains unclear, however, whether similar patterns hold outside of urban areas or if students attending a K-8 school suffer a larger drop in achievement when moving to high school. The latter possibility is particularly salient given that a key rationale for the development of middle and junior high schools was to prepare students for the transition to high school. Moreover, the general effect of moving to high school has not, to our knowledge, been investigated in a rigorous manner. Our empirical analysis aims to fill these gaps.

3. Data and descriptive statistics

The data for our analysis are drawn from the Florida Department of Education's PK-20 Education Data Warehouse and contain information on all Florida students attending public schools in grades 3 to 10 from the 2000–2001 through 2008–2009 school years. Our data extract includes the school each student attends and its location; student characteristics such as ethnicity, gender, special education classification, and free lunch status; and annual measures of absences and state math and reading test scores. We normalize the test scores by subject, year, and grade to have a mean of zero and a standard deviation of one.

We construct three different estimation samples, all of which exclude students who were missing school information, were retained in the same grade more than twice, or skipped or

[2] Byrnes and Ruby (2007) also find that, conditional on achievement in grade 5, Philadelphia students attending K-8 schools outperform those attending middle school in grade 8.

moved down a grade. First, to estimate the impact of middle school entry in grade 6 or 7, we construct a balanced panel of students in the four cohorts attending grade 3 between 2001 and 2004 who completed the state test in both math and reading in each of the following five years.[3] Second, to investigate whether the effects of middle school entry persist through grades 9 and 10, we construct a balanced panel of students in the two cohorts that attended grade 3 between 2001 and 2002 who were tested in both math and reading each of the following seven years. Finally, to estimate the effect of entering high school in grade 9, we construct a third balanced panel of students in the five cohorts that attended grade 6 between 2001 and 2005 who were tested in both math and reading the following four years.

Columns 1 to 3 of Table 1 provide summary statistics for the students in the balanced sample covering grades 3 to 8. At grade 3, 89% of the students in this sample attended a K-5 school, 8% attended a K-6 school, and 3% attended a K-8+ school.[4] Relative to students enrolled in K-5 or K-6 schools, students in K-8+ schools in grade 3 were more likely to reside in towns or rural areas rather than urban fringe communities but equally likely to reside in large cities. Thus, although the vast majority of Florida public school students attend a K-5 school followed by a middle school serving grades 6 to 8, there is substantial variation in grade configurations even within communities of different sizes.[5]

Compared with students attending K-6 or K-8+ schools, students in K-5 schools are less likely to be white and more likely to receive free or reduced price lunch. They also have lower test scores but are equally likely to be receiving special education and have similar numbers of absences. Looking at the same students 5 years later, we see that the gap in test scores between students who attended a K-8+ school in grade 3 and students who attended a K-5 school has widened and that K-8+ students now are absent less often than their K-5 counterparts. Notably, the percentage of students who were retained in the same grade at any point during this five-year period is very similar across the three groups.

Columns 4 to 6 of Table 1 present summary statistics on the students in the balanced sample covering grades 3 to 10. Sample sizes across all three groups are significantly reduced

[3] This sample definition corresponds to that used in Rockoff and Lockwood (2010). Table 5 demonstrates the robustness of our results to alternative exclusion restrictions.

[4] K-8+ schools include all schools covering all grade ranges up to grade 8 regardless whether grade 8 is highest grade served by the school or not. Less than one percent of all students attended K-3, K-4 or K-7 schools in grade 3 and are omitted from our analysis.

[5] We identify the grades offered by each school based on the students we observed enrolled in the school in our administrative data. This approach yields grade ranges that differ in only a few instances from those provided by the National Center for Education Statistics' Common Core of Data (CCD). Results using the CCD grade ranges are virtually identical to those presented here and are available from the authors upon request.

due to the exclusion of two cohorts of students and students with missing test score data in grades 9 and 10. However, the pattern of differences across groups is very similar to the pattern in columns 1 to 3. In particular, the test-score gap between students who attended a K-8 school in grade 3 and students who attended a K-5 school widens in both subjects between grades 3 and 10.

Table 2 displays summary statistics for our third balanced sample covering grades 6 to 10. Because our empirical strategy to estimate the effect of entering high school in grade 9 uses the grade range of schools attended in grade 6 as an instrument, we present summary by five different types of schools that student attended in grade 6: 6-8, K-8, K-6, K-12, and 6-10+.[6] Of the grade 6 students in this sample, 88% enrolled in a 6-8 school, 6.7% enrolled in a K-6 school, 2.6% enrolled in a K-8 school, 0.8% enrolled in a K-12 school, and 2% enrolled in a 6-10+ school. Students attending the two school types in grade that would not predict a school change at grade 9, K-10+ and 6-10+ schools, are more likely to be white and living in towns or rural areas compared to students in the other school types. Students attending K-10+ schools outperform students from all other school types in math and reading in grade 6, while the grade 6 performance of 6-10+ school students is very similar to that of students in 6-8 and K-8 schools. By grade 10 the test-score gap between 6-8 students and K-10+ has decreased slightly, while the gap between 6-8 students and K-6 students has decreased substantially. Moreover, 6-8 students now outperform 6-10+ students but do worse than K-8 students.

4. Empirical analysis

Our strategy for identifying the impacts of alternative grade configurations on student achievement parallels and extends that of Rockoff and Lockwood's (2010) study of New York City middle schools. That is, we focus on variation in achievement within students over time and develop instruments for middle school entry based on the terminal grade of the school each student attended in grade 3. We then conduct an analogous analysis of high school entry using instruments based on the terminal grade of the school attended in grade 6. In taking this approach, we assume that differences across students attending schools with different grade ranges in grade 3 and 6 are, respectively, uncorrelated with deviations from trends in academic outcomes that coincide precisely with students' movements into middle schools and high schools.

[6] Note that our data does not allow us to identify schools covering grades above grade 10. A very small fraction (less than 1%) of students attends schools with grade ranges not included in Table 2; we drop these students from our analysis.

To simplify presentation, we focus the discussion of our estimation strategy on the analysis of middle school entry. We model outcome Y_{ig} of student i in grade g as a function of student fixed effects α_i, grade fixed effects δ_g, and a set of dummy variables M_{ig}^{G} indicating whether student i observed in grade g entered middle school in grade G:

$$Y_{ig} = \alpha_i + \delta_g + \beta_g M_{ig}^{G} + \gamma X_{ig} + \varepsilon_{ig}. \quad (1)$$

The control vector X_{ig} includes variables indicating whether student i was retained in grade g, had ever been retained prior to grade g, and attended a charter school in grade g. The error term in Equation (1), ε_{ig}, includes unobserved individual traits that vary over time and other factors that influence academic outcomes. The grade fixed effects (δ_g) therefore capture patterns of achievement over grades for students who do not enter a middle school in grades 6 or 7.

We allow the coefficient on M_{ig}^{G} to vary across grades in order to estimate relative differences in outcomes between students entering middle schools and students who do not before and after potential middle school entry. This enables us to compare the immediate change in outcomes at potential middle school entry with prior and later trends in outcomes. These comparisons are useful in evaluating the plausibility of our identifying assumption and in gauging the persistence of any impacts of middle school entry.

OLS estimates of the specification in Equation (1) may be biased due to the fact that the decision to attend a middle school is endogenous and could be correlated with unobserved shocks to achievement. For example, parents could decide to enroll their child in a middle school in response to an experience (e.g., a bad school experience, a divorce, a residential move) that negatively affects achievement. To address these concerns we instrument for middle school entry in grade 6 or 7 using the terminal grade of the school a student attended in grade 3. In doing so, we assume only that such shocks are not anticipated and reflected in the choice of a school with a particular grade configuration in grade 3.

We implement this estimation approach by estimating a two-stage least squares (2SLS) model, where the set of first stage equations is given by:

$$M_{ig}^{G} = \alpha_i + \delta_g + \beta_g T_i + \gamma X_{ig} + \mu_{ig}. \quad (2)$$

The instrument, T_i, indicates the terminal grade of the school student i attended in grade 3 (6). We estimate Equation (2) separately for each combination of the grade that students might enter middle school and the grade g. Based on these estimations, we obtain predicted values

for each M_{ig}^{G}. In the second stage we then estimate Equation (1) using the predicted values for each indicator variable M_{ig}^{G} instead of its actual values and apply the standard procedure to adjust standard errors.

The instrumental variables are strongly related to actual entry into middle school. Table 3 reports regression results based on a simplified version of the first stage.[7] Columns 1 to 4 report estimated coefficients on instruments for entry into middle school in grade 6 and grade 7. In both middle school samples estimated coefficients on instruments for entry into middle school in grade 6 are around 0.7 and highly significant. The coefficients on instruments for entry into middle school in grade 7 are slightly smaller at around 0.5, but are also highly significant. Column 5 reports estimated coefficients on instruments for entry into high school in grade 9, which are based on the terminal grade of the school attended in grade 6.[8] The coefficient on the instrument for entry into high school is 0.7 and also highly significant.

While the first stage results suggest that terminal grades of schools attended in grade 3 and 6 are strong predictors of middle and high school entry, compliance is not perfect. Thus, our instrumental variables (IV) approach will identify a local average treatment effect for the subset of students who switch to middle school (high school) in accordance with their grade 3 (6) schools' grade ranges. This effect might be different from the average treatment effect in the overall population. For example, some parents of children attending K-5 elementary schools might react to the perceived quality of their local middle school and chose to enroll their children in a K–8 school in grade 6. Alternatively, parents concerned about the academic progress of a child attending a K-8 school during elementary grades might switch to a middle school. Residential moves could also lead to non-compliance when families relocate to areas with different grade configurations. While it is difficult to assess how the local treatment effect that we identify would differ from the average treatment effect in the full sample, the effect for the complier population is of considerable policy interest. This is particularly true in situations where school choice is limited and compliance can be expected to be close to one.

To clarify our IV method and preview our results, we first present reduced-form results showing the effect of predicted middle school entry based on the balanced sample covering grades 3 to 8.[9] Figure 2 charts the math and reading achievement of students attending K-5

[7] Results from the actual first stage regressions are available from the authors upon request.

[8] For the small number of students attending K-6 schools in grade 6, we construct the instruments based on the terminal grade of the school they attended in grade 7.

[9] Reduced-form results based on the balanced sample covering grades 3 to 10 and for the IV estimation of the effect of high school entry are available from the authors upon request.

and K-6 schools in grade 3 relative to those of students attending K-8 schools in grade 3.[10] As our identification is based on changes in achievement trajectories within students, the baseline differences in the grade 3 achievement of these groups of students evident in Table 1 have been normalized to zero. The dashed vertical lines at grade 5 and 6 indicate predicted middle school entry based on the terminal grade of the school students attend in grade 3.

Each panel indicates a positive trend in relative student achievement prior to predicted middle school entry, suggesting that students attending a K-5 or K-6 in grade 3 experience larger gains in achievement prior to their predicted middle school entry than students observed in K-8 schools in grade 3. After predicted middle school entry, however, we observe a sharp break in this trend. Students suffer a sharp drop in relative achievement at the predicted middle school grade that appears to grow larger the following year. Thus, after predicted middle school entry students observed in a K-5 or K-6 schools in grade 3 lag significantly behind their K-8 counterparts.

The pattern evident in the reduced-form estimates is useful in clarifying our identifying assumption. The grade configuration of the school a student attends in grade 3 is clearly not exogenous. While student fixed effects eliminate level differences in student achievement between students in grade 3, the type of school attended in grade 3 could still be correlated with unobserved student characteristics that affect learning trajectories. Thus, it is ambiguous whether the positive trend in relative achievement prior to predicted middle school entry reflects differences in school quality or simply selection into grade 3 school types that is correlated with learning trajectories. Especially given this positive trend, however, we contend that there is no plausible selection into K-5 and K-6 schools in grade 3 based on unobserved student characteristics that cause a *drop* in relative achievement at precisely the same time as middle school entry.

4.1 The effect of entering middle school on student achievement

We now present our estimates of the causal effect of entering middle school. We begin with results based on the balanced sample covering grades 3 to 8. Recall that our coefficients of interest are the interactions between grade level and having entered 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

[10] The differences reported in Figure 2 are based on estimated coefficients of the reduced-form of our IV approach including student fixed effects.

attend a middle school. Coefficients for these estimates are plotted in Figure 3. The estimates and standard errors (clustered by the school the student attended in grade 3) are shown in Appendix Table A-1.

Figure 3 confirms that students who will enter middle school in grade 6 or 7 have positive achievement trajectories in math and reading from grade 3 to 5, relative to their counterparts who never enter middle school. However, achievement in both subjects falls 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 K-8 peers through grade 6, but experience a sharp drop in achievement upon entering middle school in grade 7.

To assess the relative magnitudes and statistical significance of grade-to-grade variation in achievement evident in Figure 3, Tables 4a and 4b report annual changes in estimated coefficients (β_g). Columns 1 and 2 correspond to the estimates based on the balanced sample covering grades 3 to 8 and presented in Figure 3. The negative effects of entering middle school reported in Tables 4a and 4b are large and statistically significant at both grade 6 and grade 7. Our 2SLS estimates indicate that math achievement falls by 0.12 (0.22) standard deviations and reading achievement falls by 0.09 (0.15) standard deviations for transitions at grade 6 (grade 7).

Consistent with the findings of Rockoff and Lockwood (2010), these negative effects appear to persist during middle school grades. While students entering middle schools make larger achievement gains prior to middle school entry relative to their counterparts who never enter middle school, this pattern is reversed after middle school entry. All estimates of grade-to-grade changes displayed in columns 1 and 2 of Tables 4a and 4b are negative and most of them are statistically significant.

By grade 8, students entering middle school in grade 6 are estimated to underperform by 0.13 standard deviations in math relative to students who never entered middle school, and students entering middle school in grade 7 are estimated to underperform by 0.13 standard deviations in math and 0.09 standard deviations in reading (see Table A-1). The estimated difference in reading achievement between students entering middle school in grade 6 and students who never entered middle school is also negative but statistically insignificant. Note that these grade 8 comparisons incorporate the positive achievements trends students experienced in elementary schools along with the negative immediate and subsequent impact of middle school entry. Because the positive achievement trends prior to middle school entry

may reflect selection into K-5 and K-6 schools related to achievement trajectories, we consider them lower-bound estimates of the effect of middle school grade configuration on achievement in grade 8.

As noted above, however, one concern with using these comparisons to evaluate the merits of middle school grade configurations is that they do not reflect what happens upon transition to high school. A unique advantage of the Florida data is their inclusion of state test scores that allow us to study the persistence of middle school effects through grades 9 and 10. Figure 4 plots estimated coefficients of the interactions between grade level and entering a middle school in grade 6 or grade 7 (β_g) based on the balanced sample covering grades 3 to 10. The point estimates and with corresponding standard errors are shown in Appendix Table A-2 and the corresponding estimates for grade-to-grade gains in achievement are reported in columns 3 and 4 of Tables 4a and 4b.[11] The overall pattern of results through grade 8 is very similar to the pattern in Figure 3, although the estimates are less precise due to fact that they are based on only two cohorts of students.

We find little evidence that students who attended middle schools make larger achievement gains than students who did not between grades 8 and 9. The lone exception are students entering middle schools in grade 7, who are estimated to make a relative gain of 0.05 standard deviations in reading. These same students, however, were estimated to have experienced a loss of 0.30 standard deviations in reading between grades 6 and 8. Comparing achievement levels in grade 10, students entering middle schools in grade 6 underperform students who never entered middle school by 0.12 standard deviations in math. Achievement differences in reading and math for students entering middle schools in grade 7 are negative but are not statistically different from zero. Comparing achievement differences in grade 10 to the differences just prior to middle school entry, however, we see substantial and statistically significant losses for students entering middle schools in grade 7 relative to students who never enter middle schools.

In sum, our analysis confirms that the negative effects of transitioning to a middle school persist through the first two grades of high school. We find very little support for the hypothesis that students who attended middle schools benefit at the transition to high school

[11] Recall that this sample is less than half the size of the balanced sample covering grades 3 to 8, which included two more cohorts of students and required complete information on student achievement for grades 3 to 8 only. In particular, we observe only 4,184 students not entering middle schools in this sample. This should be kept in mind when comparing magnitudes of estimated effects of middle school entry between the two samples.

from their previous experience with school transition or from the specific educational program available in middle schools.

4.2 The effect of entering high school on student achievement

Yet it remains possible that entering high school in grade 9 affects students' achievement regardless of whether they attended a middle school. To provide evidence on this issue, we estimate the 2SLS approach reflected in Equations (1) and (2) with three modifications. First, we redefine M_{ig} to indicate whether student i observed in grade g entered high school in grade 9. Second, our instrument, T_i, now indicates the terminal grade of the school student i attended in grade 6. Third, we estimate the 2SLS model using a balanced sample covering five cohorts of students in grades 6 to 10. The presentation of results remains identical. Figure 5 plots the estimated coefficients reported in Appendix Table A-3, while Column 5 of Tables 4a and 4b report the corresponding differences between the estimated coefficients in consecutive grades and their standard errors.

Figure 5 shows that students entering high school in grade 9 make larger gains in math and reading from grade 6 to grade 8 than do students who do not enter high school in grade 9. In grade 9 we observe a small but statistically significant drop in relative achievement: math achievement falls by 0.03 standard deviations and reading achievement falls by 0.05 standard deviations. However, relative achievement begins to increase again after this immediate drop at the transition to high school. From grade 9 to 10, students entering high school in grade 9 gain 0.02 standard deviations in math; relative reading achievement gains are statistically insignificant but have a positive sign. Comparing achievement levels in grade 10, students entering high school in grade 9 are estimated to gain 0.11 and 0.13 standard deviations more in math and reading, respectively, between grades 6 and 10 than students who do not enter high school in grade 9.

The identification strategy has the same rationale as before. Given that we observe an increasing trend in relative achievement before high school entry, we cannot think of any reason that enrollment in grade 6 should be correlated with unobserved student characteristics that cause a drop in achievement that coincides with high school entry. Thus, we are confident that the estimated drops in achievement at high school entry reflect a causal effect. In contrast to the immediate drops in achievement at middle school entry, however, the immediate effect of high school entry is relatively small. More importantly, we find no evidence that high school entry affects students' achievement trajectories.

5. Robustness Analysis, Effect Heterogeneity, and Behavioral Outcomes

We consider below whether the results reported above are sensitive to a variety of changes in the sample definition and model specification. Having demonstrated the robustness of our preferred estimates, we examine whether the effects of middle- and high school entry vary across student subgroups defined in terms of gender, prior achievement, ethnicity, and community type. Finally, we provide evidence on the extent to which alternative grade configurations also affect outcomes other than standardized test scores including attendance, dropout behavior, and retention in grade 9.

5.1 Robustness Analysis

Tables 5a and 5b present results of alternative specifications intended to demonstrate the robustness of our estimates of the effects of grade configuration on student achievement in math and reading, respectively. For each transition, we report changes in relative performance prior to the transition, the immediate change in relative performance at the transition ("drop"), and the changes in relative performance after the transition. For example, in the case of the transition to middle schools in grade 6, the prior trend refers to the change in relative achievement from grade 3 to grade 5, "drop" refers to the change in relative performance from grade 5 to grade 6, and the post trend represents the change in relative achievement from grade 6 to grade 8. To facilitate comparison with our preferred results, we report the results of our preferred specification in this format in the first row.

The first issue we address is the inclusion of charter schools in our estimation samples. Charter schools accounted for nearly half of all K-8 schools in operation in Florida during our sample period and fewer than 10 percent of middle schools. Although we control for charter school attendance in our preferred specification, one might still worry that the substantially higher share of charter K-8 influences our results.[12] Row 2 of Tables 5a and 5b report the results from specifications which exclude students who attended a charter school in any grade. The results show that this restriction has a negligible impact on the results.

Another potential concern relates to our definition of middle schools. Following Rockoff and Lockwood (2010), in our main analysis we use information on the lowest grade that a school serves only to identify middle school transitions. For example, we would code a student as moving to a middle school entry in grade 6 if we observe that this student switches

[12] Using a student fixed effects approach to study the effectiveness of Florida charter schools, Sass (2006) finds that new charter schools are initially less effective than traditional public schools but that they outperform traditional public schools in reading and are as effective in math by year five.

to a school that begins in grade 6. Although the vast majority of these middle school entries are in fact changes to "true" middle schools which end at grade 8, some students identified as moving to middle schools in fact enter, for example, schools serving grades 6 to 12. Row 3 of Tables 5a and 5b confirms that our point estimates are almost identical if we exclude students moving to schools that do not end in grade 8.

Differences in grade retention might also affect our results. In our preferred results we deal with the problem of selective retention by controlling for whether students were repeating a given grade and whether they had repeated a prior grade and by excluding students retained in the same grade more than twice. However, to the extent that middle school or high school entry affects students' probability of being retained, it is unclear whether the retention controls are appropriate. We therefore present two alternative strategies as robustness checks: excluding students retained at any grade and eliminating our controls for grade retention. Rows 3 and 4 of Tables 5a and 5b demonstrate that these changes to the specification and estimation sample do not alter our findings.

Finally, our results could in theory be biased by non-random attrition and selective test-taking. While we cannot observe test scores for students who were not tested, left the state, or enrolled in private schools, we can relax our balanced sample restriction and include students with missing test scores for some grade levels. Row 5 of Tables 5a and 5b confirms that doing so does not affect our main findings. While relaxing the balanced sample restriction is not a definitive test for selection bias, the results of this robustness check again strengthen the causal interpretation of our results.

5.2 Subgroup Analysis

The average effects presented above could conceal important heterogeneities in the effects of middle- and high school entry. We explore possible heterogeneous effect of middle- and high school entry along four dimensions: gender, prior test performance, ethnicity, and whether students attend schools in urban or rural areas. The results of these subgroup analyses are reported in Tables 6a and 6b.

Consistent with Rockoff and Lockwood's (2010) findings for New York City, we find no differences in effect size for girls and boys (rows 2 and 3) but substantially larger negative effects of middle school entry in math for students with below median achievement levels in grade 3 (rows 4 and 5). Lower-achieving students also experience larger gains in math achievement prior to enrolling in a middle school and larger declines after the initial transition to middle school. Students below the median test score in grade 6 also experience a larger

drop in math achievement upon the transition to high school. These patterns are consistent with the idea that lower-achieving students have access to fewer educational resources outside of schools and may therefore be more strongly influenced by school transitions or changes in school quality. However, in contrast to Rockoff and Lockwood (2010) we find no clear indication of differences in effect sizes between higher- and lower-achieving students in reading.

Results for students of different ethnicities (rows 6-8) follow a similar pattern, with traditionally disadvantaged subgroups exhibiting larger effects of grade configuration in math. Black students in particular experience large relative gains prior to middle school entry but then suffer far larger drops both at and following the transition. Again, however, we find only small and statistically insignificant differences between the effects estimated for students of different ethnicities in reading.

Finally, we take advantage of our statewide database to investigate differences in the effects of middle school and high school entry between urban and rural areas. We use Census Bureau classifications to group students into three categories according to the location of the school that they attended in grade 3: large or midsize cities; in the urban fringe of a large or midsize city; and in towns and rural areas. The overall pattern of results (rows 9-11) suggests that the negative effects of entering middle school are most pronounced in cities (this is clearly the case for transitions at grade 6 or 7 in math and at grade 6 in reading. They remain sizeable and statistically significant even in rural areas, however, confirming that the negative effects of middle school grade configurations are by no means limited to large urban school districts.

5.3 Dropout, Absences, and Grade Retention

We supplement our analysis of math and reading achievement by conducting similar analyses of the effects of middle school and high school entry on student absences, a proxy for high school dropout by grade 10, and retention in grade 9. Panel A of Table 7 shows the estimated effects on the relative days of absence in a school year of middle- and high school entry. For students entering middle school in grade 7, we find that absences increase by roughly one day per year upon the transition to middle school and by an additional 0.4 days per year over the following two years, both as compared to students who never enter middle school. These are effects are large in magnitude, given that our data indicate that the average Florida student in is absent 8 days in grade 6 and 9 days in grade 9. However, we find no significant effect on absences for students entering middle school entry in grade 7, and

entering high school in grade 9 appears to decrease student absence by 1.3 days per year. Because the estimated achievement effects of middle school entry are somewhat larger for students entering in grade 7 than for students entering in grade 6, it seems unlikely that student absenteeism can account for more than a negligible share of the effects of middle school attendance on achievement.

Grade configuration – and middle school attendance in particular – could also influence the likelihood of dropping out from high school. Although early arguments for the creation of middle schools emphasized their role in promoting student engagement and success in high school, Bedard and Do (2005) find that school districts with a larger share of grade 6 students in middle schools had small decreases in school completion rates 7 years later. Our own finding that the effects of middle school attendance on math achievement are most pronounced middle school effects for lower-achieving students also suggests the value of considering dropout as an additional outcome variable.

Our analysis of the effects of middle school attendance on dropout behavior is unfortunately limited in two key ways. First, we do not have a direct indicator that students have dropped out of school. We instead construct a proxy for high school dropout before grade 10 based on whether they are enrolled in a Florida public school in the year after they were in grade 9. Because we do not observe students enrolled in private schools, enrolled in schools in another state, or having transferred to a homeschooling or adult education program, this proxy should exaggerate the extent of actual school dropout. And, in fact, while official statistics indicate that grade 10 dropout rates in Florida are between 3 to 4 percent, our proxy indicates a dropout rate of roughly 8 percent.

Second, as we can construct this measure for school dropout only in grade 10, we can only estimate a cross-sectional version of Equation (1) with our binary dropout proxy as the dependent variable. While we can include grade 3 math and reading achievement as controls, the identifying assumption of our IV approach becomes more restrictive. Specifically, we now have to assume that enrollment in schools with different grade ranges in grade 3 is uncorrelated with unobserved student characteristics that affect dropout probabilities. For this reason, we report OLS estimates of the effect on dropout alongside our IV estimates and admit that we are less confident in the causal interpretation of our results.

With these caveats in mind, we present in Panel B of Table 7 estimates of the effect of middle school and high school entry on school dropout. Both the IV and the OLS estimate indicate that the probability of dropping out by grade 10 is about 1 percentage point (or 12.5 percent) higher among students who entered middle school in grade 6. The point estimates for

the effect of middle school entry in grade 7 are positive and roughly 60 percent as large, but statistically insignificant. Interestingly, the OLS estimate of the effects of high school entry indicates a large reduction in the probability of dropping out among students moving to high schools in grade 9 but the IV estimate is very close to zero. This likely reflects the fact that several of the Florida schools with non-traditional grade spans at the secondary level are designed for at-risk students. Students who attend such schools, but who were not predicted to do so based on their grade configuration in grade 6, are at greater risk of dropping out.

A closely related outcome is grade retention in grade 9, which is typically a strong predictor of eventually dropping out of school. In Panel C of Table 7 we therefore use similar cross-sectional models to examine how middle school is related to grade 9 retention rates. We find no evidence that middle school entry in grade 6 affects grade 9 retention rates, but middle school entry in grade 7 appears to increase the probability of retention in grade 9 by 1 percentage point. It is unclear why the pattern of results for student entering middle schools in grades 6 and 7 is reversed for this indicator. At a minimum, however, the two sets of results cast doubt on arguments that middle schools, despite their apparently negative effects on student achievement, result in increased high school completion.

6. Conclusion

Most American students enter middle school in grade 6 or 7 and high school in grade 9. This pattern reflects the influence of pedagogical theories that, over the past half-century, all but eliminated the K-8 school from the American educational landscape. However, a minor fraction of students attend more comprehensive schools covering grades K-8, 6-12, or even K-12. Our paper compares achievement trends of students entering middle school and high school relative to those of their peers who do not and asks whether taking the path less travelled makes “all the difference.” At least with respect to student achievement, our results indicate that doing so matters a great deal.

Drawing on administrative data from Florida, we find that students entering middle school in grade 6 or 7 experience a substantial drop in student achievement in math and English relative to their peers who do not enter middle schools. Relative achievement continues to fall during middle school grades, but we find no evidence for further reductions in relative achievement during grades 9 and 10. We also find smaller one-time drops in student achievement at the transition to high school, but in contrast to the middle school transition relative achievement continues to improve afterwards.

The drops in achievement that we observe as students move to both middle and high schools indicate that school transitions (or being in the youngest cohort in a school) adversely impact student performance. This might indicate that the mere act of switching schools or relative-age effects have large effects on student achievement. However, the magnitude and persistence of the middle school effect suggests that transitions are particularly costly for adolescent students. This might indicate that educational quality is lower in middle schools than in K-8 schools for students in grades 6 to 8. Educational quality might be lower if adolescents are easier to educate in settings that also contain younger students. It might also be lower, because middle schools in Florida receive fewer resources or use different educational practices.

Further research is needed to isolate the mechanisms by which grade configuration influences student outcomes. Determining the underlying mechanisms is crucial for guiding educational policy. It might be possible to reduce or even completely eliminate the negative effects of school transitions identified in this paper if the observed drops in relative achievement are driven by differences in school resources, educational practices or other policy parameters. However, if drops in relative achievement are explained by factors inevitably tied to grade configurations (relative age effects, lasting effects of school transitions), there exists little hope that a remedy can be found that does not involve moving away from the currently dominant grade configuration in US public schools.

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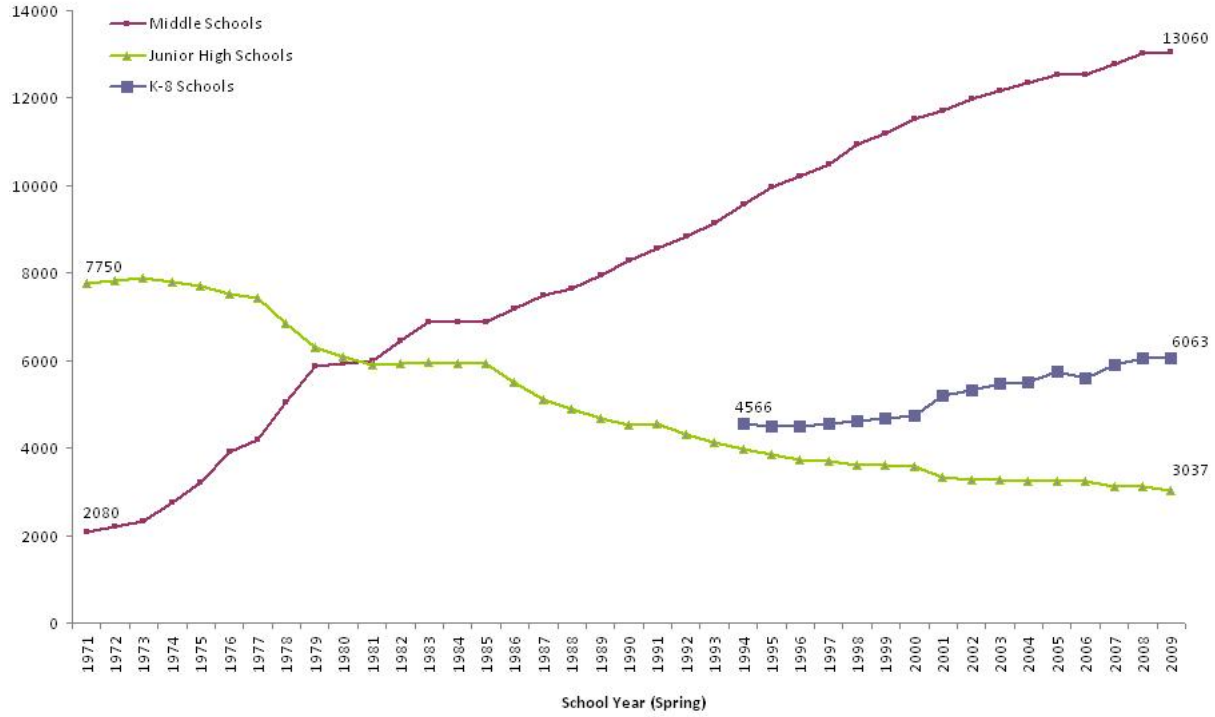
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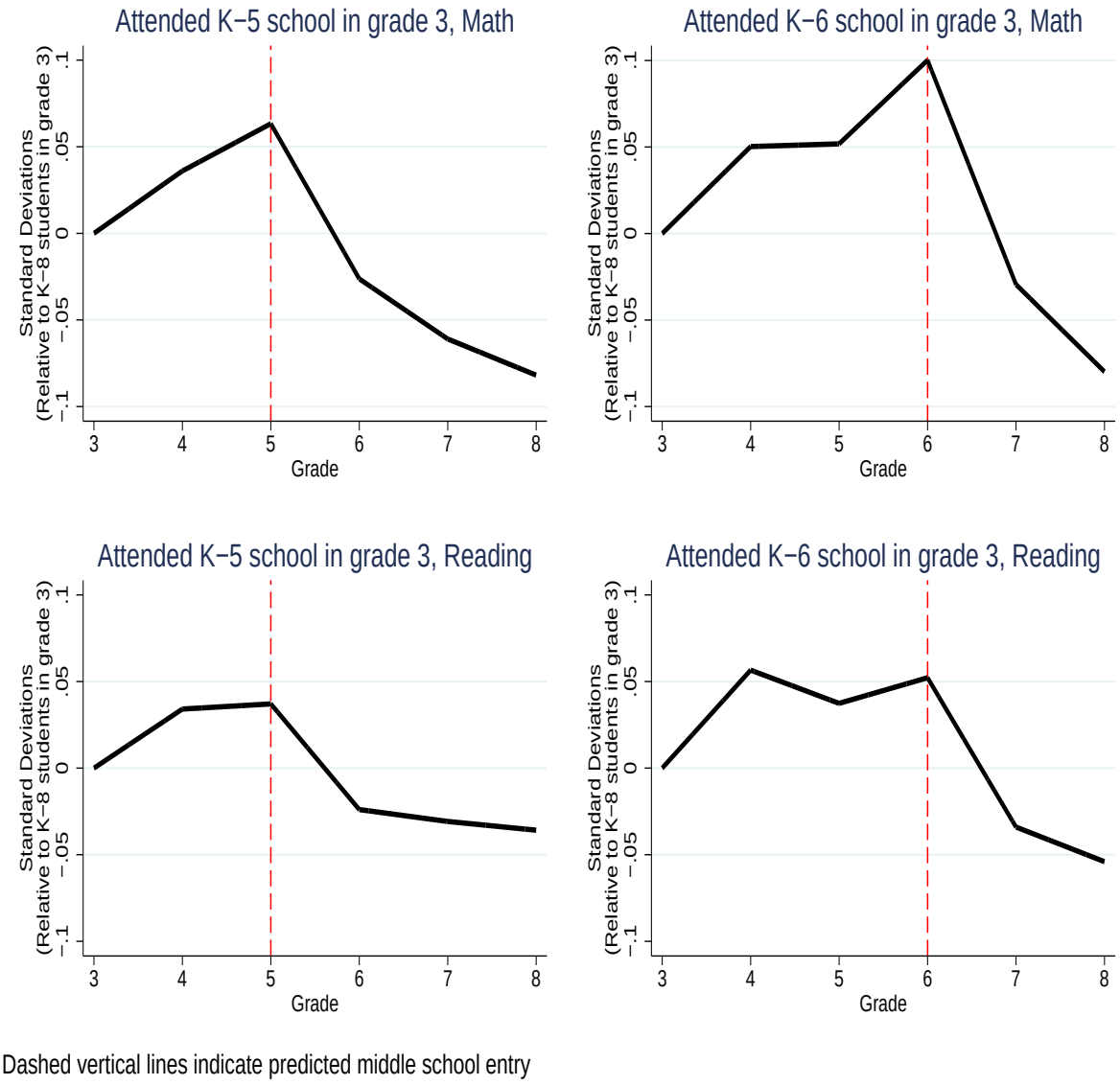
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Figure 1: Number of U.S. Public Schools, by type, 1970-2009



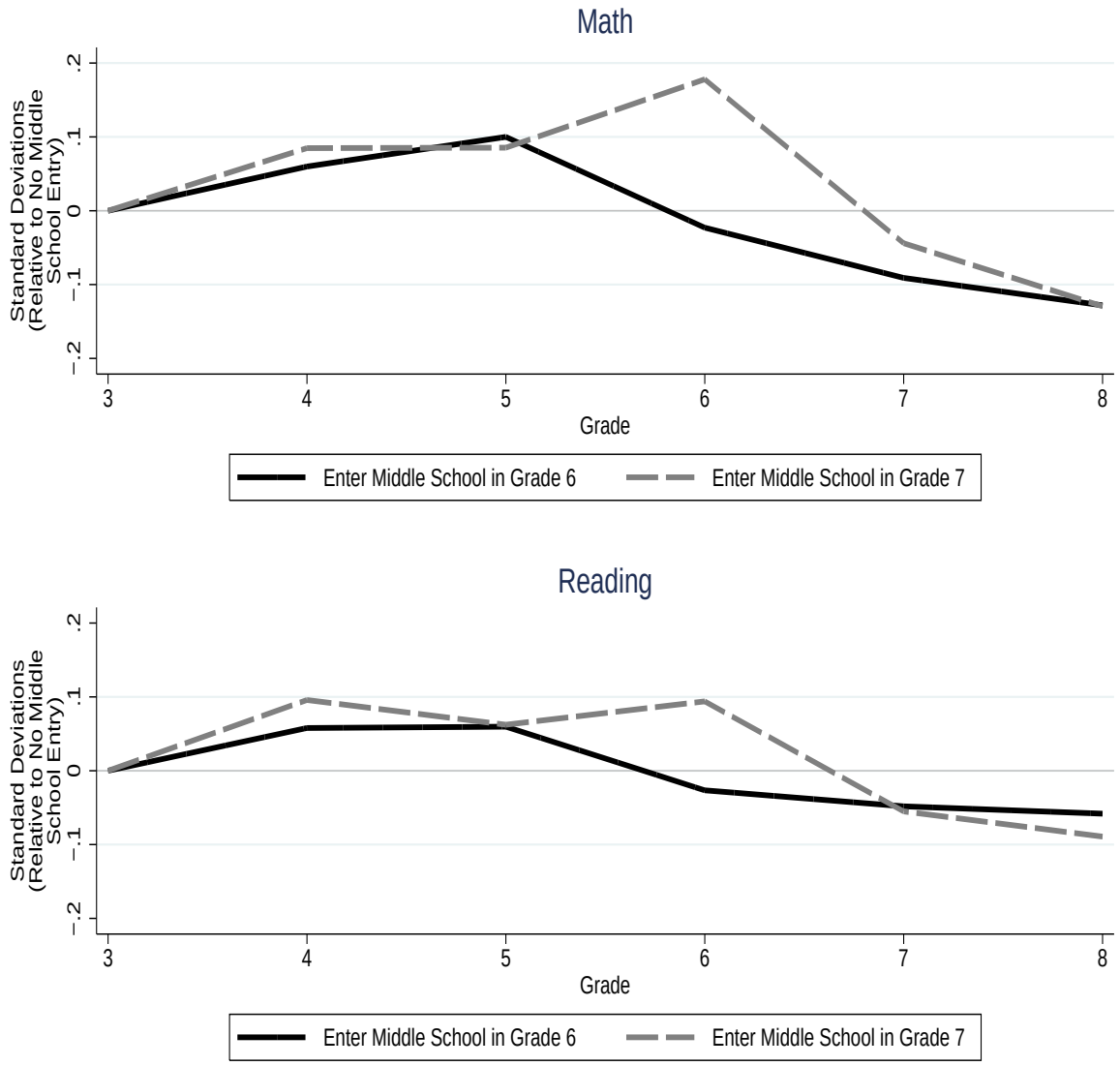
Note: School types are defined by grade span as follows: Middle School: grade 4, 5, or 6 to grade 6, 7, or 8; Junior High School: grade 7 to grade 8 or 9; K-8: grade PK, K, or 1 to grade 8. Source: National Center for Education Statistics, Digest of Education Statistics, 1995-2010.

Figure 2: Reduced-form estimates of grade 3 school type on student achievement
[Grades 3 to 8 balanced sample]



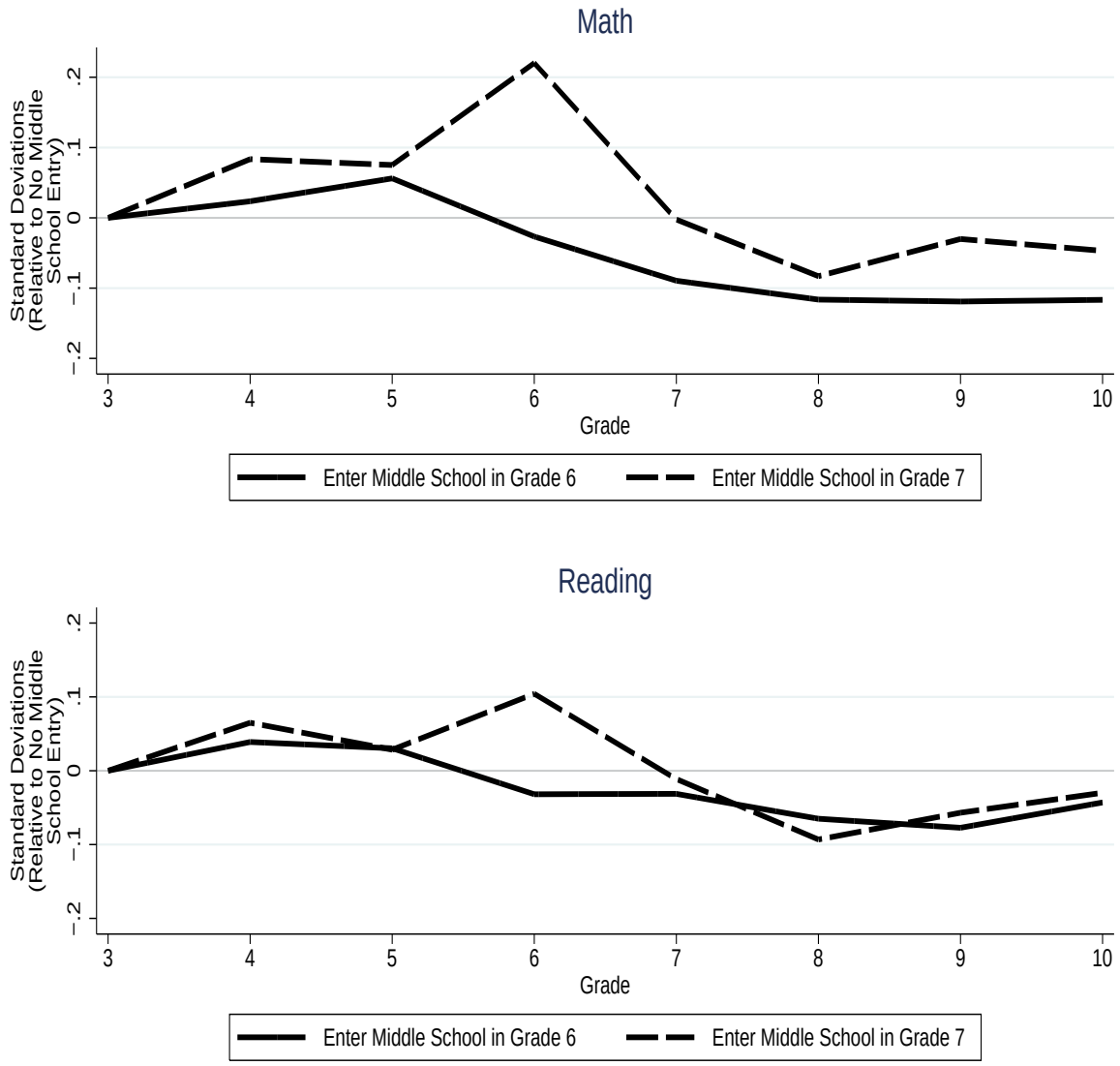
Note: Impact of entering K-5 and K-6 schools in grade 3 on student achievement relative to achievement of students entering K-8 schools in grade 3. Figures plot reduced-form coefficient estimates for grade interacted with an indicator for the type of school entered in grade 3. Reduced-form regressions include student fixed effects, as well as controls for grade, for whether the student attends a charter school, for whether the student was retained that year, and for whether the student was retained in any previous year. Standard errors are clustered by school attended in grade 3. All differences are highly significant.

Figure 3: IV estimates of the impact of entering middle school on student achievement [Grades 3 to 8 balanced sample]



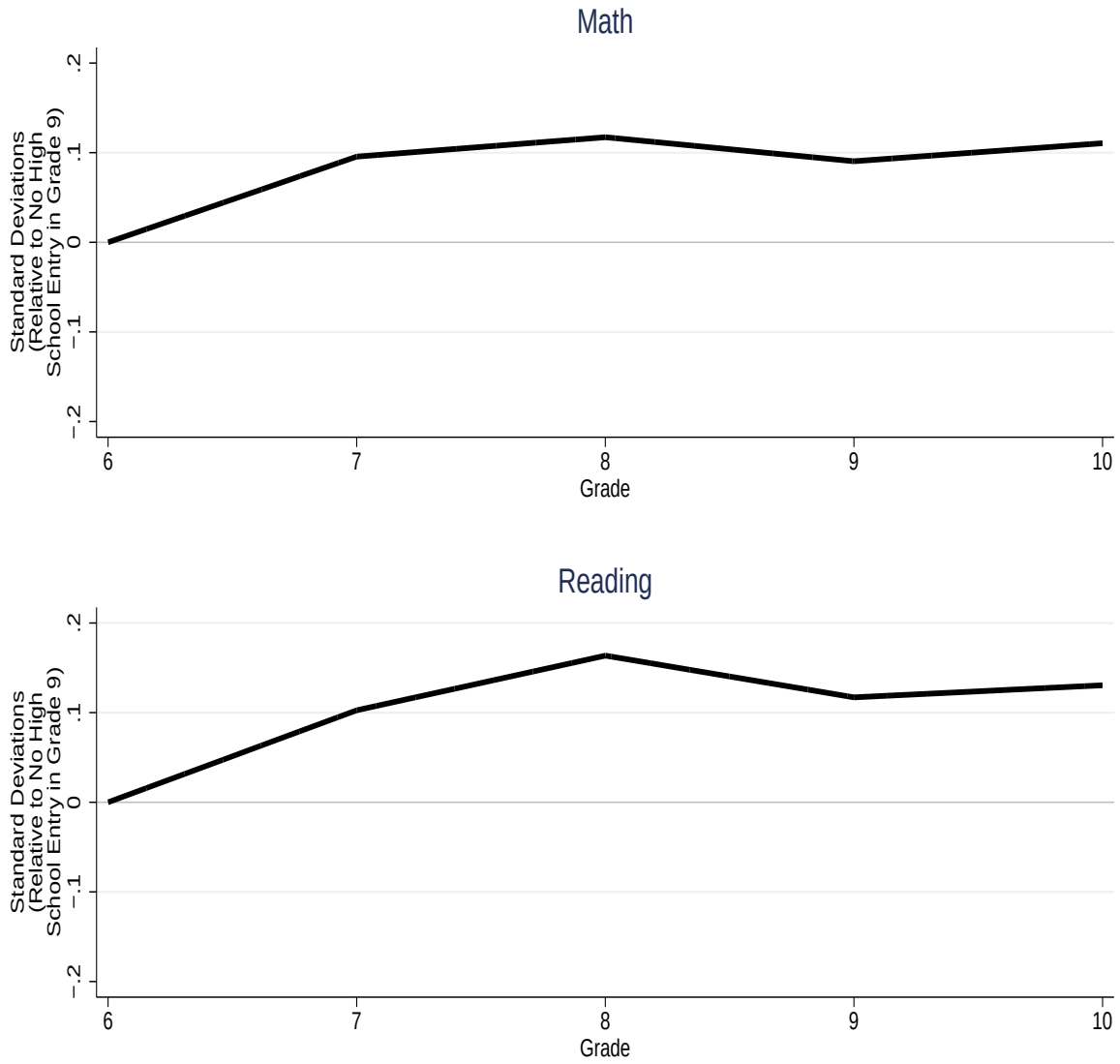
Note: These figures plot coefficient estimates for grade interacted with an indicator for the year in which a student enters middle school. The plotted coefficients and their standard errors are given in Appendix Table A-1. All regressions include student fixed effects, as well as controls for grade, for whether the student attends a charter school, for whether the student was retained that year, and for whether the student was retained in any previous year.

Figure 4: IV estimates of the impact of entering middle school on student achievement [Grades 3 to 10 balanced sample]



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 A-2. All regressions include student fixed effects, as well as controls for grade, for whether the student attends a charter school, for whether the student was retained that year, and for whether the student was retained in any previous year.

Figure 5: IV estimates of the impact of entering high school on student achievement [Grades 6 to 10 balanced sample]



Note: These figures plot coefficient estimates for grade interacted with an indicator for the year in which a student enters high school. The plotted coefficients and their standard errors are given in Appendix Table A-3. All regressions include student fixed effects, as well as controls for grade, for whether the student attends a charter school, for whether the student was held back that year, and for whether the student was held back in any previous year.

Table 1: Summary statistics on students in sample, by grade 3 school structure

	Balanced sample Grades 3 to 8			Balanced sample Grades 3 to 10		
	Range of school, grade 3					
	K - 5	K - 6	K - 8+	K - 5	K - 6	K - 8+
Panel A: Static attributes						
Number of students	409,221	34,583	12,901	136,391	12,507	3,890
White	50 %	55 %	57 %	54 %	57 %	62 %
Black	22 %	22 %	14 %	20 %	20 %	12 %
Hispanic	22 %	19 %	25 %	21 %	19 %	22 %
Location of grade 3 school						
City	24 %	24 %	24 %	23 %	24 %	22 %
Urban fringe	60 %	61 %	37 %	57 %	58 %	36 %
Town or rural	16 %	15 %	39 %	20 %	17 %	42 %
Panel B: Dynamic attributes,	*grade 3*			*grade 3*		
Free or reduced lunch	51 %	44 %	41 %	44 %	39 %	35 %
Special education	15 %	15 %	15 %	11 %	11 %	11 %
FCAT math	-0.01	0.06	0.01	-0.01	0.05	0.02
	(1.00)	(0.99)	(1.00)	(1.00)	(0.98)	(0.96)
FCAT reading	-0.01	0.07	0.07	-0.01	0.07	0.09
	(1.00)	(1.00)	(1.01)	(1.00)	(1.00)	(0.99)
Absences per year	6.90	6.74	6.91	6.55	6.43	6.47
	(6.84)	(6.35)	(6.49)	(6.07)	(5.94)	(5.73)
Panel C: Dynamic attributes,	*grade 8*			*grade 10*		
Ever held back	9 %	10 %	9 %	5 %	6 %	5 %
Free or reduced lunch	45 %	39 %	38 %	35 %	31 %	27 %
Special education	11 %	11 %	12 %	8 %	8 %	9 %
FCAT math	-0.01	0.06	0.10	-0.01	0.09	0.11
	(1.00)	(0.98)	(0.98)	(1.01)	(0.93)	(0.96)
FCAT reading	-0.01	0.05	0.11	-0.01	0.08	0.12
	(1.00)	(0.99)	(1.02)	(1.00)	(0.97)	(1.01)
Absences per year	9.05	8.17	8.47	8.67	8.12	8.16
	(9.17)	(8.26)	(8.41)	(9.48)	(8.70)	(8.38)

Note: Sample includes a balanced panel of students who attended grade 3 between the school years 2000-2001 and 2003-2004 and were tested in the Florida school system for the following five years. Achievement test scores are normalized within year-grade cells. Where relevant, standard deviations are shown in parentheses.

Table 2: Summary statistics on students in sample, by grade 6 school structure
[Grades 6 to 10 balanced sample]

	Range of school, grade 6				
	6 - 8	K - 6	K - 8	K - 10+	6 - 10+
Panel A: Static attributes					
Number of students	409,887	31,176	12,335	3,788	9,510
White	54 %	63 %	56 %	77 %	71 %
Black	20 %	17 %	12 %	13 %	15 %
Hispanic	21 %	16 %	29 %	5 %	11 %
Location of grade 6 school					
City	24 %	26 %	21 %	28 %	16 %
Urban fringe	58 %	59 %	40 %	17 %	35 %
Town or rural	18 %	15 %	39 %	53 %	49 %
Panel B: Dynamic attributes, grade 6					
Free or reduced lunch	42 %	36 %	39 %	29 %	41 %
Special education	12 %	12 %	13 %	17 %	13 %
FCAT math	-0.02	0.21	-0.03	0.23	-0.02
	(1.00)	(0.95)	(0.97)	(1.05)	(1.00)
FCAT reading	-0.01	0.16	-0.00	0.30	-0.01
	(1.00)	(0.98)	(0.99)	(1.03)	(1.00)
Absences per year	7.04	6.37	6.68	6.74	7.16
	(6.84)	(5.93)	(6.26)	(6.87)	(6.72)
Panel C: Dynamic attributes, grade 10					
Free or reduced lunch	33 %	26 %	32 %	24 %	34 %
Special education	9 %	9 %	10 %	11 %	11 %
FCAT math	-0.01	0.09	0.02	0.23	-0.09
	(1.00)	(0.94)	(0.97)	(1.10)	(1.00)
FCAT reading	-0.01	0.06	0.03	0.26	-0.07
	(1.00)	(0.97)	(0.99)	(1.09)	(1.01)
Absences per year	8.41	8.03	8.20	8.40	9.52
	(9.27)	(8.39)	(8.71)	(8.67)	(9.72)

Note: Sample includes a balanced panel of students who attended grade 6 between the school years 2000-2001 and 2004-2005 and were tested in the Florida school system for the following four years. Achievement test scores are normalized within year-grade cells. Where relevant, standard deviations are shown in parentheses.

Table 3: School structure as a predictor of middle and high school entrance

Balanced Sample	Grades 3 to 8		Grades 3 to 10		Grades 6 to 10
	Enter middle school in grade 6	Enter middle school in grade 7	Enter middle school in grade 6	Enter middle school in grade 7	Enter high school in grade 9
Instrument for grade 6 middle school entry	0.661***		0.670***		
	[0.022]		[0.028]		
Instrument for grade 7 middle school entry		0.627***		0.641***	
		[0.030]		[0.036]	
Instrument for grade 9 high school entry					0.724***
					[0.029]
Constant	0.299***	0.015***	0.293***	0.014***	0.258***
	[0.022]	[0.001]	[0.028]	[0.001]	[0.029]
R^2	0.421	0.473	0.444	0.497	0.459
Observations	456,705		152,788		471,270

* p<0.10, ** p<0.05, *** p<0.01

Note: The instrument for grade 6 middle school entry is whether a student was enrolled in a K-5 school in grade 3; likewise the instrument for grade 7 middle school entry is enrollment in a K-6 school in grade 3. The instrument for grade 9 high school entry is whether a student was enrolled in grade 6 in a school with grade 8 as highest grade covered. If students attend a 3 to 6 elementary school in grade 6, the instrument for grade 9 high school entry is whether a student was enrolled in grade 7 in a school with grade 8 as highest grade covered. Standard errors (in brackets) clustered by school attended in grade 3 in columns 1 to 4 and clustered by school attended in grade 6 in the last column.

Table 4a: Impacts of Grade Configuration: Gains in Relative Math Achievement

	Annual gains in normalized math achievement scores, relative to students who do not enter middle school in grades 6 or 7				high school in grade 9
	Balanced sample grades 3 to 8		Balanced sample grades 3 to 10		Balanced sample grades 6 to 10
	Students entering middle school		*Students entering middle school*		*Students entering high school*
	in grade 6	*in grade 7*	*in grade 6*	*in grade 7*	*in grade 9*
Grade 3 to 4	0.060**	0.085**	0.024	0.084**	
	[0.029]	[0.036]	[0.031]	[0.038]	
Grade 4 to 5	0.040*	0.001	0.033	-0.008	
	[0.021]	[0.027]	[0.031]	[0.037]	
Grade 5 to 6	**-0.123*** **	0.093***	**-0.083*** **	0.145***	
	[0.020]	[0.026]	**[0.029]**	[0.036]	
Grade 6 to 7	-0.068***	**-0.222*** **	-0.063***	**-0.223*** **	0.096***
	[0.015]	**[0.020]**	[0.022]	**[0.027]**	[0.017]
Grade 7 to 8	-0.037***	-0.085***	-0.027	-0.081***	0.022*
	[0.013]	[0.015]	[0.017]	[0.020]	[0.013]
Grade 8 to 9			-0.003	0.053***	**-0.027** **
			[0.017]	[0.020]	**[0.012]**
Grade 9 to 10			0.002	-0.017	0.020**
			[0.015]	[0.018]	[0.009]

* p<0.10, ** p<0.05, *** p<0.01

Note: Displayed estimates are based on differences between estimated coefficients of IV specifications reported in Table A-1 to A-3. Displayed standard errors and significance levels are based on linear combination tests between estimated coefficients for subsequent grades. Tests are conducted against the null hypothesis that coefficients for subsequent grades are identical. Estimates in bold represent immediate impacts of entering middle or high school.

Table 4b: Impacts of Grade Configuration: Gains in Relative Reading Achievement

	Annual gains in normalized reading achievement scores, relative to students who do not enter middle school in grades 6 or 7				high school in grade 9
	Balanced sample grades 3 to 8		Balanced sample grades 3 to 10		Balanced sample grades 6 to 10
	Students entering middle school		*Students entering middle school*		*Students entering high school*
	in grade 6	*in grade 7*	*in grade 6*	*in grade 7*	*in grade 9*
Grade 3 to 4	0.058**	0.096***	0.039	0.065*	
	[0.026]	[0.031]	[0.027]	[0.033]	
Grade 4 to 5	0.002	-0.033*	-0.008	-0.037	
	[0.014]	[0.019]	[0.024]	[0.029]	
Grade 5 to 6	**-0.086*** **	0.032*	**-0.062*** **	0.076***	
	[0.014]	[0.018]	**[0.020]**	[0.024]	
Grade 6 to 7	-0.022	**-0.149*** **	0.000	**-0.115*** **	0.103***
	[0.015]	**[0.019]**	[0.024]	**[0.029]**	[0.014]
Grade 7 to 8	-0.010	-0.034**	-0.034*	-0.082***	0.061***
	[0.012]	[0.014]	[0.018]	[0.021]	[0.012]
Grade 8 to 9			-0.012	0.036	**-0.047*** **
			[0.023]	[0.025]	**[0.016]**
Grade 9 to 10			0.034*	0.027	0.014
			[0.019]	[0.022]	[0.011]

* p<0.10, ** p<0.05, *** p<0.01

Note: Displayed estimates are based on differences between estimated coefficients of IV specifications reported in Table A-1 to A-3. Displayed standard errors and significance levels are based on linear combination tests between estimated coefficients for subsequent grades. Tests are conducted against the null hypothesis that coefficients for subsequent grades are identical. Estimates in bold represent immediate impacts of entering middle or high school.

Table 5a: Robustness Checks, Math

	Middle school entry grade 6			Middle school entry grade 7			High school entry grade 9		
	prior trend	drop	post trend	prior trend	drop	post trend	prior trend	drop	post trend
grades	*3 to 5*	*5 to 6*	*6 to 8*	*3 to 6*	*6 to 7*	*7 to 8*	*6 to 8*	*8 to 9*	9 to 10
Baseline									
	0.100 ***	-0.123 ***	-0.105 ***	0.178 ***	-0.222 ***	-0.085 ***	0.117 ***	-0.027 **	0.020 **
	[0.036]	[0.020]	[0.016]	[0.046]	[0.020]	[0.015]	[0.022]	[0.012]	[0.009]
Robustness									
no charter	0.121 ***	-0.111 ***	-0.085 ***	0.199 ***	-0.207 ***	-0.071 ***	0.122 ***	-0.039 ***	0.025 ***
schools	[0.037]	[0.019]	[0.017]	[0.047]	[0.020]	[0.015]	[0.024]	[0.012]	[0.009]
no other	0.092 ***	-0.124 ***	-0.108 ***	0.172 ***	-0.223 ***	-0.086 ***			
6+ schools	[0.035]	[0.020]	[0.016]	[0.048]	[0.021]	[0.016]			
no retained	0.084 **	-0.119 ***	-0.100 ***	0.170 ***	-0.211 ***	-0.087 ***	0.116 ***	-0.022 *	0.019 **
students	[0.037]	[0.021]	[0.017]	[0.047]	[0.020]	[0.015]	[0.023]	[0.012]	[0.009]
no retention	0.099 ***	-0.124 ***	-0.105 ***	0.181 ***	-0.222 ***	-0.084 ***	0.115 ***	-0.027 **	0.021 **
controls	[0.036]	[0.020]	[0.016]	[0.046]	[0.020]	[0.015]	[0.022]	[0.012]	[0.009]
unbalanced	0.106 ***	-0.141 ***	-0.098 ***	0.163 ***	-0.218 ***	-0.071 ***	0.115 ***	-0.037 ***	0.029 ***
sample	[0.035]	[0.021]	[0.016]	[0.045]	[0.018]	[0.016]	[0.020]	[0.012]	[0.011]

* p<0.10, ** p<0.05, *** p<0.01

Note: The first column indicates the type of robustness check. Results are based on 2SLS models. Our preferred results are reported in the first row.

Table 5b: Robustness Checks, Reading

	Middle school entry grade 6			Middle school entry grade 7			High school entry grade 9		
	prior trend	drop	post trend	prior trend	drop	post trend	prior trend	drop	post trend
grades	*3 to 5*	*5 to 6*	*6 to 8*	*3 to 6*	*6 to 7*	*7 to 8*	*6 to 8*	*8 to 9*	9 to 10
Baseline									
	0.060 **	-0.086 ***	-0.032 *	0.094 ***	-0.149 ***	-0.034 **	0.164 ***	-0.047 ***	0.014
	[0.024]	[0.014]	[0.018]	[0.035]	[0.019]	[0.014]	[0.020]	[0.016]	[0.011]
Robustness									
no charter	0.073 ***	-0.077 ***	-0.027	0.110 ***	-0.151 ***	-0.029 *	0.167 ***	-0.053 ***	0.016
schools	[0.026]	[0.014]	[0.019]	[0.035]	[0.019]	[0.015]	[0.018]	[0.017]	[0.012]
no other	0.056 **	-0.086 ***	-0.032 *	0.088 **	-0.140 ***	-0.028 *			
6+ schools	[0.024]	[0.014]	[0.018]	[0.037]	[0.020]	[0.015]			
no retained	0.055 **	-0.088 ***	-0.029	0.088 **	-0.150 ***	-0.031 **	0.168 ***	-0.048 ***	0.014
students	[0.024]	[0.015]	[0.019]	[0.035]	[0.020]	[0.015]	[0.020]	[0.017]	[0.012]
no retention	0.059 **	-0.088 ***	-0.032 *	0.098 ***	-0.149 ***	-0.033 **	0.161 ***	-0.047 ***	0.014
controls	[0.024]	[0.014]	[0.018]	[0.035]	[0.019]	[0.014]	[0.019]	[0.016]	[0.011]
unbalanced	0.048 *	-0.089 ***	-0.022	0.082 **	-0.144 ***	-0.020	0.145 ***	-0.046 ***	0.021 *
sample	[0.025]	[0.014]	[0.019]	[0.034]	[0.019]	[0.015]	[0.018]	[0.013]	[0.012]

* p<0.10, ** p<0.05, *** p<0.01

Note: The first column indicates the type of robustness check. Results are based on 2SLS models. Our preferred results are reported in the first row.

Table 6a: Subgroup Results, Math

	Middle school entry grade 6			Middle school entry grade 7			High school entry grade 9		
	prior trend	drop	post trend	prior trend	drop	post trend	prior trend	drop	post trend
grades	*3 to 5*	*5 to 6*	*6 to 8*	*3 to 6*	*6 to 7*	*7 to 8*	*6 to 8*	*8 to 9*	9 to 10
Baseline									
	0.100 ***	-0.123 ***	-0.105 ***	0.178 ***	-0.222 ***	-0.085 ***	0.117 ***	-0.027 **	0.020 **
	[0.036]	[0.020]	[0.016]	[0.046]	[0.020]	[0.015]	[0.022]	[0.012]	[0.009]
Subgroups									
males	0.076 *	-0.117 ***	-0.123 ***	0.163 ***	-0.244 ***	-0.094 ***	0.134 ***	-0.033 **	0.029 **
	[0.039]	[0.020]	[0.021]	[0.050]	[0.022]	[0.019]	[0.024]	[0.014]	[0.012]
females	0.122 ***	-0.128 ***	-0.088 ***	0.190 ***	-0.200 ***	-0.077 ***	0.102 ***	-0.021 *	0.013
	[0.036]	[0.025]	[0.019]	[0.048]	[0.023]	[0.017]	[0.024]	[0.012]	[0.011]
> median	0.061	-0.079 ***	-0.090 ***	0.173 ***	-0.185 ***	-0.079 ***	0.098 ***	-0.014	-0.005
test score	[0.038]	[0.020]	[0.016]	[0.048]	[0.022]	[0.016]	[0.032]	[0.013]	[0.009]
<= median	0.143 ***	-0.179 ***	-0.126 ***	0.211 ***	-0.271 ***	-0.095 ***	0.110 ***	-0.048 ***	0.044 ***
test score	[0.047]	[0.026]	[0.021]	[0.058]	[0.027]	[0.024]	[0.022]	[0.016]	[0.015]
white	0.069 **	-0.105 ***	-0.090 ***	0.138 ***	-0.184 ***	-0.078 ***	0.085 ***	-0.025 *	0.008
	[0.031]	[0.022]	[0.019]	[0.038]	[0.020]	[0.016]	[0.024]	[0.013]	[0.010]
black	0.338 ***	-0.223 ***	-0.191 ***	0.357 ***	-0.397 ***	-0.069 *	0.154 ***	-0.049 **	0.044 *
	[0.071]	[0.057]	[0.036]	[0.105]	[0.050]	[0.039]	[0.035]	[0.025]	[0.025]
hispanic	0.092	-0.134 ***	-0.090 ***	0.347 ***	-0.256 ***	-0.097 ***	0.209 ***	-0.025	0.028
	[0.068]	[0.039]	[0.027]	[0.092]	[0.039]	[0.034]	[0.041]	[0.024]	[0.023]
city	0.099	-0.191 ***	-0.125 ***	0.158 *	-0.273 ***	-0.080 ***	0.114	-0.033	0.017
	[0.083]	[0.054]	[0.029]	[0.082]	[0.034]	[0.029]	[0.077]	[0.030]	[0.028]
urban	0.005	-0.125 ***	-0.131 ***	0.088	-0.241 ***	-0.102 ***	0.170 ***	-0.030	0.027 *
fringe	[0.050]	[0.031]	[0.027]	[0.074]	[0.034]	[0.023]	[0.030]	[0.020]	[0.015]
town or	0.147 ***	-0.081 ***	-0.067 ***	0.137 **	-0.147 ***	-0.052	0.066 **	-0.036 **	0.009
rural	[0.043]	[0.029]	[0.024]	[0.062]	[0.039]	[0.033]	[0.028]	[0.017]	[0.013]

* p<0.10, ** p<0.05, *** p<0.01

Note: The first column indicates the type of subgroup analysis. All results are based on 2SLS models. Our preferred results are reported in the first row. Above and below median test score refers to the test score in grade 3 in columns 2 to 7 and to the test score in grade 6 in columns 8 to 10. Location information refers to the location of the school that students attended in grade 3 and is based on definitions used by the Census Bureau.

Table 6b: Subgroup Results, Reading

	Middle school entry grade 6			Middle school entry grade 7			High school entry grade 9		
	prior trend	drop	post trend	prior trend	drop	post trend	prior trend	drop	post trend
grades	*3 to 5*	*5 to 6*	*6 to 8*	*3 to 6*	*6 to 7*	*7 to 8*	*6 to 8*	*8 to 9*	9 to 10
Baseline									
	0.060 **	-0.086 ***	-0.032 *	0.094 ***	-0.149 ***	-0.034 **	0.164 ***	-0.047 ***	0.014
	[0.024]	[0.014]	[0.018]	[0.035]	[0.019]	[0.014]	[0.020]	[0.016]	[0.011]
Subgroups									
males	0.043	-0.067 ***	-0.045 **	0.095 **	-0.169 ***	-0.026	0.170 ***	-0.044 **	0.030 **
	[0.029]	[0.018]	[0.023]	[0.039]	[0.025]	[0.020]	[0.021]	[0.018]	[0.015]
females	0.075 ***	-0.104 ***	-0.021	0.093 ***	-0.130 ***	-0.044 **	0.156 ***	-0.048 ***	-0.002
	[0.025]	[0.017]	[0.020]	[0.036]	[0.019]	[0.018]	[0.021]	[0.017]	[0.011]
> median	0.045 *	-0.092 ***	-0.031 *	0.074 **	-0.139 ***	-0.040 **	0.138 ***	-0.060 **	0.011
score	[0.027]	[0.016]	[0.019]	[0.034]	[0.023]	[0.017]	[0.021]	[0.023]	[0.013]
<= median	0.046	-0.083 ***	-0.039	0.116 **	-0.166 ***	-0.025	0.150 ***	-0.031 *	0.012
test score	[0.030]	[0.020]	[0.024]	[0.046]	[0.022]	[0.022]	[0.024]	[0.016]	[0.015]
white	0.059 **	-0.072 ***	-0.039 **	0.108 ***	-0.160 ***	-0.029 **	0.126 ***	-0.052 ***	0.006
	[0.024]	[0.016]	[0.016]	[0.031]	[0.018]	[0.013]	[0.019]	[0.018]	[0.013]
black	0.137 ***	-0.109 ***	0.032	0.137 **	-0.101 ***	0.010	0.121 ***	-0.035	0.019
	[0.037]	[0.036]	[0.035]	[0.069]	[0.036]	[0.041]	[0.032]	[0.024]	[0.021]
hispanic	0.085 **	-0.110 ***	-0.051	0.199 ***	-0.160 ***	-0.042	0.222 ***	-0.021	-0.004
	[0.040]	[0.027]	[0.038]	[0.058]	[0.039]	[0.036]	[0.040]	[0.029]	[0.028]
city	0.103 **	-0.165 ***	0.028	0.132 *	-0.135 ***	-0.010	0.081 *	-0.007	-0.013
	[0.052]	[0.037]	[0.023]	[0.071]	[0.030]	[0.025]	[0.042]	[0.024]	[0.026]
urban	0.011	-0.113 ***	-0.094 ***	-0.006	-0.197 ***	-0.053 *	0.206 ***	-0.073 ***	0.008
fringe	[0.036]	[0.022]	[0.032]	[0.048]	[0.032]	[0.029]	[0.043]	[0.025]	[0.018]
town or	0.055	-0.035 *	-0.057 ***	0.087 *	-0.126 ***	-0.042	0.117 ***	-0.042 **	0.006
rural	[0.034]	[0.018]	[0.022]	[0.050]	[0.029]	[0.027]	[0.018]	[0.021]	[0.015]

* p<0.10, ** p<0.05, *** p<0.01

Note: The first column indicates the type of subgroup analysis. All results are based on 2SLS models. Our preferred results are reported in the first row. Above and below median test score refers to the test score in grade 3 in columns 2 to 7 and to the test score in grade 6 in columns 8 to 10. Location information refers to the location of the school that students attended in grade 3 and is based on definitions used by the Census Bureau.

Table 7: Absences, School Dropout, and Grade 9 Retention

	Middle school entry grade 6	Middle school entry grade 7	High school entry grade 9
Panel A: Days of Absence			
prior trend	-0.484 ***	-0.032	0.265
	[0.169]	[0.238]	[0.226]
drop (i.e. increase)	0.967 ***	-0.259	-1.266 ***
	[0.193]	[0.221]	[0.219]
post trend	0.412 **	0.053	0.068
	[0.208]	[0.182]	[0.139]
Panel B: School Dropout in Grade 10			
OLS	0.010***	0.006	–0.061***
	[0.003]	[0.004]	[0.010]
IV	0.014**	0.008	–0.004
	[0.006]	[0.007]	[0.015]
Panel C: Retention in Grade 9			
OLS	0.002	0.010***	–0.002
	[0.002]	[0.002]	[0.002]
IV	0.002	0.010**	0.005*
	[0.003]	[0.004]	[0.003]

* p<0.10, ** p<0.05, *** p<0.01

Note: Panel A reports results of estimating a 2SLS specification identical with our main specification, but with student absence in a school year as dependent variable. Panel B and C report OLS and IV results from estimating a cross-sectional model. The specifications in Panels B and C in rows (row) 2 an 3 (4) include controls for grade 3 (6) test scores, race, gender, year of birth, indicators for whether a student received free or reduced lunch in grade 3 (6), and an indicator for whether a student was classified as a special education student in grade 3 (6). The dependent variable in Panel B is a proxy for high school dropout in grade 10 that indicates whether a student was not enrolled in any public school in Florida in the year when the student should have entered grade 10. The dependent variable in Panel C indicates whether a student repeated grade 9. Standards errors (in brackets) are clustered by school attended in grade 3 (6) in rows (row) 2 and 3 (4).

Table A-1: Achievement Regression Results [Grades 3 to 8 balanced sample]

	Normalized achievement scores, relative to students in K-8 schools			
	Math		Reading	
	2SLS	OLS	2SLS	OLS
Students entering middle school in grade 6				
Grade 4	0.060**	0.026***	0.058**	0.025***
	[0.029]	[0.010]	[0.026]	[0.009]
Grade 5	0.100***	0.065***	0.060**	0.038***
	[0.036]	[0.012]	[0.024]	[0.008]
Grade 6	–0.023	–0.035**	–0.027	–0.019*
	[0.037]	[0.014]	[0.028]	[0.011]
Grade 7	–0.091**	–0.058***	–0.048	–0.029**
	[0.038]	[0.015]	[0.036]	[0.013]
Grade 8	–0.128***	–0.070***	–0.058	–0.035**
	[0.038]	[0.014]	[0.040]	[0.014]
Students entering middle school in grade 7				
Grade 4	0.085**	0.032**	0.096***	0.038***
	[0.036]	[0.014]	[0.031]	[0.012]
Grade 5	0.085*	0.025	0.062**	0.031***
	[0.045]	[0.016]	[0.030]	[0.011]
Grade 6	0.178***	0.117***	0.094***	0.073***
	[0.046]	[0.019]	[0.035]	[0.014]
Grade 7	–0.044	–0.024	–0.055	–0.049***
	[0.046]	[0.018]	[0.043]	[0.015]
Grade 8	–0.129***	–0.068***	–0.089*	–0.081***
	[0.046]	[0.018]	[0.047]	[0.016]

* p<0.10, ** p<0.05, *** p<0.01

Note: The number of observations in each regression is 2,781,333. All regressions include student fixed effects, as well as controls for grade, for whether the student attends a charter school, for whether the student was retained that year, and for whether the student was retained in any previous year. Standards errors (in brackets) are clustered by school attended in grade 3.

Table A-2: Achievement Regression Results [Grades 3 to 10 balanced sample]

	Normalized achievement scores, relative to students in K-8 schools			
	Math		Reading	
	2SLS	OLS	2SLS	OLS
Students entering middle school in grade 6				
Grade 4	0.024	0.001	0.039	0.024*
	[0.031]	[0.015]	[0.027]	[0.013]
Grade 5	0.056	0.040**	0.030	0.038***
	[0.044]	[0.019]	[0.026]	[0.012]
Grade 6	–0.027	–0.061***	–0.032	–0.018
	[0.047]	[0.022]	[0.030]	[0.014]
Grade 7	–0.089*	–0.083***	–0.031	–0.022
	[0.048]	[0.023]	[0.039]	[0.017]
Grade 8	–0.116**	–0.088***	–0.065	–0.030
	[0.047]	[0.021]	[0.045]	[0.019]
Grade 9	–0.119**	–0.081***	–0.077**	–0.039**
	[0.048]	[0.021]	[0.039]	[0.017]
Grade 10	–0.117**	–0.081***	–0.043	–0.021
	[0.052]	[0.022]	[0.047]	[0.020]
Students entering middle school in grade 7				
Grade 4	0.084**	0.021	0.065*	0.025
	[0.038]	[0.019]	[0.033]	[0.017]
Grade 5	0.075	0.012	0.028	0.031*
	[0.055]	[0.025]	[0.032]	[0.016]
Grade 6	0.220***	0.109***	0.104***	0.091***
	[0.059]	[0.028]	[0.036]	[0.018]
Grade 7	–0.002	–0.033	–0.011	–0.031
	[0.056]	[0.027]	[0.047]	[0.021]
Grade 8	–0.083	–0.068***	–0.093*	–0.081***
	[0.055]	[0.025]	[0.053]	[0.023]
Grade 9	–0.030	–0.032	–0.057	–0.049**
	[0.056]	[0.025]	[0.047]	[0.021]
Grade 10	–0.047	–0.041	–0.030	–0.042*
	[0.061]	[0.026]	[0.056]	[0.025]

* p<0.10, ** p<0.05, *** p<0.01

Note: The number of observations in each regression is 1,230,144. All regressions include student fixed effects, as well as controls for grade, for whether the student attends a charter school, for whether the student was retained that year, and for whether the student was retained in any previous year. Standards errors (in brackets) are clustered by school attended in grade 3.

Table A-3: Achievement Regression Results [Grades 6 to 10 balanced sample]

	Normalized achievement scores, relative to students not entering high school in grade 9			
	Math		Reading	
	2SLS	OLS	2SLS	OLS
Students entering high school in grade 9				
Grade 7	0.096***	0.063***	0.103***	0.064***
	[0.017]	[0.010]	[0.014]	[0.008]
Grade 8	0.117***	0.088***	0.164***	0.125***
	[0.022]	[0.013]	[0.020]	[0.012]
Grade 9	0.090***	0.077***	0.117***	0.098***
	[0.020]	[0.012]	[0.020]	[0.011]
Grade 10	0.111***	0.094***	0.131***	0.128***
	[0.022]	[0.013]	[0.025]	[0.016]

* p<0.10, ** p<0.05, *** p<0.01

Note: The number of observations in each regression is 2,371,373. All regressions include student fixed effects, as well as controls for grade, for whether the student attends a charter school, for whether the student was retained that year, and for whether the student was retained in any previous year. Standards errors (in brackets) are clustered by school attended in grade 6.