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One course, many outcomes: A multi-site regression discontinuity analysis of early Algebra across California middle schools

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Abstract

We identify 510 California public middle schools (and 753 school-years) that use a 7th grade achievement threshold to place students into 8th grade Algebra, and we use these schools to estimate fuzzy regression discontinuity effects of 8th grade Algebra placement. We find that enrolling in 8th grade Algebra boosts students' chances of taking advanced math courses in high school by 30 percentage points in 9th grade and 16 percentage points in 11th grade, as well as boosting achievement on the 10th grade math California High School Exit Exam by .031sd (ITT) and .053sd (LATE). Eighth-grade algebra has a smaller, positive effect on student ELA achievement in grades 9 through 11. Importantly, we also find that the effects of 8th grade Algebra vary substantially across students and schools. Encouragingly, women, students of color, and English-Language Learners benefit disproportionately from access to accelerated coursework. However, school-level decisions about how to implement accelerated coursework in middle school appear to matter. In particular, we find that the benefits of 8th grade algebra are substantially larger in schools that enroll students whose 7th grade math scores are at least "Proficient" (or grade level).

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Introduction

Between 1990 and 2015, the proportion of eighth graders in U.S. public schools enrolled in Algebra or a more advanced mathematics course more than doubled to 44 percent. This increase was particularly pronounced in California, where 8th grade Algebra enrollment rates peaked at 68 percent in 2013 in the wake of a decades-long policy effort to make Algebra the default mathematics course for 8th graders. The push to enroll more students in 8th grade Algebra is predicated on the idea that exposing students to more advanced material accelerates their skills acquisition (Kurlaender, Reardon, & Jackson, 2008; Allensworth et al., 2014) and improves their labor market outcomes (Goodman 2019). Yet evidence on the effects of course acceleration is mixed. Both high-achieving and low achieving students can thrive in well-designed Algebra classrooms (Heppen et al. 2012, Cortes, Goodman, & Nomi 2015). However, recent quasi-experimental evaluations suggest that, on average, Algebra policies administered at scale have modest or even negative average effects on students' mathematics achievement (Clotfelter, Ladd, & Vigdor, 2015; Domina, McEachin, Penner, & Penner, 2015; Dougherty, Goodman, Hill, Litke, & Page 2017).

In this paper, we argue that in order to understand the effects of 8th grade Algebra courses, it is essential to explicitly model cross-school variation in the effects of course exposure. Schools differ considerably in the ways they approach 8th grade Algebra (Rickles 2011; Domina, Hanselman, Hwang, & McEachin, 2016). We thus expect the effects of 8th grade Algebra exposure to vary considerably across schools. We use data from all 8th graders in California public schools in the 2007-8 to 2010-11 school years to identify 510 schools in which students' rates of enrolling in 8th grade Algebra varied discontinuously at a threshold in the 7th grade math test score achievement distribution in at least one school year, for a total of 753 school-year sites.

We then use a fuzzy regression discontinuity design to examine the average local effect of 8th grade Algebra on achievement and course-taking outcomes, as well as the extent to which these effects vary across schools and student demographics. Our analyses indicate that the average effects of 8th grade Algebra enrollment on students' advanced math course enrollment are substantial and positive, while the average effects on mathematics and ELA test scores are modest. Importantly, however, we find substantial cross-school variation in the achievement effects of 8th grade Algebra. For example we find that 38 percent of the site-specific effects of 8th grade algebra on students' math achievement on the 10th grade California High School Exit Exam (CAHSEE) are negative. Descriptive analyses suggest that the effects of early Algebra placement trend positive in schools that set high test score thresholds for enrolling in 8th grade Algebra, as well as schools with larger shares of relatively high-achieving and socioeconomically advantaged students. Encouragingly, we find that women, students of color, and English-Language Learners benefit disproportionately from access to accelerated coursework.

Our paper makes two major contributions. First, we contribute to the educational policy literature by providing unbiased estimates of the effects of accelerated coursework drawn from a wide range of educational settings, as well as how these effects vary across school contexts and students. Several studies indicate that enrolling in advanced courses improves students' achievement and their likelihood of success in higher education and in careers involving advanced quantitative skills net of a rich set of observational controls (Attewell, & Domina, 2008; Long, Conger, & Iatarola, 2012; Gamoran et al., 1997; Gamoran, & Hannigan 2000; Rose, & Betts, 2004; Schmidt et al., 2001, 2012; Stein, Kaufman, Sherman, & Hillen, 2011). However, a range of confounding factors potentially bias these observational estimates. The handful of existing experimental and quasi-experimental studies, meanwhile, provide a remarkably uneven accounting of the effects of 8th grade Algebra assignment, with experimental analyses from one setting returning positive test score effects of nearly 0.4 standard deviations (Heppen et al., 2012) and quasi-experimental analyses from another setting returning negative test score effects of nearly 0.5 standard deviations (Clotfelter, Ladd, & Vigdor, 2015). Interpreted as reasonably well-identified upper- and lower-bound estimates, this body of research would seem to suggest that the effects of 8th grade Algebra vary substantially across time and place.

Second, we combine a regression discontinuity design with methods developed to measure cross-site variation in multi-site research settings. Much like the North Carolina district that Dougherty and colleagues study (2015, 2017), several of California's largest public school districts call on schools to place students in 8th grade algebra who scored above a set threshold on the 7th grade mathematics California Standards Test (CST). Fresno and Long Beach Unified, for example, mandated that students who scored higher than 325 (halfway between "Basic" and "Proficient") on the 7th grade CST be placed in Algebra as 8th graders. This approach garnered substantial attention among educators across the state (Marsh, Bush-Mecenas, & Hough, 2017). If implemented with fidelity, such formula-based placement policies provide an opportunity to apply regression discontinuity methods to estimate the effects of advanced course enrollments. Such analyses hinge on the assumption that in the absence of the formula-based assignment there would be a continuous relationship between prior CST scores and later outcomes for students across the prior-CST distribution. Discontinuities in that relationship at the assignment threshold thus provide a "good as random assignment" (Lee & Lemieux 2010) signal regarding the effects of 8th grade Algebra assignment on student achievement (Imbens & Lemieux 2008).

In the typical application of regression discontinuity methods, however, the researcher knows the location of the placement threshold. While we are aware of policies in approximately 37 schools that use 7th grade test scores to place students in 8th grade Algebra, there approximately 1500 schools serving middle school grades in California in any given year, many of which likely use similar placement strategies. We build on the work of Card, Mas, & Rothstein (2008) to empirically identify settings in which assignment practices facilitate regression discontinuity analyses. We then take advantage of the fact that we are estimating regression discontinuity analyses in multiple settings to explicitly model variation in the effects of 8th grade Algebra across schools (e.g. Raudenbush, Reardon, Nomi, 2012).

Cross-site effect heterogeneity is a common phenomenon in a policy landscape defined by federalism and local discretion. Prior research documents substantial site-level variation in the effects of multiple policy interventions, including early childhood education (Bloom & Weiland, 2015), charter schools (Angrist, Pathak & Walters 2013; Clark Tuttle et al. 2015), and welfare-to-work programs (Bloom, Hill, & Riccio 2003). There is good reason to expect similar effect heterogeneity in our setting. Approximately a quarter of California middle schools enrolled virtually all 8th graders in at least Algebra and while a quarter reserved 8th grade Algebra for a small group of high-performing students (Domina et al., 2016). These disparate placement rates reflect differences between educators who believe “it’s better to challenge kids” and those who “don’t want students to be in a class where they’re…not going to be successful” (Rickles, p. 508). In line with earlier evidence suggesting that high-achieving students benefit more than lower-achieving students from advanced courses (Clotfelter, Ladd, & Vigdor 2015; Domina, 2014; Simzar, Domina, & Tran, 2016), we find that the effects of 8th grade Algebra are most positive in schools that restrict access to the course to relatively high-achieving students.

Data

Our analyses use data provided by the California Department of Education (CDE) describing all 6th through 11th graders enrolled in California public schools between the 2005-06 to 2012-13 school years. From these data, we create a panel of four cohorts of 8th graders who completed 8th grade between the 2007-08 and 2010-11 school years, which allows us to follow them from 6th through 10th grade (and 11th grade for the first three cohorts). In these years, the California Department of Education was culminating a decades-long policy effort aimed at broadening students' access to 8th grade Algebra, a course once reserved for a relatively small proportion of high-achieving students. In 2008, the state declared Algebra the "sole course of record" for accountability in 8th grade mathematics, threatening schools with accountability penalties for enrolling 8th graders in pre-Algebra or other less advanced courses. Court actions and the state's 2010 move to the Common Core State Standards prevented the Algebra-for-all policy's full implementation. However, these policy efforts induced California middle schools to develop new approaches to middle school mathematics course placements.

Our administrative data include students' 6th through 11th grade California Standards Test (CST) subject identifiers and scores, 10th grade California High School Exit Exam (CAHSEE) scores, as well as basic student-level demographics and school and district identifiers. The CSTs, administered each spring for accountability purposes, are designed to measure student mastery of state academic standards. Students take an end-of-grade ELA CST in grades 3 to 11. By contrast, math CSTs are course-specific. While virtually all California students take the same grade-level CST annually through the 7th grade, 8th graders who enroll in Algebra take the Algebra CST and 8th graders who enroll in pre-Algebra take the 8th grade General Mathematics CST. As such, the test identifier associated with students' 8th grade math CST provides information on students' 8th grade math course enrollment.[2] Table 1 provides a descriptive summary of these data.

Since our analyses hinge on the association between 7th grade CSTs and 8th grade course placements comparing students in algebra to a general math course, we exclude students who take the Algebra CST as 7th graders and students who take end-of-grade tests designed for students with severe learning disabilities (collectively this is approximately 17 percent of the 8th grade population).

Methods

Student selection into Algebra is likely driven by a number of observed and unobserved factors. In this paper, we implement an augmented regression discontinuity design to estimate the exogenous local average treatment effect (LATE) of 8th grade Algebra on students' math and ELA achievement and high school math course-taking. Such a design is ideally suited to a scenario in which schools and districts place students into 8th grade Algebra using an explicitly articulated system based on observable factors, such as students' 7th grade math achievement. However, while California incentivized Algebra enrollment over the 1990s and 2000s, the state did not implement a universal enrollment policy nor did it require schools and districts to report how they enrolled students in 8th grade Algebra. As a result, we observe pronounced heterogeneity in middle school math placement policies and practices across the more than 300 districts and 1500 schools that serve California middle school students (e.g. Domina et al., 2016). Since several California districts had stated policies of placing students into 8th grade courses

[2] Although course-enrollment data are not publicly available for all California public school students, analyses of data from one large California public school district indicates that end-of-course tests provide a highly reliable proxy for course content. In this district, approximately 99% of eighth graders who enroll in pre-Algebra courses take the eighth-grade General Mathematics California Standards Test (CST). Similarly, 99% of students in Algebra I courses enroll in the eighth-grade Algebra CST. Analyses of data from another large California public school district point to a similarly high level of correspondence between course enrollment and end of course CST completion (Taylor, 2011).

based on a 7th grade test score threshold, we search across the state for test score based assignments. However, even in districts with explicit policies the implementation of these threshold-based assignment mechanisms varied across schools: some schools followed the district guidelines, others adapted them by moving the cut score, and still others ignored the guidelines altogether.[3] As such, we focus our paper on school-based regression discontinuities.

Identifying discontinuities in 8th grade Algebra assignments

We implement an algorithm to identify settings in which students' likelihood of 8th grade Algebra placement varies discontinuously based on 7th grade math CST scores, using data from each of the 1,479 California schools that enrolled at least 50 8th graders in a given cohort. Separately for each of the school-year combinations, we conduct a series of first-stage linear probability OLS regressions:

$$Alg_{it} = \beta_0 + \beta_1 1[CST_{i,t-1} \geq x] + \beta_2(CST_{i,t-1} - x) + \beta_3 1[CST_{i,t-1} \geq x] * (CST_{i,t-1} - x) + \epsilon_{it}. \quad (1)$$

In each run of Model (1), Alg_{it} is a dichotomous variable distinguishing students who enroll in 8th grade Algebra from students who enroll in grade-level General Mathematics in year *t*, and *CST* is student *i*'s score on the 7th grade math CST in year *t-1*. Because the CSTs in all subjects and grades are discrete, we prefer a linear-spline functional form for (1) and we cluster our standard errors at the school-level (Gelman & Imbens, 2014; Lee & Card, 2008).[4] For each potential threshold *x*, we restrict our search to iterate across potential thresholds from 295 to 355, a range that includes two key policy relevant thresholds "Basic" (score of 300) and "Proficient"

3 We do not have detailed information about the reasons schools adapted or ignored the guidelines. But it is likely schools faced capacity or human capital constraints in the number of algebra teachers or classrooms available.
4 The results are more conservative with a quadratic functional form. But based on an inspection of the data, and that most quadratic terms in the school specific regressions are not statistically significant, we prefer the linear specification. Results from the quadratic specification are available upon request.

(score of 350), and also restrict (1) to students within +/- 75 points of *x* (roughly 1sd on the 7th grade math CST).[5]

For each iteration, we store: 1) The magnitude of the discontinuity in the rate of Algebra placement at the assumed cut point, β_1; 2) the amount of variance explained, R^2, by (1) when CST=*x*; 3) the location of the assumed discontinuity, *x*; 4) the t-statistic for the simple test $\hat{\beta}_1 = 0$; and 5) the percent of students in Algebra at the right- and left-hand side of *x*, estimated from the model. Hansen (2000) demonstrated that the value of *x* which maximizes the R^2 from (1) identifies a break in the forcing variable. Following prior applied work (Andrews, Imberman, & Lovenheim, 2017; Bertrand, Hanna, & Mullainathan, 2010; Chay, McEwan, & Urquiola, 2005; Goodman, Hurwitz, & Smith, 2015; Pan, 2015; Steinberg, 2014), we use this value of *x*, which represents an estimated structural break in the likelihood of treatment conditional on a continuous forcing variable, in a traditional fuzzy RD framework.

While we execute the search process and estimate $\widehat{\beta_1}$ across all schools, we cannot use the full sample to estimate the test-statistic for $\widehat{\beta_1} = 0$ since doing so could overidentify RD schools (Card et al., 2008; Hansen, 2000; Pan, 2015). To ensure that the thresholds we identify are meaningful we bootstrap confidence intervals for $\hat{\beta}_1$ at *x* for each school-year combination (Pan 2015). Specifically, we resample students with replacement within a given school-year to create 1,000 bootstrap replicates, and estimate (1) at the proposed algebra cutoff (i.e., *x*) and store $\hat{\beta}_1$each time. We then calculate 99 percent confidence intervals from the empirical

[5] The range of possible CST scores runs from 150 to 600. Scores were also given performance labels: Far Below Basic is 150 to 256, Below Basic is 257 to 299, Basic is 300 to 349, Proficient is 350 to 413, and Advanced is 414 to 600. Students who scored above 350 are considered to be at grade level. We limit our search to scores between 295 and 355, as the density of the 7th grade math CST thins out above and below these limits.

distribution of the 1,000 $\hat{\beta}_1$ for each school-year setting.[6] We consider a school-year combination in which the 99 percent confidence interval for β_1 does not include 0 to be a school in which students' likelihood of 8th grade Algebra placement varies discontinuously at a threshold *x* in a given year. We use these discontinuities to estimate the effects of 8th grade Algebra assignment in each school-year combination.

Of the 1479 schools (and 4469 school-by-year units) in the search sample, we initially identify 972 school-year settings (in 603 unique schools) that use a course placement system in which students' placement rates vary discontinuously at a threshold on the 7th grade math test score distribution and pass our bootstrap test. In Table 1 we provide a descriptive comparison of California middle schools in which we find evidence of discontinuous 8th grade math course assignment based on 7th grade test scores (RD schools) and our non-RD schools. Table 1 further distinguishes between our initial RD search sample that includes the 972 school-year sites that pass the bootstrap test and our main analytic "trimmed sample" that includes only the 753 school-year sites that also pass a placebo test (discussed shortly). Sixth and 7th grade math and ELA scores are approximately 0.15 standard deviations lower in RD schools than in non-RD schools. Further, RD schools have larger shares of Hispanic and lower socioeconomic status students, and fewer White students compared to non-RD schools.

As a first test on the validity of our search process, we pool all of the possible RD schools into a single data set, re-centering each RD around the school-year specific cutoff. We then use this pooled data set to estimate Model (1) to examine the overall magnitude of the pooled first stage, which we report in the first column of Panel A in Table 2. On average, there is a 41

6 To ensure that our results are not sensitive to the specific thresholds we use to determine whether schools are RD schools, we also estimate our models using one- and two-tailed 95 and 99 percent confidence intervals. We find similar results across these groups of schools.

percentage point difference in the likelihood of taking algebra in 8th grade for students just above their school-year specific threshold compared to students just below their school-year specific threshold.

TABLE 2 ABOUT HERE

In Column 2 of Panel A (Table 2), we report the results of an adapted McCrary test to see if there is bunching or manipulation of students' test scores around the discontinuity (McCrary, 2008). For each school-year we collapsed our data down to the individual CST score. In this case, each cell represented the number of students who received a given score (e.g., 300) in a given school-year combination. We then estimate (1) using these cell counts as dependent variables. While statistically significant, the results suggest that the difference in cell size between scores just to the right and left of the cutoff differ only by .282 of a student.[7]

In the rest of the Columns in Panel A, we report the results of placebo RDs that use students' prior achievement, demographics, and completion of the 10th grade CAHSEE as dependent variables. Differences in student characteristics at RD thresholds may indicate endogenous placement of students at the margin of either side of the cutoff, or an endogenous selection of where to locate the placement threshold. Potentially most problematic to our analysis, students just above their school-year specific cutoff score .02 to .05 standard deviations higher on their 6th and 7th grade ELA and 6th grade math CST compared to students just below their school-year specific cutoffs (these test scores are standardized by grade, subject, and year). In this case, however, manipulation of student test scores is unlikely since such manipulation would require educators to alter student scores in administrative record databases, or alter student responses on 7th grade tests based on a precise awareness of the 7th grade math threshold and

[7] We also ran the density test suggested by Cattaneo, Jansson and Ma (2018) using the Stata program -rddensity- which likewise suggests that bunching is not a substantial concern (p=.53).

students' 6th grade math test score (as well as students' 6th and 7th grade ELA scores). Similarly, while it is possible schools could try to pick a 7th grade math test score for their cutoff such that a handful of students above the threshold did better on 6th (and do better on their 7th grade ELA CSTs) than students just below the cutoff, this also seems unlikely.

We address the discontinuity in students' prior achievement by first averaging students' 6th grade math and ELA CSTs and 7th grade ELA CST into a single test score. We then re-run Model (1) separately for each of the 972 school-year combinations that passed the bootstrap test, using students' averaged prior achievement as a dependent variable. For each site specific regression, we store the p-value for the t-test that $\hat{\beta}_1 = 0$. We remove from the sample schools with a p-value<=.2 (i.e., schools that exhibit some evidence of having a statistically significant discontinuity in students' prior achievement at the estimated threshold).[8] We identify 753 school-year settings (in 510 unique schools) that pass this placebo test, which we call the "trimmed sample." In Panel B of Table 2, we report the results for the first stage (Column 1), the adapted McCrary test (Column 2), and the placebo regressions (Columns 3 to 13). The discontinuity in students' 6th grade math CST scores at the school-year specific thresholds has decreased but is still statistically significant while the discontinuities in students' 6th and 7th grade ELA scores have disappeared. We do not think the small difference in 6th grade math scores is due to human manipulation, and the difference does not appear to reflect meaningful unobserved differences between students just above and below the cutoff. In Appendix A we present our main results using our full sample, including specifications which directly control for students 6th grade math CST.

[8] We chose .2 as a conservative p-value given the small sample sizes in some school-year cells. Our main results are similar if we choose a less conservative value (e.g. .05).

In Figure 1 we show the pooled first stage for our trimmed sample. The relationship between 7th grade test scores and algebra placement in 8th grade appears linear with a noticeable jump at the estimated school-year cutoff. In Figure 2 we show the distribution of estimated 7th grade cutoffs. It is notable that this distribution has sizable spikes at 300 and 350, the state's threshold for labelling a students' mathematics skills "Basic" and "Proficient." In these schools, students who score 299 on the 7th grade math CST (and whose mathematics skills thus rated as "Below Basic" by state law) are substantially less likely to be placed in 8th grade Algebra than students who score 301 (and whose mathematics skills are thus rated "Basic"). The histogram reveals a similar spike at 350 – the state's proficiency threshold. In addition, we observe a smaller spike at 325, the threshold that Fresno and Long Beach Unified articulated in their explicit district-wide 8th grade Algebra placement policies. Indeed, more than half of the schools that we identify as regression discontinuity settings have placement thresholds at one of these three accountability policy-relevant points in the 7th grade math CST score distribution. We present a version of our results limiting our search to schools that have a discontinuity point at 300, 325, or 350 in Appendix A.

FIGURES 1 AND 2 ABOUT HERE

In Table 3 we present statistics from the RD search algorithm for non-RD schools, the schools that passed the bootstrap test (i.e., the "initial RD sample"), and the trimmed sample of RD schools (the schools that also passed the placebo test). As noted above, in order for a school-year to be identified as a regression discontinuity setting, students' rates of 8th grade mathematics course enrollment must vary discontinuously at a point in the 7th grade mathematics test score distribution. RD schools had a much larger first stage coefficient (.48 compared to -.004), R^2 (.57 compared to .35), and t-statistics (5.4 compared to -0.08) from Model (1). Each of these comparisons is consistent with the conclusion that our RD search algorithm flagged school-year settings that use substantially different approaches to placing students in 8th grade Algebra than the non-RD schools.

TABLE 3 ABOUT HERE

Estimating the effects of 8th grade Algebra assignments

Since our search algorithm identifies many school-years in which compliance with treatment is not absolute, we use fuzzy regression discontinuity models to estimate the effects of 8th grade Algebra assignment in these sites (Trochim, 1984; Hahn, Todd, Van der Klaauw, 2001). These models make three key assumptions: (1) selection into 8th grade math courses is strongly determined by the placement formula; (2) students and teachers are unable to control students' location on either side of the cutoff; (3) potential outcomes are a continuous function of the assignment variable at the cutoff (such that a student who scored 400 on a 7th grade math achievement test is not appreciably different from a classmate who scored 399 on the same test). If these assumptions hold, our discontinuity analyses provide internally valid estimates of the causal effects of 8th grade Algebra for students near the threshold in each of these schools (Imbens & Lemiuex 2007; Lee & Lemiuex 2010; McCrary 2008).

A typical fuzzy RD design will predict treatment participation as a function of a forcing variable and an exogenous cutoff, and then use predicted treatment in a second stage model to estimate the Local Average Treatment Effect (LATE) of a policy or program on an outcome of interest. While our analyses follow these general steps, we also want to account for the potential treatment effect heterogeneity across our 753 school-year RD sites. One approach to estimating the effects across sites is to pool cases across these school-year RDs into a single RD analysis. However, as Cattaneo, Keele, Titiunik, Vazquez-Bare & Keele (2016) note, substantial information about effect heterogeneity is lost by simply pooling estimates into a single state-wide (re-centered) regression discontinuity.

We therefore use a method developed by Raudenbush, Reardon, & Nomi (2012) that uses site-specific intercepts (i.e. fixed-effects) and random coefficients to account for treatment effect heterogeneity in multi-site research settings. Their approach has two benefits over simply pooling our data into a single fuzzy RD and ignoring heterogeneity. First, their approach generates a weighted LATE where the weight is a function of both treatment participation compliance and the precision of site-specific LATEs. Second, the method estimates the variance of treatment effects across sites.

The first step in our fuzzy RD method is to estimate Model (1) separately for each school-year RD site and estimate $\widehat{Alg}_{ist}$.[9] With these predictions in hand, we pool our data centering the forcing variable around school-year specific cutoffs and estimate the following second-stage model:

$$Y_{is,t+p} = \delta_0 + \delta_1 \widehat{Alg}_{ist} + \delta_2 \left(CST_{is,t-1} - x\right) + \delta_3 1\left[CST_{is,t-1} \geq x\right] * \left(CST_{is,t-1} - x\right) + \alpha_{st} + \eta_{is,t+p}. \quad (2)$$

In Model 2, we estimate the outcome of interest for student *i*, in school *s*, at time *t*+*p* (where *p* is the number of years since 8th grade in time *t*) as a linear function of their predicted algebra participation ($\widehat{Alg}_{ist}$), the forcing variable (i.e. the distance between their 7th grade math CST and the school's placement threshold, $\left(CST_{is,t-1} - x\right)$); an interaction between indicator variable for scoring above the school's cutoff and the forcing variable ($1\left[CST_{is,t-1} \geq x\right] * \left(CST_{is,t-1} - x\right)$); and a school-year fixed-effect (α_{st}). Our coefficient of interest (δ_1) captures the pooled LATE

9 This is equivalent to estimating Model (1) over our pooled data set with *k* instruments, where *k* is equal to the number of school-year RD sites.

effect of participating in 8th grade algebra on students' outcomes across all RD sites. Our dependent variables include measures of advanced math course-taking in high school, high school math achievement, and middle and high school ELA achievement. For advanced course-taking, we measure whether students completed Geometry in 9th grade, Algebra II in 10th grade, and an advanced math course in 11th grade (e.g., pre-calculus).

Following Raudenbush, Reardon, and Nomi (2012), we estimate Model (2) as a mixed model with site specific intercepts (our school-year fixed effects α_{st}) and a random coefficient for our coefficient of interest (i.e., $\delta_1 \sim N(\delta_1, \tau_\delta^2)$ where $\delta_1$is the mean LATE across RD sites and τ_δ^2 is the estimated variance of the site-specific LATEs). Model (2) will produce a consistent estimate of δ_1 if the heterogeneity in cross-site treatment compliance is not correlated with cross-site treatment effects. We cluster our standard errors at the school-year level. In Appendix B we present the results of our fuzzy RD analysis using a number of alternative estimation techniques and samples.

Results

Figures 3 and 4 present our reduced form (or Intent to Treat) scatter plots for two of our outcomes of interest: 10th grade math CAHSEE scores (Figure 3) and accelerated mathematics course-taking in 11th grade (Figure 4). A few patterns emerge. First, 7th grade math CST scores are positively correlated with students' 10th grade math CAHSEE achievement and 11th grade accelerated course-taking. Second, in both figures this relationship between 7th grade test scores and our outcomes of interest are approximately linear. Third, there is a small to moderate difference in 10th grade math CAHSEE achievement and 11th grade accelerated math course-taking for students just above the school-year algebra threshold compared to students just below the threshold. Fourth, while students just above the school-year specific threshold were 41 percentage points more likely to enroll in algebra in 8th grade, by 11th grade this difference appears to have fallen to approximately 7 percentage points.

FIGURES 3 AND 4 ABOUT HERE

In Table 4 we build on Figures 3 and 4 by presenting our ITT results of the effect of algebra on students' 10th grade CAHSEE achievement, HS course-taking, and ELA CST scores in Panel A and our two-stage fuzzy RD LATE results in Panel B. We also present the variance of our LATE estimates (τ_{δ}^{2}) in Panel B. We see in Panel B that students just above their school-year specific thresholds who completed algebra in 8th grade outscored their peers just below the threshold who completed general mathematics in 8th grade by .053sd (math) and .034sd (ELA) on the CAHSEE tests. We also find that placement in 8th grade Algebra increases student odds of completing advanced math courses in grades 9 through 11 (Columns 3 to 6). While these results are perhaps unsurprising given the hierarchical structure of high school mathematics course sequences, it is worth noting that more than half of California students placed into 8th grade Algebra repeat it in 9th grade (Liang, Heckman, & Abedi 2012). As such, it is reassuring to note that placement in 8th grade Algebra increases students' likelihood of 9th grade Geometry placement by nearly 30 percentage points, 10th grade Algebra II by nearly 20 percentage points, and 11th grade Trigonometry or Pre-calculus by 16 percentage points. Finally, we find evidence that taking Algebra in 8th grade had a small spillover effect on ELA achievement: We find consistent evidence of an effect of roughly .02 to .03sd on ELA achievement on CSTs in grades 8 through 11, as well as the 10th grade ELA CAHSEE. Although our data do not allow us to examine the mechanisms producing these spillover effects, it seems likely that they are driven by peer-effects, as prior research suggests that students in Algebra are more likely to take their ELA courses with other Algebra students as well. Appendix B reports results from supplemental analyses showing that these results are robust across multiple samples and alternative estimation methods (e.g., local linear regressions).

TABLE 4 ABOUT HERE

While the results in Table 4 provide useful information about the average benefit of 8th grade algebra for students near a school-year specific placement threshold, they may conceal substantial variation in the effects of 8th grade Algebra across diverse academic settings. The variance around our fuzzy RD estimates suggests wide variation in the school-year specific effects. For example, we find an average LATE of .053sd for math CAHSEE achievement with a $\tau_{\delta}^{2} = .025$ (or a standard deviation of .16), suggesting that 38 percent of the site-specific treatment effects are negative. In Figure 5 we graphically represent the wide distribution of positive and negative effects via a histogram and kernel density plot of empirical Bayes estimates from Model (2) for the 10th grade math CAHSEE; Figure 6 presents the analogous distribution for 11th grade math course-taking.

FIGURES 5 AND 6 ABOUT HERE

Cross-Site Heterogeneity

We next turn to examining cross-site heterogeneity. One important way in which the effectiveness of 8th grade algebra may vary across sites has to do with the location of schools' 7th grade math CST placement threshold. The location of the placement threshold may affect 8th grade algebra in a number of ways. First, many schools appear to use an accountability policy-relevant threshold (e.g. 300, 325, or 350), while others used thresholds in-between these scores. Our analysis of 8th grade algebra for the schools that use accountability policy-relevant thresholds may conflate both the effect of accountability performance labeling (e.g. Papay, Murnane, & Willett, 2016) and the effect of algebra. Second, while the identification of RD schools that use accountability policy-relevant thresholds in our search has strong face validity, it is less clear why schools would choose thresholds outside of these scores. Third, and finally, schools that use higher test score thresholds are reserving algebra for their most prepared students, while schools with thresholds toward “Basic” allow both more students to take algebra and more students with weaker math backgrounds. If the effects of algebra vary with student readiness or if the quality of algebra instruction varies with school norms about course provisions, the local effects of 8th grade algebra placement could vary. (See Appendix Table C.1 for basic demographic differences among schools with cutoffs at 300, 325, and 350).

FIGURES 7 AND 8 ABOUT HERE

We explore these possibilities graphically in Figures 7 and 8. In each of these figures we plot the site-specific treatment effects for 8th grade algebra on 10th grade math CAHSEE (Figure 7) and 11th grade advanced math course-taking (Figure 8) against schools’ 7th grade math CST thresholds. We fit a flexible local linear polynomial regression line in these figures.[10] If our estimates of the effects of 8th grade algebra conflate potential accountability effects at thresholds of 300, 325, and 350, we would expect to see noticeable peaks or valleys at these thresholds compared to the points in-between. However, we do not see a noticeable pattern between effects at 300, 325, and 350 versus the non-accountability policy-relevant points in either figure. While we are unable to document school specific reasons for the use of different 7th grade math CST thresholds, the lack of a systematic difference between schools using 300, 325, and 350 versus a cutoff in-between these points supports the use of all placement thresholds in our evaluation of 8th grade algebra.

[10] We use an Epanechniko kernel, local polynomial order of 1, and a bandwidth of 2 CST points.

Consistent with our earlier research (Domina, McEachin, Penner, & Penner, 2015; Domina, 2014) as well as work in Chicago (Allensworth, Nomi, Montgomery, & Lee, 2009) and North Carolina (Clotfelter, Ladd & Vigdor, 2015), the patterns in Figures 7 and 8 indicate that students benefit more from early Algebra assignment when access to the class is restricted to relatively high achieving students. The relationship between 8th grade algebra effectiveness and the algebra placement threshold is particularly striking when comparing students' likelihood of remaining on the advanced course-taking track in high school. By 11th grade students in the schools with cutoffs of at least 340 still maintained a 20 to 25 percent point advantage in the likelihood of taking advanced math, but this advantage is closer to five percentage points for students at the margin of algebra in a school with a cutoff near 300. In Appendix A we present similar figures for the rest of our main outcomes of interest. One finding of note in Appendix A is the negative relationship between 7th grade math CST thresholds and 10th grade ELA test scores, and the flat-to-negative relationship for 8th to 11th grade ELA CST scores.

While beyond the scope of this study, it is possible that while students near 300 on the 7th grade math CST are not ready to fully benefit from accelerated math instruction, they do receive general instructional benefits from taking course work with higher performing peers. In Appendix Table C.2 we report the demographics for students not in algebra and in algebra across the three accountability policy-relevant cutoffs. Interestingly, students who take algebra across the three cutoffs (i.e. 300, 325, and 350) have roughly the same within school standing on 7th grade math CST (approximately 6.5 decile), and while not shown, the same is true for students whose score is equal to the cutoff (approximately 5.3 decile). These results instead suggest that one likely driver of the differential effectiveness of 8th grade algebra is not necessarily a student's relative academic standing, but their prior math ability and readiness for more advanced curricula and whether the schools' instruction is prepared for students with below-grade-level math preparation. On average, students who take algebra in the schools with a cutoff of 300 look demographically more similar to those that did not take algebra in schools using a cutoff of 350.

We further test whether the relationship between algebra placement thresholds and students' HS outcomes is a by-product of the difference in student demographics across the thresholds. We estimate simple OLS regressions of site-specific effects of 8th grade algebra on three site-level demographics: 7th grade math CST threshold, share of students who are socioeconomically disadvantaged (SED) (an index created by the CDE which includes students who either qualify for free- and reduced-price lunch or whose parents have not received a high school diploma), and the 8th grade cohorts' average standardized 7th grade math CST scores. The results presented in Table 5 suggest that the patterns shown in Figures 7 and 8 hold even after controlling for student poverty and prior achievement. For example, going from a cutscore of 300 to 350 is associated with an increase in the average effect of 8th grade algebra of .02sd on the 10th grade math CAHSEE and 25, 20, and 15 percentage points on the likelihood of taking advanced math courses in 9th, 10th, and 11th grade.

Up this point our analysis has focused on the local effect of 8th grade Algebra on students' 10th grade CAHSEE achievement, HS math course-taking, and ELA achievement in grades 8 to 11, as well as how these effects vary across our RD sites. However, it is also important to understand how the effect of 8th grade Algebra varies across student subgroups, especially those who are less likely to be exposed to accelerated math curriculum.

TABLE 5 ABOUT HERE

Student-level Heterogeneity

In our final analysis we evaluate the effect of 8th grade algebra separately for male, female, Black, Hispanic, White, Asian, SED, non-SED, ELL, and non-ELL students; we report these results in Table 6. A few interesting patterns emerge. First, across all of the student subgroups that we examine, we find no evidence of a negative average effect of 8th grade Algebra on 10th grade math and ELA CAHSEE scores, HS math course-taking, and 8th through 11th grade ELA CST scores. Our results suggest that students who often do not get the same access to accelerated curriculum—female, minority, low-income, and ELL students—all benefit from Algebra in 8th grade. Second, across 9th to 11th grade, the positive effect of 8th grade Algebra on HS course-taking is larger for female students who completed Algebra in 8th grade than for their male peers. This effect is perhaps explained by previous research demonstrating that girls' mathematics course-taking decisions are highly responsive their peers' course-taking decisions (Riegle-Crumb, Farkas, & Muller 2006; Frank et al., 2008), so that initial placement in 8th grade serves in providing girls not only access to an advanced course trajectory, but also to a set of peers who influence later course-taking outcomes. To the degree that curricular choices in RD schools are driven less by student interest, parent pressure, and teacher evaluations, this finding is also congruent with research observing that highly standardized educational systems tend to have smaller gender gaps in mathematics (Ayalon 2002; Ayalon and Livneh 2013). Future research should explore whether the effects we observe here last through post-secondary education and into the labor market (e.g. Goodman, 2019).

TABLE 6 ABOUT HERE

Third, we also find important positive effects for Black students. Not only does 8th grade Algebra have a large positive effect on math CAHSEE scores for Black students (.15sd), but Black students assigned to 8th grade Algebra also experience large test score gains on the ELA

CAHSEE and the 8th through 11th grade ELA CST. On each of these outcomes, Black students thus receive greater benefits from enrolling in 8th grade Algebra than White students. If threshold-based assignment policies also narrow Black/White gaps in exposure to accelerated coursework (Dougherty et al. 2015), these policies may help to narrow Black/White achievement gaps through undermining racial segregation and opportunity hoarding within schools (Lewis and Diamond 2015). Likewise, the analyses reported in Table 7 indicate that the large benefits that ELL students receive from 8th grade Algebra on their math CAHSEE scores and HS math course-taking do not come at the expense of ELA achievement. In fact, ELL students who complete Algebra in 8th grade score .06 to .1sd higher on the ELA CAHSEE and CST. This underscores that ELL students' effort in advanced math courses does not detract from their mastery of English and performance on ELA tests.

We also estimated the student subgroup models separately by algebra cutoffs of 300, 325, and 350, and report the results in Appendix C. The patterns are largely consistent with the general finding that students do better in 8th grade Algebra when they are exposed to higher achieving peers (e.g., a cutoff near 350). Our heterogeneity findings highlight both the promise that efforts to enroll students in accelerated coursework holds for students and the challenges that schools face in successfully implementing these efforts. That is, on the one hand our results suggest schools with more stringent requirements for accelerated curriculum have better student outcomes. But students of color and from low-income backgrounds are less likely to enroll in these schools. On the other hand, students of color, women, and ELL students gain the most from accelerated curriculum. So although our findings suggest that schools should make a special effort to enroll traditionally underserved students in advanced courses; they suggest that placing lower performing students in accelerated courses can be risky. Balancing these two implications is a difficult task.

Conclusions

School systems have experimented with a number of different approaches to curricular intensification, and 8th grade Algebra in particular, over the past two decades. Our analyses estimates the causal effects of 8th grade Algebra on students' outcomes, finding evidence of small positive local average effects for achievement and larger positive local average effects on students access to subsequent advanced math courses. In addition, by documenting a substantial degree of heterogeneity across schools and students in the effects of early Algebra, our analyses provide deeper understanding of the contextual factors related to the success of curricular intensification. Before we highlight our key contributions to the field and policy implications of our findings, it is important to keep in mind our study's limitations.

First, while our examination of 8th grade Algebra uses a large data set from a large, diverse state, we lack data on the instructional or curricular mechanisms that contribute to the effects of 8th grade Algebra assignments and the variation in these effects across schools. Exploratory analyses indicate that textbook adoptions do not explain cross-school variation in the effects of 8th grade Algebra. However, we lack data on the extent to which teacher quality, classroom assignment practices, and status hierarchies vary with 8th grade Algebra assignment and across schools, for example. Future research can help clarify the extent to which these and other factors contribute to the variation in the effects of 8th grade Algebra.

Second, we note that important questions exist about the extent to which our findings generalize. We rely on a non-random sample of schools that appear to use 7th grade math CST scores to place students in algebra in 8th grade. These schools are on average lower performing and have larger shares of students of color and who are considered SED by the CDE. And while we know of some districts that used explicit placement thresholds (e.g. Fresno and Long Beach Unified School Districts), we can't distinguish between schools that a priori established a threshold from those whose thresholds were more a mechanical byproduct of space constraints in algebra classrooms.

With that said, our paper does extend the field in a number of ways, and has implications for future math acceleration policies. First, we provide quasi-experimental estimates of the local average treatment effect of 8th grade Algebra enrollments for thousands of students across a diverse set of California middle schools on a wide range of short- and medium-term academic outcomes. Our estimates of the local average treatment effects of early Algebra on student achievement are closer to zero than correlational estimates on nationally representative data (e.g. Stein et al., 2011), and are near the middle of the broad distribution of experimental and quasi-experimental estimates. Our analyses suggest that enrolling in 8th grade Algebra boosts students' math by approximately 0.05 standard deviations. These estimated effect sizes are more modest than experimental estimates from schools in rural New England (Heppen et al., 2012), but more positive than instrumental variable analyses from North Carolina in the 1990s (Clotfelter, Ladd, and Vigdor, 2015), and roughly equivalent to more recent regression discontinuity estimates from a single school district in North Carolina (Dougherty et al., 2017). Further, we find small, positive effects on students ELA test scores, suggesting that the benefits to students' academic achievement operate broadly beyond mathematics, perhaps due to peer effects. Finally, we find that enrolling in 8th grade Algebra substantially boosts students' advanced mathematics courses taking rates throughout high school, ultimately increasing students' likelihood of being on track to take Calculus in 12th grade by approximately 16 percentage points.

Our second contribution to the literature on curricular intensification is to document the pronounced heterogeneity in local average effects of early Algebra across California middle schools. Prior studies conceptualize early Algebra placement as a single treatment across the different schools being studied and focus on its average effect. By contrast, our analyses acknowledge that many key aspects of the early Algebra experience vary across school settings. In particular, we focus on the relationship between school-level variation in 8th grade Algebra course placement thresholds and the effects of 8th grade Algebra. In some schools, 8th grade Algebra is reserved for relatively high achieving students; in others, the course is open to students with a wider array of pre-Algebraic skills. This effect heterogeneity may help to explain the remarkable dispersion among experimental and quasi-experimental estimates of the effects of 8th grade Algebra. In light of the fact that Algebra placement has large positive effects in some California middle schools, large negative effects in others, and a range of effects in between, it is perhaps not surprising that well-estimated analyses of the effects of early Algebra in different settings yield different results. Treatment effect heterogeneity is a crucial, and crucially under-estimated, parameter for policy research. The degree of heterogeneity that we document here may not be unusual in education more broadly in the U.S., given that local actors have considerable discretion over whether and how to implement policy directives (Weiss et al. 2017). Modeling that treatment effect heterogeneity is an important first step toward better understanding policy implementation processes and their consequences.

Beyond documenting the heterogeneity in the effects of 8th grade Algebra placement across California middle schools, our analyses provide insights into the sources of this heterogeneity . These analyses are necessarily exploratory, as schools' decisions around policies like where to locate placement thresholds are not exogenous. Nonetheless, these analyses provide some descriptive evidence about the contexts in which early Algebra is and is not effective. We find that the effects of 8th grade Algebra tend to be more positive in schools that restrict access to Algebra to students who achieved relatively high scored on their 7th grade mathematics test scores, and in schools with lower shares of students who are considered SED by the CDE. Taken together, these analyses suggest that 8th grade Algebra is particularly effective at boosting the achievement of relatively high-achieving students in advantaged schools.

This variation across contexts has important implications for understanding the capacity of access to early Algebra course placement policies to narrow achievement gaps. While these results are necessarily impressionistic, they are consistent with the hypothesis that students need either a high degree of academic preparation or a substantial academic support to benefit from access to accelerated coursework. Future research could focus on separating the student, peer, and teacher factors that may drive the negative relationship between 8th grade algebra course-taking and high poverty schools. In doing so, our analyses draw attention to the importance of understanding effect heterogeneity and moving beyond one-size-fits-all accounts of curricular intensification. For example, Chicago public schools found success in a double-dose algebra curriculum for 9th graders that included a particular focus on instructional strategies for students with below-average prior achievement (e.g. Cortes, Goodman, & Nomi, 2015; Nomi, & Allensworth, 2013).

Third, our results also indicate that all students, particularly those who often have less access to curricular intensification, benefit from 8th grade algebra. We found important and policy relevant benefits of 8th grade algebra for female, Black, ELL, and SED students. For the students at the margin of algebra placement in our RD schools, 8th grade algebra served to help narrow important and persistent achievement and attainment gaps. Future research should focus on whether these benefits persist through post-secondary education and the labor market. However, in light of evidence establishing causal links between high school courses and labor market outcomes (Goodman, 2019), we suspect accessing 8th grade Algebra substantially influences students' life courses.

In addition to these empirical contributions to the literature on curricular intensification, our analyses have methodological implications for studies in a wide range of policy settings. The regression discontinuity design (RDD) is rapidly becoming a workhorse methodology for causal estimation in policy research. Regression discontinuity designs are particularly useful in educational research, where they provide opportunities to separate the effects of educational interventions operating at scale from potentially confounding selection processes while avoiding the expense, logistic challenges, and potential ethical issues surrounding randomized control trials. Traditional RD estimates are typically only possible in settings in which assignment to treatment conditions vary discontinuously at a *known* threshold in an observed forcing variable. In practice, this is a major limitation, since there are many settings where a treatment threshold is likely but unknown to the researcher. Applying a RD search algorithm to a setting where treatment placement discontinuities are likely to exist in other contexts may create opportunities for rigorous evaluation of the effects of a wide range of policy interventions.

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Figures

Figure 1: Scatter Plot of the Pooled First Stages for RD Schools

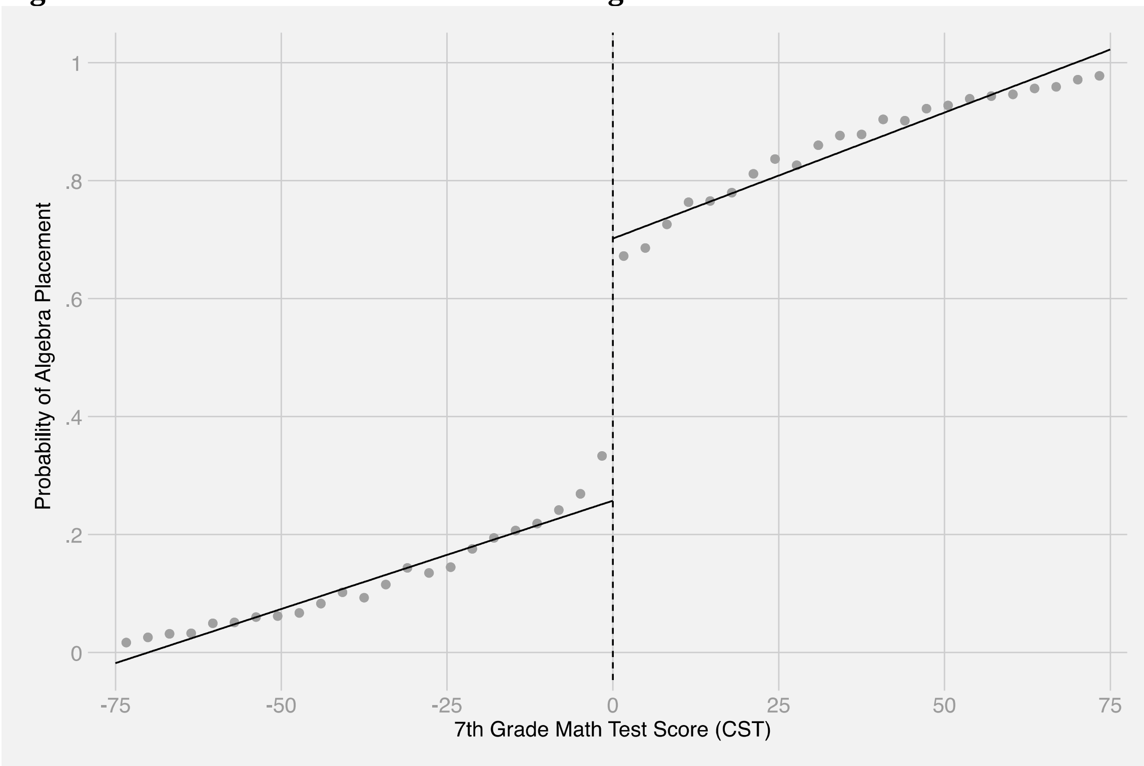


Figure 2: Location of Discontinuity Points for RD Schools

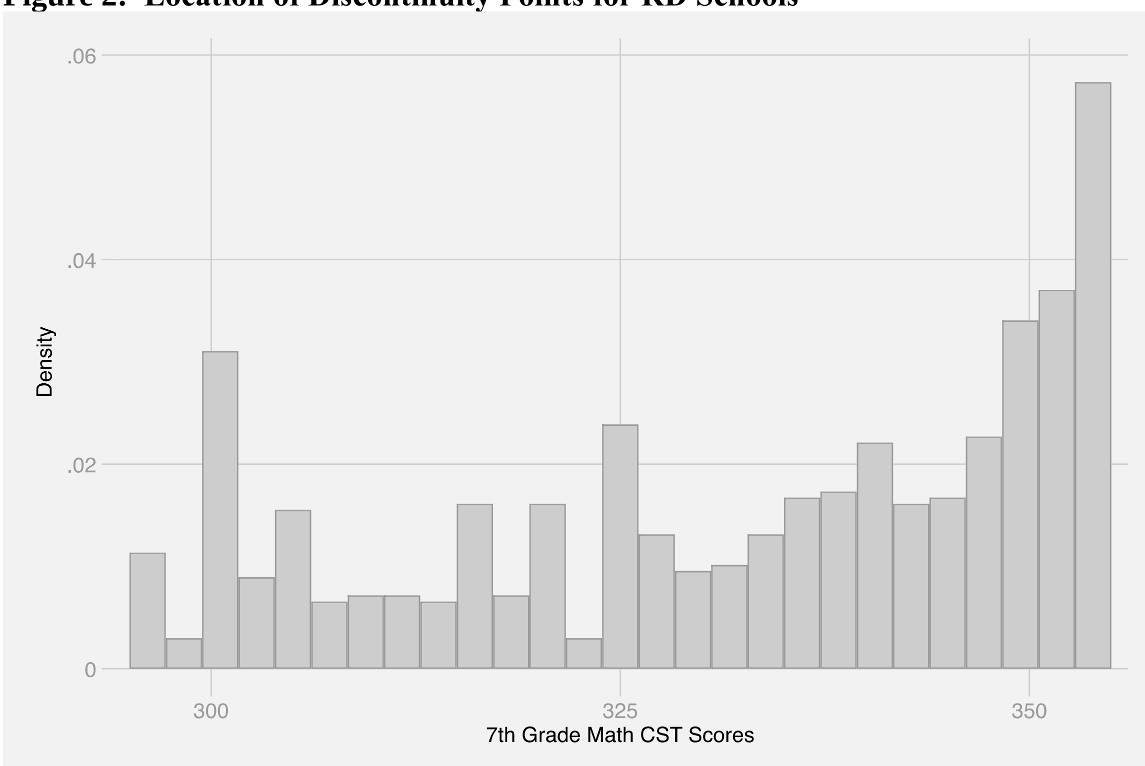


Figure 3: Scatter Plot of the Intent to Treat Effect of 8th Grade Algebra on 10th Grade Math CAHSEE

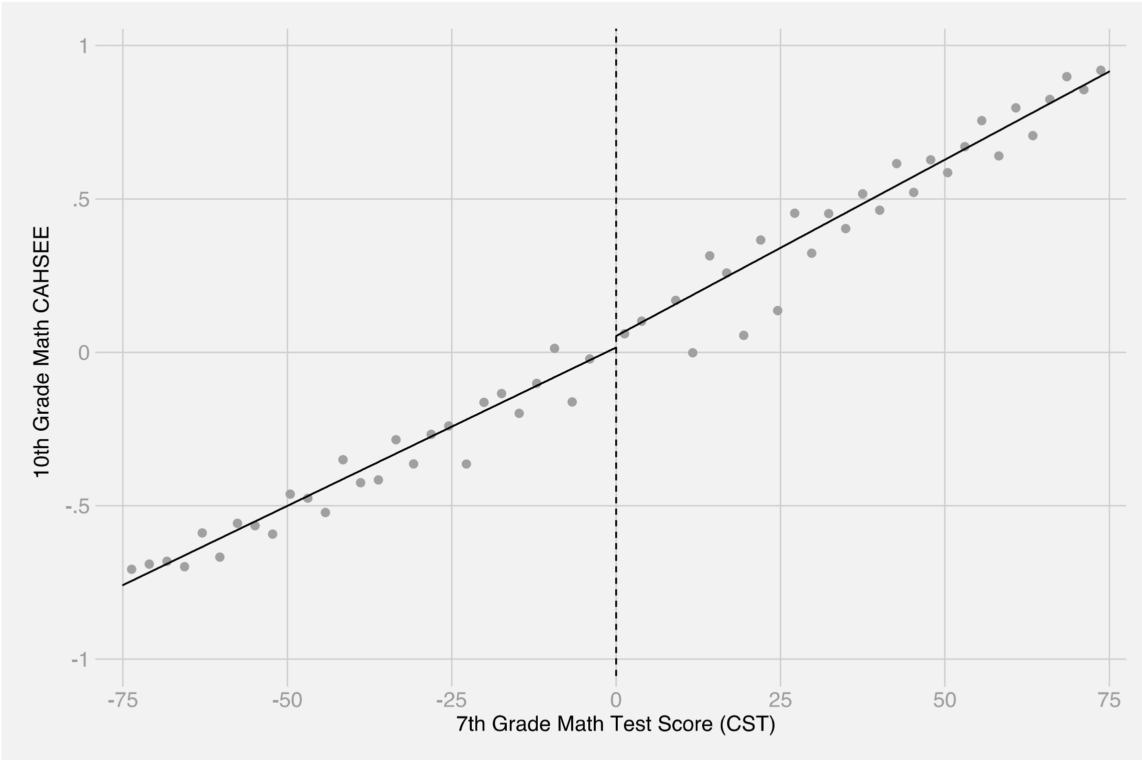


Figure 4: Scatter Plot of the Intent to Treat Effect of 8th Grade Algebra on 11th Grade Advanced Math Course-Taking

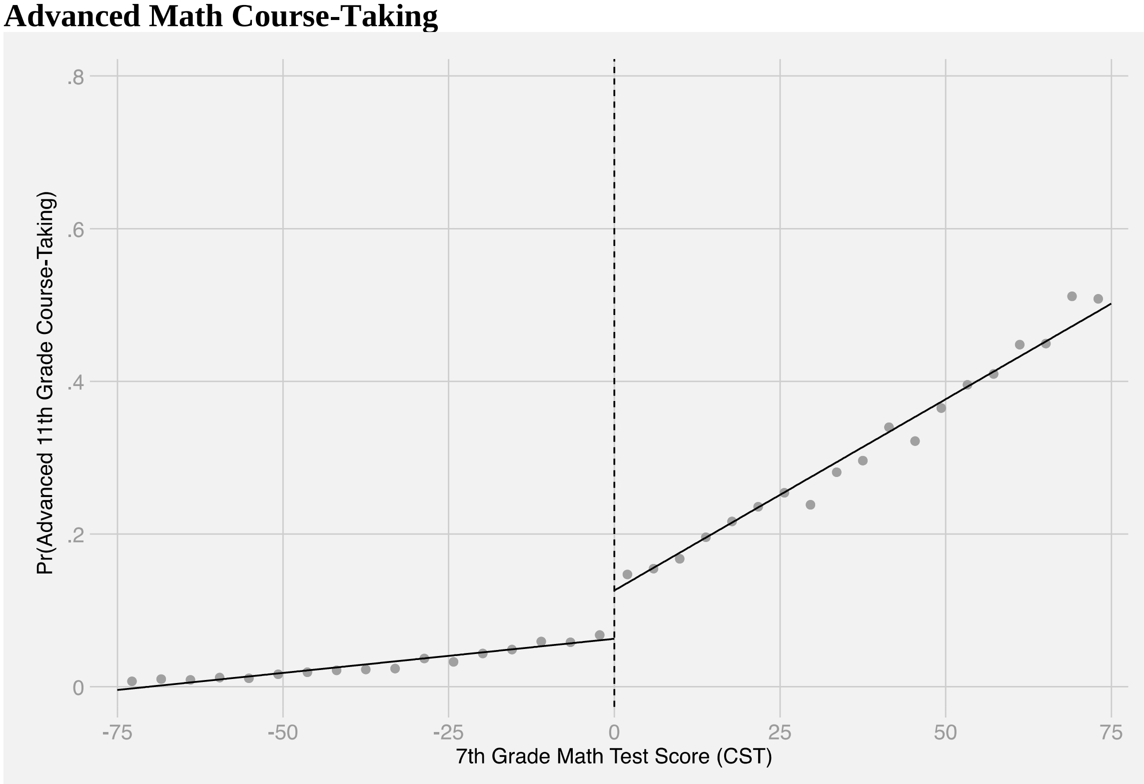


Figure 5: Distribution of the Site-Specific Fuzzy RD Estimates of 8th Grade Algebra on 10th Grade Math CAHSEE

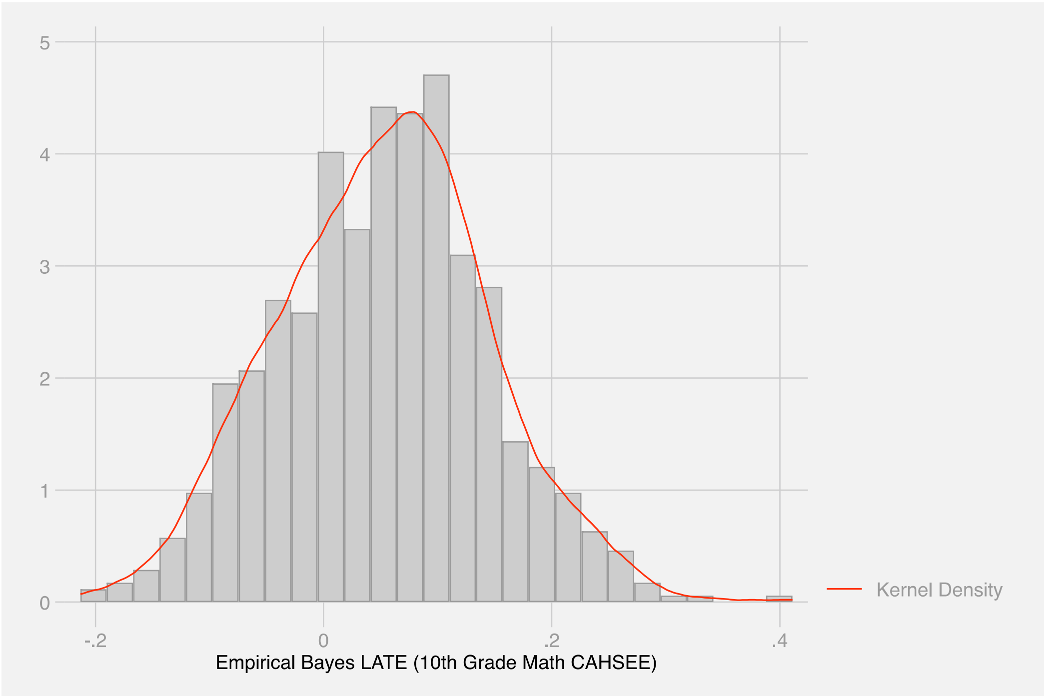


Figure 6: Distribution of the Site-Specific Fuzzy RD Estimates of 8th Grade Algebra on 11th Grade Advanced Math Course-Taking

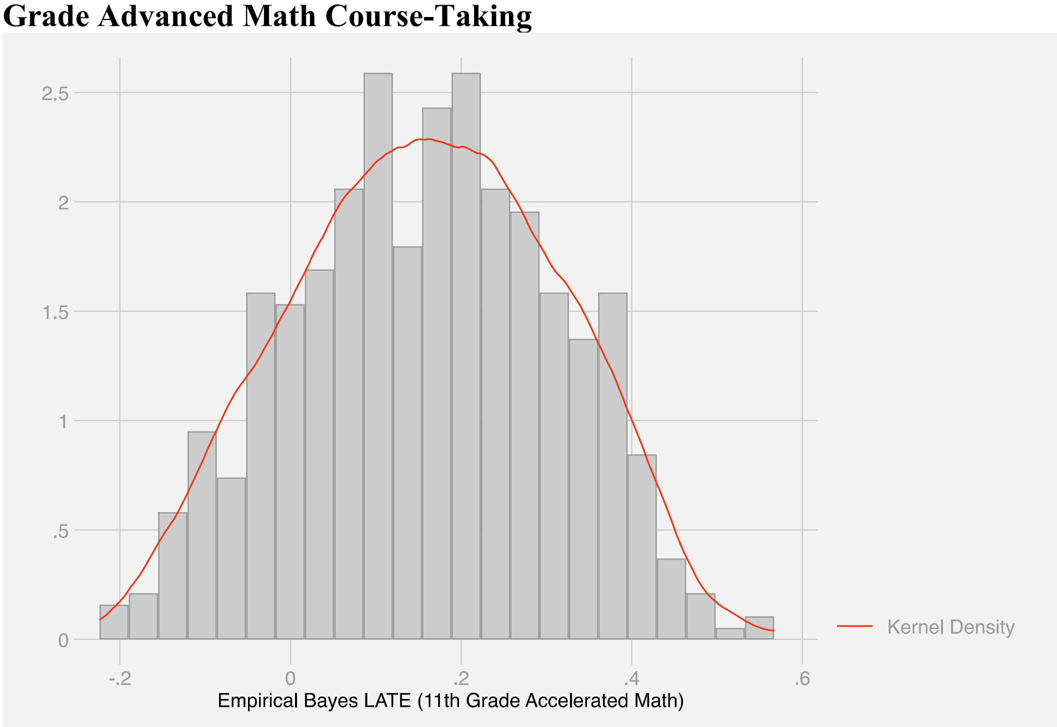


Figure 7: Scatter Plot of Site-Specific Effects of 8th Grade Algebra on 10th Grade Math CAHSEE and the Location of the 7th Grade Math CST Algebra Placement Cutoff

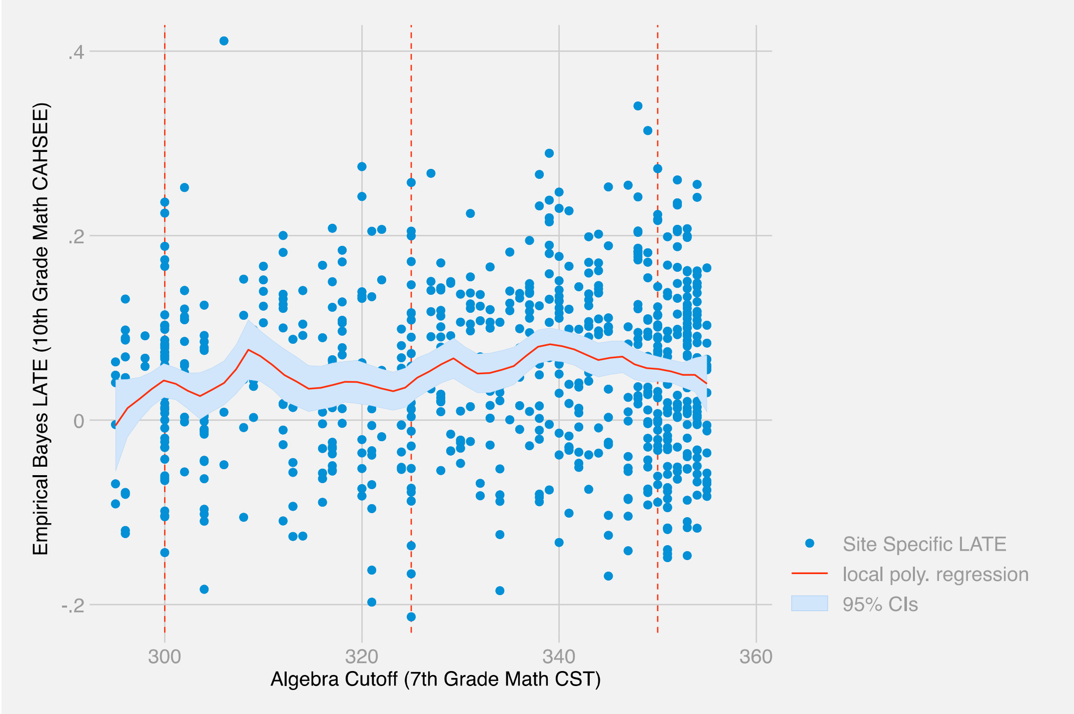
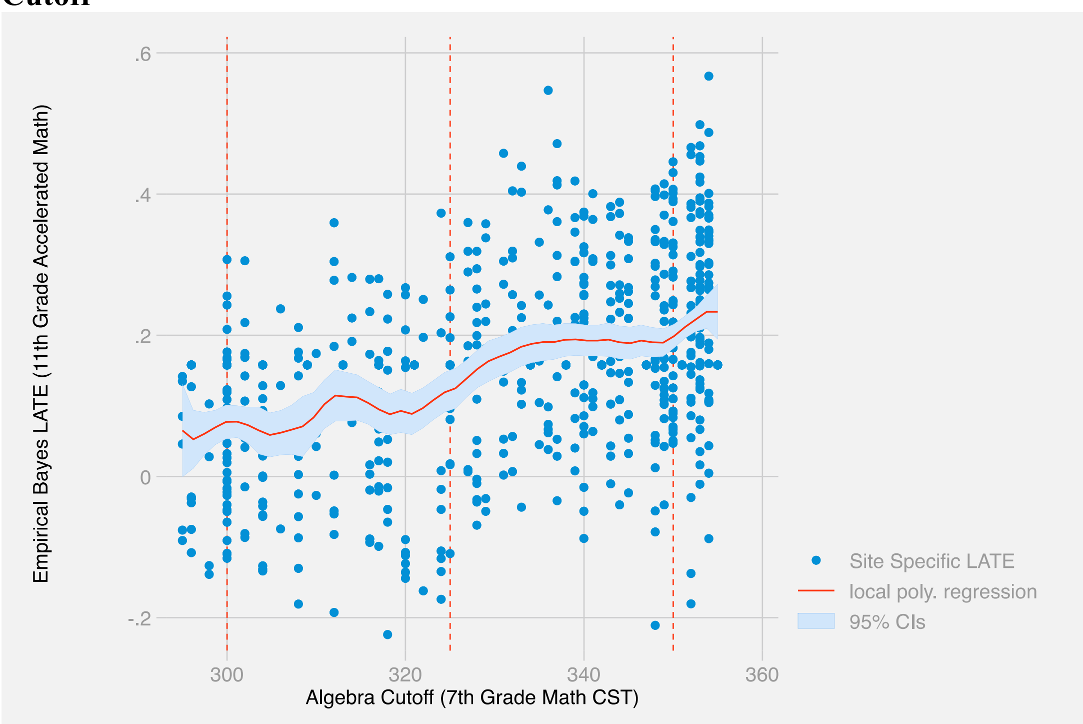


Figure 8: Scatter Plot of Site-Specific Effects of 8th Grade Algebra on 11th Grade Advanced Math Course-Taking and the Location of the 7th Grade Math CST Algebra Placement Cutoff



Tables

Table 1: Descriptive Statistics for our Analytic Sample by RD School Status

	Non-RD Schools			Initial RD Search Sample			Trimmed RD Search Sample		
Student Dependent Variables	Mean	SD	N	Mean	SD	N	Mean	SD	N
10th Grade Math CAHSEE	0.148	0.743	452093	0.057	0.735	186763	0.069	0.734	144351
10th Grade ELA CAHSEE	0.221	0.755	452166	0.102	0.747	186815	0.111	0.747	144363
9th Grade Accelerated Math	0.238	0.426	488642	0.236	0.425	201443	0.240	0.427	155513
10th Grade Accelerated Math	0.216	0.412	488642	0.204	0.403	201443	0.207	0.405	155513
11th Grade Accelerated Math	0.131	0.338	488642	0.119	0.324	201443	0.124	0.329	155513
8th Grade ELA CST	-0.075	0.813	487945	-0.211	0.795	201060	-0.195	0.796	155241
9th Grade ELA CST	-0.029	0.810	458967	-0.173	0.788	189922	-0.162	0.791	146910
10th Grade ELA CST	-0.058	0.821	439094	-0.188	0.809	181456	-0.179	0.811	140405
11th Grade ELA CST	-0.075	0.842	332211	-0.188	0.822	129651	-0.178	0.822	101441
Student Independent Variables	Mean	SD	N	Mean	SD	N	Mean	SD	N
6th Grade Math CST	-0.129	0.705	462062	-0.229	0.681	190820	-0.212	0.684	147088
7th Grade Math CST	-0.094	0.649	488642	-0.179	0.633	201443	-0.165	0.633	155513
6th Grade ELA CST	-0.041	0.805	462346	-0.178	0.780	190918	-0.161	0.781	147149
7th Grade ELA CST	-0.054	0.801	488172	-0.200	0.783	201215	-0.181	0.784	155330
Male Student	0.477	0.499	488642	0.478	0.500	201443	0.478	0.500	155513
SED Student	0.555	0.497	488548	0.688	0.463	201406	0.679	0.467	155481
Asian Student	0.062	0.241	486584	0.062	0.241	201013	0.066	0.248	155159
Black Student	0.069	0.254	486584	0.069	0.254	201013	0.069	0.254	155159
Hispanic Student	0.518	0.500	486584	0.628	0.483	201013	0.617	0.486	155159
ELL Student	0.158	0.365	488328	0.199	0.399	201341	0.197	0.398	155432
Took 10th Grade Math CAHSEE	0.925	0.263	488642	0.927	0.260	201443	0.928	0.258	155513
Took 10th Grade ELA CAHSEE	0.925	0.263	488642	0.927	0.260	201443	0.928	0.258	155513

Table 2: First Stage and Placebo Regression Analysis of 8th Grade Algebra Course Assignment

Panel A: Initial RD Search Sample

	First Stage	Density Test	6th Grade Math CST	6th Grade ELA CST	7th Grade ELA CST	Male Student	FRPL Student	Asian Student	Black Student	Hispanic Student	ELL Student	Has 10th grade Math CAHSEE	Has 10th Grade ELA CAHSEE
1[CST>=Cutoff]	0.412***	-0.282*	0.046***	0.032***	0.020***	0.005	-0.002	0.006**	-0.001	-0.010**	-0.015***	0.002	0.001
	(0.007)	(0.112)	(0.004)	(0.005)	(0.005)	(0.004)	(0.003)	(0.002)	(0.002)	(0.003)	(0.004)	(0.002)	(0.002)
# of Students	201443	201443	190820	190918	201215	201443	201406	201013	201013	201013	201341	201443	201443
# of School/years	972	972	972	972	972	972	972	972	972	972	972	972	972

Panel B: Trimmed Sample

	First Stage	Density Test	6th Grade Math CST	6th Grade ELA CST	7th Grade ELA CST	Male Student	FRPL Student	Asian Student	Black Student	Hispanic Student	ELL Student	Has 10th grade Math CAHSEE	Has 10th Grade ELA CAHSEE
1[CST>=Cutoff]	0.410***	-0.142	0.034***	0.009+	-0.006	0.010*	0.001	0.007**	-0.003	-0.008+	-0.002	0.001	0.002
	(0.008)	(0.121)	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)	(0.002)	(0.002)	(0.004)	(0.004)	(0.003)	(0.003)
# of Students	155513	155513	147088	147149	155330	155513	155481	155159	155159	155159	155432	155513	155513
# of School/years	753	753	753	753	753	753	753	753	753	753	753	753	753

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: The results presented in this table use a pooled dataset of all 738 RD sites centered around their school-year specific algebra cutoff (e.g. a 7th grade math CST score of 325). Column 2, the adapted McCary Density Test, uses data aggregated to the discrete CST math score level instead of student-level data. The coefficients in the table are from a pooled reduced-form linear spline with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. The model also includes school-year fixed-effects and standard errors are clustered at the school-year level.

Table 3: Descriptive Statistics for the RD Search Process

	Non-RD Schools			Initial RD Search Sample			Trimmed RD Search Sample		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
First Stage Magnitude	-0.004	0.197	2720	0.484	0.168	972	0.481	0.169	753
First Stage Location	333.513	18.451	2720	331.061	19.038	972	332.158	18.645	753
First Stage R2	0.348	0.134	2720	0.571	0.139	972	0.571	0.14	753
First Stage T-Stat	-0.080	1.473	2720	5.420	3.533	972	5.436	3.752	753
First Stage Lefthand Limit	0.489	0.355	2720	0.238	0.161	972	0.237	0.162	753
First Stage Righthand Limit	0.486	0.339	2720	0.722	0.181	972	0.718	0.182	753
Number of 8th graders	179.648	109	2720	207.246	99.823	972	206.525	97.322	753

Table 4. Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes

	Panel A: ITT Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
1[CST>=Cutoff]	0.031***	0.016**	0.135***	0.092***	0.067***	0.013*	0.015**	0.022***	0.021**
	(0.005)	(0.005)	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)	(0.006)	(0.007)
	Panel B: Fuzzy RD LATE Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.053***	0.034**	0.297***	0.203***	0.158***	0.021*	0.025*	0.030*	0.026+
	(0.011)	(0.011)	(0.013)	(0.012)	(0.011)	(0.011)	(0.011)	(0.012)	(0.015)
τ^2	0.025	0.024	0.044	0.036	0.026	0.031	0.030	0.033	0.029
# of Students	144351	144363	155513	155513	117755	155241	146910	140405	101441
# of School-Years	753	753	753	753	550	753	753	753	550
# of Schools	510	510	510	510	424	510	510	510	424

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: The coefficients are from a two-stage model with treatment-by-site instruments, school-year fixed-effects, and a random coefficient for the treatment (8th grade algebra). The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level.

Table 5: Site-level OLS Regressions of Site-Specific Effects of 8th Grade Algebra on School Demographics.

	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra Placement Threshold	0.001*	-0.001***	0.005***	0.004***	0.003***	0.000	-0.000**	0.000	0.000
	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
% FRPL	0.009	-0.002	0.048	-0.023	-0.03	-0.088***	-0.054***	-0.041***	-0.039***
	(0.016)	(0.012)	(0.031)	(0.031)	(0.024)	(0.013)	(0.010)	(0.009)	(0.006)
Avg. 7th Grade math CST	-0.028	-0.008	-0.011	-0.01	-0.013	-0.045*	0.006	-0.025+	-0.024**
	(0.025)	(0.016)	(0.046)	(0.045)	(0.034)	(0.018)	(0.014)	(0.013)	(0.009)
Adjusted R2	0.008	0.085	0.175	0.152	0.176	0.064	0.064	0.037	0.049
# of School-Years	753	753	753	753	753	753	753	753	753

+ $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Note: The coefficients are from a RD site-level OLS regression of the various effects of 8th grade algebra on site-level characteristics. The site-level effects are empirical bayes estimates from Model (2). Robust standard errors are in parenthesis.

Table 6: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes By Student Subgroup

	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Male	0.068***	0.058**	0.253***	0.169***	0.129***	0.034*	0.037*	0.039*	0.0171
	(0.015)	(0.016)	(0.013)	(0.012)	(0.012)	(0.017)	(0.016)	(0.017)	(0.022)
Female	0.062***	0.042**	0.331***	0.231***	.175***	0.024+	0.025+	0.040**	0.052**
	(0.013)	(0.014)	(0.016)	(0.014)	(0.013)	(0.013)	(0.014)	(0.015)	(0.018)
Black	0.151***	0.130***	0.287***	0.193***	0.158***	0.117***	0.168***	0.149***	0.159***
	(0.027)	(0.032)	(0.022)	(0.019)	(0.020)	(0.033)	(0.030)	(0.035)	(0.045)
Hispanic	0.051***	0.060***	0.277***	0.186***	0.145***	0.054***	0.048***	0.066***	0.055**
	(0.013)	(0.014)	(0.014)	(0.012)	(0.012)	(0.013)	(0.013)	(0.015)	(0.018)
White	0.113***	0.083***	0.269***	0.194***	0.130***	0.061*	0.031	0.056*	0.068*
	(0.021)	(0.023)	(0.019)	(0.017)	(0.017)	(0.024)	(0.024)	(0.026)	(0.033)
Asian	0.077*	0.05	0.446***	0.348***	0.286***	0.066+	0.043	0.045	0.094*
	(0.031)	(0.033)	(0.026)	(0.027)	(0.029)	(0.036)	(0.033)	(0.036)	(0.038)
SED	0.065***	0.058***	0.291***	0.196***	0.151***	0.038**	0.049***	0.060***	0.054**
	(0.013)	(0.013)	(0.014)	(0.012)	(0.012)	(0.013)	(0.013)	(0.015)	(0.018)
Non-SED	0.086***	0.048**	0.286***	0.209***	0.158***	0.038+	0.039*	0.031	0.049+
	(0.018)	(0.018)	(0.017)	(0.015)	(0.015)	(0.020)	(0.019)	(0.021)	(0.025)
ELL	0.135***	0.097***	0.308***	0.225***	0.200***	0.061**	0.068***	0.110***	0.081**
	(0.020)	(0.020)	(0.018)	(0.016)	(0.017)	(0.021)	(0.020)	(0.022)	(0.028)
Non-ELL	0.046***	0.033**	0.296***	0.202***	.154***	0.017	0.025*	0.021	0.023
	(0.012)	(0.012)	(0.014)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.016)

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: The coefficients are from a two-stage model with treatment-by-site instruments, school-year fixed-effects, and a random coefficient for the treatment (8th grade algebra) run separately by student subgroup. The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level. SED=Socioeconomically disadvantaged, and ELL=English Language Learner.

Appendix A

Figure A. 1: Scatter Plot of the Intent to Treat Effect of 8th Grade Algebra on 10th Grade ELA CAHSEE

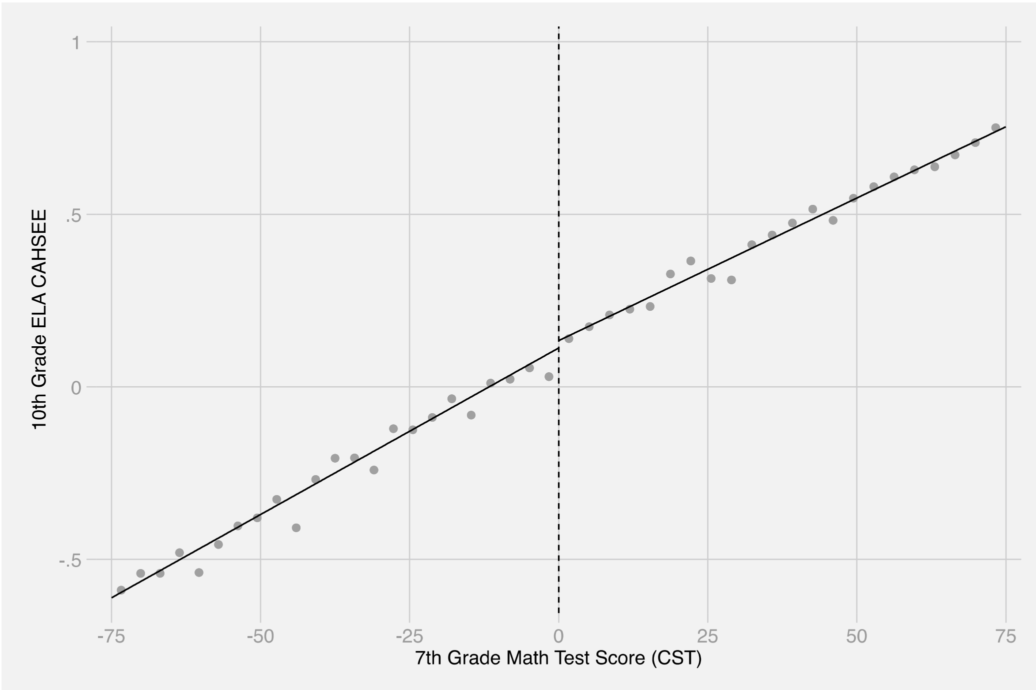


Figure A. 2: Scatter Plot of the Intent to Treat Effect of 8th Grade Algebra on 9th Grade Accelerated Math Course-Taking

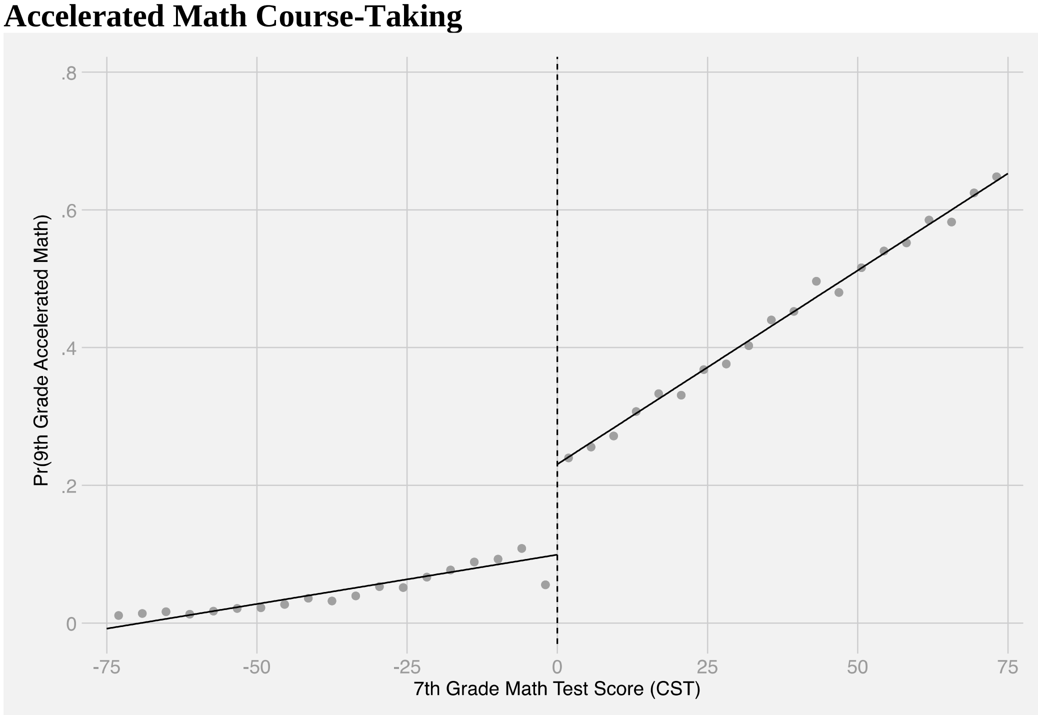


Figure A. 3: Scatter Plot of the Intent to Treat Effect of 8th Grade Algebra on 10th Grade Accelerated Math Course-Taking

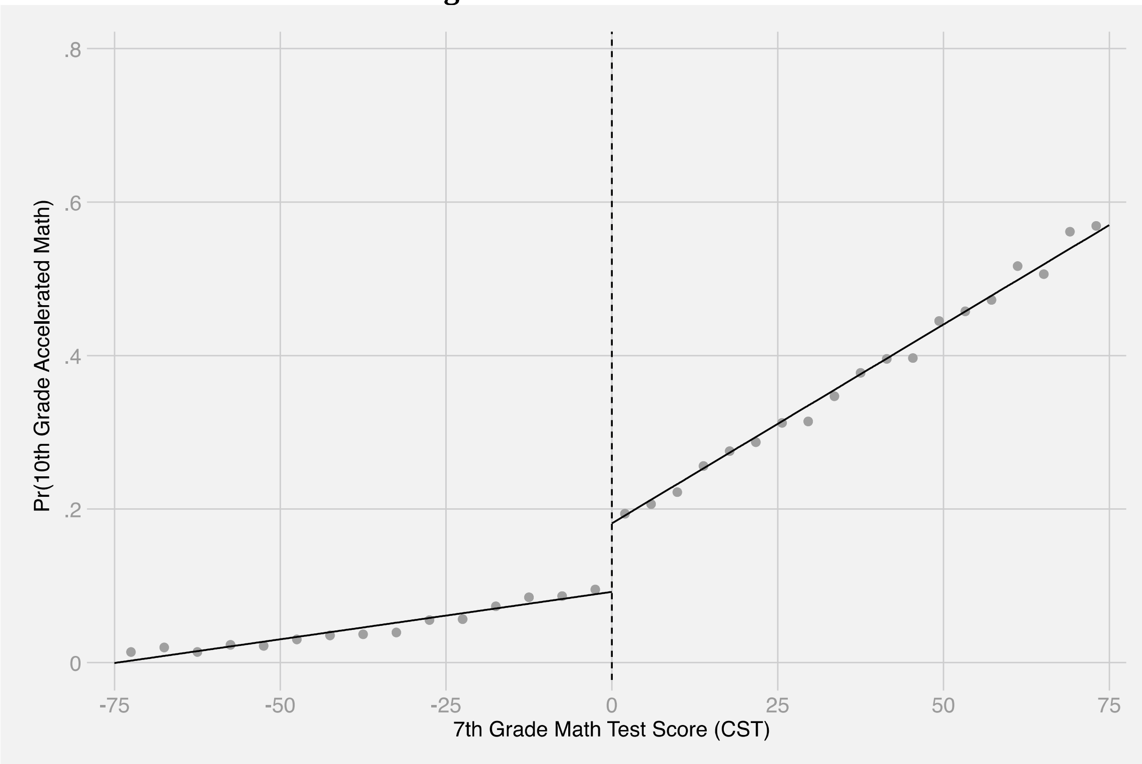


Figure A. 4: Scatter Plot of the Intent to Treat Effect of 8th Grade Algebra on 8th Grade ELA CST

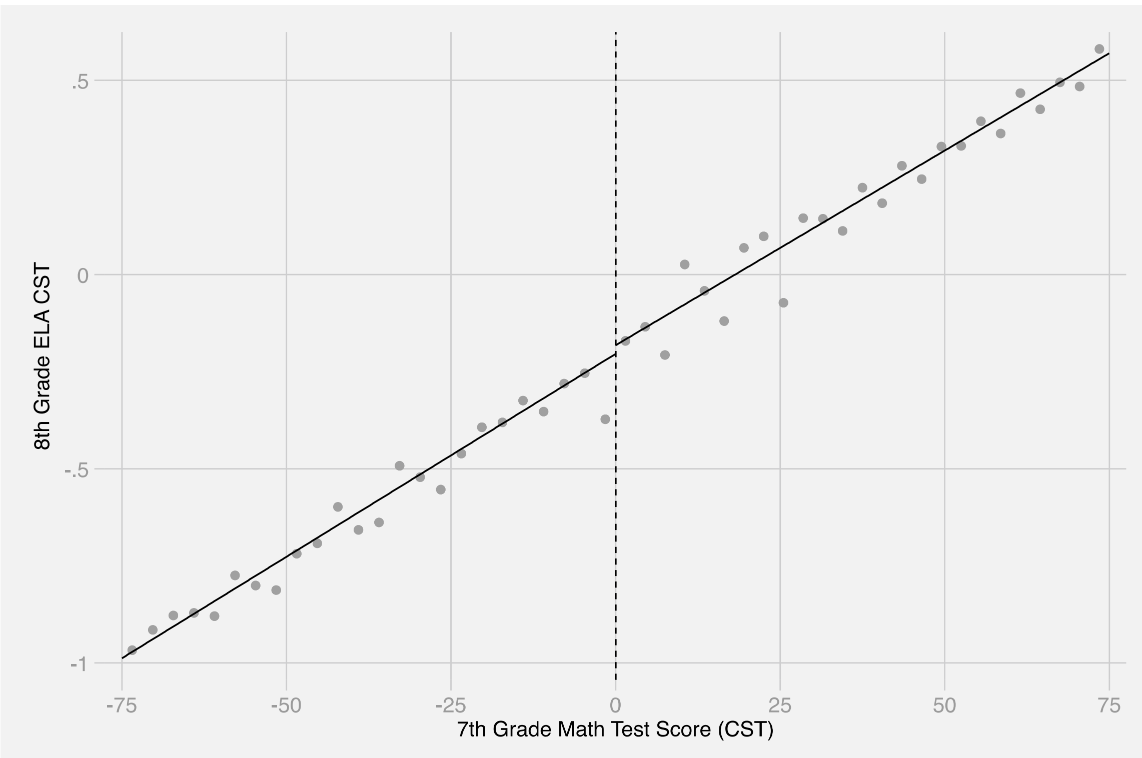


Figure A. 5: Scatter Plot of the Intent to Treat Effect of 8th Grade Algebra on 9th Grade ELA CST

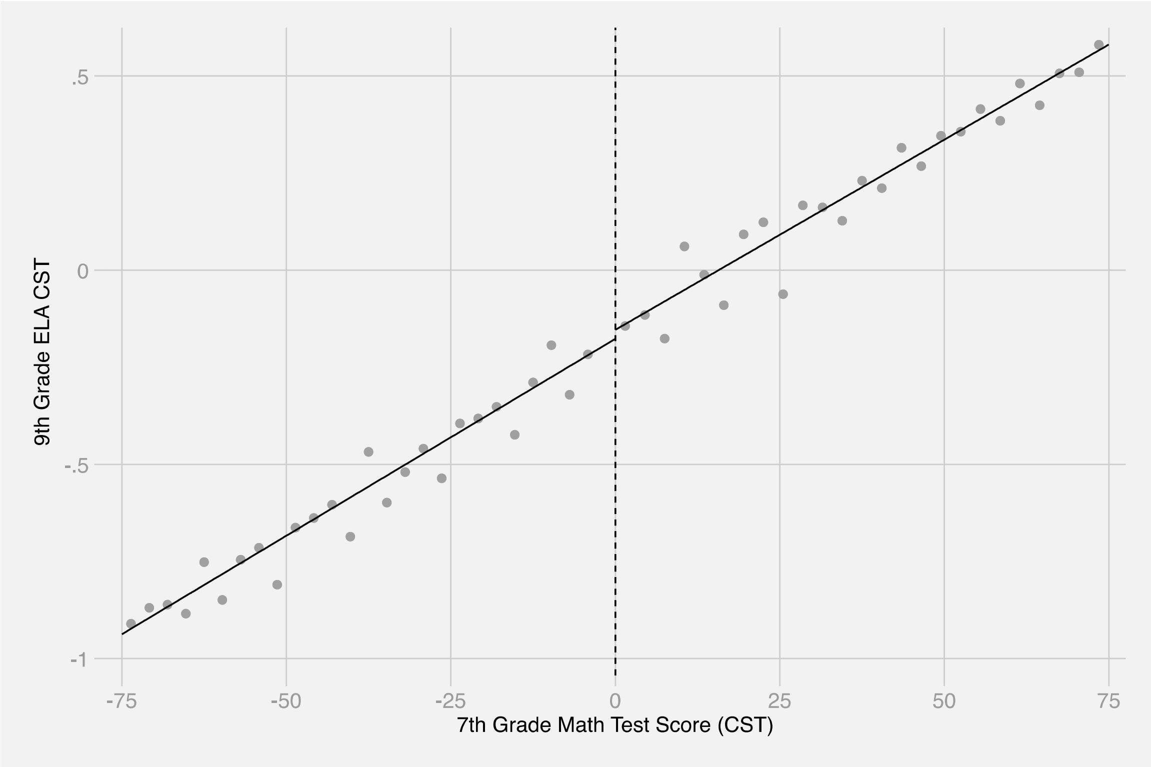


Figure A. 6: Scatter Plot of the Intent to Treat Effect of 8th Grade Algebra on 10th Grade ELA CST

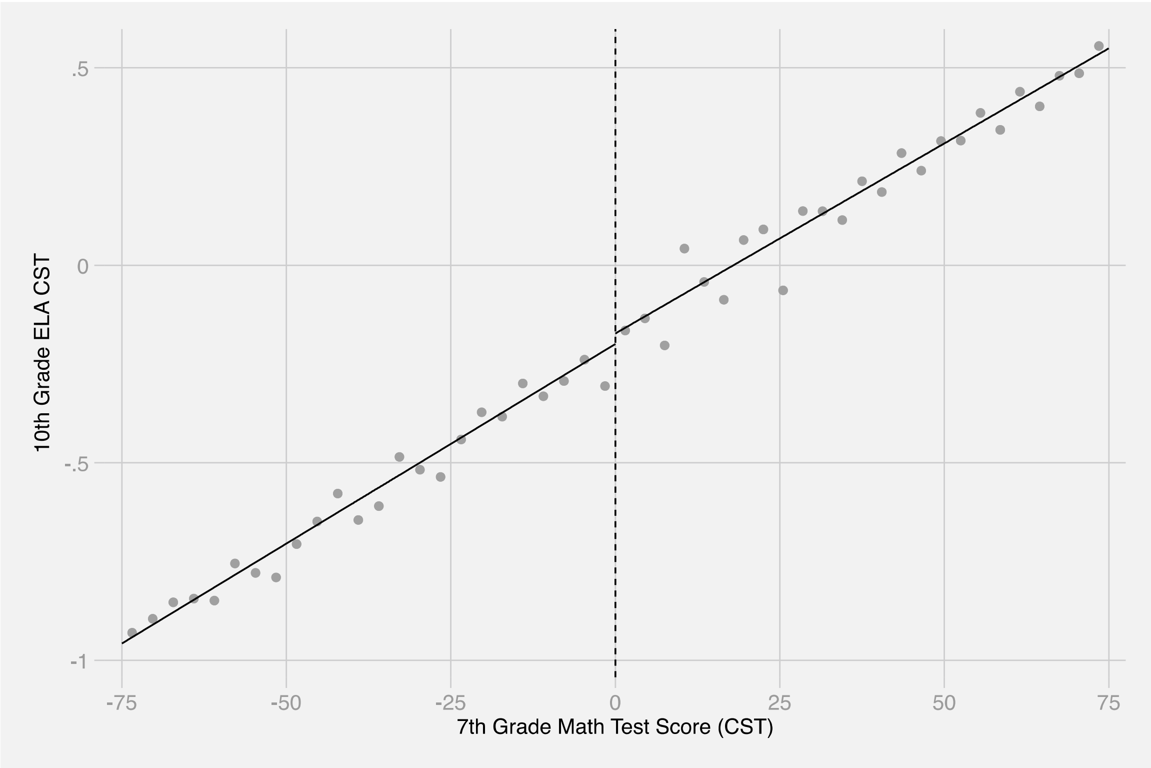


Figure A. 7: Scatter Plot of the Intent to Treat Effect of 8th Grade Algebra on 11th Grade ELA CST

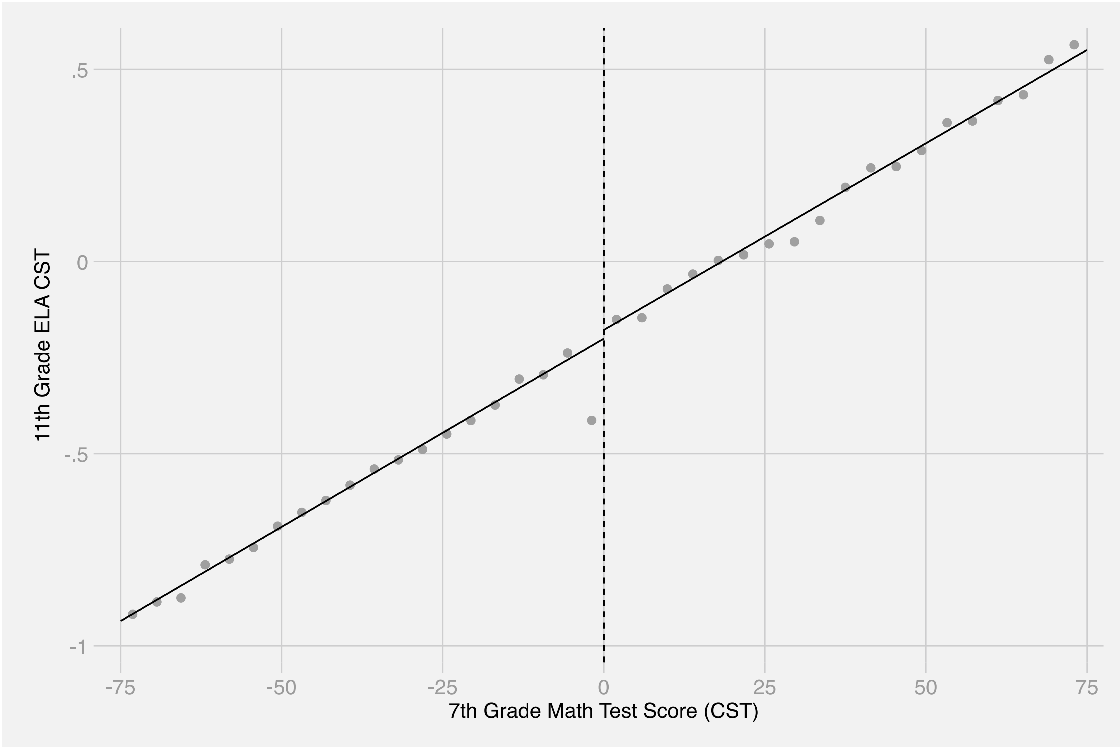


Figure A. 8: Scatter Plot of Site-Specific Effects of 8th Grade Algebra on 10th Grade ELA CAHSEE and the Location of the 7th Grade Math CST Algebra Placement Cutoff

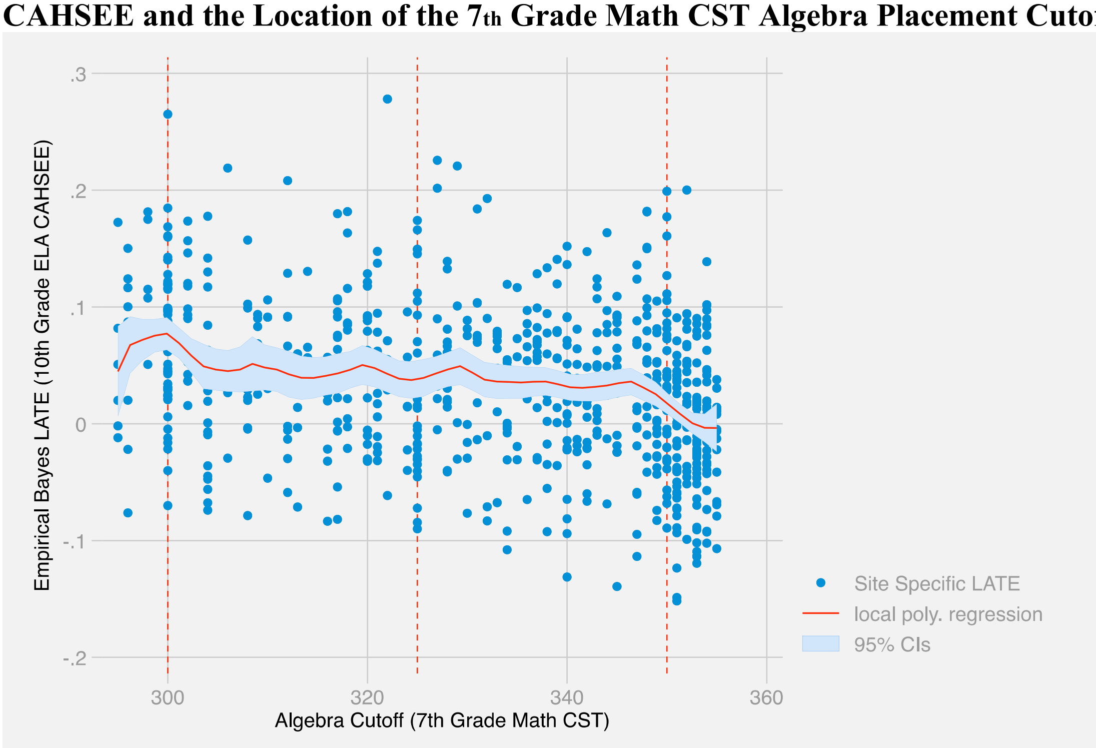


Figure A. 9: Scatter Plot of Site-Specific Effects of 8th Grade Algebra on 9th Grade Advanced Math Course-Taking and the Location of the 7th Grade Math CST Algebra Placement Cutoff

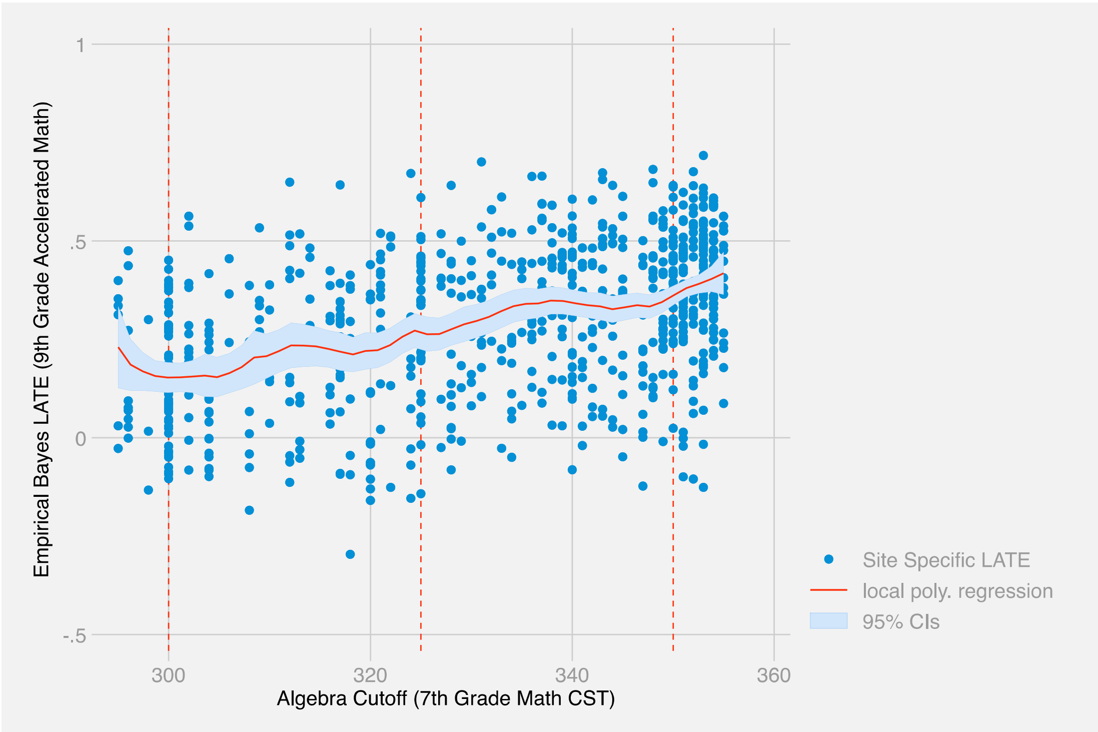


Figure A. 10: Scatter Plot of Site-Specific Effects of 8th Grade Algebra on 10th Grade Advanced Math Course-Taking and the Location of the 7th Grade Math CST Algebra Placement Cutoff

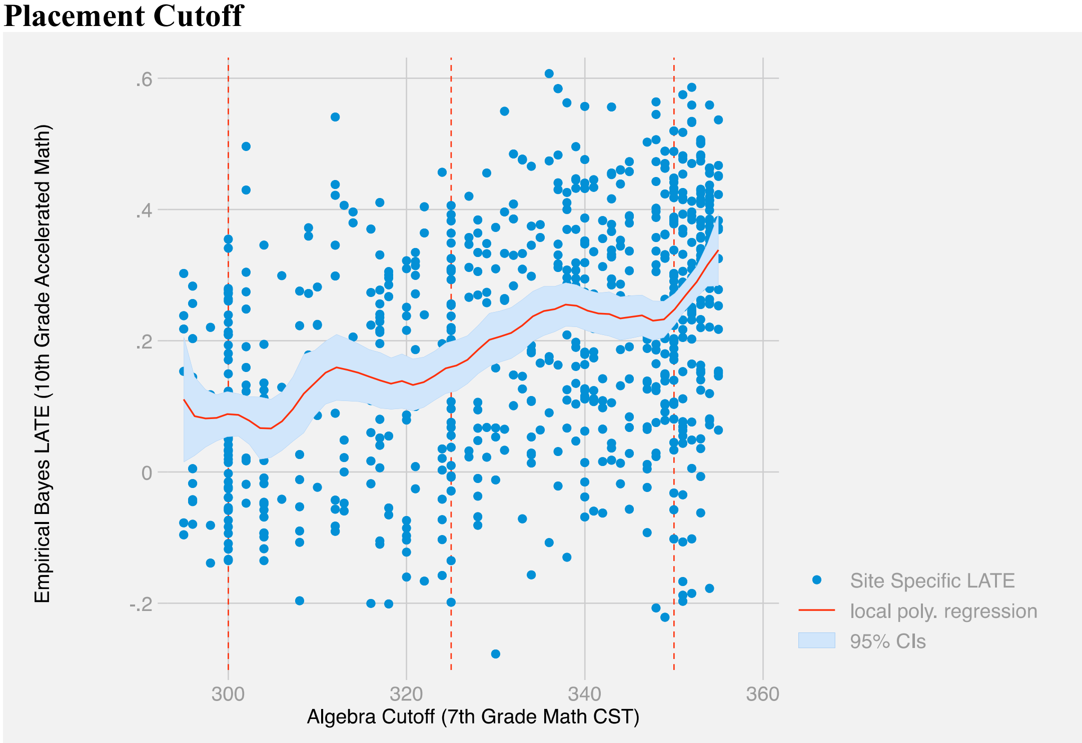


Figure A. 11: Scatter Plot of Site-Specific Effects of 8th Grade Algebra on 8th Grade ELA CST and the Location of the 7th Grade Math CST Algebra Placement Cutoff

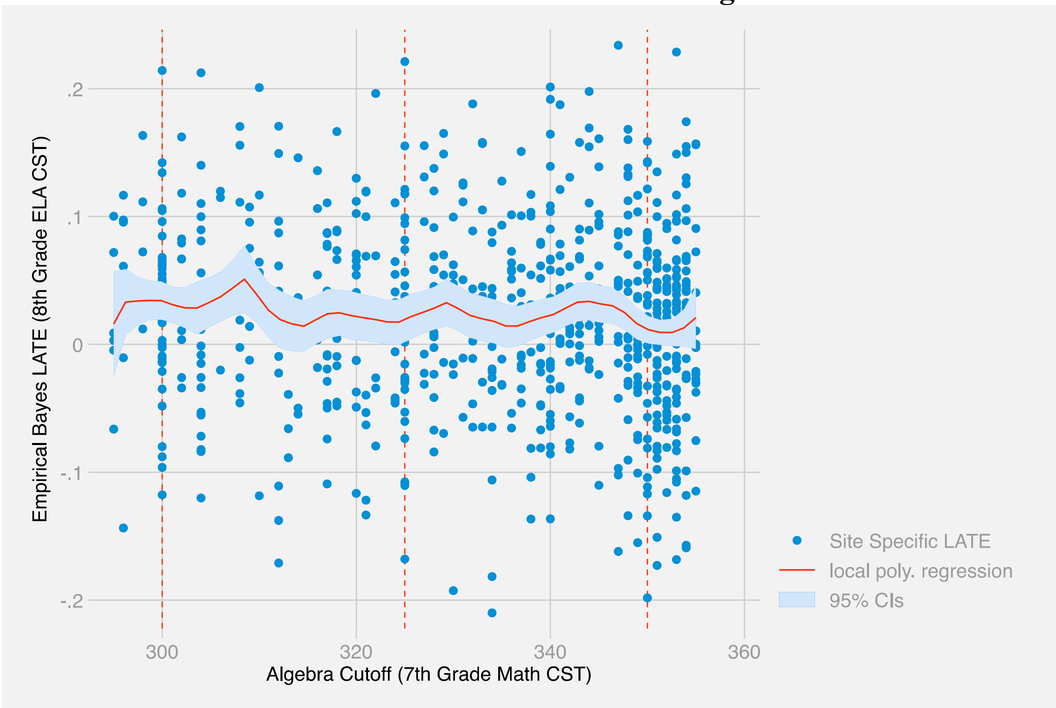


Figure A. 12: Scatter Plot of Site-Specific Effects of 8th Grade Algebra on 9th Grade ELA CST and the Location of the 7th Grade Math CST Algebra Placement Cutoff

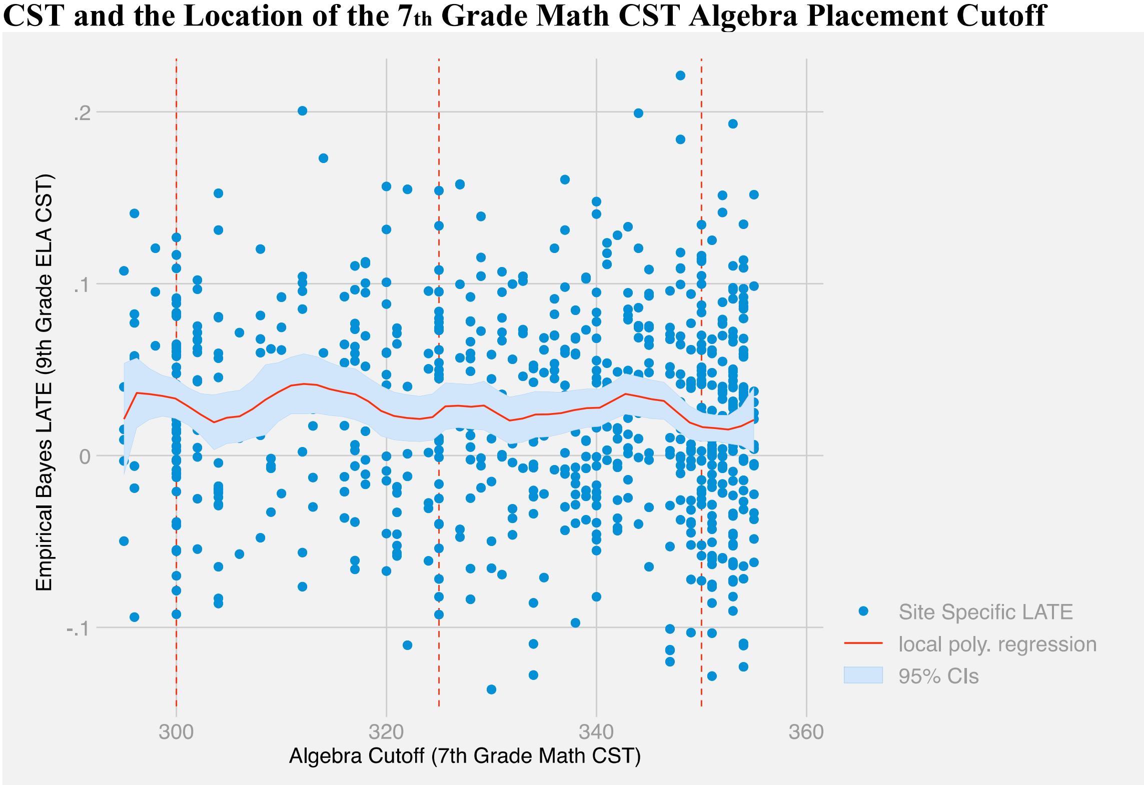


Figure A. 13: Scatter Plot of Site-Specific Effects of 8th Grade Algebra on 10th Grade ELA CST and the Location of the 7th Grade Math CST Algebra Placement Cutoff

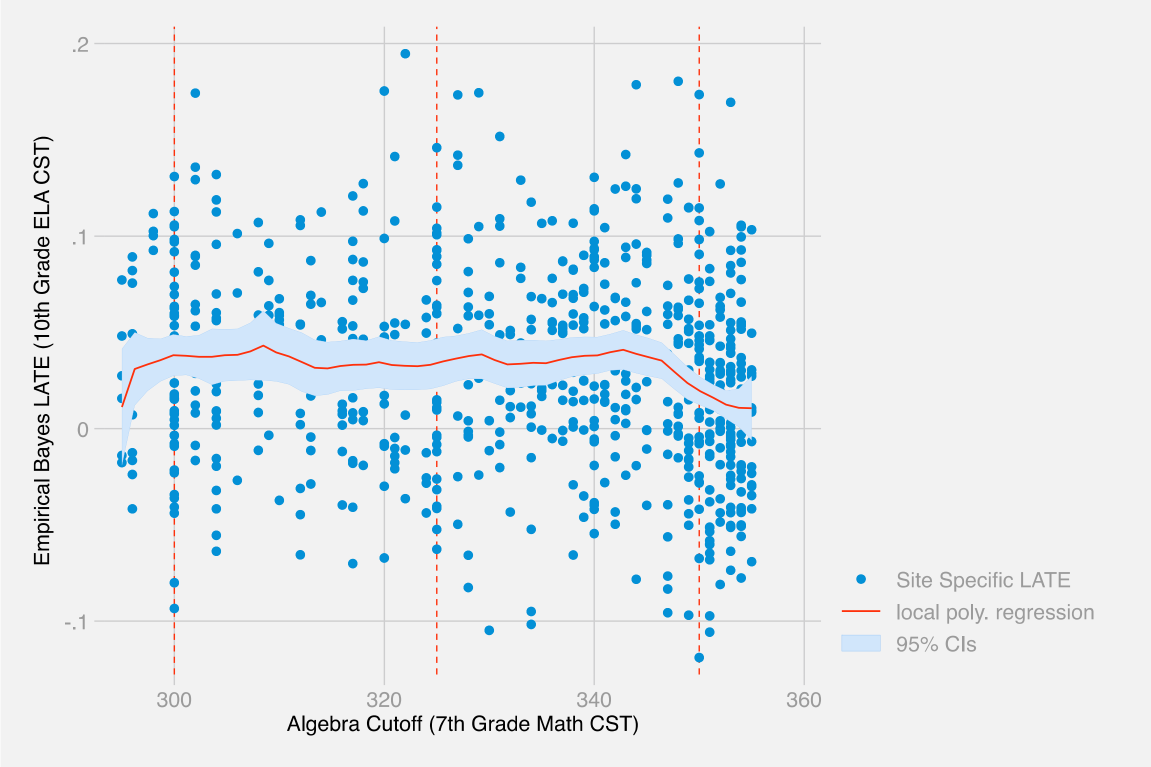
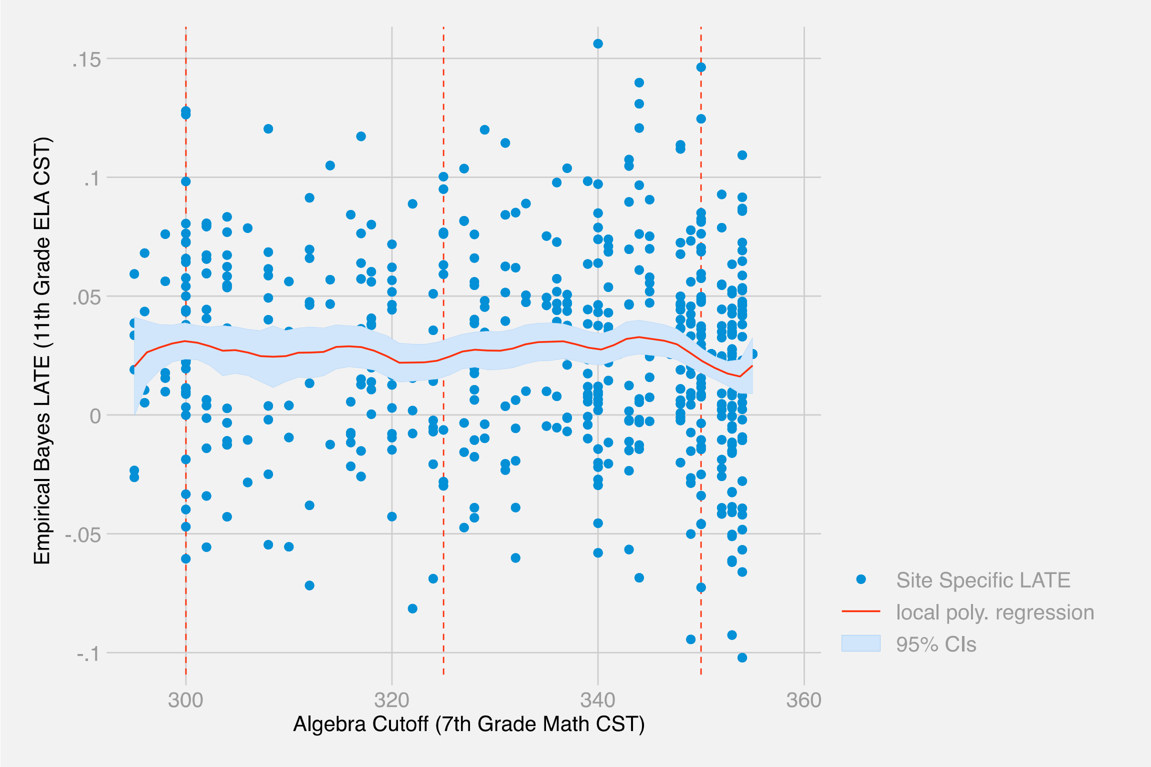


Figure A. 14: Scatter Plot of Site-Specific Effects of 8th Grade Algebra on 11th Grade ELA CST and the Location of the 7th Grade Math CST Algebra Placement Cutoff



Appendix B

In this appendix we report our main results using a number of different samples and model specifications and estimation techniques. We start with two main samples. First, we have the full set of 972 school-year observations that passed our bootstrap test that we call the "full sample". Second, we have the trimmed sample used in the analysis in the manuscript and includes the 753 school-year observations that not only passed the bootstrap test but also our placebo test using students' 6th and 7th grade math and ELA CST scores as a dependent variable in Model (1). We call this sample the "trimmed sample". The key difference between the full and trimmed samples is that the former does not correct for the small discontinuity in prior achievement at the placement thresholds while the latter does. Therefore, across the specifications reported below, in each one we include results for the full sample that controls for students' 6th grade math CST scores.

We also introduce two new subsamples. The first are schools that have an algebra placement policy using 7th grade math CST scores of 300, 325, or 350. We call these policy-relevant cut scores since 300 and 350 correspond with the cutoff for the "Basic" and "Proficient" performance categories—the former considered below grade-level, and the latter considered grade-level. We also include 325 because a number of school districts had stated policies using this score. Second, we include a set of schools in districts with known policies that use 7th grade math CST scores for 8th grade Algebra placement.

Finally we introduce two new specifications/estimation approaches to the random coefficient model with site fixed-effects and site-by-treatment instruments used in the manuscript. The first uses the same pooled data set used in the manuscript but estimates Model (1) with a single instrument, and Model (2) without a random coefficient but keeps the rest of the specification including school-year fixed effects. The second also uses the same pooled data set from the manuscript but estimates Models (1) and (2) using a local linear regression with a triangular kernel and a bandwidth estimated following Calonico, Cattaneo, and Titiunik (2014). We used the Stata command -rdrobust- to estimate this model (Calonico, S., Cattaneo, M.D., Farrell, M.H., & Titiunik, 2017).

We present the results across Tables B.1 to B.21. There are a few exceptions where the results deviate slightly from the manuscript, however, the qualitative results from our main model hold across these alternative specifications. For example, the results from the local linear specification tend to report larger positive effects of 8th grade algebra on student outcomes than our random coefficient model in the manuscript. We interpret the collection of our results as students in 8th grade algebra in our RD sites experienced positive test score improvements on the math CAHSEE and were more likely to take advanced math courses in high school than students just below the algebra placement threshold who completed a remedial math course in 8th grade.

Table B. 1: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Random Coefficient Model with Site Fixed-Effects (Full Sample)

	Panel A: ITT Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
1[CST>=Cutoff]	0.039***	0.033***	0.133***	0.089***	0.064***	0.031***	0.035***	0.038***	0.033***
	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.007)
	Panel B: Fuzzy RD Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.065***	0.061***	0.289***	0.198***	0.151***	0.051***	0.060***	0.058***	0.049***
	(0.010)	(0.011)	(0.012)	(0.010)	(0.009)	(0.011)	(0.011)	(0.012)	(0.014)
τ^2	0.022	0.018	0.044	0.036	0.027	0.026	0.022	0.024	0.022
# of Students	186763	186815	201443	201443	150817	201060	189922	181456	129651
# of School-Years	972	972	972	972	703	972	972	972	703
# of Schools	603	603	603	603	508	603	603	603	508

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses all 972 initial school-year observations that passed the bootstrap test. The coefficients are from a two-stage model with treatment-by-site instruments, school-year fixed-effects, and a random coefficient for the treatment (8th grade algebra). The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level.

Table B. 2: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Random Coefficient Model with Site Fixed-Effects (Full Sample; Conditional on 6th Grade Math CST)

	Panel A: ITT Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
1[CST>=Cutoff]	0.023***	0.018***	0.129***	0.085***	0.061***	0.015**	0.019***	0.022***	0.014*
	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.007)
	Panel B: Fuzzy RD Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.037***	0.039***	0.281***	0.191***	0.146***	0.023*	0.035***	0.034**	0.020
	(0.009)	(0.010)	(0.012)	(0.011)	(0.010)	(0.010)	(0.010)	(0.011)	(0.013)
τ^2	0.125	0.178	0.249	0.215	0.169	0.000	0.000	0.000	0.000
# of Students	178085	178126	190820	190820	142202	190477	180996	173305	123497
# of School-Years	972	972	972	972	703	972	972	972	703
# of Schools	603	603	603	603	508	603	603	603	508

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses all 972 initial school-year observations that passed the bootstrap test. The coefficients are from a two-stage model with treatment-by-site instruments, school-year fixed-effects, and a random coefficient for the treatment (8th grade algebra). The Model also includes a control for students' 6th grade math CST. The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level.

Table B. 3: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Random Coefficient Model with Site Fixed-Effects (Full Sample; Schools with Policy Cutpoints of 300, 325, or 350 Only)

	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
Panel A: ITT Effects									
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
1[CST>=Cutoff]	0.030***	0.025***	0.133***	0.091***	0.069***	0.025***	0.028***	0.028***	0.021*
	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.009)
Panel B: Fuzzy RD Effects									
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.046***	0.050***	0.286***	0.201***	0.165***	0.039**	0.048***	0.037**	0.033+
	(0.011)	(0.012)	(0.014)	(0.012)	(0.012)	(0.013)	(0.013)	(0.014)	(0.017)
τ^2	0.026	0.021	0.044	0.037	0.028	0.028	0.024	0.029	0.025
# of Students	122192	122251	132015	132015	96584	131759	124915	119313	83142
# of School-Years	630	630	630	630	443	630	630	630	443
# of Schools	451	451	451	451	357	451	451	451	357

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses all 972 initial school-year observations that passed the bootstrap test and that have an algebra placement cutoff using 7th grade math CST scores of 300, 325, or 350. The coefficients are from a two-stage model with treatment-by-site instruments, school-year fixed-effects, and a random coefficient for the treatment (8th grade algebra). The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level.

Table B. 4: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Random Coefficient Model with Site Fixed-Effects (Full Sample; Schools in Districts with Known Policies Only)

	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
Panel A: ITT Effects									
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
1[CST>=Cutoff]	0.026	0.019	0.243***	0.152***	0.121***	0.005	-0.011	0.008	0.018
	(0.016)	(0.016)	(0.022)	(0.020)	(0.022)	(0.016)	(0.017)	(0.020)	(0.021)
Panel B: Fuzzy RD Effects									
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.035	0.031	0.447***	0.279***	0.259***	-0.006	-0.011	0.019	0.001
	(0.028)	(0.029)	(0.034)	(0.032)	(0.041)	(0.036)	(0.035)	(0.039)	(0.045)
τ^2	0.019	0.012	0.044	0.034	0.021	0.027	0.022	0.016	0.019
# of Students	13654	13675	14615	14615	9362	14591	13821	13218	8097
# of School-Years	69	69	69	69	42	69	69	69	42
# of Schools	37	37	37	37	27	37	37	37	27

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses all 972 initial school-year observations that passed the bootstrap test and that are in districts with known placement policies using 7th grade math CST scores. The coefficients are from a two-stage model with treatment-by-site instruments, school-year fixed-effects, and a random coefficient for the treatment (8th grade algebra). The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level.

Table B. 5: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Random Coefficient Model with Site Fixed-Effects (Trimmed Sample; Schools with Policy Cutpoints of 300, 325, or 350 Only)

	Panel A: ITT Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
1[CST>=Cutoff]	0.023***	0.012+	0.135***	0.094***	0.071***	0.009	0.012+	0.014+	0.013
	(0.007)	(0.007)	(0.008)	(0.007)	(0.006)	(0.007)	(0.006)	(0.007)	(0.009)

	Panel B: Fuzzy RD Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.034**	0.026*	0.294***	0.206***	0.169***	0.014	0.019	0.015	0.016
	(0.013)	(0.013)	(0.015)	(0.014)	(0.014)	(0.013)	(0.013)	(0.014)	(0.017)
τ^2	0.029	0.028	0.045	0.037	0.028	0.033	0.032	0.037	0.031
# of Students	95876	95909	103480	103480	76540	103290	97862	93407	65919
# of School-Years	492	492	492	492	351	492	492	492	351
# of Schools	376	376	376	376	298	376	376	376	298

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses the trimmed sample of school-year observations that pass our bootstrap and placebo test and that have an algebra placement cutoff using 7th grade math CST scores of 300, 325, or 350. The coefficients are from a two-stage model with treatment-by-site instruments, school-year fixed-effects, and a random coefficient for the treatment (8th grade algebra). The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level.

Table B. 6: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Random Coefficient Model with Site Fixed-Effects (Trimmed Sample; Schools in Districts with Known Policies Only)

Panel A: ITT Effects

	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
1[CST>=Cutoff]	0.014	-0.004	0.237***	0.139***	.109***	-0.016	-0.023	-0.006	0.009
	(0.019)	(0.014)	(0.025)	(0.022)	(0.026)	(0.015)	(0.016)	(0.019)	(0.020)

Panel B: Fuzzy RD Effects

	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.033	0.017	0.441***	0.266***	0.254***	-0.025	-0.011	0.017	-0.010
	(0.031)	(0.028)	(0.041)	(0.035)	(0.052)	(0.030)	(0.031)	(0.031)	(0.037)
τ^2	0.019	0.011	0.047	0.035	0.024	0.025	0.018	0.013	0.016
# of Students	10952	10976	11729	11729	6690	11712	11096	10624	5804
# of School-Years	55	55	55	55	30	55	55	55	30
# of Schools	34	34	34	34	21	34	34	34	21

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses the trimmed sample of school-year observations that pass our bootstrap and placebo test and that are in districts with known placement policies using 7th grade math CST scores. The coefficients are from a two-stage model with treatment-by-site instruments, school-year fixed-effects, and a random coefficient for the treatment (8th grade algebra). The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level.

Table B. 7: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Pooled Model with Site Fixed-Effects (Full Sample)

	Panel A: ITT Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
	Panel A: ITT Estimates of Taking 8th Grade Algebra								
1[CST>=Cutoff]	0.042***	0.035***	0.129***	0.088***	0.060***	0.033***	0.036***	0.039***	0.033***
	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)	(0.006)	(0.006)	(0.007)
	Panel B: Fuzzy RD Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.095***	0.079***	0.290***	0.197***	0.139***	0.074***	0.081***	0.088***	0.075***
	(0.011)	(0.012)	(0.011)	(0.009)	(0.009)	(0.012)	(0.012)	(0.014)	(0.016)
# of Students	186763	186815	201443	201443	150817	201060	189922	181456	129651
# of School-Years	972	972	972	972	703	972	972	972	703
# of Schools	603	603	603	603	508	603	603	603	508

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses all 972 initial school-year observations that passed the bootstrap test. The coefficients are from a pooled model with school-year fixed-effects and a single instrument. The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level.

Table B. 8: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Pooled Model with Site Fixed-Effects (Full Sample; Conditional on 6th Grade Math CST)

	Panel A: ITT Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
	Panel A: ITT Estimates of Taking 8th Grade Algebra								
1[CST>=Cutoff	0.026***	0.020***	0.125***	0.084***	0.058***	0.016**	0.020***	0.024***	0.015*
	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)	(0.006)	(0.007)
	Panel B: Fuzzy RD Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.059***	0.046***	0.284***	0.191***	0.134***	0.037**	0.045***	0.053***	0.034*
	(0.011)	(0.012)	(0.011)	(0.010)	(0.010)	(0.012)	(0.012)	(0.013)	(0.016)
# of Students	178085	178126	190820	190820	142202	190477	180996	173305	123497
# of School-Years	972	972	972	972	703	972	972	972	703
# of Schools	603	603	603	603	508	603	603	603	508

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses all 972 initial school-year observations that passed the bootstrap test. The coefficients are from a pooled model with school-year fixed-effects and a single instrument. The Model also includes a control for students' 6th grade math CST. The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level.

Table B. 9: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Pooled Model with Site Fixed-Effects (Full Sample; Schools with Policy Cutpoints of 300, 325, or 350 Only)

	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
	Panel A: ITT Estimates of Taking 8th Grade Algebra								
1[CST>=Cutoff	0.034***	0.027***	0.131***	0.092***	0.066***	0.027***	0.030***	0.030***	0.021*
	(0.006)	(0.007)	(0.006)	(0.005)	(0.005)	(0.007)	(0.007)	(0.007)	(0.009)
	Panel B: Fuzzy RD Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.075***	0.060***	0.286***	0.200***	0.150***	0.060***	0.065***	0.065***	0.046*
	(0.013)	(0.014)	(0.013)	(0.012)	(0.012)	(0.015)	(0.015)	(0.016)	(0.020)
# of Students	122192	122251	132015	132015	96584	131759	124915	119313	83142
# of School-Years	630	630	630	630	443	630	630	630	443
# of Schools	451	451	451	451	357	451	451	451	357

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses all 972 initial school-year observations that passed the bootstrap test and that have an algebra placement cutoff using 7th grade math CST scores of 300, 325, or 350. The coefficients are from a pooled model with school-year fixed-effects and a single instrument. The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level.

Table B. 10: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Pooled Model with Site Fixed-Effects (Full Sample; Schools in Districts with Known Policies Only)

	Panel A: ITT Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
	Panel A: ITT Estimates of Taking 8th Grade Algebra								
1[CST>=Cutoff	0.031*	0.021	0.248***	0.155***	0.117***	0.006	-0.011	0.01	0.018
	(0.014)	(0.017)	(0.017)	(0.015)	(0.018)	(0.017)	(0.016)	(0.019)	(0.021)
	Panel B: Fuzzy RD Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.058*	0.039	0.466***	0.292***	0.248***	0.012	-0.02	0.018	0.038
	(0.028)	(0.031)	(0.029)	(0.027)	(0.035)	(0.032)	(0.031)	(0.035)	(0.044)
# of Students	18538	18559	19858	19858	13323	19825	18757	17918	11417
# of School-Years	69	69	69	69	42	69	69	69	42
# of Schools	37	37	37	37	27	37	37	37	27

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses all 972 initial school-year observations that passed the bootstrap test and that are in districts with known placement policies using 7th grade math CST scores. The coefficients are from a pooled model with school-year fixed-effects and a single instrument. The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level.

Table B. 11: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Pooled Model with Site Fixed-Effects (Trimmed Sample)

	Panel A: ITT Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
	Panel A: ITT Estimates of Taking 8th Grade Algebra								
1[CST>=Cutoff	0.035***	0.019***	0.131***	0.090***	0.063***	0.015**	0.017**	0.023***	0.021**
	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.008)
	Panel B: Fuzzy RD Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.079***	0.042***	0.295***	0.202***	0.145***	0.034**	0.037**	0.052***	0.047**
	(0.013)	(0.012)	(0.012)	(0.011)	(0.011)	(0.012)	(0.012)	(0.014)	(0.017)
# of Students	144351	144363	155513	155513	117755	155241	146910	140405	101441
# of School-Years	753	753	753	753	550	753	753	753	550
# of Schools	510	510	510	510	424	510	510	510	424

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses the trimmed sample of school-year observations that pass our bootstrap and placebo test. The coefficients are from a pooled model with school-year fixed-effects and a single instrument. The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level.

Table B. 12: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Pooled Model with Site Fixed-Effects (Trimmed Sample; Schools with Policy Cutpoints of 300, 325, or 350 Only)

	Panel A: ITT Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
	Panel A: ITT Estimates of Taking 8th Grade Algebra								
1[CST>=Cutoff	0.029***	0.015*	0.131***	0.092***	0.065***	0.012+	0.013*	0.017*	0.014
	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)	(0.008)	(0.009)
	Panel B: Fuzzy RD Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.063***	0.033*	0.287***	0.201***	0.149***	0.025+	0.029*	0.037*	0.031
	(0.015)	(0.015)	(0.015)	(0.013)	(0.014)	(0.014)	(0.015)	(0.017)	(0.021)
# of Students	95876	95909	103480	103480	76540	103290	97862	93407	65919
# of School-Years	492	492	492	492	351	492	492	492	351
# of Schools	376	376	376	376	298	376	376	376	298

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses the trimmed sample of school-year observations that pass our bootstrap and placebo test and that have an algebra placement cutoff using 7th grade math CST scores of 300, 325, or 350. The coefficients are from a pooled model with school-year fixed-effects and a single instrument. The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level.

Table B. 13: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Pooled Model with Site Fixed-Effects (Trimmed Sample; Schools in Districts with Known Policies Only)

	Panel A: ITT Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
	Panel A: ITT Estimates of Taking 8th Grade Algebra								
1[CST>=Cutoff	0.021	-0.002	0.242***	0.143***	0.107***	-0.014	-0.022	-0.004	0.01
	(0.017)	(0.017)	(0.019)	(0.017)	(0.021)	(0.016)	(0.016)	(0.018)	(0.020)
	Panel B: Fuzzy RD Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.038	-0.004	0.451***	0.265***	0.226***	-0.026	-0.04	-0.008	0.02
	(0.032)	(0.032)	(0.032)	(0.030)	(0.041)	(0.029)	(0.030)	(0.033)	(0.042)
# of Students	15146	15166	16223	16223	10578	16198	15327	14637	9058
# of School-Years	55	55	55	55	30	55	55	55	30
# of Schools	34	34	34	34	21	34	34	34	21

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses the trimmed sample of school-year observations that pass our bootstrap and placebo test and that are in districts with known placement policies using 7th grade math CST scores. The coefficients are from a pooled model with school-year fixed-effects and a single instrument. The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level.

Table B. 14: First Stage Estimates from a Local Linear Regression Specification

Panel A: Full Sample												
	Density Test	6th Grade Math CST	6th Grade ELA CST	7th Grade ELA CST	Male Student	FRPL Student	Asian Student	Black Student	Hispanic Student	ELL Student	Has 10th grade Math CAHSEE	Has 10th Grade ELA CAHSEE
1[CST>=Cutoff]	-0.071	0.050**	0.035+	0.032+	-0.008	-0.001	0.016**	-0.003	-0.016	-0.019+	0.002	0.003
	(0.290)	(0.017)	(0.018)	(0.019)	(0.008)	(0.013)	(0.005)	(0.006)	(0.014)	(0.010)	(0.004)	(0.004)
Bandwidth	25.90	28.52	35.06	31.03	25.07	39.56	31.59	30.91	34.96	23.32	27.97	29.43
# of Students	201443	190820	190918	201215	201443	201406	201013	201013	201013	201341	201443	201443
# of School/years	972	972	972	972	972	972	972	972	972	972	972	972

Panel B: Trimmed Sample												
	Density Test	6th Grade Math CST	6th Grade ELA CST	7th Grade ELA CST	Male Student	FRPL Student	Asian Student	Black Student	Hispanic Student	ELL Student	Has 10th grade Math CAHSEE	Has 10th Grade ELA CAHSEE
1[CST>=Cutoff]	0.072	0.039*	0.007	0.002	-0.008	0.001	0.022*	-0.004	-0.017	-0.005	-0.001	0.001
	(0.323)	(0.019)	(0.020)	(0.022)	(0.009)	(0.015)	(0.006)	(0.007)	(0.017)	(0.011)	(0.005)	(0.005)
Bandwidth	21.90	25.96	31.37	29.18	24.91	34.02	23.71	22.79	28.78	23.51	23.31	25.22
# of Students	155513	147088	147149	155330	155513	155481	155159	155159	155159	155432	155513	155513
# of School/years	753	753	753	753	753	753	753	753	753	753	753	753

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: The coefficients were estimated using a local linear regression with a triangular kernel using Stata's -rdrobust- command. Bandwidth's were estimated using Calonico, Cattaneo, and Titiunik (2014).

Table B. 15: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Local Linear Regression (Full Sample)

Panel A: ITT Effects

	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
1[CST>=Cutoff]	0.048**	0.068***	0.114***	0.085***	0.062***	0.056**	0.054**	0.052**	0.047*
	(0.017)	(0.018)	(0.009)	(0.008)	(0.008)	(0.020)	(0.019)	(0.018)	(0.020)
Bandwidth	29.007	20.771	20.546	24.484	20.08	25.775	26.989	27.409	30.148

Panel B: Fuzzy RD Effects

	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.129**	0.188***	0.304***	0.224***	0.128***	0.142**	0.141**	0.14**	0.134*
	(0.047)	(0.051)	(0.020)	(0.019)	(0.015)	(0.053)	(0.051)	(0.050)	(0.058)
Bandwidth	29.28	19.625	28.287	30.942	26.179	29.074	27.973	26.465	26.431
# of Students	186763	186815	201443	201443	150817	201060	189922	181456	129651
# of School-Years	972	972	972	972	703	972	972	972	703
# of Schools	603	603	603	603	508	603	603	603	508

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses all 972 initial school-year observations that passed the bootstrap test. The coefficients were estimated using a local linear regression with a triangular kernel using Stata's -rdrobust- command. Bandwidth's were estimated using Calonico, Cattaneo, and Titiunik (2014).

Table B. 16: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Local Linear Regression (Full Sample; Condition on 6th Grade Math CST)

	Panel A: ITT Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
1[CST>=Cutoff]	0.025*	0.042**	0.108***	0.078***	0.058***	0.032*	0.028*	0.024+	0.015
	(0.013)	(0.014)	(0.009)	(0.008)	(0.008)	(0.015)	(0.014)	(0.015)	(0.018)
Bandwidth	27.76	19.554	20.843	24.539	21.913	21.913	24.105	23.224	20.921
	Panel B: Fuzzy RD Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.079*	0.118**	0.296***	0.213***	0..164***	0.085+	0.081+	0.063	0.049
	(0.039)	(0.043)	(0.021)	(0.020)	(0.021)	(0.043)	(0.040)	(0.041)	(0.048)
Bandwidth	19.803	16.789	23.709	25.746	19.535	20.228	21.804	21.868	22.201
# of Students	186763	186815	201443	201443	142202	201060	189922	181456	129651
# of School-Years	972	972	972	972	703	972	972	972	703
# of Schools	603	603	603	603	508	603	603	603	508

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses all 972 initial school-year observations that passed the bootstrap test. The coefficients were estimated using a local linear regression with a triangular kernel using Stata's -rdrobust- command. Bandwidth's were estimated using Calonico, Cattaneo, and Titiunik (2014). Model also controls for students 6th grade math CST.

Table B. 17: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Local Linear Regression (Full Sample; Schools with Policy Cutpoints of 300, 325, or 350 Only)

Panel A: ITT Effects

	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
1[CST>=Cutoff]	0.037	0.047*	0.113***	0.085***	0.065***	0.047+	0.047+	0.039+	0.021
	(0.023)	(0.022)	(0.011)	(0.009)	(0.009)	(0.026)	(0.025)	(0.024)	(0.028)
Bandwidth	25.411	26.866	20.069	22.693	21.516	27.676	27.726	31.513	28.555

Panel B: Fuzzy RD Effects

	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.102	0.142*	0.303***	0.238***	0.182***	0.148+	0.123+	0.096	0.046
	(0.063)	(0.067)	(0.027)	(0.027)	(0.026)	(0.076)	(0.072)	(0.071)	(0.097)
Bandwidth	26.22	19.147	19.685	17.098	20.474	17.987	20.988	18.875	15.584
# of Students	122192	122251	132015	132015	96584	131759	124915	119313	83142
# of School-Years	630	630	630	630	443	630	630	630	443
# of Schools	451	451	451	451	357	451	451	451	357

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses all 972 initial school-year observations that passed the bootstrap test and that have an algebra placement cutoff using 7th grade math CST scores of 300, 325, or 350. The coefficients were estimated using a local linear regression with a triangular kernel using Stata's -rdrobust- command. Bandwidth's were estimated using Calonico, Cattaneo, and Titiunik (2014).

Table B. 18: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Local Linear Regression (Full Sample; Schools in Districts with Known Policies Only)

Panel A: ITT Effects

	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
1[CST>=Cutoff]	0.048	0.086	0.186***	0.12***	0.086**	0.052	0.032	0.061	0.075
	(0.049)	(0.060)	(0.030)	(0.026)	(0.031)	(0.065)	(0.063)	(0.067)	(0.078)
Bandwidth	30.091	23.023	22.837	20.855	22.070	24.356	23.664	20.413	34.292

Panel B: Fuzzy RD Effects

	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.125	0.215	0.448***	0.293***	0.245**	0.15	0.076	0.179	0.291
	(0.126)	(0.148)	(0.064)	(0.055)	(0.074)	(0.163)	(0.151)	(0.178)	(0.249)
Bandwidth	24.033	22.879	23.253	23.797	24.647	21.389	23.706	18.274	22.672
# of Students	13654	13675	14615	14615	13323	14591	13821	13218	8097
# of School-Years	69	69	69	69	42	69	69	69	42
# of Schools	37	37	37	37	27	37	37	37	27

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses all 972 initial school-year observations that passed the bootstrap test and that are in districts with known placement policies using 7th grade math CST scores. The coefficients were estimated using a local linear regression with a triangular kernel using Stata's -rdrobust- command. Bandwidth's were estimated using Calonico, Cattaneo, and Titiunik (2014).

Table B. 19: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Local Linear Regression (Trimmed Sample)

	Panel A: ITT Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
1[CST>=Cutoff]	0.051*	0.067**	0.12***	0.087***	0.069***	0.038+	0.028	0.036+	0.041+
	(0.021)	(0.022)	(0.010)	(0.009)	(0.008)	(0.022)	(0.021)	(0.021)	(0.023)
Bandwidth	19.913	17.785	22.277	24.764	26.630	24.007	25.721	26.569	31.078
	Panel B: Fuzzy RD Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.13**	0.163**	0.313***	0.236***	0.189***	0.099+	0.078	0.091+	0.109+
	(0.053)	(0.057)	(0.023)	(0.023)	(0.022)	(0.059)	(0.057)	(0.055)	(0.062)
Bandwidth	25.293	19.642	28.295	23.005	24.362	27.166	26.986	28.863	30.888
# of Students	144351	144363	155513	155513	117755	155241	146910	140405	101441
# of School-Years	753	753	753	753	550	753	753	753	550
# of Schools	510	510	510	510	424	510	510	510	424

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses the trimmed sample of school-year observations that passed the bootstrap and placebo test. The coefficients were estimated using a local linear regression with a triangular kernel using Stata’s -rdrobust- command. Bandwidth’s were estimated using Calonico, Cattaneo, and Titiunik (2014).

Table B. 20: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Local Linear Regression (Trimmed Sample; Schools with Policy Cutpoints of 300, 325, or 350 Only)

	Panel A: ITT Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
1[CST>=Cutoff]	0.042	0.046+	0.116***	0.086***	0.066***	0.036	0.033	0.026	0.022
	(0.027)	(0.026)	(0.012)	(0.011)	(0.010)	(0.029)	(0.028)	(0.027)	(0.030)
Bandwidth	23.826	24.815	23.988	24.679	25.835	28.04	30.003	31.684	36.034
	Panel B: Fuzzy RD Effects								
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.106	0.148*	0.304***	0.225***	0.185***	0.097	0.089	0.068	0.051
	(0.071)	(0.073)	(0.028)	(0.027)	(0.029)	(0.079)	(0.076)	(0.078)	(0.097)
Bandwidth	25.281	21.317	27.117	25.656	23.533	25.637	25.468	20.668	18.87
# of Students	95876	95909	103480	103480	76540	103290	97862	93407	65919
# of School-Years	492	492	492	492	351	492	492	492	351
# of Schools	376	376	376	376	298	376	376	376	298

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses the trimmed sample of school-year observations that passed the bootstrap and placebo test and that have an algebra placement cutoff using 7th grade math CST scores of 300, 325, or 350. The coefficients were estimated using a local linear regression with a triangular kernel using Stata's -rdrobust- command. Bandwidth's were estimated using Calonico, Cattaneo, and Titiunik (2014).

Table B. 21: Fuzzy RD Estimates of 8th Grade Algebra Course Assignment on Educational Outcomes Using a Local Linear Regression (Trimmed Sample; Schools in Districts with Known Policies Only)

Panel A: ITT Effects									
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
1[CST>=Cutoff]	0.038	0.064	0.192***	0.115***	0.085*	0.029	0.015	0.042	0.097
	(0.054)	(0.065)	(0.032)	(0.028)	(0.035)	(0.069)	(0.065)	(0.068)	(0.091)
Bandwidth	31.939	24.4	26.844	25.275	25.844	25.535	26.58	22.826	27.951
Panel B: Fuzzy RD Effects									
	10th Grade CAHSEE		Advanced Math Course-Taking			ELA CST			
	Math	ELA	9th Grade	10th Grade	11th Grade	8th Grade	9th Grade	10th Grade	11th Grade
Algebra	0.091	0.162	0.439***	0.26***	0.238*	0.065	0.041	0.079	0.391
	(0.128)	(0.157)	(0.065)	(0.056)	(0.076)	(0.158)	(0.157)	(0.145)	(0.291)
Bandwidth	26.437	22.691	26.993	27.197	32.917	25.276	23.058	27.638	20.215
# of Students	10952	10976	11729	11729	10578	11712	11096	10624	5804
# of School-Years	55	55	55	55	30	55	55	55	30
# of Schools	34	34	34	34	21	34	34	34	21

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: This sample uses the trimmed sample of school-year observations that passed the bootstrap and placebo test and that are in districts with known placement policies using 7th grade math CST scores. The coefficients were estimated using a local linear regression with a triangular kernel using Stata's -rdrobust- command. Bandwidth's were estimated using Calonico, Cattaneo, and Titiunik (2014).

APPENDIX C

Table C. 1: Student Demographics and Achievement by Algebra Policy Cutoff (300, 325, or 350)

	Algebra Cutoff = 300			Algebra Cutoff = 325			Algebra Cutoff = 350		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Share of 8th Graders in Algebra	0.626	0.484	24338	0.518	0.5	22853	0.437	0.496	56289
7th Grade CST Math (std.)	-0.493	0.563	24338	-0.287	0.599	22853	0.049	0.612	56289
7th Grade CST ELA (std.)	-0.485	0.744	24304	-0.332	0.769	22808	0.02	0.756	56249
Black	0.086		24324	0.071		22807	0.064		56128
White	0.122		24324	0.132		22807	0.273		56128
Hispanic	0.720		24324	0.671		22807	0.544		56128
SED	0.777		24334	0.768		22852	0.594		56283

Table C. 2: Student Demographics and Achievement by 8th grade Math Course and Algebra Policy Cutoff (300, 325, or 350)

	Algebra Cutoff = 300						Algebra Cutoff = 325						Algebra Cutoff = 350					
	Not Algebra			Algebra			Not Algebra			Algebra			Not Algebra			Algebra		
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
Within School Decile 7th grade CST Math	2.93	1.90	9095	6.76	2.32	15243	3.33	2.06	11014	7.21	2.15	11839	3.65	2.20	31682	7.49	2.05	24607
7th Grade CST Math (std.)	-0.98	0.41	9095	-0.20	0.43	15243	-0.72	0.43	11014	0.11	0.43	11839	-0.32	0.45	31682	0.52	0.45	24607
Within School Decile 7th grade CST ELA	3.67	2.40	9073	6.40	2.63	15231	3.98	2.52	10984	6.67	2.55	11824	4.21	2.55	31655	6.86	2.52	24594
7th Grade CST ELA (std.)	-0.93	0.65	9073	-0.22	0.67	15231	-0.71	0.68	10984	0.02	0.68	11824	-0.29	0.68	31655	0.42	0.65	24594
Black	0.11		9090	0.07		15234	0.08		10994	0.06		11813	0.07		31603	0.05		24525
White	0.09		9090	0.14		15234	0.11		10994	0.16		11813	0.23		31603	0.33		24525
Hispanic	0.76		9090	0.70		15234	0.73		10994	0.62		11813	0.61		31603	0.46		24525
SED	0.82		9093	0.75		15241	0.82		11014	0.72		11838	0.66		31677	0.51		24606

Table C. 3: Fuzzy RD Effects of 8th Grade Algebra on 10th Grade Math CAHSEE by Student Subgroup and School Policy Cutoff

	10th Grade CAHSEE					
	Math			ELA		
	c=300	c=325	c=350	c=300	c=325	c=350
Male	0.088**	0.055	0.045+	0.085*	0.022	0.048+
	(0.029)	(0.040)	(0.025)	(0.039)	(0.034)	(0.026)
Female	0.035	0.068+	0.070**	0.117***	0.047	0.033
	(0.032)	(0.035)	(0.023)	(0.035)	(0.037)	(0.025)
Black	0.07	0.193**	0.181***	0.082	0.166*	0.104+
	(0.068)	(0.062)	(0.039)	(0.071)	(0.074)	(0.060)
Hispanic	0.049+	0.024	0.058*	0.077**	0.007	0.073**
	(0.026)	(0.034)	(0.023)	(0.024)	(0.031)	(0.024)
White	0.035	0.213**	0.095***	0.145*	0.192*	0.078*
	(0.062)	(0.065)	(0.028)	(0.068)	(0.083)	(0.037)
Asian	0.107	0.141+	0.089+	-0.012	0.071	0.023
	(0.109)	(0.072)	(0.047)	(0.139)	(0.061)	(0.051)
SED	0.052+	0.062+	0.057*	0.085**	0.02	0.081**
	(0.027)	(0.033)	(0.024)	(0.027)	(0.029)	(0.025)
Non-SED	0.014	0.146**	0.103***	0.066	0.062	0.033
	(0.053)	(0.054)	(0.027)	(0.054)	(0.048)	(0.027)
ELL	0.144**	0.074+	0.197***	0.073+	0.027	0.084+
	(0.045)	(0.041)	(0.042)	(0.041)	(0.041)	(0.043)
Non-ELL	-0.004	0.073*	0.046*	0.053+	0.023	0.031
	(0.026)	(0.032)	(0.019)	(0.031)	(0.033)	(0.020)

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: We first partition the data by student subgroup and school policy cutoff. The coefficients are from a two-stage model with treatment-by-site instruments, school-year fixed-effects, and a random coefficient for the treatment (8th grade algebra). The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level. SED=Socioeconomically disadvantaged, and ELL=English Language Learner.

Table C. 4: Fuzzy RD Effects of 8th Grade Algebra on 11th Grade Accelerated Math Course-Taking by Student Subgroup and School Policy Cutoff

	Advanced Course Taking								
	9th Grade			10th Grade			11th Grade		
	c=300	c=325	c=350	c=300	c=325	c=350	c=300	c=325	c=350
Male	0.077***	0.205***	0.335***	0.039*	0.117***	0.258***	0.025	0.088**	0.204***
	(0.020)	(0.029)	(0.025)	(0.017)	(0.024)	(0.023)	(0.018)	(0.032)	(0.023)
Female	0.123***	0.299***	0.452***	0.060*	0.187***	0.342***	0.018	0.119***	0.288***
	(0.028)	(0.032)	(0.024)	(0.026)	(0.028)	(0.024)	(0.021)	(0.034)	(0.022)
Black	0.070+	0.234***	0.450***	0.066+	0.101**	0.316***	0.070*	0.088*	0.255***
	(0.039)	(0.043)	(0.038)	(0.034)	(0.037)	(0.038)	(0.032)	(0.042)	(0.043)
Hispanic	0.110***	0.223***	0.388***	0.049*	0.122***	0.300***	0.014	0.065*	0.258***
	(0.022)	(0.032)	(0.026)	(0.021)	(0.025)	(0.023)	(0.020)	(0.033)	(0.022)
White	0.092*	0.194***	0.358***	0.063+	0.114**	0.282***	0.037	0.038	0.203***
	(0.042)	(0.041)	(0.028)	(0.034)	(0.039)	(0.027)	(0.036)	(0.041)	(0.027)
Asian	0.185**	0.414***	0.519***	0.114+	0.374***	0.391***	0.128	0.300***	0.340***
	(0.068)	(0.062)	(0.037)	(0.063)	(0.059)	(0.042)	(0.085)	(0.078)	(0.043)
SED	0.110***	0.258***	0.395***	0.056**	0.154***	0.292***	0.025	0.114***	0.243***
	(0.022)	(0.030)	(0.026)	(0.020)	(0.023)	(0.024)	(0.019)	(0.028)	(0.022)
Non-SED	0.082*	0.238***	0.393***	0.037	0.155***	0.315***	0.007	0.101*	0.257***
	(0.032)	(0.036)	(0.027)	(0.025)	(0.034)	(0.025)	(0.025)	(0.048)	(0.025)
ELL	0.120***	0.284***	0.416***	0.077**	0.178***	0.320***	0.043+	0.150***	0.335***
	(0.029)	(0.035)	(0.036)	(0.024)	(0.033)	(0.036)	(0.023)	(0.035)	(0.038)
Non-ELL	0.101***	0.241***	0.406***	0.041+	0.143***	0.311***	0.012	0.085**	0.254***
	(0.025)	(0.030)	(0.023)	(0.023)	(0.025)	(0.022)	(0.019)	(0.032)	(0.020)

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: We first partition the data by student subgroup and school policy cutoff. The coefficients are from a two-stage model with treatment-by-site instruments, school-year fixed-effects, and a random coefficient for the treatment (8th grade algebra). The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level. SED=Socioeconomically disadvantaged, and ELL=English Language Learner.

Table C. 5: Fuzzy RD Effects of 8th Grade Algebra on 9th to 11th Grade ELA CST by Student Subgroup and School Policy Cutoff

	ELA CST											
	8th Grade			9th Grade			10th Grade			11th Grade		
	c=300	c=325	c=350	c=300	c=325	c=350	c=300	c=325	c=350	c=300	c=325	c=350
Male	0.041	0.002	0.065*	0.054	0.049	0.041	-0.002	0.046	0.064*	0.023	-0.037	0.054
	(0.038)	(0.036)	(0.026)	(0.043)	(0.039)	(0.026)	(0.045)	(0.046)	(0.029)	(0.051)	(0.069)	(0.034)
Female	0.056+	0.058	-0.006	0.063*	0.05	0.027	0.085*	0.080*	0.005	0.072*	0.095+	0.017
	(0.029)	(0.036)	(0.025)	(0.031)	(0.031)	(0.025)	(0.034)	(0.036)	(0.027)	(0.034)	(0.053)	(0.034)
Black	0.135+	0.081	0.105+	0.115	0.133*	0.147**	0.063	0.154+	0.124*	0.08	0.08	0.183*
	(0.073)	(0.080)	(0.055)	(0.072)	(0.062)	(0.055)	(0.090)	(0.088)	(0.059)	(0.093)	(0.099)	(0.090)
Hispanic	0.054*	0.039	0.073**	0.067*	0.026	0.062**	0.041	0.077+	0.079**	0.038	0.005	0.091**
	(0.024)	(0.029)	(0.023)	(0.028)	(0.033)	(0.024)	(0.031)	(0.040)	(0.024)	(0.034)	(0.053)	(0.031)
White	0.111	0.133+	0.056	-0.05	0.182*	0.075*	0.012	0.258**	0.053	-0.045	0.318**	0.061
	(0.071)	(0.079)	(0.037)	(0.074)	(0.078)	(0.036)	(0.080)	(0.091)	(0.039)	(0.100)	(0.099)	(0.045)
Asian	-0.055	-0.022	0.030	-0.124	-0.024	0.064	0.063	0.008	0.041	0.147	0.15	0.068
	(0.098)	(0.084)	(0.059)	(0.117)	(0.072)	(0.053)	(0.092)	(0.091)	(0.059)	(0.117)	(0.097)	(0.062)
SED	0.060*	0.021	0.056*	0.076*	0.029	0.056*	0.055+	0.048	0.062*	0.052	-0.011	0.075*
	(0.028)	(0.028)	(0.024)	(0.030)	(0.031)	(0.024)	(0.032)	(0.038)	(0.026)	(0.037)	(0.050)	(0.032)
Non-SED	-0.029	-0.004	0.062*	-0.031	0.051	0.067*	-0.021	0.065	0.019	-0.024	0.153+	0.056
	(0.054)	(0.053)	(0.031)	(0.058)	(0.055)	(0.028)	(0.063)	(0.053)	(0.030)	(0.065)	(0.078)	(0.037)
ELL	0.064	0.029	0.058	0.070+	0.040	0.098*	0.028	0.030	0.168***	0.005	0.008	0.127*
	(0.044)	(0.037)	(0.040)	(0.036)	(0.044)	(0.047)	(0.047)	(0.045)	(0.048)	(0.061)	(0.052)	(0.055)
Non-ELL	0.008	-0.006	0.034+	0.01	0.052+	0.029	-0.007	0.055	0.011	0.031	0.010	0.025
	(0.026)	(0.031)	(0.021)	(0.030)	(0.031)	(0.019)	(0.034)	(0.037)	(0.020)	(0.036)	(0.047)	(0.027)

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: We first partition the data by student subgroup and school policy cutoff. The coefficients are from a two-stage model with treatment-by-site instruments, school-year fixed-effects, and a random coefficient for the treatment (8th grade algebra). The model also uses a linear spline specification with an indicator for whether students' 7th grade CST are above the school-specific policy threshold, a linear control for students' 7th grade CST scores, and an interaction between the indicator variable and the linear control for students' 7th grade CST scores. Standard errors are clustered at the school-year level. SED=Socioeconomically disadvantaged, and ELL=English Language Learner.