The Impact of Alternative Grade Configurations on Student Outcomes through Middle and High School[*]

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First 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 sharp drops in student achievement. We extend this evidence by confirming that these achievement drops occur in nonurban areas and persist through grade 10, by which time most students have transitioned into high school. We also find that middle school attendance increases student absences and is associated with higher grade 10 dropout rates. 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

Among the most basic questions facing education policymakers 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 at minimum 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., a 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 to students 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 makes the U.S. a valuable potential source of evidence on the role of grade configuration in education production.

Recent findings from New York City (Rockoff and Lockwood 2010) indicate that entering 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 ease students' transition to high school and simply having experienced a prior school transition may make students more resilient in the face of subsequent transitions. It is also unclear from existing evidence whether the transition to high school in grade 9 has negative consequences for students regardless of the grade configurations to which they were previously exposed.

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 traits 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 substantial even in small towns and rural areas. We find little evidence that students who attended middle school make larger achievement gains than their peers' 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, 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 move into a new school in grade 9. From grade 8 to 9 they suffer a small but statistically significant drop in relative achievement of 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 suggest 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 such transitions are particularly costly for younger students or that middle schools provide lower quality education than K-8 schools for students in grades 6 to 8. Although administrative data indicate that Florida middle schools spend less per student, have larger student-teacher ratios, and have much larger cohort sizes than K-8 schools, we find no evidence that these differences account for their negative effect on student achievement. Moreover, data from a recent survey of Florida principals (Rouse et al. 2007) reveal few differences in the educational practices across schools with different grade configurations. The absence of compelling alternative explanations for the negative effects of middle school attendance suggests that adolescents may be more difficult to educate in settings that do not contain younger students.

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 the effects of grade configuration on attendance and school dropout by grade 10. Section 6 uses administrative and survey data to evaluate potential explanations for our findings. Section 7 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 American private school students in grades 6 and 7 attend middle or junior high schools (Rockoff and Lockwood 2010).

Concerns about the performance of middle schools have recently led several urban school districts to experiment with a return to the traditional K-8 model (Hough 2005). Evidence suggesting that the relative standing of American students on international assessments of student achievement declines in the middle grades has also contributed to a broader reconsideration of the organization and approach of schools serving adolescent students (see, e.g., Schmitt et al. 1999, Juvonen et al. 2004). However, most 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 (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 comes from Rockoff and Lockwood (2010), who develop the identification strategy that we apply in our empirical analysis.[1] 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 districts or if students attending a K-8 school suffer a larger drop in achievement when moving 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 these 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

[1] Using earlier data from New York City, Schwartz et al. (forthcoming) find that students moving from K-4 to 5-8 schools or attending K-8 schools outperform students following other grade span paths in grade 8. Byrnes and Ruby (2007) 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 enrolled in grade 3 between 2001 and 2004 who completed the state test in both math and reading in each of the following five years. 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 enrolled in 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 enrolled in 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.[2] 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.[3]

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 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 due to the exclusion of two cohorts of students and students with missing test score data in

[2] 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.

[3] 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.

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 provides 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 these statistics for five different types of schools that students attended in grade 6: 6-8, K-8, K-6, K-12, and 6-10+.[4] 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 6 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 achievement that coincide precisely with students' movements into middle schools and high schools.

[4] 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*:

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

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) could 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 in which the set of first stage equations is given by:

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

The instrument, T_{ig}, indicates the terminal grade of the school student *i* attended in grade 3 (6) interacted with an indicator for grade *g*. We estimate Equation (2) separately for each combination of the grade that students might enter middle school and 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 their actual values and apply the standard procedure to adjust standard errors.

Table 3, which reports regression results based on a simplified version of the first stage, demonstrates that these instrumental variables are strong predictors of actual entry into middle school.[5] Columns 1 to 4 report estimated coefficients on the instruments for entry into middle school in grade 6 and grade 7. In both middle school samples, the estimated coefficients on the instruments for entry into middle school in grade 6 and grade 7 are between 0.6 and 0.7 and highly statistically significant. Column 5 reports the estimated coefficient on the instrument for entry into high school in grade 9, which is based on the terminal grade of the school attended in grade 6.[6] The coefficient on the instrument for entry into high school is 0.724 and also highly significant.

While the first stage results suggest that terminal grades of schools attended in grade 3 and 6 are highly related to 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 by enrolling 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 choice among grade configurations is limited and compliance can be expected to be close to one.

To clarify our IV method and preview our findings, we first present reduced-form results showing the effect of predicted middle school entry based on the balanced sample covering

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

[6] 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.

grades 3 to 8.[7] Figure 2 charts the math and reading achievement of students attending K-5 and K-6 schools in grade 3 relative to those of students attending K-8 schools in grade 3.[8] As our identification is based on changes in achievement trajectories within students, differences in grade 3 achievement across these groups of students 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 reveals 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 in the following year. After predicted middle school entry students observed in a K-5 or K-6 school in grade 3 lag well 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 across students in grade 3, the type of school attended in grade 3 could still be correlated with unobserved student characteristics that affect learning trajectories. It is therefore 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 would cause a drop in relative achievement in the specific year students enter middle schools.

4.1 The effect of middle school entry 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

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[7] 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.

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

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 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 magnitude and statistical significance of the 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 plotted 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 Rockoff and Lockwood (2010), we find that these negative effects persist during middle school grades. While students entering middle schools make larger achievement gains prior to entering middle school than students who never enter middle school, this pattern is reversed after middle school entry. All of the relevant 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 achievement trends students experienced in elementary schools along with the negative immediate and subsequent impact of middle school entry. Because these positive achievement trends prior to middle school entry could reflect selection into K-5 and K-6 schools related to achievement trajectories, we consider them lower-bound estimates of the effect of experiencing a middle school grade configuration by 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.[9] 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 quite substantial and statistically significant losses for students entering middle schools in grade 7 relative to students who never enter middle schools.

[9] 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.

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

4.2 The effect of high school entry 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 four 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. Finally, we now cluster standard errors by the school students attended in grade 6. 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 reports 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 justification 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 alters students' achievement trajectories.

5. Robustness analysis, effect heterogeneity, and behavioral outcomes

In this section, we examine whether the results reported above are sensitive to various changes in the sample definition and model specification. Having demonstrated the robustness of our preferred estimates, we examine whether the effects of middle school 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, for the transition to middle schools in grade 6, the prior trend refers to the total 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. We report the results of our preferred specification in this format in each table's 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 analysis period and fewer than 10 percent of middle schools. Although our preferred specification controls for charter school attendance, one might still worry that the substantially higher share of charter K-8 schools influences our results.[10] Row 2 of Tables 5a

[10] 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.

and 5b, which report the results of specifications which exclude students who attended a charter school in any grade, 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 identify middle school transitions using only information on the lowest grade that a school serves. For example, we code a student as moving to a middle school in grade 6 if we observe the student switching 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 schools that also include high school grades. Row 3 of Tables 5a and 5b confirms that our results are unchanged 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 address the problem of selective retention by excluding students retained in the same grade more than twice and by controlling for both whether students were repeating a given grade and whether they had repeated a prior grade. 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 use two alternative strategies as robustness checks: excluding students retained in any grade and eliminating both retention controls. 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 missing test scores in some grade levels. Row 5 of Tables 5a and 5b confirms that doing so does not affect our results. 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 school and high school entry. We explore possible heterogeneous effect along four dimensions: gender, prior test performance, ethnicity, and 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 with below-median test scores 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, 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 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 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. Given that the average Florida student is absent 8 days in grade 6, this effect is quite large. However, we find no significant effect on absences for students entering middle school in grade 7, making it unlikely that student absenteeism accounts for more than a negligible share of the effects of middle school attendance on achievement. Interestingly, entering high school in grade 9 appears to decrease student absence by 1.3 days per year.

Grade configuration patterns 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 lower high school completion rates 7 years later. Our own finding that the effects of middle school attendance on math achievement are most pronounced for lower-achieving students also suggests the value of considering dropout as an additional outcome variable.

Unfortunately, our ability to study the effects of middle school attendance on dropout behavior is 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 annual grade 10 dropout rates in Florida are between 3 to 4 percent, our proxy indicates an annual rate of roughly 8 percent.

Second, as we can only construct this measure of school dropout 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 control variables, the identifying assumption of our IV approach becomes more restrictive. We now must assume that enrollment in schools with different grade ranges in grade 3 is not correlated with unobserved student traits 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 effect 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 retention in grade 9, which has been shown to be a strong predictor of eventually dropping out of school (Allensworth et al. 2005). 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. Potential mechanisms for the effects of middle school attendance

The results presented above show that transitions into both middle schools and high schools cause drops in student achievement but that these effects are far larger and persistent only for students entering middle schools. We also find negative effects on attendance only for students entering middle school in grade 6. One possible interpretation of this pattern is that school transitions are more disruptive for younger students, possibly because they are more susceptible to the negative influence of older students (Cook et al. 2008). In contrast to Rockoff and Lockwood (2010), however, our point estimates suggest that the effect of middle school entry on student achievement is larger for students entering in grade 7 than for students entering in grade 6. Moreover, the fact that relative achievement continues to decline after students' initial entry into middle schools strongly suggests that average educational quality in Florida is lower in middle schools than in K-8 schools.

To explore why this might be the case, we first present in Table 8 administrative data on several characteristics of Florida elementary, K-8, and middle schools during the 2005-06 school year.[11] Florida middle schools spend 11% less per student and have larger student/teacher ratios than K-8 schools, suggesting a potential role for differences in overall resource levels. In contrast, we find no evidence that differences in observed teacher characteristics could explain our findings. Average teacher experience and average teacher salaries are similar across school types, while the share of the school's instructional staff without prior experience is higher in K-8 schools (26.9% vs. 21.3%). Of course, middle school teachers could still be worse in unobserved ways, a possibility we consider below with survey data. Perhaps the most striking difference across school types, however, involves cohort sizes. Although middle schools offer fewer grades than K-8 schools, Florida middle schools on average enroll 146 more students than their K-8 counterparts. As a result, their typical grade cohorts are almost three times as large.

Table 9 presents results from a series of regression models examining whether these observed differences between middle schools and K-8 schools are likely to contribute to differences in school quality. For the sample of students entering middle schools in grade 6, we separately regressed their grade 6 math and reading test scores on their grade 5 scores and each school characteristic reported in Table 8. In other words, we examined whether the size of the drop in relative achievement suffered by students entering middle schools in grade 6 varied with the characteristics of the middle school they attended. A second set of regression models in each subject controlled additionally for the same characteristic of the elementary school the student attended in grade 5 and therefore relates the size of the middle school drop to changes in the relevant indicator.

Although the potential endogeneity of school resource levels and cohort sizes makes this exercise less than definitive, the results provide little evidence that low middle school quality stems from differences in the characteristics we observe. For example, students moving in grade 6 to middle schools with higher spending levels actually suffered larger drops in relative achievement during this transition, while the drop was smaller for students moving to schools with larger student/teacher ratios. Although average teacher experience is positively correlated with grade 6 achievement, teacher experience levels did not differ significantly across school types. Finally, larger middle school cohort sizes were positively related to changes in achievement from grade 5 to grade 6.

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[11] Given that our main findings were robust to the exclusion of charter schools and data on school characteristics are unavailable for many charter schools (Row 2 of Tables 5a and 5b), we exclude these schools from Table 8.

Middle schools could also differ in their educational practices from K-8 schools in ways that lead to lower student achievement gains. To explore this possibility, we draw on a unique survey of Florida school principals of conducted in 2003-04 to document responses to the state's high-stakes accountability system (Rouse et al. 2007). Although the survey's confidentiality restrictions preclude us from linking survey responses to specific schools, we can nonetheless document any differences in the average responses offered by principals of different school types.

Table 10, which presents data from relevant survey items by school type, reveals few statistically significant differences in the educational practices of middle and K-8 schools. In particular, we observe no differences in the length of the school day or in any of three indexes measuring the extent to which schools had adopted specific policies to help low-performing students, policies to improve the performance of ineffective teachers, and incentives to reward highly effective teachers. If anything, these measures suggest that middle schools are more likely to have policies aimed at improving student achievement. We also find no differences across school types in an index measuring the degree of teacher autonomy. A battery of questions related to scheduling and staffing policies indicates that middle schools are more likely than K-8 schools to provide teachers with common preparation periods (81% vs. 70%), more likely to organize teachers into teams (92% vs. 76%), and less likely to have teachers "loop" with the same classroom of students across multiple grades (14% vs. 31%). These differences are relatively modest in size, however, and we are unaware of any research suggesting that the practices in question are related to student achievement gains.

A final set of survey items asked not about specific policies or practices but about the school's overall climate. On these items, middle school principals expressed significantly lower levels of agreement with statements indicating that their new and veteran teachers were excellent, suggesting that teachers in these schools may be less well equipped to deal with the challenges presented by their students. Middle school principals also expressed higher levels of agreement with the statement that parents are worried about violence in the school. Although differences on the remaining items were not statistically insignificant, they consistently point in the direction of middle schools having less advantageous school climates than K-8 schools.

In short, we find little evidence that the negative effects of middle school attendance are attributable to differences in resources, cohort sizes, or educational practices. We do, however, find suggestive evidence that the overall climate for student learning is worse in middle schools. This suggests a final potential interpretation of our results that is directly related to the choice of grade configuration: Students may benefit from being among the oldest students in a school setting that includes very young students, perhaps because they have greater opportunity to take on leadership roles. This interpretation could account both for the clear gains in relative achievement made by K-5 and K-6 students prior to entering middle schools and for the superior performance of K-8 students relative to their middle school peers. As Rockoff and Lockwood (2010) note, this interpretation is impossible to test with observational data due to the fact that the separation of students by age is inherent in the use of elementary and middle schools.

7. Conclusion

The most common grade configurations in American school districts lead public school students to make two structural school transitions, entering a middle school in grade 6 or 7 and a high school in grade 9. This pattern reflects the influence of enrollment pressures and pedagogical theories that, over the past half-century, all but eliminated the K-8 school from the American educational landscape. However, a small fraction of students attend more comprehensive schools encompassing grades K-8, 6-12, or even K-12. Our paper exploits this variation by comparing the achievement trajectories of students entering middle school and high school relative to those of their peers who do not.

We find that Florida students entering middle school in grade 6 or 7 experience a large drop in student achievement in math and English relative to their peers who do not enter middle schools. Their relative achievement continues to fall while they remain in middle school and shows little sign of recovering in grades 9 and 10. These effects are not limited to urban areas and in math appear to be more pronounced for students in the bottom half of the achievement distribution and for ethnic minorities. We also find that students entering high school in grade 9 experience a smaller one-time drop in relative achievement, but in contrast to the middle school transition their relative achievement improves in grade 10.

Taken as a whole, these results suggest that structural school transitions lower student achievement but that middle schools in particular have adverse consequences for American students. Especially when considered along those of other recent studies (e.g. Bedard and Do 2005, Cook et al. 2008, Rockoff and Lockwood 2010, Schwartz et al. forthcoming), our findings clearly support ongoing efforts in several states and major urban school districts to convert standalone elementary and middle schools into K-8 grade configurations (see, e.g., Hough 2005). They are also relevant to the growing charter school sector, which has the opportunity to adopt alternative grade configurations without the potential disruption caused by school conversions. Although more research is needed to explain the negative effects of middle schools, the lack of a definitive explanation should make policymakers cautious about their ability to take steps to mitigate these effects while maintaining existing grade configurations.

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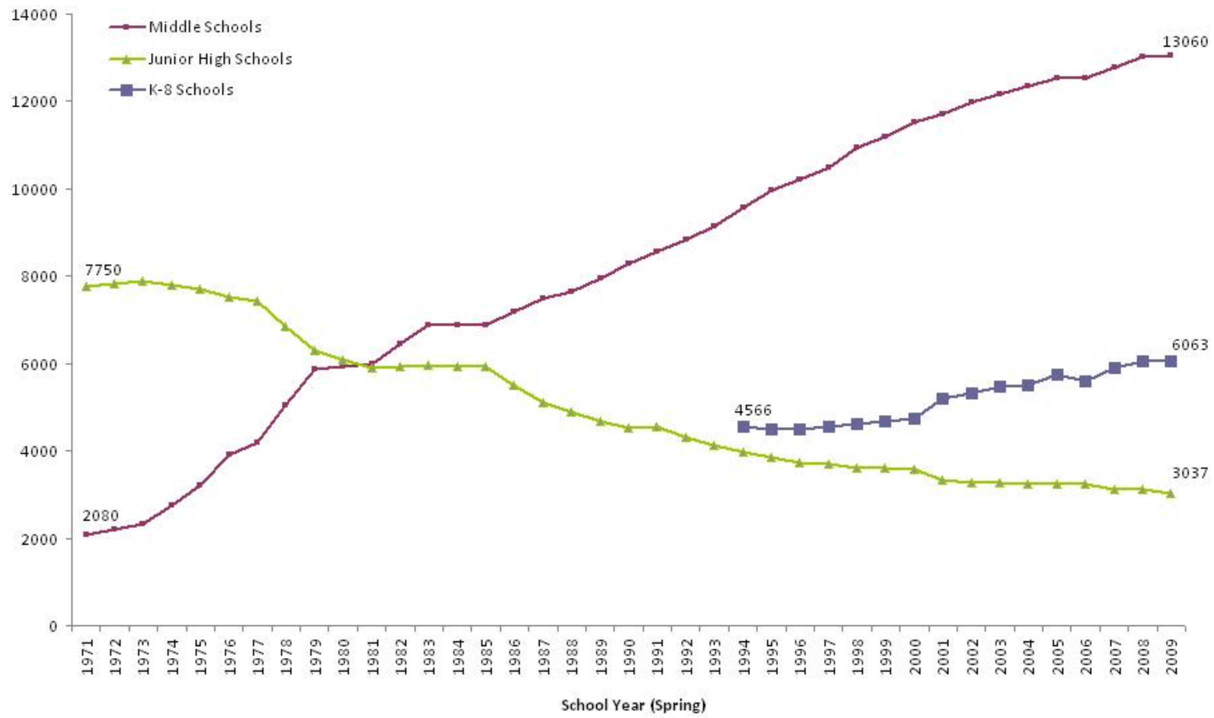
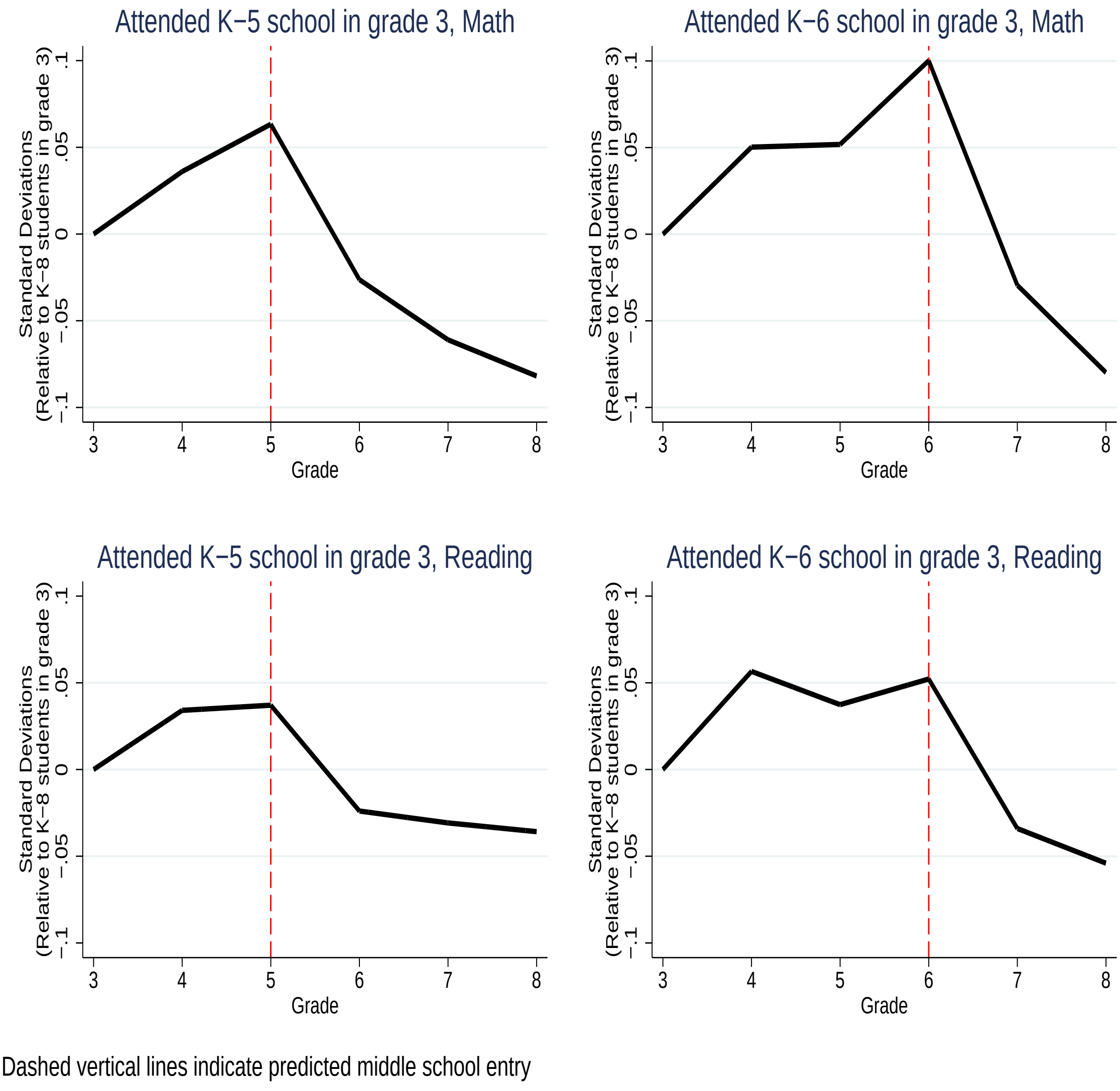
Figure 1: Number of U.S. Public Schools, by type, 1970-2009



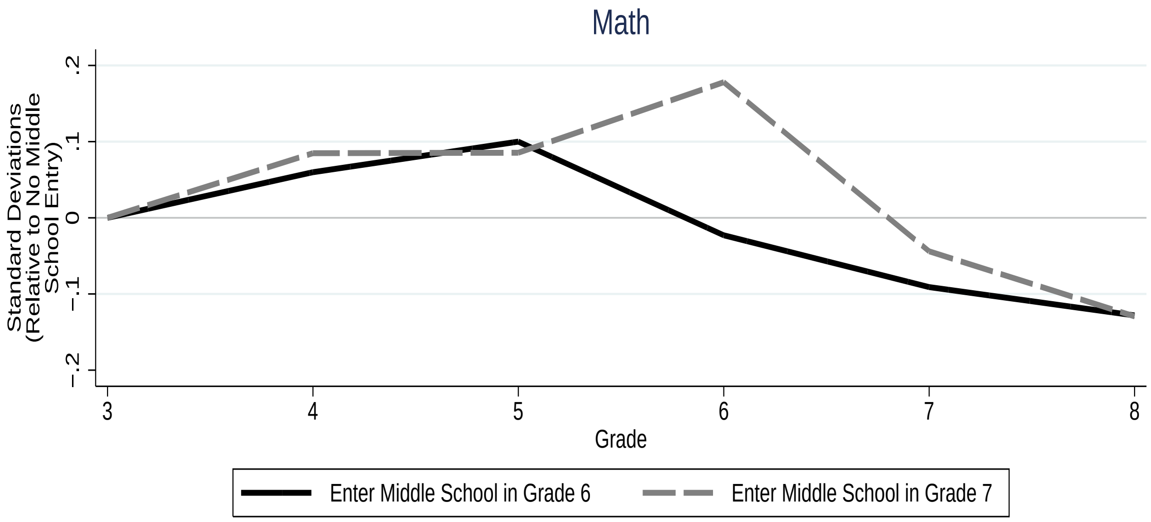
Note: School types are defined by grade span as follows: Middle School: grade 4, 5, or 6 to grade 6, 7, or 8; Junior High School: grade 7 to grade 8 or 9; K-8: grade PK, K, or 1 to grade 8. Source: National Center for Education Statistics, Digest of Education Statistics, 1995-2010.

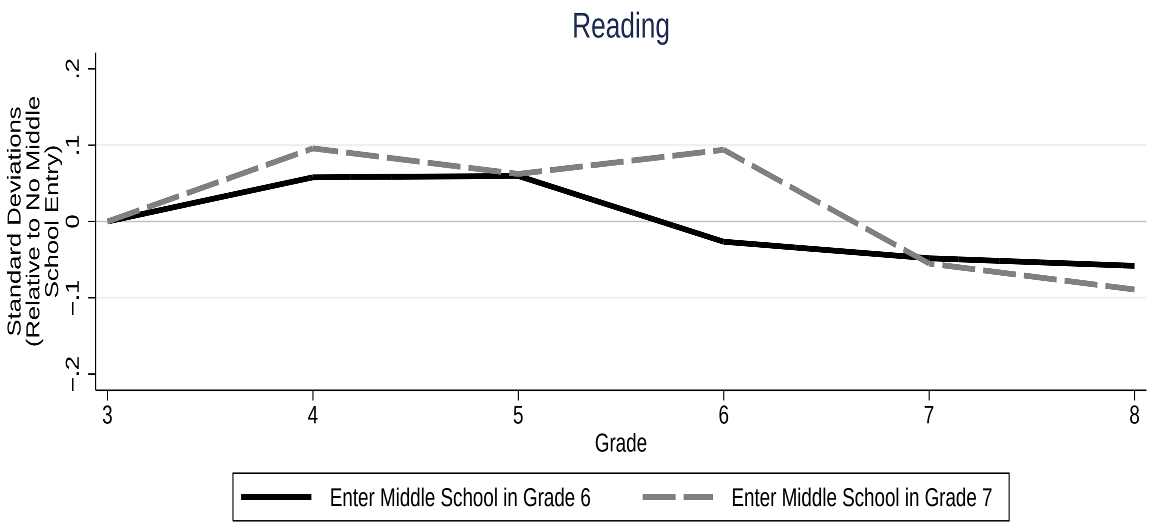
Figure 2: Reduced-form estimates of grade 3 school type on student achievement
[Grades 3 to 8 balanced sample]



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.

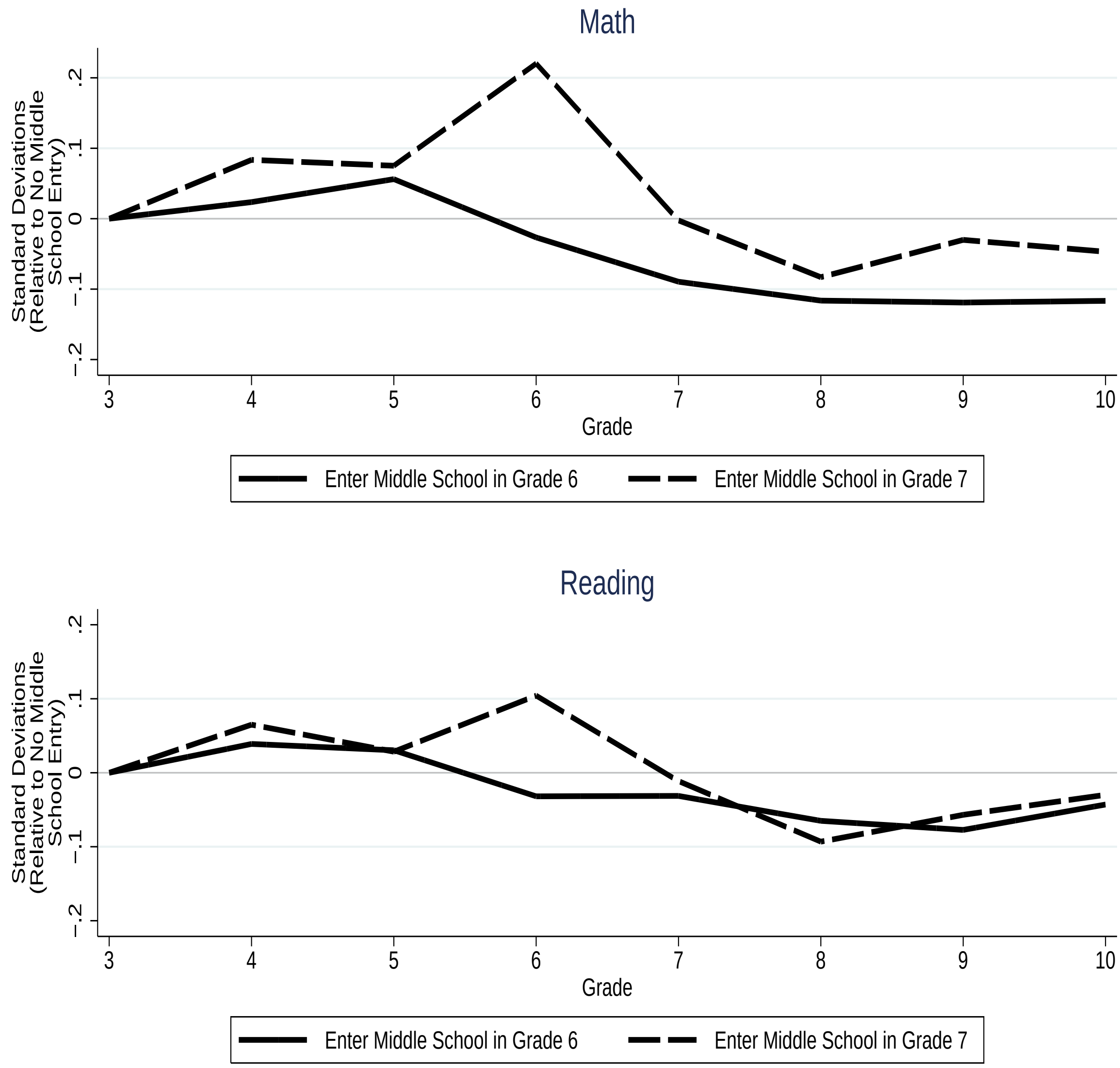
Figure 3: IV estimates of the impact of entering middle school on student achievement [Grades 3 to 8 balanced sample]





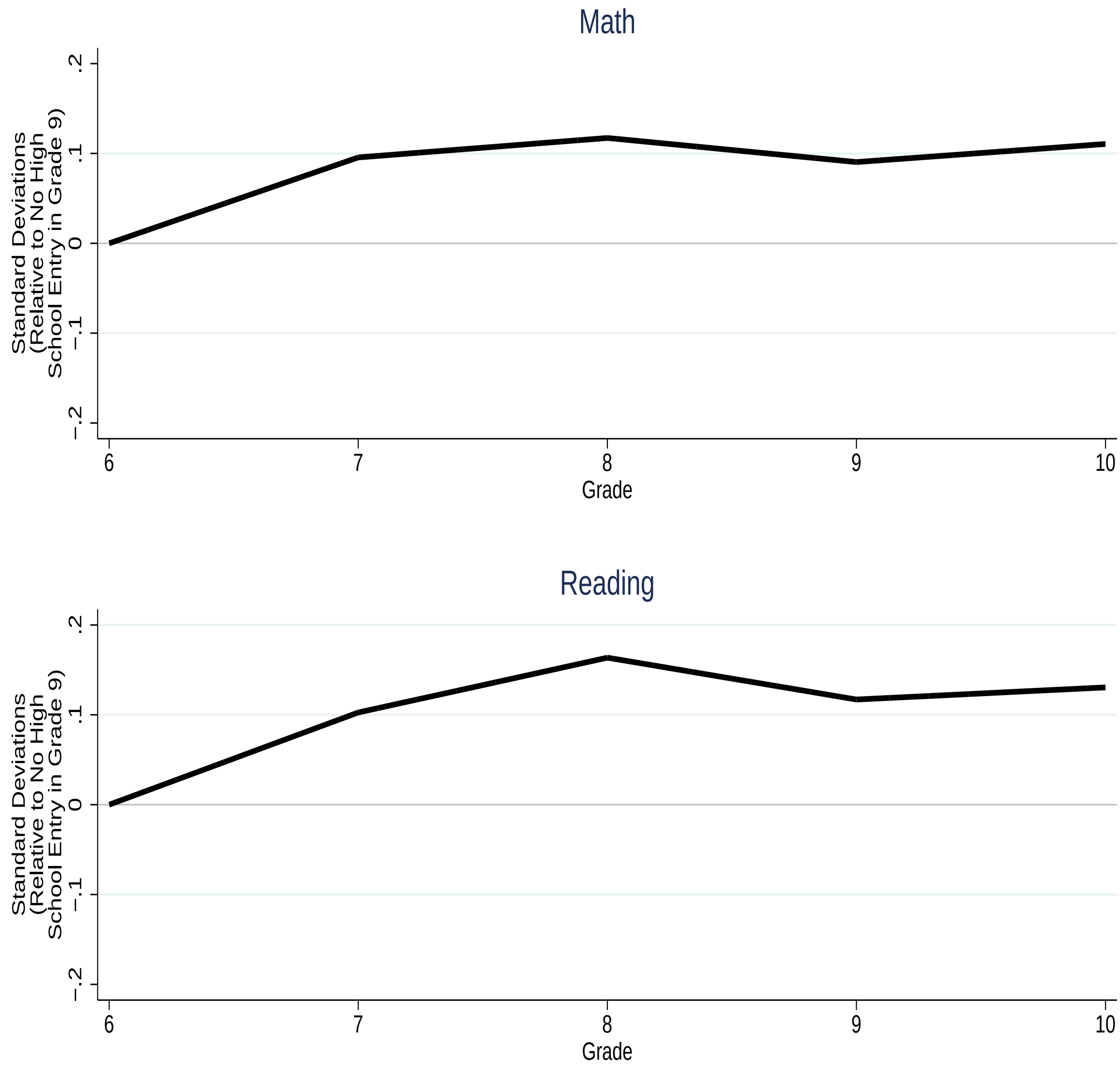
Note: These figures plot coefficient estimates for grade interacted with an indicator for the year in which a student enters middle school. The plotted coefficients and their standard errors are given in Appendix Table A-1. All regressions include student fixed effects, as well as controls for grade, 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 in grade 6	*in grade 7*	*Students entering middle school in grade 6*	*in grade 7*	*Students entering high school 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 8: Mean Characteristics by School Type (Administrative Data)

	Elementary	Middle	K-8	p-value of middle-k8 difference
Expenditure per student ($)	7,381	6,752	7,563	0.02
Student/teacher ratio	15.16	17.32	15.92	0.00
Average teacher experience (years)	12.58	12.07	11.93	0.79
Average teacher salary ($)	41,833	41,813	41,177	0.26
New instructional staff (%)	20.78	21.33	26.93	0.01
Number of students	714	1,040	894	0.02
Cohort size				
Grade 6	88	333	118	0.00
Grade 7	.	363	125	0.00
Grade 8	.	360	117	0.00
N	1,577 - 1,595	427 - 484	43 - 48	

Note: All characteristics are measured in the 2005-2006 school year. Cohort sizes by school type are based on the Common Core of Data. All other characteristics stem from the Florida Department of Educations Return on Investment/School Efficiency Measure website (http://roi.fldoe.org/index.cfm). Charter schools are excluded from the sample.

Table 9: Correlates of Grade 5 to 6 Achievement Gains, Students entering Middle School in Grade 6

	Outcome: Normalized achievement scores in grade 6			
	Math		Reading	
Expenditure per student ($100)	–0.0026***	–0.0021***	–0.0019***	–0.0017***
	[0.0002]	[0.0002]	[0.0002]	[0.0002]
Student/teacher ratio	0.0022***	0.0004	0.0031***	0.0011**
	[0.0006]	[0.0006]	[0.0005]	[0.0005]
Average teacher experience (years)	0.0072***	0.0066***	0.0043***	0.0045***
	[0.0007]	[0.0007]	[0.0005]	[0.0005]
Average teacher salary ($100)	0.0000	0.0001	0.0003***	0.0003***
	[0.0001]	[0.0001]	[0.0001]	[0.0001]
New instructional staff (%)	–0.0003	–0.0001	–0.0003*	–0.0000
	[0.0002]	[0.0002]	[0.0002]	[0.0002]
Cohort size	0.0001***	0.0001***	0.0001***	0.0001***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Math score in grade 5	yes	yes	no	no
Reading score in grade 5	no	no	yes	yes
Grade 5 school characteristics	no	yes	no	yes
Observations	375,393	369,685	375,393	369,685

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

Note: Each cell reports coefficient estimates based on a separate regression of grade 6 test scores on the variable indicated in the first column. All regressions control for student characteristics. These include gender, year of birth, race, whether a student received free or reduced lunch, whether a student is coded as special education student, and whether a student ever repeated a grade. Regressions in columns 2 and 4 additionally control for grade 5 school characteristics. These include cohort size, average teacher experience, average teacher salary, percent of new instructional staff, student/teacher ratio, expenditure per student, and incidence of crime and violence. Standards errors (in brackets) are clustered by school attended in grade 6.

Table 10: Mean Characteristics by School Type (Survey Data)

	Elementary	Middle	K-8	p-value of middle-k8 difference
Length of school Day (minutes)	378.00	398.14	393.30	0.36
Index measures of school policies (Mean=0, SD=1)				
policies to help low-performing students	0.06	0.10	-0.01	0.45
policies to improve low-performing teachers	0.05	-0.04	-0.16	0.40
incentives to reward teacher performance	-0.04	0.11	-0.06	0.23
extent of teacher autonomy	0.01	-0.05	-0.05	0.98
Scheduling and Staffing (share of schools using...)				
block scheduling	0.35	0.34	0.38	0.64
common preparation periods	0.93	0.81	0.70	0.09
subject matter specialist teachers	0.64	0.58	0.58	0.97
teachers organized into teams	0.97	0.92	0.76	0.00
looping	0.44	0.14	0.31	0.00
multi-age classrooms	0.29	0.42	0.47	0.50
School climate (average agreement, 1-5 scale)				
staff morale is low	1.70	1.98	1.84	0.36
staff support/encourage each other	4.30	4.11	4.29	0.14
teachers understand expectations	4.45	4.27	4.32	0.60
new teachers are excellent	3.84	3.65	4.00	0.00
veteran teachers are excellent	4.07	3.94	4.13	0.11
student disruption interferes with learning	1.97	2.39	2.25	0.38
parents worry about violence	1.52	2.07	1.45	0.00
parents monitor academic progress	3.26	3.14	3.29	0.33
N	1,178-1,210	377-429	46-56	

Note: Average characteristics by school type are based on a principal survey conducted in 2004. Length of school day is measured in grade four for elementary schools and grade seven for middle and K-8 schools.

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

	Normalized achievement scores, relative to students not entering middle school			
	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 not entering middle school			
	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.