Schedule-Driven Productivity: Evidence from Non-traditional School Calendars

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Abstract

Firms and schools strive to increase productivity by optimally structuring the schedules of their employees and students. We analyze the impact of non-traditional school calendars on student and teacher productivity. These calendars differentially allocate mandated instructional time by choosing 1) the number of hours in the school day, 2) the number of school days each year, and 3) the distribution of school days throughout the year. To do this, we use administrative data on over 2 million students and exploit the staggered elimination of non-traditional school calendars that vary on these three dimensions. We find that while school schedules have little impact on younger children's learning, school schedules with longer and fewer school days have large negative effects on older students that are equivalent to decreasing teacher quality by nearly one standard deviation. Our results appear to be driven by changes in at-home study behavior and school start times rather than how school days are distributed throughout the year. In addition, school schedules with longer and fewer school days increase teacher turnover. Our results reveal that daily school schedules appear to impact school productivity more than yearly school calendars.

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1 Introduction

Firms, schools, and other organizations often look to increase productivity while facing time constraints for their employees or students. Understanding the optimal way to structure the allocation of individuals' time throughout the day and year may enhance the efficiency of an organization. For example, there may be meaningful productivity differences between employees working five 8-hour days a week or four 10-hour days a week. Alternatively, differences between working fifty 40-hour weeks or forty 50-hour weeks may be substantial.

Similarly, the way schools structure the fixed amount of time students and teachers are required to spend in school may impact students' learning. In the United States, the modal high school student is constrained to spend 1,080 hours per year enrolled in school (see Figure A.1).[1] School districts could allocate this time in varied combinations of days per year and hours per day. However, most school districts allocate students' time into 180 6-hour days with a long summer break. This typical allocation of school time is a holdout from the past when schools did not hold classes during the summer months due to a lack of air conditioning (de Melker and Weber, 2014; Pedersen, 2012). While this allocation of school time may be optimal given its ubiquity, there is limited empirical evidence on the optimal structure of a school's daily schedule and yearly calendar.

In this paper, we estimate the effect of different school schedules on student achievement. While holding the total number of instructional hours in the school year fixed, the school schedules vary based on 1) the number of hours students spend in school each day, 2) the number of school days each year, and 3) the distribution of school days throughout the year. We estimate the impact of different school schedules using administrative

[1]States mandate the minimum number of educational hours students are required to receive in each grade. Using the 2018 state educational mandates and student-grade populations in each state, we find that 28% of elementary students are enrolled for at least 900 educational hours and 19% for at least 1,080 hours. For middle school students, 32% are enrolled for at least 900 hours, 16% for at least 990 hours, and 21% for at least 1,080 hours. For high school students, 11% are enrolled for at least 900 hours, 22% are enrolled for at least 990 hours, and 35% for at least 1,080 hours. See State Education Practices, Table 5.14 for state educational mandates.

data for over 2 million students from the Los Angeles Unified School District (LAUSD). To do this, we exploit the staggered elimination of two non-traditional school calendars that vary on these three dimensions.

By 2002, 20% of LAUSD schools were using one of two non-traditional calendars to combat overcrowding because of increased student population growth in the 1990s. The first calendar, the Concept 6 calendar, enrolled students for 163 days, lengthened the school day by 39 minutes by starting earlier, and divided the summer break into two shorter breaks. The second non-traditional school calendar, the 90-30 calendar, enrolled students for 180 days and retained the same daily schedule as the traditional school calendar, but divided the 3-month-long summer break into two shorter breaks. However, decreasing student enrollment in the 2000s and a lawsuit against the state of California induced the LAUSD to transition all of its schools to a traditional school calendar by 2012. Using this setting, we estimate the impact of school calendars on student achievement and teacher turnover using a difference-in-differences framework, that exploits variation from schools transitioning from a non-traditional calendar to a traditional calendar between 2002 and 2012. We also overcome potential endogenous selection into schools by leveraging within-student variation.

Our main estimates indicate that while school calendar structure has little to no impact on younger students' test scores, the calendar structure significantly impacts older students. We find those elementary and middle school students on a calendar with longer and fewer school days—the Concept 6 calendar—perform academically just as well as those with shorter and more school days. However, we find that having a school calendar with longer and fewer school days has a large negative impact on high school students. When high schools transitioned from the Concept 6 calendar to the traditional calendar, students' test scores increased by 0.08 to 0.15 standard deviations in math and 0.06 to 0.10 standard deviations in English. This is roughly equivalent to improving teacher quality by one standard deviation (Chetty, Friedman and Rockoff, 2014; Petek and

Pope, Forthcoming). While we see significant effects for high school students across the student-achievement distribution, our results suggest that high-achieving students have the largest benefits from a school calendar with shorter and more school days. These results suggest that even with a fixed amount of instructional time, how that time is allocated throughout the school day and the school year is an often-overlooked yet significant policy that influences student learning.

In addition to test scores, we estimate the effect of school calendar structure on student absences, grade repetition, and dropping out of high school. We find that transitioning to a traditional calendar decreases absences for elementary school students by 6 to 11 percent while having little effect on the absences of older students. This suggests that families may not be willing or able to adjust their family schedules to match non-traditional school calendars relative to traditional school calendars, especially for younger children. We also find no meaningful effect of changing school calendars on the probability that a student repeats a grade or drops out of high school.

A school's academic calendar may also affect teachers. While teachers work the same number of hours, teachers on a non-traditional school calendar are usually required to share classrooms and have their summer break divided throughout the year. With Concept 6 calendars, teachers also have longer daily schedules. These additional schedule changes may result in more teacher turnover in schools that are on a non-traditional calendar. While we find no effect on teacher turnover for teachers transitioning from a 90-30 calendar, we find that transitioning from a Concept 6 to a traditional calendar decreases teacher turnover. Teachers who transition from a Concept 6 calendar are 3.3 percentage points, or 16 percent, less likely to leave the school. These results suggest that teachers dislike having longer and fewer school days.

The similarities and differences between the three school calendars suggest four potential mechanisms that could explain our results. These mechanisms include 1) school start times, 2) longer school days, 3) how school days are distributed throughout the year, and 4) changes in at-home study time. First, estimates from Edwards (2012) and Kim (2022) suggest that the earlier school start times for schools on Concept 6 calendars could explain up to half of the overall effect found for high school students as the benefits for later school start times largely coming from additional sleep time for adolescents (Carrell, Maghakian and West, 2011; Heissel and Norris, 2018). Second, due to increased fatigue, longer school days have been shown to negatively affect students' GPAs and test scores (Pope, 2016). However, back-of-the-envelope calculations suggest that fatigue from longer school days explains less than 5% of our results. Third, since we find little to no effect of transitioning from a 90-30 to a traditional calendar,[2] how school days are distributed throughout the year is unlikely to explain the effect found for high school students. Lastly, even if teachers assign the same amount of homework each day, because Concept 6 calendars have fewer school days, students would spend nearly 10% less time doing schoolwork at home. Teachers may also adjust to longer school days by assigning even less homework. While our data does not allow us to analyze students' at-home study behavior, work by Eren and Henderson (2011) suggests a 10% reduction in homework could explain approximately 30% of our results.

This paper contributes to two distinct literatures. The first literature focuses on workplace productivity. Research looking at the impact of work schedules on workplace productivity focuses on changes in productivity and safety between day and night shifts (Folkard and Tucker, 2003) and the effect of longer and fewer work days for police officers or medical professionals (Amendola et al., 2011; Thompson, 2019; Banakhar, 2017). Amendola et al. (2011) find that police officers on 10-hour shifts performed no differently than those on 8-hour shifts but that those on 12-hour shifts experienced significantly higher levels of fatigue and lower levels of alertness. In their review, Banakhar (2017) finds that nurses experienced increased fatigue when on 12-hour shifts instead of 8-hour shifts. Moreover, Thompson (2019) measures the reaction time, lapses of attention,

[2]These results for the 90-30 calendar are similar to those of McMullen and Rouse (2012) who analyze a similar school calendar in North Carolina.

and muscle function assessments in a lab setting after single 12-hour shifts and three consecutive 12-hour shifts. They find increased fatigue impairments when working a single shift and additional impairments with consecutive work shifts. Recently, there has been renewed interest in the four-day work week which increases the number of hours worked each day but eliminates one workday each week. Firms and governments in the United Kingdom, Japan, and Iceland are currently performing randomized controlled trials in order to study the impacts of a four-day workweek on workplace productivity (Kalia, 2022; BBC News, 2021; Chappell, 2019).

Secondly, we add to a growing literature interested in how deviating from the traditional school calendar affects student achievement. Researchers have primarily focused on later school start times (Carrell, Maghakian and West, 2011; Edwards, 2012; Hinrichs, 2011; Kim, 2022), a four-day school week (Anderson and Walker, 2015; Fischer and Argyle, 2018; Thompson, 2021), rearranging the daily class schedule Pope (2016), and year-round school calendars (Graves, 2010; Graves, McMullen and Rouse, 2018; McMullen and Rouse, 2012). The setting in our paper is most similar to work done by Graves (2010) and McMullen and Rouse (2012) who study the effect of year-round calendars on student achievement. Graves (2010) provides some of the first estimates of the effect of a year-round calendar on student achievement. Using school-level data in California, she finds that the test scores of students on a year-round calendar are 1-2 percentile points lower than those of students on traditional calendars. In subsequent work, Graves (2011) finds larger negative effects of year-round calendars for low-income and minority students.

Later work by McMullen and Rouse (2012) overcomes student selection by using student-level data and relying on within-student variation in calendar type. They exploit a 2007 North Carolina school policy change where 22 elementary and middle schools transitioned from a traditional calendar to a year-round calendar that still had 180 days but split the summer break into four small breaks. They find little evidence that this year-round calendar impacts student test scores suggesting that how days are distributed throughout the year has little impact on student learning. In later work, McMullen, Rouse and Haan (2015) consider possible distributional effects of the year-round calendar using a quantile approach and find a small positive effect for the lowest-performing students in North Carolina after schools transitioned to this year-round school calendar.

In contrast to this literature, our paper benefits from the LAUSD's use of two types of non-traditional calendars. This allows us to estimate not only the effect of how school days are distributed throughout the year but also the impact of longer and fewer school days. Our paper finds that changes to the daily school schedule appear to be more important than changes in the yearly school calendar. These results potentially reconcile the limited effect of year-round calendars found by McMullen and Rouse (2012) with the negative effect found by Graves (2010). Like McMullen and Rouse (2012), we exploit policy variation and find that transitioning from a year-round calendar with 180 days and more breaks to the traditional calendar has little effect on student achievement. However, we also find that transitioning from a year-round calendar with longer and fewer school days to a traditional calendar significantly improves student achievement. These effects are even larger than those found by Graves (2010) since she combines all types of year-round calendars and estimates an average effect across all year-round calendar types. Our paper helps better understand the literature on year-round calendars by distinguishing between calendars that do or do not change the daily school schedule and estimating their differential impact on student and teacher productivity.

2 LAUSD and Non-traditional School Calendars

During the 1990s, the LAUSD suffered from overcrowded schools because of a large increase in its student population (see Figure A.2). In response, schools in the LAUSD adopted non-traditional school calendars which allowed schools to simultaneously meet building-capacity constraints and accommodate the increased number of students.[3] By 2002, more than 20% of schools in the LAUSD had adopted a non-traditional calendar.

In the early 2000s, concerns that California schools did not provide adequate access to teachers, instructional materials, or school buildings resulted in a class-action lawsuit against the State of California (Williams et al., 2004). In response to this lawsuit and declining student enrollment, the LAUSD decided to eliminate non-traditional calendars from its schools by 2012.[4] Between 2004 and 2012, the LAUSD transitioned all but one of its schools back to a traditional school calendar. Our empirical method exploits this policy decision by the LAUSD to eliminate non-traditional school calendars.

When non-traditional school calendars were initially implemented in the 1990s, schools adopted one of two types of non-traditional calendars: the 90-30 or Concept 6 calendar. Figure 1 compares the traditional calendar to these two non-traditional school calendars. These three calendars varied based on 1) the number of hours students spent in school each day, 2) the number of school days each year, and 3) the distribution of school days throughout the year.[5] As in most of the country, LAUSD schools on a traditional calendar started the school year in early September and continued through June of the following year with a two-week winter break. Students then had a long summer break between June and September. Schools on a traditional school calendar provided instruction to students for 180 6-hour days.

In contrast, schools using either the 90-30 or the Concept 6 calendar ran on a track system. Schools on the track system divided the student body into multiple groups called tracks. Each track would begin the school year and have breaks at different times than

[3] One type of non-traditional school calendar—the multi-track, year-round calendars—helps alleviate overcrowding by allowing more students to enroll during the school year than could be accommodated by traditional calendars. To illustrate, suppose 150 students enroll at their neighborhood school, but the school only has a capacity of 100 students at any given time. By dividing the students into three groups of 50 students each and staggering student breaks throughout the year so that only two groups of students are in school at any time, the school is able to accommodate 150 students even with the 100-student building constraint.

[4] See Aspen Environmental Group (2004) for a detailed plan that outlines the LAUSD's goals to improve the district and how it intended to meet those goals.

[5] All three school calendars continued the typical 5-day school week.

other tracks. Under this system, breaks between tracks were staggered ensuring that at least one track of students was on break at any given time. The 90-30 calendar grouped students into four tracks while the Concept 6 calendar used three tracks. Panels B and C of Figure 1 illustrate the multi-track nature of each of the non-traditional calendars. On the 90-30 calendar, students on Tracks B, C, and D began the new school year in July. In mid-August, Track A would begin school, and Track C would begin their first break. Track C would resume roughly 30 days later, at which time Track B would begin its first break. Following this structure, each track would follow a schedule of instruction times and breaks for the remainder of the school year. Students on the Concept 6 calendar followed a similar system with three tracks instead of four. Schools that adopted either track system were able to accommodate more students.

While both non-traditional calendars use the multi-track system, major differences existed between the two. Similar to the traditional calendar, schools on the 90-30 calendar enrolled students for 180 days and had 6-hour school days. However, the 90-30 calendar eliminated the traditional summer break in lieu of two smaller breaks.[6] In contrast, the Concept 6 calendar enrolled students for only 163 days and lengthened the school day by 39 minutes to ensure equivalent instruction time.[7] In order to not interfere with after-school activities, Concept 6 schools typically started the school day 30 minutes earlier than either the 90-30 or the traditional calendar. Like the 90-30 calendar, the Concept 6 calendar converted the summer break into two smaller breaks throughout the year.

During the 1990s, schools predominantly adopted Concept 6 calendars. We observe 112 elementary schools, 19 middle schools, and 19 high schools using Concept 6 calendars. This is in contrast to the 41 elementary schools and 1 middle school that adopted the 90-30 calendar.

[6]The 90-30 calendar gets its name because of the general structure of the system: 90 days in school followed by a 30-day break.

[7]Regardless of the school calendar, California educational guidelines required that students in the same grade level receive the same number of minutes of instruction.

3 Data Description

Our analysis relies on student-level administrative data from the LAUSD. These data include all students from kindergarten to Grade 12 from the 2002–03 to 2012–13 school years. The district enrolled over 600,000 students yearly; employed over 24,000 teachers; and operated over 750 elementary, middle, and high schools during this period. The LAUSD student composition was roughly 73 percent Latino, 8 percent black, and 11 percent white.[8] For convenience, we will reference school years by the year's class start (e.g. the 2002–03 school year is denoted as 2002).

These data contain information on our student outcomes of interest: standardized math and English test scores, the fraction of days absent, whether a student repeats a grade, and whether a student drops out of high school. These test score data come from the math and English California State Tests and are normalized to be mean zero and standard deviation one at the grade-year level. The California State Test is taken in the spring of each year by all students in Grades 2 through 11. The fraction of days absent is constructed by dividing the number of days absent by the total number of days enrolled in the school year. We determine that a student repeats a grade if the student is enrolled in the same grade in two subsequent years. A student is considered a dropout if she enrolls in ninth grade and does not graduate high school within 5 years.[9] These data also include whether a student is an English-language learner, but does not include student demographic data such as gender and race. Due to the lack of individual student characteristics, we add school-level demographic characteristics obtained from the Common Core of Data to the student-level data. These data include the number of students enrolled; the student-to-teacher ratio; the percentage of students who are Asian, Hispanic, black, and white; and the percentage of students eligible for free or reduced-price lunch.

In addition to the student-level data, we use data on teachers in the school district.

[8] Statistics from https://achieve.lausd.net/facts using the Wayback Machine for earlier statistics

[9] With our definition of dropout, this includes students who drop out of school or students who leave the school district.

For each teacher, we can identify the school where they taught and the number of years of previous teaching experience. We measure teacher turnover using an indicator for whether a teacher stops teaching at a school. We observe whether a teacher moves to another LAUSD school, but we are unable to follow a teacher outside of the LAUSD.

We combine these student- and teacher-level data with school calendar data from the California Basic Educational Data System from 2002–12.[10] These data are used to determine the school calendar for each school throughout the sample period. They also allow us to determine the year that schools transitioned from a non-traditional to a traditional calendar.

Student and school summary statistics are presented in Panels A and Panel B of Table 1, respectively. We separate schools into three mutually exclusive groups: schools that transitioned from a 90-30 calendar, schools that transitioned from a Concept 6 calendar, and schools that always remained on a traditional calendar. Panel A provides student-level measures for each of these three groups while Panel B provides school-level measures. When compared to students in 90-30 schools, students in Concept 6 schools perform worse across all student outcomes. They perform worse on standardized math and English tests, are absent more, are more likely to repeat a grade, and are more likely to drop out. However, students at always traditional schools have higher test scores than those at 90-30 or Concept 6 schools with minor differences in other measures of student achievement. English language learners are more likely to be at a school with a non-traditional calendar. We also see differences in school-level measures between schools with non-traditional and traditional calendars. Compared to 90-30 and Concept 6 schools, always-traditional schools have a higher percentage of Asians, blacks, and whites in their student body but have fewer Hispanic students and fewer students on free lunch. We also see that 90-30 schools were primarily elementary schools.[11]

[10]Unfortunately, the California Basic Educational Data System no longer publicly maintains these data for years before 2008. Graciously, Jennifer Graves provided these data for the years 2002–2007.

[11]Some schools do not fit the typical model of an elementary, middle, or high school (e.g. elementary schools are usually defined as schools housing students in kindergarten to Grade 5). In LAUSD, some

4 Empirical Strategy

Our main objective is to estimate the causal effect on student outcomes of the 90–30 and Concept 6 calendars relative to the traditional calendar. However, whether a school is on either of these calendars is endogenously chosen by the school. We overcome this endogeneity issue by exploiting the staggered elimination of non-traditional calendars in the LAUSD between 2002 and 2012. We estimate the effect of each of these school calendars on student achievement measures using the following difference-in-differences framework.

Our main model is as follows:

$$Y_{igst} = \beta \text{Traditional}_{st} + \delta X_{igst-1} + \lambda S_{st} + \mu L_{igst} + \phi_s + \psi_{gt} + \epsilon_{igst} \tag{1}$$

where Y_{igst} is the outcome of interest for student i in grade g at school s in year t. These student outcomes are standardized math and English test scores, the fraction of days absent, whether a student repeats a grade, and whether a student drops out of high school. Traditional_{st} is an indicator for whether school s is on a traditional calendar in year t. In the fully specified model, we control for a vector of lagged student characteristics, X_{igst-1}, that contains lagged student test scores, a lagged indicator of suspensions, the lagged fraction of days absent, and an indicator for being an English language learner. We also control for a vector of time–variant school characteristics, S_{st}, including the fraction of students that are Hispanic, black, white, and Asian, the student–teacher ratio, and the fraction of students eligible for free or reduced–price lunch. In addition, we include controls for peer effects, L_{isgt}, which is a measure of the average lagged math and English test scores of all students in the same school and grade in year t, excluding student i. In all specifications, we include a school fixed effect, ϕ_s, and a grade–by–year fixed effect,

schools are span schools which are "schools that 'span' or cover more grades than traditional elementary, middle, or high schools such as K to 8, 7 to 12, or K to 12" (Aspen Environmental Group, 2004). These span schools make up only 4 of the schools on a non-traditional calendar and have been removed from our data.

ψ_{gt}. We cluster our standard errors at the school level.

The main coefficient of interest, β, represents the impact of transitioning from a non–traditional calendar to a traditional calendar on student achievement. Including lagged math and English test scores allows us to measure the change in test scores from year to year instead of test score levels. This allows us to measure the yearly value added by a non–traditional school calendar to student achievement. To account for differences in both of the non–traditional calendars, we separately estimate this model for schools transitioning from a Concept 6 or a 90–30 calendar. For example, when limiting the sample to both schools that transitioned from a Concept 6 calendar and schools always on a traditional calendar, the coefficient of β measures the difference in the change in test scores before and after transitioning between students whose schools transitioned and always–traditional schools. In some specifications, we exclude lagged test scores and include a student fixed effect, α_i, instead. These specifications estimate the within–student effect of schools transitioning from a non–traditional calendar to a traditional calendar.

The main identifying assumption for this model is that the achievement of students at schools with non–traditional and traditional calendars would have parallel trends in the absence of a calendar change. While the counterfactual parallel trends assumption can not be observed, we can test for parallel trends before non–traditional schools transitioned to traditional calendars. In Figures 3–6, the pre–trends can be separately seen for 90–30 and Concept 6 calendar schools. We discuss these in detail in Section 5.5 of the results and find little evidence of pre–trends, except in the case of students repeating a grade.

Additionally, for the parallel trends assumption to hold, no other policy that impacts student achievement should be occurring in conjunction with schools transitioning calendars. There were some district–wide reforms during this time period such as maintaining clean and safe schools, providing an adequate number of textbooks, and hiring qualified teachers, but these reforms were implemented in all schools and did not align with the timing of most non–traditional schools transitioning calendars. While we are unaware of any simultaneous changes to school–level policy, students may sort across schools after their school transitions to a traditional calendar, thereby potentially changing the student composition within a school. While this would be problematic for a school–level analysis, our student–level data allow us to control for student characteristics through either lagged test scores or a student fixed effect. In particular, using a student fixed effect allows us to measure the impact of transitioning calendars within a student. Our results are similar whether we control for endogenous choice using lagged test scores or a student fixed effect.

In addition to the parallel trends assumption, recent literature has examined how two–way fixed effects regressions can be biased in the presence of heterogeneous treatment effects between groups or over time (Goodman-Bacon, 2021; Callaway and Sant'Anna, 2020; De Chaisemartin and d'Haultfoeuille, 2020; Borusyak and Jaravel, 2017). We take into account the potential heterogeneous treatment effects by using the estimators suggested by Borusyak and Jaravel (2017) and Sun and Abraham (2020). When using both of these new approaches, we find that our results differ little from the traditional two–way fixed effect estimates. Our estimates using the estimators in Borusyak and Jaravel (2017) are found in Table 4. Our dynamic effect results using those of Sun and Abraham (2020) are shown in Figures 3–6.

5 Results

We present our results in five subsections. Section 5.1 presents the effect on student outcomes of transitioning from a 90–30 calendar to a traditional calendar. Analogously, Section 5.2 presents the effect of transitioning from a Concept 6 calendar. The student outcomes of interest throughout the results section are standardized math scores, standardized English scores, the fraction of days absent, the probability of repeating a grade, and the probability of dropping out. In Section 5.3, we show that the results are robust to the potential presence of heterogeneous treatment effects. Next, we investigate student achievement heterogeneity in Section 5.4. Section 5.5 provides our estimates for the dynamic effect of transitioning from either the 90–30 or the Concept 6 calendar. Lastly, Section 5.6 reports the estimates for how transitioning to the traditional calendar impacts teacher turnover by experience.

5.1 Transitioning from 90–30 Calendars

In this section, we estimate the impact on students of transitioning to a traditional calendar from a 90–30 calendar with an identical daily schedule but a dispersed summer break. We restrict the sample to schools that transitioned from a 90–30 calendar or were always on a traditional calendar and estimate Equation 1. Since all but one 90–30 schools were elementary schools, we also restrict the sample to elementary schools. We report the difference–in–differences coefficient, β, for varying specifications in the first four Columns of Table 2.

5.1.1 Standardized Math and English Test Scores

The impact of transitioning to a traditional calendar on standardized math and English test scores is found in Panels A and B of Table 2. When only grade–by–year and school fixed effects are included, the estimates in Column 1 indicate that when a school transitions to a traditional calendar, the average math and English test scores at the schools increase by 0.043 and 0.082 standard deviations, respectively, compared to always-traditional schools. This increase in test scores captures both the impact of now having a traditional calendar and potential student composition changes at the school due to transitioning.

The specification in Column 2 adds lagged test scores to account for potential changes in student composition at the school. The resulting estimates shrink and become statistically indistinguishable from zero. The estimates remain indistinguishable from zero after including lagged non–test score controls, peer controls, and time–varying school controls as seen in Column 3. In Column 4, we alternatively control for student composition changes by including student fixed effects. Again, we find little evidence that transitioning to a traditional calendar impacts student test scores. Our preferred specification, found in Column 4, suggests that transitioning from a 90–30 to a traditional calendar has little to no impact on test scores for students in elementary school.

5.1.2 Fraction of Days Absent, Repeating Grades, and Dropping Out

Panel C of Table 2 provides estimates for the fraction of days a student is absent. The estimate in Column 1 indicates that students have fewer absences after transitioning to the traditional calendar from the 90–30 calendar. The effect remains consistent when we include lagged test scores, time–varying school controls, or student fixed effects. The estimate in Column 4 implies that moving to a traditional calendar decreases elementary school student absences by 0.4 percentage points (10.9%), or by 0.72 days per year. This suggests that families may not be as willing or able to adjust their family schedules to match non–traditional school calendars relative to traditional school calendars. This result may be attributed to the increased number of school days during the summer on non–traditional calendars. Families report that they are most likely to travel during the summer months (Minnaert, 2017), suggesting that families would no longer need to pull students out of school during the summer months after a school adopted the traditional calendar.

The impacts of calendar type on repeating a grade and dropping out of school are presented in Panels D and E, respectively. For all four of our specifications, our results imply that moving from a 90–30 to a traditional calendar plays a minimal role in whether a grade is repeated. For Panel E, the standard two–way fixed effect estimates in the first three Columns imply that moving from a 90–30 to a traditional calendar has little to no impact on whether a student drops out of school. Note that since there is no within student variation for dropping out, we are unable to provide estimates from the student fixed effect specification. Overall, it appears that moving from a 90–30 calendar to a traditional calendar has little impact on students' educational outcomes except for student absences. This suggests that how vacation days are distributed throughout the year has little impact on students.

5.2 Transitioning from Concept 6 Calendars

In this section, we estimate the impact on students of transitioning from a Concept 6 calendar—with longer and fewer days—to a traditional calendar. We restrict the sample to schools that transitioned from a Concept 6 calendar or were always on a traditional calendar and estimate Equation 1. Since Concept 6 calendars were adopted by elementary, middle, and high schools, we provide estimates for the full sample of Concept 6 schools and separately for each of the three school levels. We report the difference–in–differences coefficient, β, for varying specifications in the last four Columns of Table 2 and in Table 3.

5.2.1 Standardized Math and English Test Scores

The last four columns of Table 2 present our estimates for the effect of transitioning from a Concept 6 to a traditional calendar on the full sample. The estimates for math and English test scores are found in Panels A and B, respectively. When only grade–by–year and school fixed effects are included, the estimates in Column 5 indicate that when a school transitions to a traditional calendar, the average math and English test scores of the students at the schools increase by 0.081 and 0.077 standard deviations, respectively, compared to students in always-traditional schools. After controlling for potential changes in student composition and time–varying school characteristics in Columns 6 and 7, the estimates for both math and English shrink to roughly 0.025 standard deviations. In our preferred specification in Column 8, the positive impact of moving to a traditional calendar remains consistent. Our estimates suggest that transitioning from Concept 6 to a traditional calendar increases student math scores by 0.027–0.035 standard deviations and

English test scores by 0.022–0.026 standard deviations. These effects are roughly equivalent to improving teacher quality by 25% of a standard deviation (Chetty, Friedman and Rockoff, 2014; Petek and Pope, Forthcoming).

While these overall results are moderately sized, they hide meaningful heterogeneous effects across different age groups. Table 3 reports the estimates for elementary, middle, and high school. As can be seen in the first four columns of Table 3, the estimates for elementary schools transitioning from a Concept 6 calendar mirror the results for elementary schools transitioning from 90–30 calendars. After controlling for potential changes in student composition in Columns 2–4, we find that school calendar type has little to no impact on student test scores for students in elementary school. Our results also show that moving from a Concept 6 calendar has little impact on middle school students. For all four of the specifications in Columns 5–8, we find a relatively small and statistically insignificant effect of transitioning from a Concept 6 calendar.

In contrast to the estimates for elementary and middle schools, our estimates for high schools suggest that calendars have a large and meaningful impact on high school students. The estimates reported in Columns 9–12 show that moving from a Concept 6 to a traditional calendar improves high school students' standardized math test scores by 0.097 to 0.154 standard deviations. Although somewhat smaller, the results for English are similar with effect sizes between 0.060 and 0.100 standard deviations. These impacts are statistically significant and large. For both math and English, these effect sizes are roughly equivalent to improving teacher quality by one standard deviation (Chetty, Friedman and Rockoff, 2014; Petek and Pope, Forthcoming).

5.2.2 Fraction of Days Absent, Repeating Grades, and Dropping Out

The full sample estimates for moving from a Concept 6 to a traditional calendar for the fraction of days absent, repeating grades, and dropping out are found in the last four Columns of Table 2. In Panel C and Column 5, we find that moving to a traditional school calendar decreases the number of days absent. Correcting for potential changes in student composition, the estimate moves toward zero. While our preferred specification shows little to no effect in the aggregate, Table 3 shows additional heterogeneity across school levels. Similar to the 90–30 calendars, for students in elementary school, Columns 1–4 show that transitioning from a Concept 6 calendar reduces the number of absences across all specifications. This effect on absences is about half of the size of the effect found on 90–30 calendars and suggests that transitioning from a Concept 6 to a traditional calendar reduced absences for elementary school students by 0.2 percentage points (6%), or about 0.36 days. While there appear to be modest negative effects on elementary school students, we find little evidence that moving from a Concept 6 calendar impacted older students' absences.

The estimates for grade repetition and dropping out are found in Panels D and E of Tables 2 and 3, respectively. Although the results are typically negative for repeating a grade and the probability of dropping out of high school, we find little to no evidence that moving from a Concept 6 to a traditional calendar impacts either outcome. Moreover, we do not find evidence that moving from a Concept 6 calendar impacts grade repetition or dropping out of high school for students in elementary, middle, or high school. With few exceptions, our estimates are statistically indistinguishable from zero.

Overall, our results suggest that moving from a Concept 6 calendar to a traditional calendar greatly improves the test scores of high school students while having little impact on younger students. As we further explore in the section on potential mechanisms, these results suggest that the daily schedule changes tied to having longer and fewer school days on the Concept 6 calendar drive our result rather than how school days are distributed throughout the school year.

5.3 Robustness to Heterogeneous Treatment Effects

Following the recent difference–in–differences literature, we estimate the impact of transitioning to a traditional calendar from a non–traditional calendar accounting for the potential presence of heterogeneous treatment effects (Goodman-Bacon, 2021; Callaway and Sant'Anna, 2020; De Chaisemartin and d'Haultfoeuille, 2020; Borusyak and Jaravel, 2017). Using the specification from Columns 3 and 7 of Table 2, we adjust for potential heterogeneous treatment effects by using the estimator suggested by Borusyak and Jaravel (2017) and report our results in Table 4. As seen by comparing Table 4 to Table 2 and 3, adjusting for heterogeneous treatment effects provides nearly identical results.

5.4 Student Achievement–Level Heterogeneity

In this section, we estimate the heterogeneous impact of transitioning from a non–traditional to a traditional calendar by student achievement level. To do so, we divide students into terciles representing low–achieving, middle–achieving, and high–achieving students. To allow for a student fixed effect specification, we construct a measure of academic achievement that keeps students in the same tercile over time. We construct these terciles within each grade and year using the average of a student's first observed standardized math and English test scores. We then estimate Equation 1 separately for each of these three groups.

The effect of transitioning from a 90–30 calendar to a traditional calendar by student achievement group is reported in Table A.1. We find little evidence that school calendars impact students differently based on their prior achievement across all our educational outcomes. While the effects across groups for math test scores differ little, there may be suggestive evidence of a positive effect for high–achieving students for English test scores. However, the difference between the effect sizes for high– and low–achieving students is not statistically significant. Similar to the results in the full sample, we find negative impacts on student absences. However, these effects do not differ across achievement groups. We also find no differential impact by student achievement group on whether a student repeats a grade or drops out of high school.

Table 5 reports the effect of transitioning from a Concept 6 calendar to a traditional calendar by student achievement group. For Concept 6 calendars, we find evidence that the transition to a traditional calendar improves standardized math scores for high–achieving students by 0.050 to 0.073 standard deviations as shown in Columns 10–12. In contrast, transitioning away from a Concept 6 calendar has little to no effect on the math test scores of low– or middle–achieving students. We also find transitioning to a traditional calendar improves standardized English test scores for students of all achievement groups with scores increasing by 0.01 to 0.02 standard deviations for low–achieving students, by 0.02 to 0.03 standard deviations for middle–achieving students, and by 0.03 for high–achieving students. Additionally, we find no differential impact on the fraction of days absent, repeating a grade, or dropping out of high school.

Due to the differential effects we see across Concept 6 calendars, we also test for achievement heterogeneity within elementary, middle, and high schools. We provide estimates by achievement tercile for Concept 6 elementary schools in Table 6. We find little evidence that transitioning from a Concept 6 calendar impacts standardized math and English test scores for any achievement group. We do find evidence that transitioning to a traditional calendar reduces the fraction of days absent by 0.2–0.3 percentage points among the low– and middle–achieving groups with smaller and statistically insignificant effects for the high–achieving group. We also find evidence that high–achieving students are slightly (roughly 0.1 percentage points) more likely to repeat a grade when transitioning from a Concept 6 calendar. Lastly, we find that the probability of dropping out of high school decreases by 1.5 percentage points for high–achieving elementary school students after transitioning to a traditional school calendar, while we find no analogous effect for low– and middle–achieving students. In addition, Table A.2 provides estimates for Concept 6 middle schools. Our results suggest there are few differing effects by student achievement groups for middle school students.

The estimates reported in Table 7 show the results of transitioning from a Concept 6 calendar for high school students by achievement group. The results for math test scores in Panel A show a differential effect between achievement groups. We find that moving to a traditional calendar increases standardized math scores by 0.04 to 0.07 standard deviations for low–achieving students, by 0.08 to 0.14 standard deviations for middle–achieving students, and by 0.11 to 0.24 standard deviations for high–achieving students. In contrast to the math test scores, we find that transitioning from a Concept 6 calendar increases standardized English test scores by 0.06 to 0.11 standard deviations for all achievement groups. Lastly, for high school students, we find no differential effect by achievement group for the remaining student outcomes. As we discuss further in our section on potential mechanisms, a change in at–home study time may partially explain the differential impact we find across achievement groups for older students.

5.5 Estimates of Dynamic Effects

In addition to the estimates of Equation 1 from above, we estimate the dynamic treatment effects using the estimators proposed by Sun and Abraham (2020) which account for heterogeneous treatment effects across treatment cohorts. These results are shown in Figures 3 to 6. Standard difference–in–differences dynamic effects, in which we estimate Equation 1 while interacting Traditional_{st} with dummy variables for the number of years before or after a school transitions to a traditional calendar, are shown in Figures A.3 to A.6. Each figure displays the point estimate and the 95% confidence interval. We use the pre–treatment estimates to visually test for parallel pre–trends. If significant pre–treatment effects exist, concerns about the parallel trends assumption may arise. The dynamic effect estimates also allow us to illustrate how the effect of transitioning to a traditional calendar evolves over time. We include the same controls as in Column 4 of

Tables 2 and 3 except for the probability of dropping out which uses the specification in Column 3. Because of the heterogeneous treatment effects we find between younger and older children transitioning from a Concept 6 calendar, we present these dynamic effects separately for elementary, middle, and high school students. All estimates are relative to $t = -1$, which is indicated by a vertical line. The first year in which a school operates on a traditional calendar is indicated by $t = 0$.

Figure 3 reports the dynamic effect of transitioning from a 90–30 to a traditional calendar. Again, we restrict the sample to only elementary schools since all but one 90–30 calendar school were elementary schools. Except for repeating a grade, we find little evidence of nonparallel pre–trends for 90–30 calendars. Similar to the results for 90–30 calendars in Table 2, we also find little evidence that transitioning to a traditional calendar impacts student achievement except for absences. In all of the post–transition years, we find a negative effect on absences between 0.3 and 0.5 percentage points, or a reduction in absences of 8% to 14%. Moreover, there appears to be no dynamic treatment effect for absences or any other outcome. While there are some statistically significant effects for repeating a grade post–transition, we are reluctant to interpret these effects because they appear to be following the pre–trend.

We present the dynamic estimates of transitioning from a Concept 6 to a traditional calendar in Figure 4 for elementary schools. Very similar to the results for the 90–30 calendars, we find little evidence of nonparallel pre–trends except for repeating a grade and potentially days absent. Besides absences, we find little evidence that transitioning from a Concept 6 calendar impacts student outcomes. Unlike the 90–30 calendar estimates for absences, we find a negative effect on absences that increases over time after transitioning from a Concept 6 calendar. In the first two years after transitioning, we see absences decrease by 0.1 percentage points, or 3%. This effect on absences grows and is more than 0.5 percentage points, or 14%, five years after transitioning. The dynamic estimates for middle schools that transitioned from a Concept 6 to a traditional calendar are presented in Figure 5. While there appear to be parallel pre–trends for each outcome, we also see no overall or dynamic effects of transitioning from a Concept 6 calendar for middle school students.

Figure 6 reports the dynamic effects of transitioning from a Concept 6 to a traditional calendar for high schools. While there appears to be a nonparallel pre–trend for absences and potentially repeating a grade, we see little evidence of nonparallel pre–trends for the other outcomes. Similar to our results in Table 3, we find positive effects of transitioning from a Concept 6 calendar on standardized math and English test scores. While the effects on test scores may appear to be growing over time, the difference in the effect sizes is not statistically significant because of the large standard errors in later years. In the post–transition years, we find a positive effect on math test scores of between 0.1 and 0.3 standard deviations. Similarly, for English, we find a positive effect of between 0.07 and 0.18 standard deviations. There is little evidence that transitioning from a Concept 6 calendar impacts other student outcomes for high school students. Overall, the dynamic effects are consistent with the difference–in–differences estimates and typically exhibit parallel trends. However, the effects we find appear to be relatively constant post–treatment with few effects changing dynamically over time.

5.6 Teacher Turnover

Non–traditional school calendars may also play an important role in teachers' well–being, leading teachers to have strong preferences regarding school calendar type. For example, due to the multi–track nature of the 90–30 and Concept 6 calendars, teachers frequently have to share classrooms with teachers on different tracks. In addition, while teachers work the same number of hours, teachers working on a non–traditional school calendar have a shorter summer break that may limit them from getting a summer job or vacationing at their preferred time. Also, the daily schedule for teachers on the Concept 6 calendar required more instructional hours each day. Teachers' preferences for school calendar type may result in different levels of teacher turnover for each calendar type. This may partially explain why teacher turnover rates were 23.9% and 22.1% for 90–30 and Concept 6 schools, respectively, but only 20.7% for traditional schools. Using school–level data linked to teachers, we estimate the effect of school calendar type using our difference–in–differences design. The outcome of interest is an indicator equal to one if a teacher leaves their school between years t and $t+1$.

Table 8 presents our estimates of teacher turnover for teachers who transitioned from either a 90–30 calendar (Columns 1–3) or a Concept 6 calendar (Columns 4–6) to a traditional calendar. The table reports estimates for all teachers in Panel A and reports estimates separately by teachers' level of experience in Panels B and C. The estimates in Columns 1–3 suggest that transitioning from a 90–30 to a traditional calendar has little effect on teacher turnover rates. As seen in Panels B and C, there also appears to be little effect on the turnover rates of either novice or experienced teachers. Our estimates are consistent with the results of Graves, McMullen and Rouse (2018), who find transitioning from a traditional calendar to a year–round calendar (with no change to the daily schedule) had no effect on teacher turnover.

In contrast to the 90–30 calendar, transitioning from a Concept 6 calendar to a traditional calendar decreases teacher turnover. For the three specifications in Columns 4–6, the estimated effect on teacher turnover of transitioning from a Concept 6 calendar is roughly 3.3 percentage points. With a base turnover rate of 20.6%, a 3.3 percentage point decrease is equivalent to a 16% decline in teacher turnover. Clotfelter et al. (2008) estimate that a $1,800 annual bonus payment reduces teacher turnover by 17%. These results suggest that teachers value being at a school with a traditional calendar compared to the Concept 6 calendar for one year by over $1,500. Due to the different effects found for 90–30 and Concept 6 calendars, this may suggest that teachers more highly value changes to the daily schedule than to the yearly calendar. While we find highly statistically significant effects on teacher turnover for the full sample of teachers, we find statistically insignificant or marginally significant effects for novice and experienced teachers in Panels B and C.

As in previous results, we consider the effect on teacher turnover of transitioning from a Concept 6 calendar to a traditional calendar for elementary, middle, and high school teachers. The estimates for teacher turnover by school type are found in Table 9. The effect sizes for elementary schools are nearly identical to those found in Table 8. Transitioning from a Concept 6 calendar decreases elementary school teacher turnover by 3.0 to 3.5 percentage points, or 14% to 17%. Similarly, for high school teachers, transitioning from a Concept 6 calendar decreases teacher turnover by 4.3 to 5.5 percentage points, or 22% to 28%, although this is only statistically significant for two of the three specifications. In contrast, the effect on teacher turnover is statistically insignificant and close to zero for middle school teachers. However, because of the large standard errors, we are unable to reject the differences between the effects across the three different school types. When splitting the sample by teacher experience, the estimates are noisier, and there are no clear differences across groups. Our results suggest that based on their decision to stay at or leave a school, teachers prefer traditional calendars over Concept 6 calendars. In particular, it appears that a teacher's decision to stay is more influenced by daily schedule changes in the Concept 6 calendar than by yearly calendar changes as seen in both non–traditional calendars.

6 Mechanisms

In this section, we discuss potential mechanisms for our results. Our main results demonstrate that moving from a Concept 6 to a traditional calendar improves the test scores of high school students. For younger students, we find that moving to a traditional calendar has little impact on student outcomes other than reducing absences. We also find that for high school students, moving to a traditional school calendar affects high–achieving students more than low– or middle–achieving students. We propose and investigate four potential mechanisms for our results: 1) school start times, 2) the length of school days, 3) how school days are distributed throughout the year, and 4) changes in at–home study time.

First, we investigate the impact of later school start times. After transitioning from a Concept 6 to a traditional calendar, the typical school shifted its start times by roughly 30 minutes from 7:30 a.m. to 8:00 a.m. Previous literature has found that school start times have a meaningful impact on student achievement. Using random assignment of college classes, Carrell, Maghakian and West (2011) find that starting the school day 50 minutes earlier decreases the average freshman's GPA by 0.031 to 0.076 standard deviations. Other studies also find that later school start times are associated with increases in student achievement with the largest effects for older children (Dills and Hernandez-Julian, 2008; Heissel and Norris, 2018). Work by Edwards (2012) estimates that a one–hour later school start time due to busing increases test scores by 1.5 to 2.1 percentiles, or approximately 0.05 standard deviations. Similarly, Kim (2022) finds in South Korea that a one–hour–later school start time increases math test scores by 0.069 to 0.104 standard deviations, with little effect on other subjects. This literature suggests two implications for our findings. First, later start times could explain why we find that the traditional school calendar affects the test scores of high school students but not the test scores of elementary and middle school students. Second, using the estimates for later start times from Edwards (2012) and Kim (2022), we estimate that later start times could explain one–quarter to one–half of the overall effect found for high school students. While later school start times appear to explain a meaningful part of the results, other mechanisms may explain the remaining fraction.

A second potential mechanism is student or teacher fatigue because of a longer school day. Students on a Concept 6 calendar attended school for an additional 39 minutes each school day, or 6.5 extra minutes each class period for students in middle or high school.

Pope (2016) finds that students in middle and high school who have math or English classes earlier in the school day receive higher GPAs and perform better on their standardized math and English tests. The average student with math in the first two periods sees an increase in math test scores of 0.021 standard deviations and an increase of 0.072 GPA points in their math GPA. These effects are a result of students' and teachers' increased fatigue throughout the day. Similarly, other work shows that having multiple college courses in a row results in poorer performance in later courses (Haggag et al., 2021; Williams and Shapiro, 2018). Using the estimates from Pope (2016), increased fatigue from longer school days would explain less than 5% of our results. This suggests that additional fatigue from a longer school day plays only a minor role in explaining our results.

How school days are distributed throughout the year may also explain part of our results. Work by McMullen and Rouse (2012) find those elementary and middle school students on a year-round calendar–similar to the 90-30 calendar–performed just as well as those on a traditional calendar. They conclude that the amount of time a student spends learning appears to be more important than when the learning takes place during the year. Similarly, we find when elementary school students transition from a 90-30 calendar to a traditional calendar there is little to no effect on their test scores. Although prior work by (Cooper et al., 1996; Borman and Boulay, 2004) suggests that students suffer from learning loss over breaks, our results and those from McMullen and Rouse (2012) suggest that such learning loss appears to not differ whether there is one long summer break or the summer break is spread throughout the year. However, the settings considered by McMullen and Rouse (2012) and our paper are limited to elementary and middle school students when estimating the effect of when school days are distributed throughout the year. As such, the distribution of school days during the year may potentially have a meaningful impact on older students. However given the results for elementary and middle school students, we suspect that the distribution of school days during the year is unlikely to explain our results for high school students.

Lastly, changes in school calendars may impact the amount of time students spend studying at home. For example, if teachers assigned the same amount of homework each day regardless of calendar type, because Concept 6 calendars have 17 fewer school days per year, students would spend nearly 10% less time doing schoolwork at home. While teachers may increase their amount of daily homework to compensate for the reduced number of school days, it is also possible teachers may reduce the amount of daily homework due to the longer school days and increased fatigue. Students may also shirk homework and spend less time at home studying even conditional on the amount of homework assigned because of longer school days. While our data limit us from measuring changes in at–home study behavior, Eren and Henderson (2011) find that a 60% increase in the amount of assigned homework increases students' test scores by 0.17 standard deviations. Additionally, a larger literature in education and psychology shows that students in courses with homework perform better than those in courses without homework (Roschelle et al., 2016; Grodner and Rupp, 2013). Using the results from Eren and Henderson (2011), if students received 10% less homework in Concept 6 schools this could explain approximately 30% of our results for high school students. In addition, evidence from this literature shows large effects for older students with mixed results for elementary school students (Cooper, Robinson and Patall, 2006). As such, the changes in the amount of homework may also partially explain the differential effect between younger and older students. Moreover, with longer school days, high– and low–achieving students may differentially manage their at–home study time resulting in the heterogeneous results we find across achievement groups (Del Boca, Monfardini and Nicoletti, 2017).

While these mechanisms are unlikely to fully explain the effects we are finding, the change in school start time and potential changes in at–home study behavior may explain up to 80% of the results. Both of these mechanisms also help explain the differential effect between younger and older students. In addition, changes in at–home study behavior may also potentially explain the differential effects between achievement groups. Importantly, these mechanisms demonstrate that changes to the daily school schedule appear to be more important than changes in the yearly school schedule.

7 Conclusion

In this paper, we estimate the differential impact of two different non–traditional school calendars that vary based on 1) the number of hours students spend in school each day, 2) the number of school days each year, and 3) the distribution of school days throughout the year. We exploit the staggered elimination of these two non–traditional school calendars and find that while school calendar structure has little to no impact on the test scores of younger students, the calendar structure significantly impacts older students. We find those elementary and middle school students on a calendar with longer and fewer school days—the Concept 6 calendar—perform academically just as well as those with shorter and more school days. However, we find that leaving a school calendar with longer and fewer school days increases the test scores of high school students by 0.08 to 0.15 standard deviations in math and 0.06 to 0.10 standard deviations in English. In addition, transitioning from a Concept 6 calendar decreases teacher turnover by 16%, suggesting teachers prefer traditional calendars over school calendars with longer and fewer school days.

Our finding that having a school calendar with longer and fewer school days negatively impacts older students appears to be likely driven by changes in school start times and at–home study behavior. By having longer school days—but a fixed number of instructional hours each school year—students are induced to substitute away from daily out–of–school activities, such as sleep and homework, which negatively impacts their learning. Our results show that teachers also reveal a preference against calendars with longer and fewer school days by being less likely to leave when on a traditional calendar.

These results suggest that even with a fixed amount of instructional time, how that time is allocated throughout the school day and the school year is an often–overlooked yet significant policy decision that influences students and teachers. More generally, these findings give insight into how firms and other organizations may be able to improve productivity by better structuring their employees' time.

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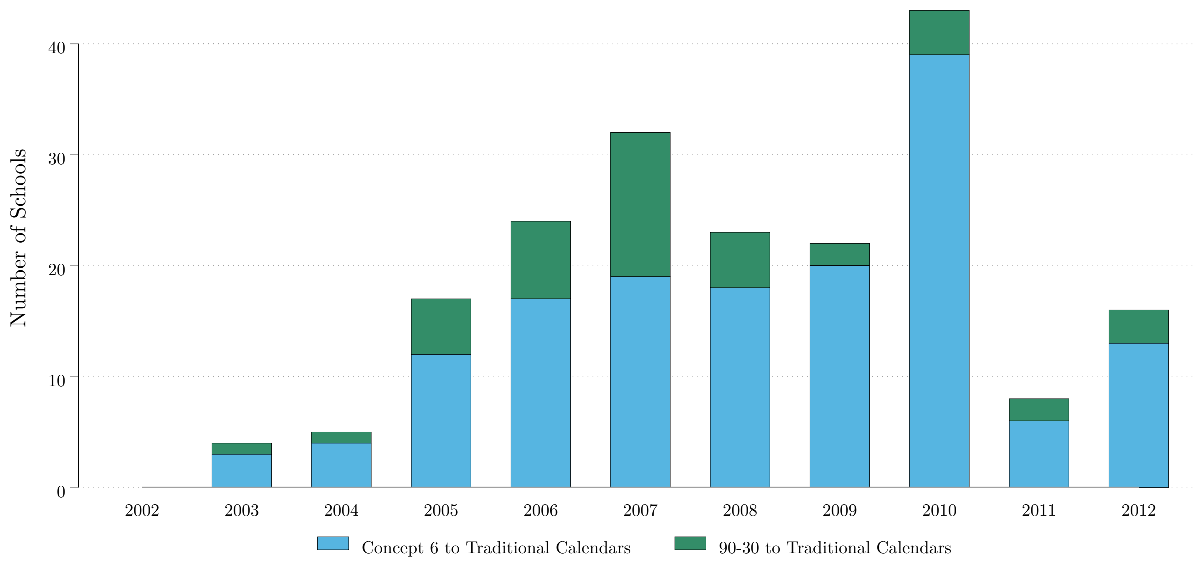
Figure 1 Non-traditional School Calendars and the Track System

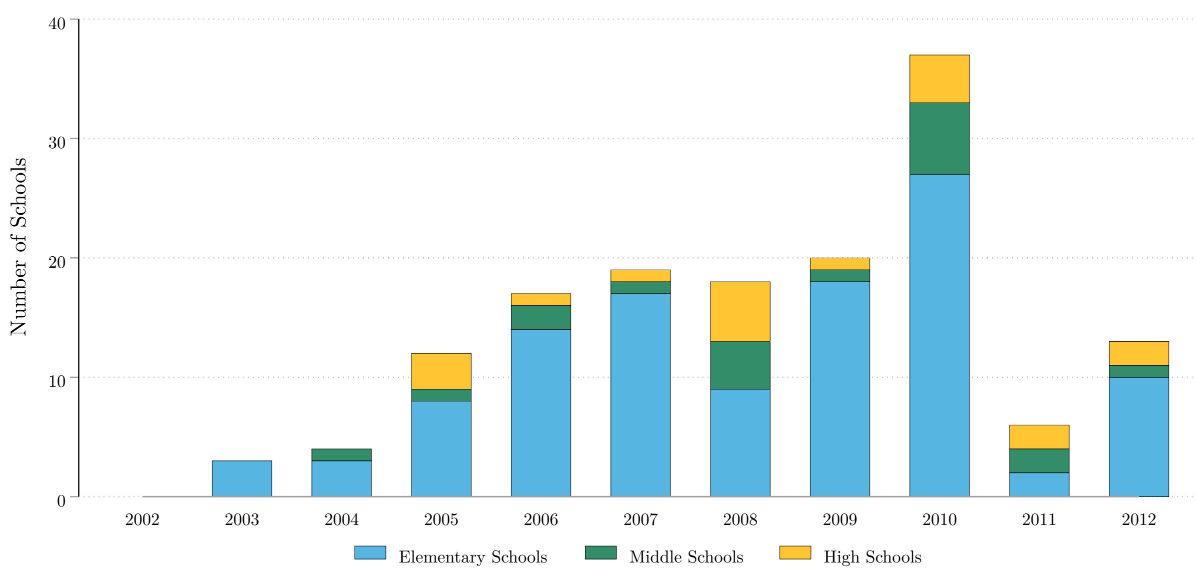
Note: We use the LAUSD 2005 school year calendar to construct this figure. Panel A shows the yearly calendar for students in a traditional calendar school. Panels B and C present the track system for schools using 90-30 and Concept 6 calendars. 90-30 schools had four tracks (Labelled A-D) while Concept 6 schools had three tracks. While 90-30 and Concept 6 calendar schools both used the track system, Concept 6 schools enrolled students for 163 days while 90-30 schools enrolled students for 180. Traditional calendars would also enroll students for 180 days.

Figure 2 Schools Transitioned to the Traditional Calendar Between 2003-2012

A. Both 90-30 and Concept 6 Schools Transitioned to Traditional Calendars

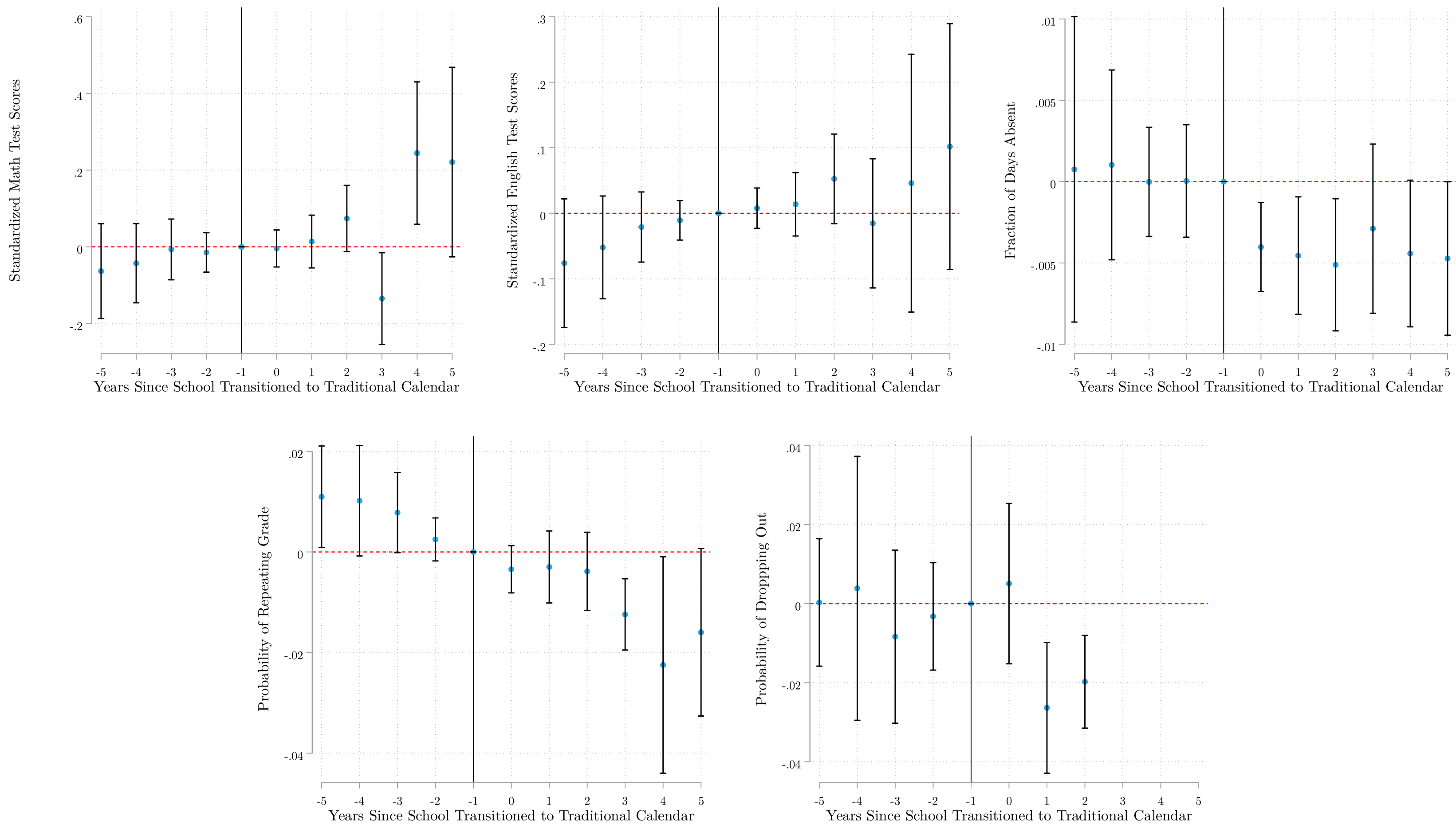


B. Elementary, Middle, and High Schools Transitioned From Concept 6 to a Traditional Calendar



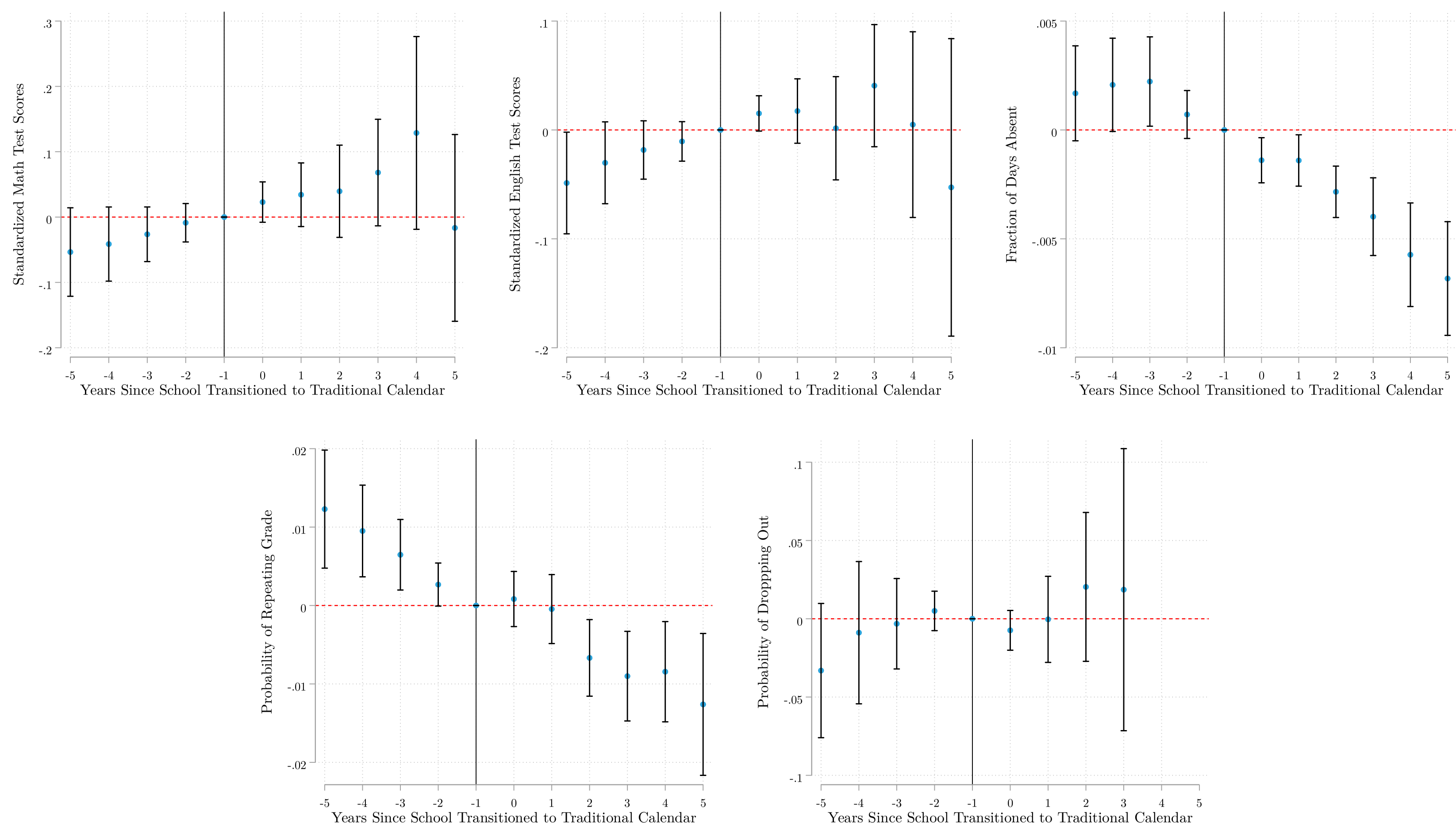
Note: Panel A depicts the number of 90-30 and Concept 6 schools that transitioned each year. The majority of 90-30 schools were elementary schools. In contrast, Concept 6 schools included elementary, middle, and high schools. Panel B displays the number of elementary, middle, and high schools that transitioned from a Concept 6 to a traditional calendar each year.

Figure 3 Dynamic Treatment Effects for Schools that Transitioned from a 90-30 to a Traditional Calendar



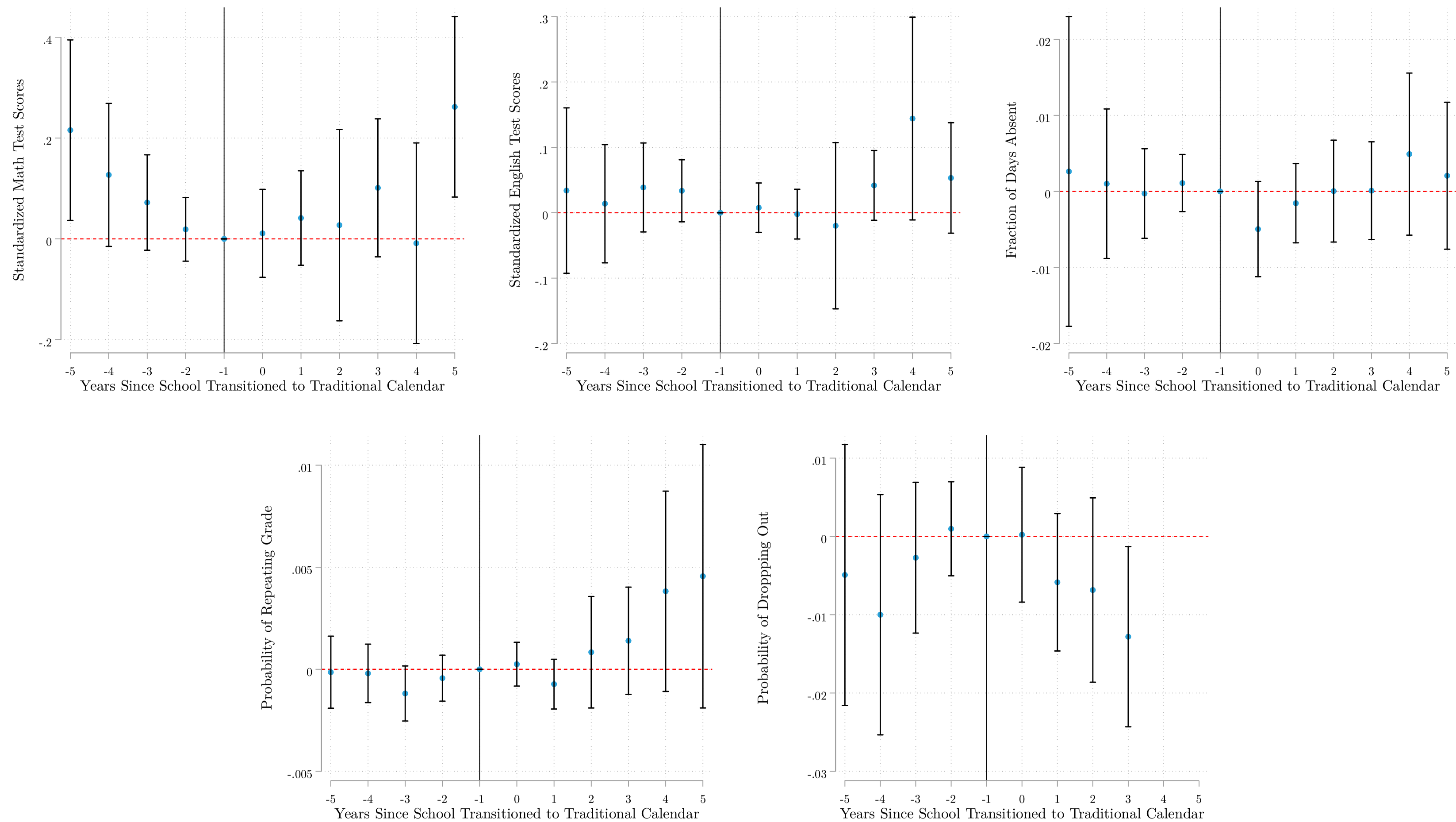
Note: We display the point estimates and 95% confidence intervals using the method described by Sun and Abraham (2020) which accounts for heterogeneous treatment effects across treatment cohorts. We use the student fixed effect specification for all outcomes except dropping out. We use the full lagged test scores specification for dropping out. Standard errors are clustered at the school level.

Figure 4 Dynamic Treatment Effects for Elementary Schools that Transitioned from a Concept 6 to a Traditional Calendar



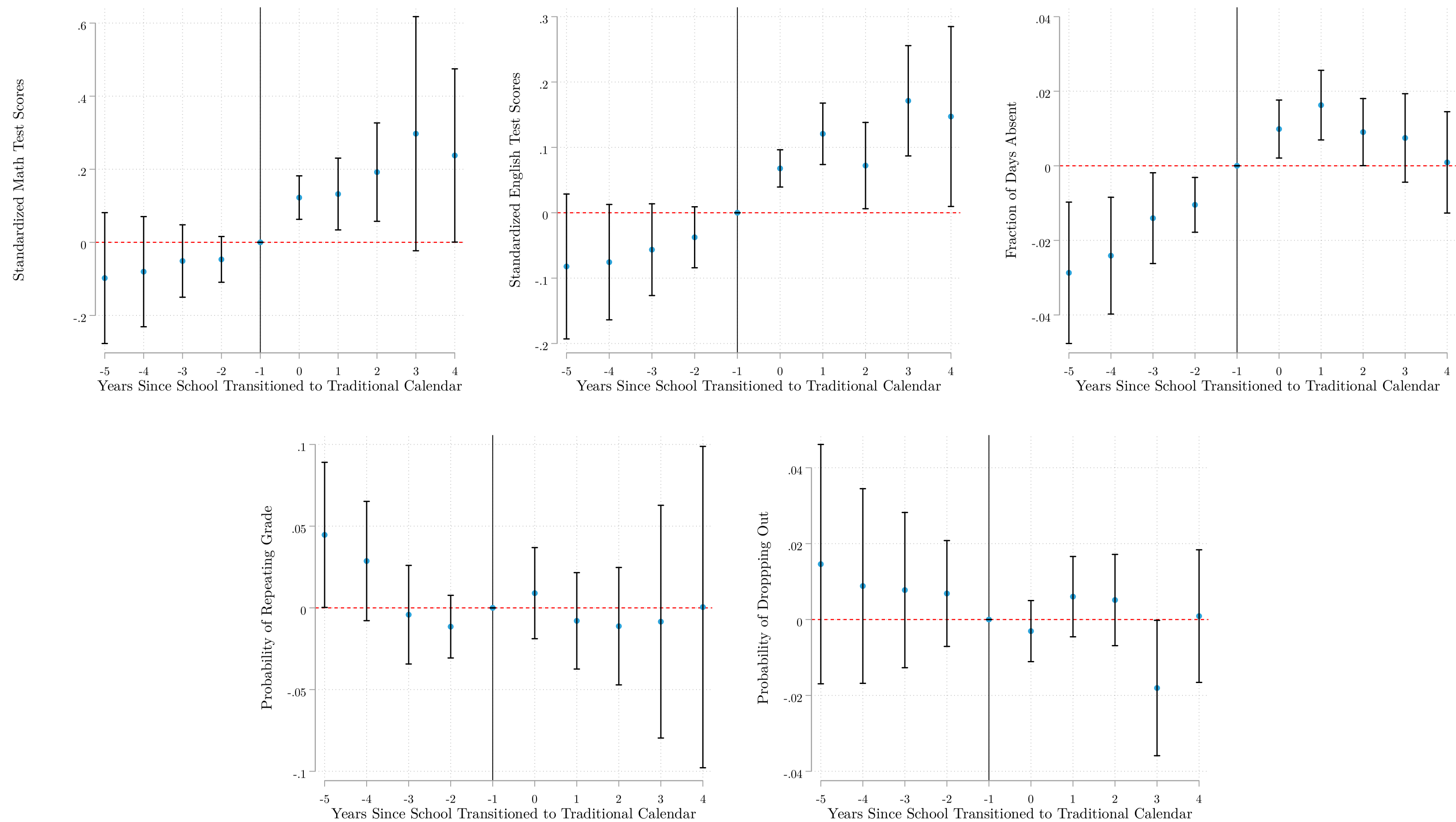
Note: We display the point estimates and 95% confidence intervals using the method described by Sun and Abraham (2020) which accounts for heterogeneous treatment effects across treatment cohorts. We use the student fixed effect specification for all outcomes except dropping out. We use the full lagged test scores specification for dropping out. Standard errors are clustered at the school level.

Figure 5 Dynamic Treatment Effects for Middle Schools that Transitioned from a Concept 6 to a Traditional Calendar



Note: We display the point estimates and 95% confidence intervals using the method described by Sun and Abraham (2020) which accounts for heterogeneous treatment effects across treatment cohorts. We use the student fixed effect specification for all outcomes except dropping out. We use the full lagged test scores specification for dropping out. Standard errors are clustered at the school level.

Figure 6 Dynamic Treatment Effects for High Schools that Transitioned from a Concept 6 to a Traditional Calendar



Note: We display the point estimates and 95% confidence intervals using the method described by Sun and Abraham (2020) which accounts for heterogeneous treatment effects across treatment cohorts. We use the student fixed effect specification for all outcomes except dropping out. We use the full lagged test scores specification for dropping out. Standard errors are clustered at the school level.

Table 1
Summary Statistics

	Transition from 90-30 Calendar	Transition from Concept 6 Calendar	Always Traditional
A. Student-Level Measures			
Standardized English Score	-0.165	-0.222	0.149
Standardized Math Score	-0.128	-0.182	0.126
Fraction of Days Absent	0.045	0.066	0.060
Repeat a Grade	0.015	0.049	0.045
Dropout	0.117	0.166	0.125
English Language Learner	0.495	0.429	0.214
Number of Student-Years	362,417	2,381,118	3,980,851
Number of Students	127,749	706,650	1,082,912
B.School-Level Measures			
Elementary Schools	42	112	273
Middle Schools	1	19	73
High Schools	0	19	141
Number of Students Enrolled	798	1,396	784
Student-Teacher Ratio	21	21	22
Fraction Asian	0.05	0.04	0.07
Fraction Hispanic	0.82	0.85	0.63
Fraction Black	0.08	0.08	0.14
Fraction White	0.03	0.02	0.14
Fraction Free Lunch Eligible	0.77	0.78	0.58
Fraction Reduced-Price Lunch	0.07	0.06	0.07

Note: Schools are separated into three, mutually exclusive groups: schools that transitioned from a 90-30 calendar, schools that transitioned from Concept 6, and schools that always remained on the traditional calendar.

Table 2
Estimates of Transitioning from a Non-traditional School Calendar

	Transition from 90-30 Calendars				Transition from Concept 6 Calendars			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A. Standardized Math Scores								
Transition to Traditional Calendar	0.043	-0.005	0.003	-0.024	0.081***	0.031***	0.027*	0.035**
	(0.027)	(0.022)	(0.024)	(0.055)	(0.019)	(0.011)	(0.014)	(0.016)
N	347,847	347,847	347,847	347,847	1,763,996	1,763,996	1,763,996	1,763,996
R^2	0.145	0.632	0.638	0.862	0.150	0.614	0.616	0.802
B. Standardized English Scores								
Transition to Traditional Calendar	0.082***	0.015	0.021	-0.001	0.077***	0.023***	0.022**	0.026***
	(0.024)	(0.013)	(0.015)	(0.029)	(0.017)	(0.008)	(0.009)	(0.009)
N	347,915	347,915	347,915	347,915	1,805,221	1,805,221	1,805,221	1,805,221
R^2	0.196	0.710	0.715	0.898	0.150	0.716	0.721	0.865
C. Fraction of Days Absent								
Transition to Traditional Calendar	-0.004**	-0.004*	-0.003*	-0.004***	-0.004***	-0.002*	-0.001	-0.000
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
N	438,387	438,387	438,387	438,387	2,363,796	2,363,796	2,363,796	2,363,796
R^2	0.029	0.046	0.275	0.703	0.102	0.132	0.411	0.651
D. Dummy if Grade is Repeated								
Transition to Traditional Calendar	-0.002	-0.001	-0.001	-0.004	-0.006	-0.004	0.003	0.002
	(0.002)	(0.002)	(0.002)	(0.003)	(0.005)	(0.005)	(0.004)	(0.004)
N	450,466	450,466	450,466	450,466	2,419,189	2,419,189	2,419,189	2,419,189
R^2	0.476	0.480	0.480	0.763	0.171	0.181	0.201	0.712
E. Dummy if Student Drops Out								
Transition to Traditional Calendar	0.005	0.005	0.008		-0.013	-0.008	-0.002	
	(0.012)	(0.012)	(0.011)		(0.010)	(0.009)	(0.007)	
N	46,204	46,204	46,204		875,284	875,284	875,284	
R^2	0.030	0.044	0.045		0.036	0.093	0.109	
Grade × Year FE	X	X	X	X	X	X	X	X
School FE	X	X	X	X	X	X	X	X
Lagged Test Scores		X	X			X	X	
Lagged Non-Test Score Controls			X				X	
Peer Controls			X				X	
Time-Varying School Controls			X	X			X	X
Student FE				X				X

Note: We present the estimates of β from equation 1 for five outcomes–standardized math scores, standardized English scores, the fraction of days absent, a dummy variable if the grade is repeated, and a dummy variable if a student drops out. To account for differences in both of the non-traditional calendars, we separately estimate this model for schools transitioning from a Concept 6 or a 90-30 calendar. **Lagged test scores** include lagged English and math test scores. **Lagged non-test score controls** include a lagged indicator of suspensions, lagged fraction of days absent, and an indicator for being an English language learner. **Peer controls** is a measure of the average lagged math and English test scores of all students in the same school and grade in year t, excluding student i. **Time-varying school controls** include the fraction of students that are Hispanic, black, white, and Asian, the student-teacher ratio, and the fraction of students eligible for free or reduced-price lunch. In all specifications, we include a school fixed effect and a grade-by-year fixed effect. We cluster our standard errors at the school level. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

Table 3

Estimates of Transitioning from Concept 6 by School-Level

	Elementary Schools				Middle Schools				High Schools			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A. Standardized Math Scores												
Transition to Traditional Calendar	0.038*	0.003	0.000	0.010	0.012	-0.018	-0.021	0.057	0.097**	0.080***	0.090***	0.154***
	(0.022)	(0.014)	(0.017)	(0.024)	(0.034)	(0.017)	(0.022)	(0.071)	(0.038)	(0.021)	(0.024)	(0.052)
N	518,077	518,077	518,077	518,077	546,761	546,761	546,761	546,761	403,472	403,472	403,472	403,472
R^2	0.155	0.634	0.638	0.863	0.168	0.681	0.683	0.866	0.143	0.528	0.530	0.814
B. Standardized English Scores												
Transition to Traditional Calendar	0.045***	0.006	-0.001	0.003	0.003	-0.022*	-0.014	0.010	0.100***	0.060***	0.062***	0.096***
	(0.016)	(0.008)	(0.010)	(0.015)	(0.031)	(0.012)	(0.018)	(0.019)	(0.026)	(0.014)	(0.013)	(0.026)
N	518,092	518,092	518,092	518,092	548,221	548,221	548,221	548,221	446,034	446,034	446,034	446,034
R^2	0.201	0.708	0.714	0.896	0.158	0.751	0.755	0.911	0.093	0.692	0.697	0.887
C. Fraction of Days Absent												
Transition to Traditional Calendar	-0.003***	-0.002***	-0.002***	-0.002***	-0.002	-0.001	-0.001	-0.004	-0.007**	-0.005**	-0.001	0.001
	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.004)
N	638,481	638,481	638,481	638,481	668,453	668,453	668,453	668,453	771,688	771,688	771,688	771,688
R^2	0.032	0.051	0.292	0.711	0.049	0.087	0.396	0.781	0.065	0.110	0.428	0.729
D. Dummy if Grade is Repeated												
Transition to Traditional Calendar	-0.001**	-0.001	-0.001	-0.002	-0.001	-0.001	-0.001**	0.000	-0.013	-0.009	0.013	-0.004
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.000)	(0.015)	(0.015)	(0.017)	(0.021)
N	658,289	658,289	658,289	658,289	672,483	672,483	672,483	672,483	790,480	790,480	790,480	790,480
R^2	0.508	0.512	0.512	0.766	0.090	0.091	0.092	0.747	0.123	0.148	0.193	0.727
E. Dummy if Student Drops Out												
Transition to Traditional Calendar	-0.006	-0.004	-0.006		-0.014**	-0.011	-0.007		-0.014	-0.008	0.002	
	(0.007)	(0.007)	(0.007)		(0.007)	(0.007)	(0.007)		(0.014)	(0.013)	(0.009)	
N	72,410	72,410	72,410		248,945	248,945	248,945		499,495	499,495	499,495	
R^2	0.029	0.043	0.045		0.027	0.077	0.087		0.036	0.103	0.128	
Grade × Year FE	X	X	X	X	X	X	X	X	X	X	X	X
School FE	X	X	X	X	X	X	X	X	X	X	X	X
Lagged Test Scores		X	X			X	X			X	X	
Lagged Non-Test Score Controls			X				X				X	
Peer Controls			X				X				X	
Time-Varying School Controls			X	X			X	X			X	X
Student FE				X				X				X

Note: We present the estimates of β from equation 1, estimated separately for elementary, middle, and high school that transitioned from a Concept 6 to a traditional calendar. **Lagged test scores** include lagged English and math test scores. **Lagged non-test score controls** include a lagged indicator of suspensions, lagged fraction of days absent, and an indicator for being an English language learner. **Peer controls** is a measure of the average lagged math and English test scores of all students in the same school and grade in year t, excluding student i. **Time-varying school controls** include the fraction of students that are Hispanic, black, white, and Asian, the student-teacher ratio, and the fraction of students eligible for free or reduced-price lunch. In all specifications, we include a school fixed effect and a grade-by-year fixed effect. We cluster our standard errors at the school level. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

Table 4
Accounting for Heterogeneous Treatment Effects in Fully Lagged Test Score Specification

	90-30 Calendar	Concept 6 Calendar			
	Elementary Schools (1)	All Schools (2)	Elementary Schools (3)	Middle Schools (4)	High Schools (5)
A. Standardized Math Scores					
Transition to Traditional Calendar	-0.035	0.025*	-0.000	-0.019	0.077***
	(0.023)	(0.014)	(0.017)	(0.023)	(0.020)
N	337,940	1,756,104	511,954	545,844	403,472
B. Standardized English Scores					
Transition to Traditional Calendar	0.003	0.028***	-0.007	0.004	0.072***
	(0.013)	(0.009)	(0.010)	(0.013)	(0.012)
N	338,011	1,797,322	511,960	547,324	446,034
C. Fraction of Days Absent					
Transition to Traditional Calendar	-0.005**	-0.001	-0.001***	-0.002	0.000
	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
N	416,069	2,353,782	630,580	667,444	771,688
D. Dummy if Grade is Repeated					
Transition to Traditional Calendar	0.001	0.003	-0.001	-0.003	0.012
	(0.002)	(0.005)	(0.001)	(0.002)	(0.009)
N	427,807	2,408,823	650,162	671,452	790,480
E. Dummy if Student Drops Out					
Transition to Traditional Calendar	0.006	-0.006	-0.005	-0.010*	-0.005
	(0.009)	(0.005)	(0.006)	(0.006)	(0.007)
N	46,113	874,197	71,560	248,945	499,490

Note: The reported estimates account for potential heterogeneous treatment effects using the estimator suggested by Borusyak and Jaravel (2017). As seen by comparing Table 4 to Table 2 and 3, adjusting for heterogeneous treatment effects provides nearly identical results. We cluster our standard errors at the school level. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

Table 5

Estimates of Transitioning from Concept 6 by Student Achievement Groups

	Low-Achieving				Middle-Achieving				High-Achieving			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A. Standardized Math Scores												
Transition to Traditional Calendar	0.016	0.013	0.009	0.012	0.029*	0.023*	0.017	0.019	0.091***	0.050***	0.061***	0.073***
	(0.012)	(0.009)	(0.012)	(0.013)	(0.016)	(0.013)	(0.016)	(0.017)	(0.023)	(0.015)	(0.020)	(0.025)
N	541,739	541,739	541,739	541,739	605,683	605,683	605,683	605,683	647,041	647,041	647,041	647,041
R^2	0.073	0.285	0.288	0.609	0.072	0.319	0.323	0.636	0.124	0.495	0.499	0.742
B. Standardized English Scores												
Transition to Traditional Calendar	0.020*	0.019**	0.013	0.017*	0.030**	0.024***	0.019*	0.025**	0.063***	0.025***	0.025**	0.030***
	(0.011)	(0.008)	(0.009)	(0.010)	(0.013)	(0.009)	(0.010)	(0.010)	(0.015)	(0.009)	(0.012)	(0.011)
N	557,260	557,260	557,260	557,260	620,229	620,229	620,229	620,229	657,129	657,129	657,129	657,129
R^2	0.047	0.363	0.369	0.668	0.043	0.426	0.434	0.716	0.106	0.577	0.581	0.800
C. Fraction of Days Absent												
Transition to Traditional Calendar	-0.002	-0.002	-0.000	0.001	-0.002*	-0.002*	-0.001	-0.001	-0.003**	-0.002*	-0.001	-0.000
	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
N	734,489	734,489	734,489	734,489	810,955	810,955	810,955	810,955	851,493	851,493	851,493	851,493
R^2	0.124	0.135	0.422	0.650	0.095	0.112	0.387	0.633	0.064	0.086	0.356	0.619
D. Dummy if Grade is Repeated												
Transition to Traditional Calendar	-0.004	-0.004	0.003	0.004	-0.005	-0.004	0.002	0.001	-0.003	-0.002	0.003	0.004**
	(0.008)	(0.008)	(0.007)	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)
N	758,061	758,061	758,061	758,061	828,244	828,244	828,244	828,244	865,708	865,708	865,708	865,708
R^2	0.236	0.238	0.256	0.710	0.148	0.154	0.175	0.718	0.077	0.084	0.102	0.724
E. Dummy if Student Drops Out												
Transition to Traditional Calendar	-0.012	-0.011	-0.005		-0.000	0.000	0.005		-0.001	0.000	-0.001	
	(0.016)	(0.015)	(0.013)		(0.008)	(0.008)	(0.006)		(0.006)	(0.006)	(0.005)	
N	221,592	221,592	221,592		308,268	308,268	308,268		365,631	365,631	365,631	
R^2	0.065	0.118	0.128		0.022	0.041	0.054		0.014	0.021	0.032	
Grade × Year FE	X	X	X	X	X	X	X	X	X	X	X	X
School FE	X	X	X	X	X	X	X	X	X	X	X	X
Lagged Test Scores		X	X			X	X			X	X	
Lagged Non-Test Score Controls			X				X				X	
Peer Controls			X				X				X	
Time-Varying School Controls			X	X			X	X			X	X
Student FE				X				X				X

Note: We present the estimates of β from equation 1 by achievement groups for all elementary, middle, and high schools that transitioned from a Concept 6 to a traditional calendar. We divide students into terciles representing low-achieving, middle-achieving, and high-achieving students. To allow for a student fixed effect specification, we construct a measure of academic achievement that keeps students in the same tercile over time. We construct these terciles within grade and year using the average of a student's first observed standardized math and English test scores. Standard errors are clustered at the school level. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

Table 6
Elementary School Estimates of Transitioning from Concept 6 by Student Achievement Groups

	Low-Achieving				Middle-Achieving				High-Achieving			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A. Standardized Math Scores												
Transition to Traditional Calendar	-0.006	-0.012	-0.013	-0.005	0.002	0.006	0.003	0.005	0.039	0.021	0.015	0.020
	(0.020)	(0.014)	(0.017)	(0.021)	(0.021)	(0.016)	(0.019)	(0.028)	(0.025)	(0.020)	(0.024)	(0.038)
N	155,386	155,386	155,386	155,386	172,383	172,383	172,383	172,383	184,299	184,299	184,299	184,299
R^2	0.069	0.354	0.360	0.747	0.053	0.316	0.324	0.739	0.089	0.403	0.412	0.769
B. Standardized English Scores												
Transition to Traditional Calendar	0.000	-0.010	-0.014	-0.015	0.012	0.008	0.007	0.002	0.048***	0.028**	0.001	0.015
	(0.014)	(0.010)	(0.011)	(0.017)	(0.014)	(0.010)	(0.012)	(0.018)	(0.017)	(0.012)	(0.014)	(0.020)
N	155,344	155,344	155,344	155,344	172,395	172,395	172,395	172,395	184,335	184,335	184,335	184,335
R^2	0.068	0.359	0.362	0.745	0.058	0.387	0.396	0.778	0.138	0.523	0.533	0.833
C. Fraction of Days Absent												
Transition to Traditional Calendar	-0.003***	-0.003***	-0.002***	-0.002***	-0.003***	-0.003***	-0.002***	-0.002**	-0.002**	-0.001**	-0.001**	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)
N	189,485	189,485	189,485	189,485	214,550	214,550	214,550	214,550	227,471	227,471	227,471	227,471
R^2	0.040	0.049	0.320	0.718	0.033	0.041	0.265	0.699	0.034	0.043	0.265	0.705
D. Dummy if Grade is Repeated												
Transition to Traditional Calendar	0.002	0.002	0.000	0.001	-0.000	-0.000	-0.001	-0.002	0.000	0.000*	0.001*	0.001***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.001)	(0.001)	(0.001)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)
N	198,969	198,969	198,969	198,969	220,095	220,095	220,095	220,095	231,859	231,859	231,859	231,859
R^2	0.550	0.552	0.553	0.784	0.341	0.343	0.344	0.694	0.158	0.158	0.159	0.673
E. Dummy if Student Drops Out												
Transition to Traditional Calendar	0.012	0.019	0.014		-0.006	-0.005	-0.003		-0.016**	-0.017**	-0.018**	
	(0.017)	(0.017)	(0.016)		(0.009)	(0.008)	(0.009)		(0.008)	(0.008)	(0.008)	
N	17,707	17,707	17,707		25,570	25,570	25,570		28,300	28,300	28,300	
R^2	0.065	0.076	0.077		0.044	0.053	0.056		0.042	0.046	0.048	
Grade × Year FE	X	X	X	X	X	X	X	X	X	X	X	X
School FE	X	X	X	X	X	X	X	X	X	X	X	X
Lagged Test Scores		X	X			X	X			X	X	
Lagged Non-Test Score Controls			X				X				X	
Peer Controls			X				X				X	
Time-Varying School Controls			X	X			X	X			X	X
Student FE				X				X				X

Note: We present the estimates of β from equation 1 by achievement groups for elementary schools that transitioned from a Concept 6 to a traditional calendar. We divide students into terciles representing low-achieving, middle-achieving, and high-achieving students. To allow for a student fixed effect specification, we construct a measure of academic achievement that keeps students in the same tercile over time. We construct these terciles within grade and year using the average of a student's first observed standardized math and English test scores. Standard errors are clustered at the school level. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

Table 7

High School Estimates of Transitioning from Concept 6 by Student Achievement Groups

	Low-Achieving				Middle-Achieving				High-Achieving			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A. Standardized Math Scores												
Transition to Traditional Calendar	0.038	0.041*	0.034	0.074	0.077**	0.087***	0.084***	0.139***	0.109**	0.110***	0.157***	0.240***
	(0.030)	(0.024)	(0.020)	(0.048)	(0.038)	(0.026)	(0.026)	(0.046)	(0.051)	(0.028)	(0.032)	(0.080)
N	111,974	111,974	111,974	111,974	134,538	134,538	134,538	134,538	146,985	146,985	146,985	146,985
R^2	0.058	0.139	0.144	0.582	0.111	0.249	0.253	0.670	0.145	0.504	0.509	0.817
B. Standardized English Scores												
Transition to Traditional Calendar	0.062***	0.063***	0.056***	0.078***	0.057*	0.059***	0.058***	0.089***	0.063**	0.053***	0.070***	0.115***
	(0.019)	(0.015)	(0.014)	(0.028)	(0.030)	(0.016)	(0.014)	(0.029)	(0.031)	(0.014)	(0.015)	(0.029)
N	127,543	127,543	127,543	127,543	149,499	149,499	149,499	149,499	157,416	157,416	157,416	157,416
R^2	0.029	0.297	0.308	0.720	0.037	0.400	0.409	0.771	0.075	0.579	0.582	0.841
C. Fraction of Days Absent												
Transition to Traditional Calendar	-0.004	-0.004	0.000	0.004	-0.003	-0.003	-0.001	0.001	-0.005**	-0.004	-0.001	-0.001
	(0.004)	(0.003)	(0.004)	(0.005)	(0.003)	(0.003)	(0.003)	(0.004)	(0.002)	(0.002)	(0.002)	(0.003)
N	223,372	223,372	223,372	223,372	256,041	256,041	256,041	256,041	267,167	267,167	267,167	267,167
R^2	0.062	0.078	0.411	0.718	0.059	0.084	0.409	0.719	0.048	0.082	0.397	0.716
D. Dummy if Grade is Repeated												
Transition to Traditional Calendar	-0.008	-0.007	0.015	-0.007	-0.011	-0.010	0.008	-0.006	-0.006	-0.004	0.012*	0.006
	(0.025)	(0.025)	(0.028)	(0.034)	(0.015)	(0.014)	(0.016)	(0.024)	(0.006)	(0.005)	(0.006)	(0.008)
N	230,774	230,774	230,774	230,774	262,311	262,311	262,311	262,311	271,456	271,456	271,456	271,456
R^2	0.149	0.154	0.200	0.715	0.120	0.135	0.181	0.734	0.072	0.091	0.131	0.751
E. Dummy if Student Drops Out												
Transition to Traditional Calendar	-0.009	-0.008	-0.001		-0.001	-0.001	0.006		0.001	0.002	0.001	
	(0.022)	(0.021)	(0.017)		(0.011)	(0.011)	(0.008)		(0.008)	(0.008)	(0.006)	
N	117,108	117,108	117,108		166,048	166,048	166,048		201,309	201,309	201,309	
R^2	0.049	0.113	0.128		0.020	0.043	0.063		0.014	0.022	0.037	
Grade × Year FE	X	X	X	X	X	X	X	X	X	X	X	X
School FE	X	X	X	X	X	X	X	X	X	X	X	X
Lagged Test Scores		X	X			X	X			X	X	
Lagged Non-Test Score Controls			X				X				X	
Peer Controls			X				X				X	
Time-Varying School Controls			X	X			X	X			X	X
Student FE				X				X				X

Note: We present the estimates of β from equation 1 by achievement groups for high schools that transitioned from a Concept 6 to a traditional calendar. We divide students into terciles representing low-achieving, middle-achieving, and high-achieving students. To allow for a student fixed effect specification, we construct a measure of academic achievement that keeps students in the same tercile over time. We construct these terciles within grade and year using the average of a student's first observed standardized math and English test scores. Standard errors are clustered at the school level. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

Table 8
Estimates of Transitioning from a Non-traditional Calendar on Teacher Turnover

	Transition from 90-30 Calendars			Transition from Concept 6 Calendars		
	(1)	(2)	(3)	(4)	(5)	(6)
A.Teacher Turnover						
Transition to Traditional Calendar	-.00751	-.0058	-.0129	-.0332***	-.031***	-.0332***
	(.0165)	(.0162)	(.0165)	(.012)	(.012)	(.012)
N	21,779	21,779	21,779	77,290	77,290	77,290
R^2	.036	.0362	.0368	.03	.0302	.03
B. Teachers with 0-2 Years of Experience						
Transition to Traditional Calendar	.0114	.0109	-.0225	.0211	.0206	.0211
	(.0399)	(.0395)	(.0457)	(.0209)	(.021)	(.0209)
N	3,992	3,992	3,992	14,867	14,867	14,867
R^2	.222	.223	.226	.148	.148	.148
C. Teachers with 3+ Years of Experience						
Transition to Traditional Calendar	.0201	.0199	.00496	-.0172*	-.0163*	-.0172*
	(.0136)	(.0134)	(.014)	(.00929)	(.00922)	(.00929)
N	17,781	17,781	17,781	62,420	62,420	62,420
R^2	.0335	.0335	.0355	.0296	.0296	.0296
Grade × Year FE	X	X	X	X	X	X
School FE	X	X	X	X	X	X
Lagged Average Grade Test Scores		X	X		X	X
Time-Varying School Controls			X			X

Note: We report teacher turnover estimates separately for schools transitioning from a Concept 6 or a 90-30 calendar. Teacher turnover is a dummy variable that is equal to one if the teacher teaches in one year but does not return to that school in the subsequent year (i.e. the teacher leaves a given school). If teachers teach multiple grades, we use the grade for which the teacher teaches the most number of students to assign a grade-by-year fixed effect. Standard errors are clustered at the school level. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

Table 9

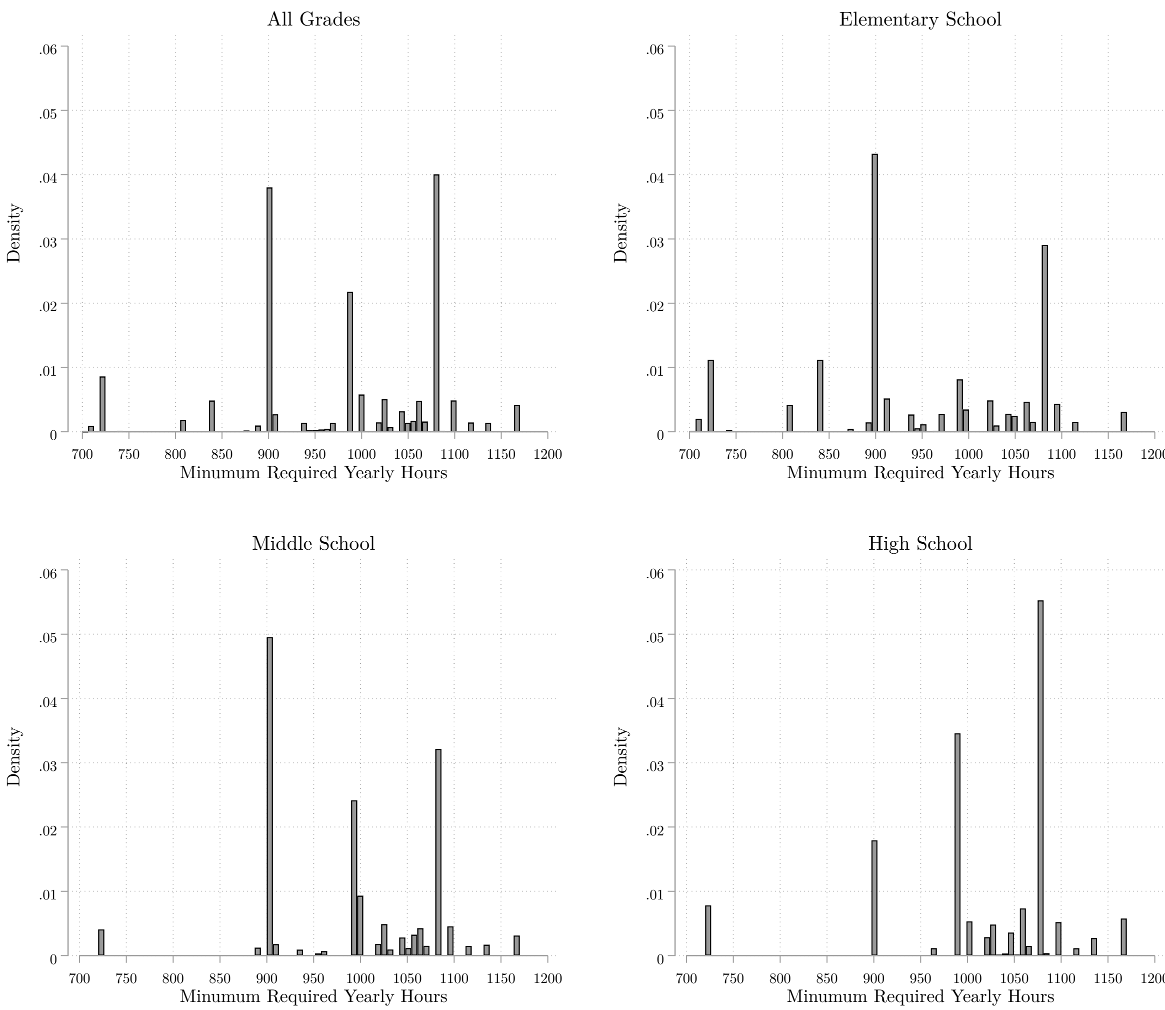
Estimates of Transitioning from Concept 6 on Teacher Turnover by School-Level

	Elementary School			Middle School			High School		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A.Teacher Turnover									
Transition to Traditional Calendar	-.0355***	-.0341***	-.0306**	-.00468	-.00117	-.00969	-.044**	-.0432**	-.0556
	(.0124)	(.0124)	(.0136)	(.0326)	(.0317)	(.0372)	(.0208)	(.0201)	(.0351)
N	31,456	31,456	31,456	26,036	26,036	26,036	18,571	18,571	18,571
R^2	.0348	.0348	.0356	.0296	.0302	.0312	.0299	.03	.0307
B. Teachers with 0-2 Years of Experience									
Transition to Traditional Calendar	.00953	.00907	-.00613	.0704	.0713	.0127	.0161	.0124	-.0708
	(.0292)	(.0292)	(.0343)	(.0505)	(.0496)	(.0517)	(.0347)	(.0346)	(.0598)
N	5,888	5,888	5,888	5,359	5,359	5,359	3,310	3,310	3,310
R^2	.201	.202	.204	.112	.112	.118	.145	.146	.15
C. Teachers with 3+ Years of Experience									
Transition to Traditional Calendar	-.012	-.0125	-.0304***	.00382	.00569	-.0137	-.0373**	-.0345**	-.0476*
	(.0104)	(.0105)	(.0113)	(.0236)	(.023)	(.0335)	(.0156)	(.0148)	(.0282)
N	25,564	25,564	25,564	20,677	20,677	20,677	15,255	15,255	15,255
R^2	.0329	.0329	.0343	.0262	.0265	.0287	.0346	.035	.0367
Grade $\times$ Year FE	X	X	X	X	X	X	X	X	X
School FE	X	X	X	X	X	X	X	X	X
Lagged Average Grade Test Scores		X	X		X	X		X	X
Time-Varying School Controls			X			X			X

Note: For schools that transitioned from a Concept 6 calendar, we report teacher turnover estimates by school-level. Teacher turnover is a dummy variable that is equal to one if the teacher teaches in one year but does not return to that school in the subsequent year (i.e. the teacher leaves a given school). If teachers teach multiple grades, we use the grade for which the teacher teaches the most number of students to assign a grade-by-year fixed effect. Standard errors are clustered at the school level.

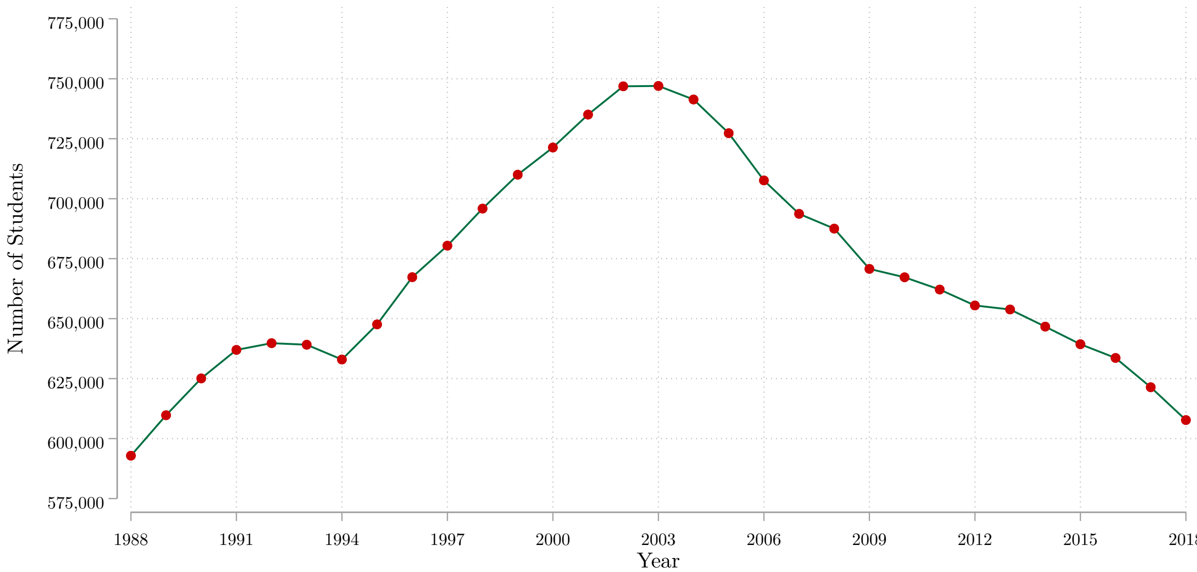
A Appendix

Figure A.1 The National Distribution of the Minimum Number of Hours Enrolled in School Required Using 2018 Data



Note: States mandate the minimum number of educational hours students are required to receive in each grade. Using the 2018 state educational mandates and student-grade populations in each state, we find that 28% of elementary students are enrolled for at least 900 educational hours and 19% for at least 1,080 hours. For middle school students, 32% are enrolled for at least 900 hours, 16% for at least 990 hours, and 21% for at least 1,080 hours. For high school students, 11% are enrolled for at least 900 hours, 22% are enrolled for at least 990 hours, and 35% for at least 1,080 hours. See State Education Practices, Table 5.14 for state educational mandates.

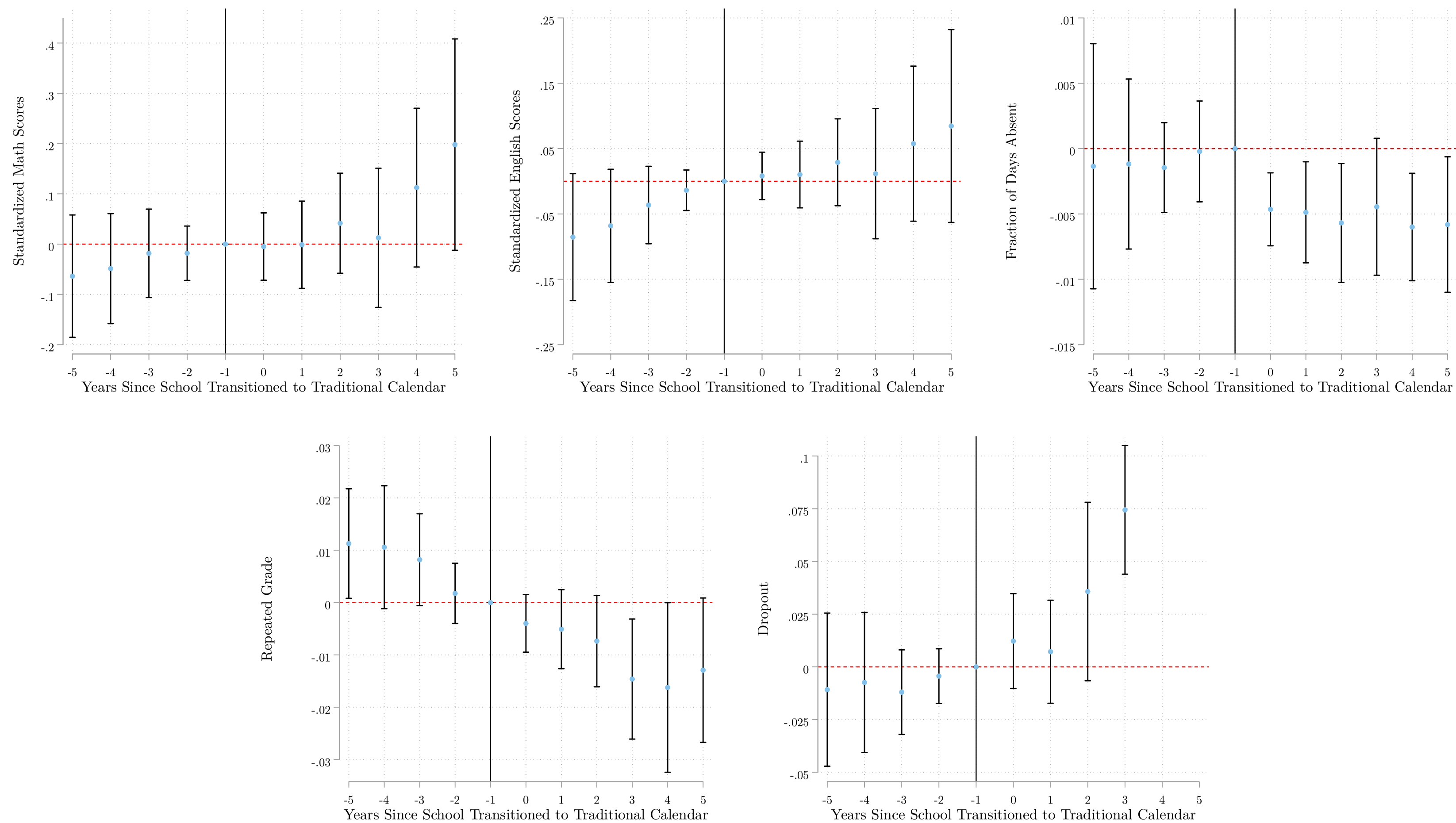
Figure A.2 The Number of Students Attending a School in the LAUSD Increased Substantially in the 1990s



Source: Authors' calculations using Census Day Enrollment by School data maintained by the California Department of Education.

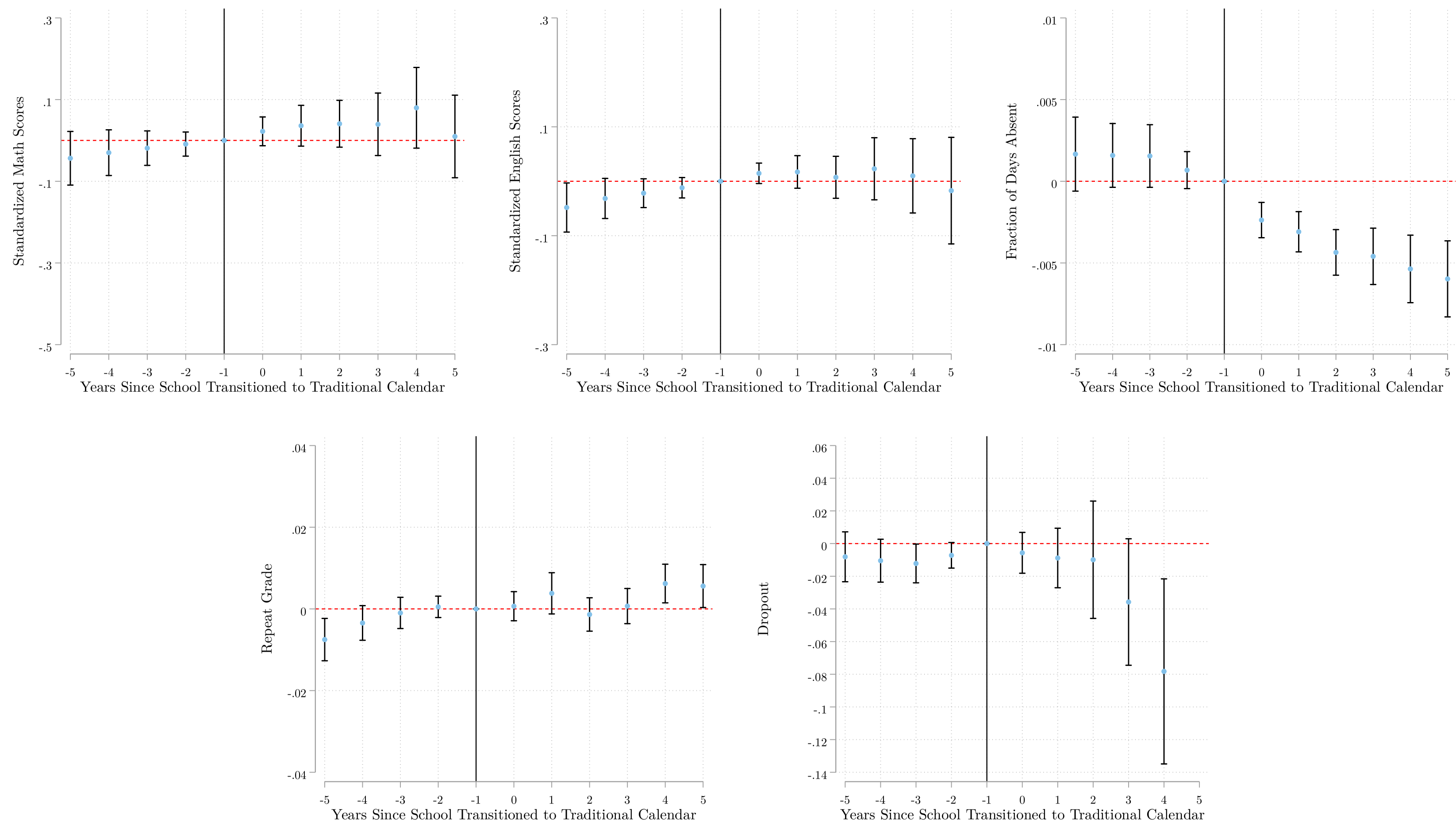
Note: Our data include the 2002 to 2012 school years. During the 1990s, the LAUSD suffered from overcrowded schools because of a large increase in its student population. In response, schools in the LAUSD adopted non-traditional school calendars which allowed schools to simultaneously meet building-capacity constraints and accommodate the increased number of students. By 2002, more than 20% of schools in the LAUSD had adopted a non-traditional calendar.

Figure A.3 Dynamic Treatment Effects for Elementary Schools that Transitioned from a 90-30 to a Traditional Calendar



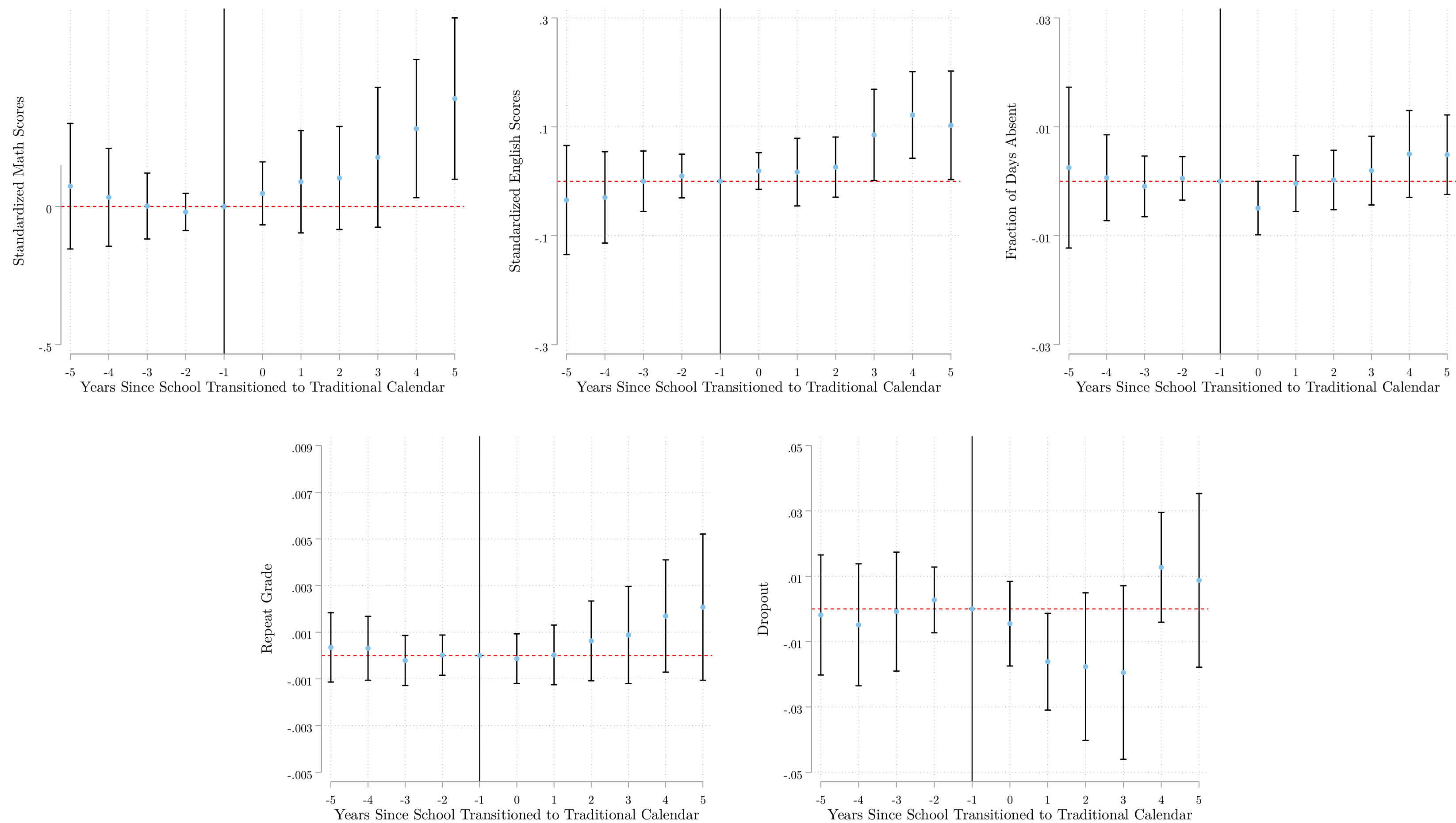
Note: We display the point estimates and 95% confidence intervals without correcting for heterogeneous treatment effects across treatment cohorts. Standard errors are clustered at the school level. Standard errors are clustered at the school level.

Figure A.4 Dynamic Treatment Effects for Elementary Schools that Transitioned from a Concept 6 to a Traditional Calendar



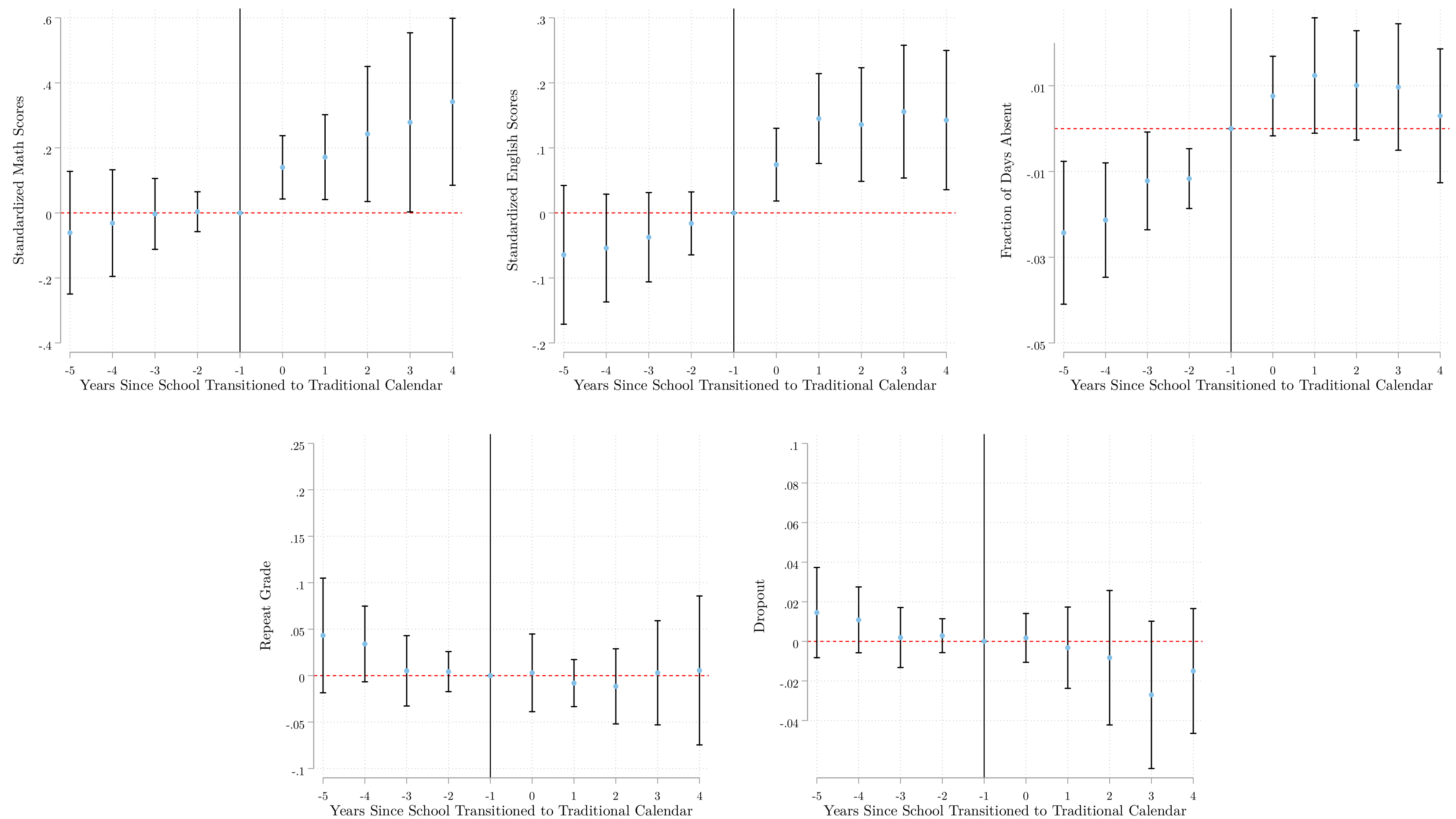
Note: We display the point estimates and 95% confidence intervals without correcting for heterogeneous treatment effects across treatment cohorts. Standard errors are clustered at the school level. Standard errors are clustered at the school level.

Figure A.5 Dynamic Treatment Effects for Middle Schools that Transitioned from a Concept 6 to a Traditional Calendar



Note: We display the point estimates and 95% confidence intervals without correcting for heterogeneous treatment effects across treatment cohorts. Standard errors are clustered at the school level. Standard errors are clustered at the school level.

Figure A.6 Dynamic Treatment Effects for High Schools that Transitioned from a Concept 6 to a Traditional Calendar



Note: We display the point estimates and 95% confidence intervals without correcting for heterogeneous treatment effects across treatment cohorts. Standard errors are clustered at the school level. Standard errors are clustered at the school level.

Table A.1

Estimates of Transitioning from a 90-30 Calendar by Student Achievement Groups

	Low-Achieving				Middle-Achieving				High-Achieving			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A. Standardized Math Scores												
Transition to Traditional Calendar	0.023	0.011	0.020	0.028	-0.014	-0.008	0.011	-0.029	0.062*	0.022	0.048	0.023
	(0.024)	(0.016)	(0.018)	(0.029)	(0.030)	(0.023)	(0.024)	(0.034)	(0.037)	(0.036)	(0.039)	(0.045)
N	293,741	293,741	293,741	293,741	382,865	382,865	382,865	382,865	482,069	482,069	482,069	482,069
R^2	0.078	0.296	0.300	0.637	0.074	0.323	0.328	0.655	0.119	0.492	0.497	0.748
B. Standardized English Scores												
Transition to Traditional Calendar	0.025	0.000	0.001	-0.007	0.044**	0.022	0.031*	0.023	0.080***	0.025	0.029	0.039**
	(0.022)	(0.017)	(0.017)	(0.025)	(0.021)	(0.015)	(0.017)	(0.017)	(0.027)	(0.018)	(0.020)	(0.018)
N	302,559	302,559	302,559	302,559	391,985	391,985	391,985	391,985	489,642	489,642	489,642	489,642
R^2	0.051	0.369	0.375	0.690	0.046	0.427	0.434	0.729	0.100	0.573	0.577	0.804
C. Fraction of Days Absent												
Transition to Traditional Calendar	-0.003	-0.003	-0.000	-0.004	-0.003	-0.003	-0.003	-0.004**	-0.004**	-0.003*	-0.002*	-0.003*
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)
N	412,117	412,117	412,117	412,117	522,722	522,722	522,722	522,722	636,473	636,473	636,473	636,473
R^2	0.105	0.116	0.399	0.663	0.081	0.096	0.366	0.645	0.055	0.076	0.340	0.626
D. Dummy if Grade is Repeated												
Transition to Traditional Calendar	0.001	0.001	0.007*	0.001	-0.001	-0.001	0.003	-0.003	0.000	0.001***	0.004***	0.002
	(0.003)	(0.003)	(0.004)	(0.004)	(0.001)	(0.002)	(0.003)	(0.002)	(0.000)	(0.000)	(0.001)	(0.001)
N	425,782	425,782	425,782	425,782	534,276	534,276	534,276	534,276	647,383	647,383	647,383	647,383
R^2	0.238	0.240	0.253	0.722	0.150	0.156	0.172	0.729	0.079	0.086	0.099	0.735
E. Dummy if Student Drops Out												
Transition to Traditional Calendar	-0.009	-0.010	-0.007		0.000	0.005	0.010		0.005	0.006	0.004	
	(0.015)	(0.016)	(0.018)		(0.015)	(0.014)	(0.014)		(0.006)	(0.006)	(0.007)	
N	122,263	122,263	122,263		191,806	191,806	191,806		257,930	257,930	257,930	
R^2	0.066	0.117	0.126		0.023	0.041	0.053		0.014	0.020	0.030	
Grade × Year FE	X	X	X	X	X	X	X	X	X	X	X	X
School FE	X	X	X	X	X	X	X	X	X	X	X	X
Lagged Test Scores		X	X			X	X			X	X	
Lagged Non-Test Score Controls			X				X				X	
Peer Controls			X				X				X	
Time-Varying School Controls			X	X			X	X			X	X
Student FE				X				X				X

Note: We present the estimates of β from equation 1 by achievement groups for elementary schools that transitioned from a 90-30 to a traditional calendar. We divide students into terciles representing low-achieving, middle-achieving, and high-achieving students. To allow for a student fixed effect specification, we construct a measure of academic achievement that keeps students in the same tercile over time. We construct these terciles within grade and year using the average of a student's first observed standardized math and English test scores. Standard errors are clustered at the school level. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

Table A.2

Middle School Estimates of Transitioning from Concept 6 by Student Achievement Groups

	Low-Achieving				Middle-Achieving				High-Achieving			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A. Standardized Math Scores												
Transition to Traditional Calendar	-0.007	-0.008	-0.005	0.051	-0.020	-0.031	-0.040*	0.039	0.008	-0.022	-0.027	0.073
	(0.020)	(0.017)	(0.018)	(0.047)	(0.030)	(0.020)	(0.023)	(0.079)	(0.036)	(0.027)	(0.038)	(0.113)
N	165,714	165,714	165,714	165,714	180,352	180,352	180,352	180,352	189,848	189,848	189,848	189,848
R^2	0.054	0.328	0.332	0.716	0.062	0.400	0.404	0.745	0.128	0.555	0.558	0.811
B. Standardized English Scores												
Transition to Traditional Calendar	-0.007	-0.002	0.000	0.033	-0.024	-0.026	-0.018	0.010	-0.010	-0.036*	-0.026	-0.024
	(0.019)	(0.013)	(0.018)	(0.021)	(0.024)	(0.017)	(0.022)	(0.024)	(0.026)	(0.020)	(0.026)	(0.033)
N	166,552	166,552	166,552	166,552	180,772	180,772	180,772	180,772	190,048	190,048	190,048	190,048
R^2	0.038	0.400	0.408	0.771	0.030	0.467	0.475	0.806	0.104	0.624	0.627	0.865
C. Fraction of Days Absent												
Transition to Traditional Calendar	-0.001	-0.000	-0.000	-0.003	-0.000	0.000	-0.001	-0.006**	-0.001	-0.000	-0.001	-0.003
	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)
N	206,500	206,500	206,500	206,500	220,052	220,052	220,052	220,052	227,807	227,807	227,807	227,807
R^2	0.063	0.080	0.402	0.781	0.043	0.065	0.370	0.770	0.028	0.055	0.354	0.769
D. Dummy if Grade is Repeated												
Transition to Traditional Calendar	-0.001	-0.001	-0.002**	0.000	-0.001	-0.001	-0.001	0.000	-0.001	-0.001	-0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
N	207,892	207,892	207,892	207,892	221,341	221,341	221,341	221,341	229,057	229,057	229,057	229,057
R^2	0.093	0.093	0.095	0.720	0.109	0.109	0.111	0.792	0.073	0.073	0.074	0.812
E. Dummy if Student Drops Out												
Transition to Traditional Calendar	-0.032	-0.031	-0.018		0.002	0.003	0.004		-0.001	0.000	-0.004	
	(0.022)	(0.019)	(0.022)		(0.008)	(0.009)	(0.008)		(0.005)	(0.006)	(0.006)	
N	64,804	64,804	64,804		86,264	86,264	86,264		93,837	93,837	93,837	
R^2	0.054	0.104	0.111		0.013	0.030	0.037		0.008	0.014	0.020	
Grade × Year FE	X	X	X	X	X	X	X	X	X	X	X	X
School FE	X	X	X	X	X	X	X	X	X	X	X	X
Lagged Test Scores		X	X			X	X			X	X	
Lagged Non-Test Score Controls			X				X				X	
Peer Controls			X				X				X	
Time-Varying School Controls			X	X			X	X			X	X
Student FE				X				X				X

Note: We present the estimates of β from equation 1 by achievement groups for middle schools that transitioned from a Concept 6 to a traditional calendar. We divide students into terciles representing low-achieving, middle-achieving, and high-achieving students. To allow for a student fixed effect specification, we construct a measure of academic achievement that keeps students in the same tercile over time. We construct these terciles within grade and year using the average of a student's first observed standardized math and English test scores. Standard errors are clustered at the school level. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.