Effects of Four-day School Weeks on Achievement: Evidence from Oregon[☆]

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Abstract

In recent years, there has been a growing trend for school districts to switch from a traditional five-day school week to a four-day week schedule with lengthened hours. While this shift to a shorter school week potentially helps school districts cut costs, there may be implications for student achievement, which this paper considers. This study uses a difference-in-differences analysis using a panel data set of student-level test scores to examine the effects of the adoption of these four-day school weeks on student achievement in Oregon. I generally find that student achievement declines following the switch to a four-day school week, as math test scores fall by around one-tenth of a standard deviation and fewer students are likely to meet proficiency targets. Looking at differential effects across student groups, minority, low-income, and special education students seem to be the most affected by these policies, possibly exacerbating pre-existing achievement gaps in these districts. The event study results suggest, however, that these effects are largely transitory and by four years after the policy is introduced the average student is scoring at the same level they were prior to the policy. One potential mechanism for these effects, appears to be the early start times associated with longer school days under a four day school week schedule.

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1. Introduction

In recent years, there has been a growing trend for school districts to switch from a traditional five-day school week to a four-day week schedule with lengthened hours each day. According to the National Conference of State Legislatures, twenty-one states currently have public school districts operating on four day school weeks.[1] There are currently 68 school districts in Oregon that operate with four-day school schedules. The switch to a four-day school week is often motivated by financial considerations, as it is one potential way fiscally-troubled school districts can realize financial savings related to transportation and operational expenses (utilities, food service, staffing, etc.).

While this shift to a shorter school week potentially helps school districts cut costs, there may be implications for student achievement, although the overall effect is largely ambiguous. Since overall yearly instructional time (i.e., amount of time in the classroom) largely remains the same regardless of whether a four or five-day school week is used, if the amount of instructional time is all that matters for student achievement then we should not expect to see much impact on test score performance. If the composition of instructional time matters, then the switch to a four-day school week that includes longer school days and often earlier start times may have several potential impacts on student achievement. Given the longer days, there may be greater fatigue causing students to be less engaged towards the end of the day causing students to learn less and lead to reduced achievement. Additionally, longer school days may also change the number of topics taught each day and may cause teachers to change their teaching styles, which likely has an ambiguous effect and will depend on how well these changes promote student learning. The day of school that is taken off is usually a Monday or Friday, which leads to longer weekends and the potential for greater weekend learning loss, as students may not retain as much from the previous week as they might in a five-day school week setting. In addition, what activities students engage in on the day off may also impact achievement effects of this type of policy. While some four-day school week districts offer disciplinary and remedial education services or other educational activities on the day off, which could potentially improve achievement for students struggling academically, many families and students are free to choose what activities to engage in on the day off, which may or may not promote student learning.

Despite the growing use of these policies across the United States and the clear questions regarding the implications of these policies for student learning and achievement, little rigorous empirical research

[1] These 21 states are Arizona, California, Colorado, Georgia, Idaho, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Missouri, Montana, Nebraska, New Mexico, Nevada, Oklahoma, Oregon, South Dakota, Utah, Wisconsin and Wyoming. (National Conference of State Legislatures)

has been conducted on this topic. Building off the little research we do know – primarily the Anderson and Walker (2015) study of Colorado – this study uses a difference-in-differences analysis using a panel data set of student-level test scores to examine the effects of the adoption of these four-day school weeks on student achievement in Oregon. This is the first paper to my knowledge to assess these policies using student-level information and thus the first to assess what types of students are most affected by these policies and the mechanisms through which achievement may be affected. I generally find that student achievement declines following the switch to a four-day school week, as math test scores fall by around one-tenth of a standard deviation and fewer students are likely to meet proficiency targets. Looking at differential effects across student groups, minority, low-income, and special education students seem to be the most affected by these policies, possibly exacerbating pre-existing achievement gaps in these districts. The event study results suggest, however, that these effects are largely transitory and by four years after the policy is introduced the average student is scoring at the same level they were prior to the policy. One potential mechanism for these effects, may be the early start times associated with longer school days under a four day school week schedule, but more evidence is needed on the role of teacher quality on these achievement losses.

2. Previous Literature

Much of the previous literature (Amys, 2016; Bell, 2011; Daly and Richburg, 1984; Feaster, 2002; Grau and Shaugnessy, 1987; Hale, 2007; Hegwood, 2016; McCoy, 1983; Reeves, 2014; Reinke, 1987; Sagness and Salzman, 1993; Tharp, 2014; Yarborough and Gilman, 2006) on four-day school weeks has largely focused on case studies of specific districts or more descriptive/cross-sectional studies of various states allowing four-day school weeks.[2] While these are helpful for understanding the institutional settings, the debates that are at the forefront of these decisions, and the differences between four and five-day school week districts, these studies provide little, if any, credible causal evidence of the effects of these policies on achievement. Anderson and Walker (2015) is the main exception, using a panel difference-in-differences approach to examine the effects of adopting a four-day school week on student proficiency rates. Their study provides the most credible evidence to date on the causal effect of the switch to four-day school weeks on student achievement. They generally find a positive effect of four-day school weeks on 4th and 5th grade math and reading proficiency rates.

[2]For a thorough review of this literature, see Donis-Keller and Silvernail, 2009.

Although the purpose of this paper is quite similar to the Anderson and Walker (2015) study, this study has some notable contributions. First, by analyzing a different institutional setting, this paper provides a comparison to the Anderson and Walker (2015) results and provides context for the generalizability of state-specific studies of four-day school weeks. This study also has the clear advantage of using student-level data compared to the district-level aggregate proficiency rates used in the Colorado study. Thus, in addition to assessing the overall impact of four-day school weeks on student performance, I am also able to examine differential effects of four-day school weeks on different student groups. Finally, as I have information on student-level absences and disciplinary measures and a host of teacher-level characteristics, I am able to examine some of the potential channels through which student achievement is affected by these policies.

This paper also relates to the larger discussion surrounding the effects of changing the length and composition of the school year. Some school districts try to increase the school year by adding additional days, while others naturally have fewer days due to weather-related cancellations. Previous quasi-experimental research (Aucejo and Romano, 2013; Clotfelter, Ladd, and Vigdor, 2009; Fitzpatrick, Grissmer, and Hastedt, 2011; Goodman, 2014; Hansen, 2011; Hayes and Gershenson, 2016; Leuven et al., 2010; Marcotte and Hansen, 2010; Parinduri, 2014; Pischke, 2007; Sims, 2008) generally finds that an additional day of schooling prior to the testing date has a positive effect on student achievement. In particular, days lost due to weather-related cancellations have been found to negatively impact performance due to missed instruction time prior to the standardized test (Marcotte, 2007; Marcotte and Hemelt, 2008), since districts on five-day school week schedules often only have the option of adding make-up days to the end of the school year. More flexible school schedules, such as the four-day school week, may allow school districts to more easily reschedule school days cancelled due to weather, meaning that districts may be able to make up missed days of instruction before standardized tests are administered. Previous literature has also focused on changes to a year-round school schedule, but find little positive effects on student achievement. Most notably, Graves (2010, 2011) finds that switching to a year-round school calendar may negatively impact student achievement. McMullen and Rouse (2012) find little, if any, impact of these year-round school calendars on student achievement. Similar to this study, they examine differential effects of these policies on racial subgroups, but find no evidence that any racial subgroup benefits from year-round schooling.

In addition to changes in the size and composition of the school year, previous research has also examined variation in the length and start of the school day. Previous literature (Bellei, 2009; Hincapie,

2016; Jensen, 2013) generally finds that lengthening the school day has a positive effect on student achievement. Much of this is likely due to increased instructional time throughout the year and thus, it is unclear whether a similar effect would be present in a four day school week setting in which overall yearly instructional time is unchanged. A growing literature on the achievement effects of school start times has shown that starting the school day later also has positive effects on achievement (Wahlstrom, et al., 1998; Carell, Maghakian, and West, 2011; Wong, 2011; Hinrichs, 2011; Edwards, 2012; Heissel and Norris, 2017) Most notably, Edwards (2012) finds that moving school start times one hour later increases reading test scores by 0.03 to 0.1 standard deviations and math test scores by 0.06 to 0.09 standard deviations. He finds smaller effects for elementary school students, but notes that this may be due to the fact that elementary schools in his sample generally have much later start times. Heissel and Norris (2017) find that moving school start times one hour later relative to sunrise would increase test scores by 0.073 standard deviations in math and 0.048 standard deviations in reading. These results are quite applicable to the four-day school week setting, given that school districts in Oregon that implement a four-day school week often start earlier than those with traditional five-day school weeks.

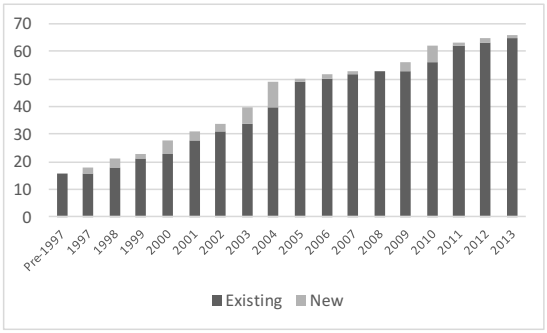
3. Background and Institutional Details

The use of four-day school weeks dates back to the 1930s in South Dakota, with more recent four-day school week policies starting in the 1970s (Donis-Keller and Silvernail, 2009). As of 2016, 21 states have some districts operating on four-day school weeks (NCSL, 2017), up from 17 in 2008-2009 (Donis-Keller and Silvernail, 2009; Gaines, 2008). In Oregon, two districts in Southern Oregon implemented one-year trials of a four-day school week during the 1983 school year. Shortly, there after five other districts in Eastern Oregon adopted similar policies and the number of school districts using four-day school weeks has grown ever since. Since 1997, as shown in Panel (a) of Figure 1, there has been a steady increase in the number of school districts adopting these types of school schedules. There were 16 districts with a four-day school week prior to 1997 and since then there have been two major periods of adoption – one between 1997 and 2003 and another between 2009 and 2013. This study will be identifying the effect of the adoption of four-day school weeks by this latter group of districts, during which 13 districts adopted a four-day school week. As of 2013, 65 school districts were operating on a four-day school week.

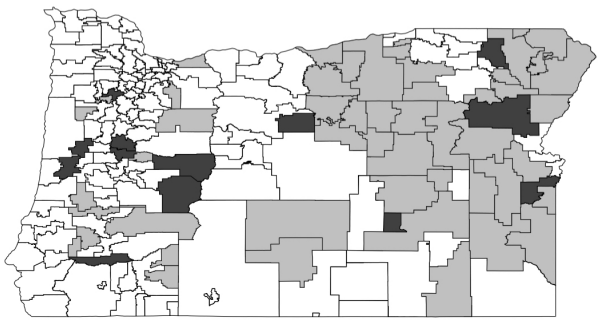
Across the many states that allow four-day school weeks, a majority of the districts that adopt these policies are small, rural districts – and Oregon is certainly no exception. As shown in Panel (b) of Figure

1, which provides the geographical variation in the districts that have adopted a four-day school week, the large majority of four-day school week districts are located in rural Eastern Oregon. The per-pupil cost savings from transportation, etc. in these districts may be among highest in the state and thus these are likely the districts with the most incentive to adopt one of these policies. However, the 13 districts that adopted a four-day school week in the 2008-2014 time span examined in this study, which are highlighted in darker gray, are spread out across many regions of the state. The student populations in these districts represent only about 3 percent of the total number of grade 3-8 students in the state, a similar percentage as found in Colorado four-day school week districts (Anderson and Walker, 2015), making Oregon an interesting comparison state to Colorado.

Figure 1: Geographic and Yearly Distribution of Labeled Municipalities



(a) Number of Districts with Four Day School Week, by Year



(b) Map of Four Day School Week Districts

In Oregon, the choice to adopt a four-day school week is largely up the discretion of the school district and the structure of these four-day school weeks can vary widely across districts. Districts interested in switching to a four-day school week must submit an application for an alternative school year (i.e., school year that offers below 175 days of instruction) to the Superintendent of Public Instruction at least 90 days prior to the upcoming school year.[3] Interested school districts also need to outline the basic plan for operating on a four day school week, including the needs addressed by the four day school week, the goals of the policy, and how those goals would be addressed. Particular items school districts must address include, the impact on student activities and support programs (e.g., counseling, safety), the estimated cost savings, and how the district will ensure instructional time is maintained. Regardless of the type of school schedule used, Oregon public schools have guidelines establishing minimum required hours of instructional time, which vary between 900 and 990 hours depending on grade level. To

[3]This essentially requests school districts to submit a waiver of OAR 581-22-502 that requires that Oregon school districts offer 175 days of instruction.

maintain the minimum instructional time requirement, the hours per day for Monday through Thursday are increased in school districts on a four-day school week. This, often means school districts start earlier and end later, with some school districts moving start times up to 7:00 am and others not ending the school day until 4:30 PM.

As a cost saving method, some districts eliminated teachers from working on Fridays or allowed only a certain amount of days per month for teachers to work on Fridays. Other districts allowed teachers to work every Friday for teaching prep or grading purposes. Sizable cost savings through these policy changes often do not come from reduced instructional costs because instructional staff work the same amount of hours, but in a reduced time frame. School districts can potentially make the most cost savings from reducing operations, extra student services, transportation, nutritional services, and maintenance on the day off. However, some schools keep the school open on the off-day for staff use or for students? extracurricular activities, which reduces the potential cost savings. Financially, switching to a four-day school week has the potential for a maximum of 5.43% savings for an average district, but districts actually experienced savings between 0.4% and 2.5% (Griffith, 2011).

4. Data Sources and Descriptive Statistics

The four day school week data comes from a survey conducted by the Oregon Department of Education and the Oregon School Boards Association.[4] These phone surveys identified which school districts currently had a four day school week and, if so, when the policy was initially implemented.[5] This survey also collected information on school start and end times. This four-day school week information is augmented with information on student test scores, student-level characteristics, school-level teacher characteristics, and district-level financial and demographic characteristics.

From the Oregon Department of Education, I obtain student-level and teacher-level records from 2008-2014.[6] The main variables of interest are student-level math and reading standardized test scores for grades 3 through 8 from the Oregon Assessment of Knowledge and Skills (OAKS) tests. In order to make test scores comparable across grades and years, I use a common convention in the literature (see

[4]https://olis.leg.state.or.us/liz/2015R1/Downloads/CommitteeMeetingDocument/53070

[5]One limitation of this survey, however, is that I am unable to tell whether school districts with five day weeks when the survey was conducted had four-day school weeks in the past. In addition, there is no indication of whether the policy was implemented in all schools in the district or only at certain schools within the district. Both of these limitations would lead results to be potentially biased towards zero and thus, the results of this analysis can likely be taken as a lower bound on the effect of four day school weeks on achievement.

[6]The year in this study refers to the school year and thus the data spans the 2007-2008 school year to the 2013-2014 school year.

Bifulco and Ladd, 2006 or McMullen and Rouse, 2012) and standardize these test scores within grade and school year so that the grade-by-year test scores have means of zero and standard deviations of one. These data also include a host of other student-level information, including the student's gender, race, free and reduced priced lunch eligibility status, ESL program participation, special education or gifted status, number of absences, and the number of discipline incidents. The teacher level data set includes a host of teacher characteristics, including race, experience, licensure, educational attainment, and base salary. Unfortunately, during the time period of this study, student and teacher data are not linked and thus, I aggregate the teacher data to the school-level to match to the student-level data. In total, this study analyzes 1,991,670 individual test scores from 602,361 students in grades 3 to 8 during 2008-2014.

Detailed information on school district expenditures and revenues is obtained from the National Center for Education Statistics (NCES) Common Core of Data. School district demographic data, including school-age population, enrollment counts by race, number of full-time equivalent teachers, and number of schools, are obtained from the NCES Common Core of Data and the Small Area Income and Poverty Estimates. Regional economic characteristics, including the number of mid-March employees and the total number of establishments, are obtained from the ZIP Code business patterns data from the Census.

Table 1 presents summary statistics for both four-day and five-day school week districts and there are some interesting differences to note. First, students in four-day school weeks have standardized math and reading test scores that are substantially lower than students in five-day school weeks. On average, students in four-day school weeks have math test scores that are 0.138 standard deviations below the average in the sample and reading test scores that are 0.078 standard deviations below the sample average, while students in five day school weeks have test scores that are 0.1 standard deviations above the sample average. As discussed before, districts with four-day schools tend to be largely rural districts and thus, on average, have much smaller student enrollment (420 students to 3,560 students), greater populations of white students (79.4 percent to 65.6 percent) and students eligible for free and reduced priced lunch (54.5 percent to 48.4 percent) than five day school week districts. Due to the smaller student populations, four-day school week districts collect more per-pupil revenue and spend more per-pupil on educational services than do five-day school week districts. Four-day school week districts also have fewer student absences and discipline incidents than five-day school week districts.

Table 1: Summary Statistics

	Full Sample	Four-Day Only	Five-Day Only
Student Outcomes			
Standardized math score	0.006	-0.138	0.011
	(0.999)	(0.857)	(1.003)
Standardized reading score	0.009	-0.078	0.012
	(0.994)	(0.902)	(0.997)
Days Absent	9.991	8.346	10.046
	(10.012)	(8.281)	(10.060)
Number of Discipline Incidents	0.328	0.166	0.334
	(3.893)	(2.292)	(3.935)
Student Characteristics			
Fraction of White Students	0.660	0.794	0.656
	(0.474)	(0.405)	(0.475)
Fraction of Black Students	0.026	0.005	0.027
	(0.161)	(0.069)	(0.163)
Fraction of Hispanic Students	0.074	0.050	0.075
	(0.262)	(0.218)	(0.263)
Fraction of Asian Students	0.048	0.007	0.049
	(0.214)	(0.085)	(0.217)
Fraction of Indian Students	0.019	0.014	0.019
	(0.136)	(0.115)	(0.137)
Fraction of Multi race Students	0.166	0.127	0.167
	(0.372)	(0.333)	(0.373)
Fraction of Female Students	0.491	0.494	0.491
	(0.500)	(0.500)	(0.500)
Fraction of FRL Eligible Students	0.486	0.545	0.484
	(0.500)	(0.498)	(0.500)
Fraction of ESL Students	0.049	0.025	0.050
	(0.216)	(0.155)	(0.217)
Fraction of Special Education Students	0.142	0.139	0.142
	(0.349)	(0.346)	(0.349)
Fraction of Talented in Reading Students	0.035	0.010	0.036
	(0.184)	(0.098)	(0.187)
Fraction of Talented in Math Students	0.033	0.010	0.034
	(0.179)	(0.099)	(0.181)
School District Characteristics			
Enrollment	3031	420	3560
	(6044)	(494)	(6498)
Pupil-teacher ratio	17.538	13.911	18.407
	(7.567)	(5.726)	(7.696)
Total Revenue PP	11013	15269	10151
	(9089)	(11530)	(8249)
Total Operating Expenditures PP	9717	13762	8898
	(7400)	(9822)	(6508)
Total Capital Expenditures	906	923	902
	(2602)	(2904)	(2526)
Fraction of Teachers with 0-3 Yrs Experience	0.206	0.210	0.205
	(0.156)	(0.195)	(0.144)
Fraction of Teachers with 4-10 Yrs of Experience	0.278	0.270	0.280
	(0.145)	(0.185)	(0.133)
Fraction of Teachers with 11+ Yrs Experience	0.516	0.520	0.515
	(0.179)	(0.222)	(0.166)
Fraction of Teachers with Advanced Degree	0.584	0.519	0.601
	(0.209)	(0.226)	(0.202)
Teacher Turnover	0.149	0.162	0.146
	(0.159)	(0.204)	(0.145)
Fraction of Teachers that are Licensed	0.975	0.971	0.977
	(0.119)	(0.149)	(0.110)
Observations	1,991,670	63,864	1,927,806
Number of students	602,361	17,646	584,715
Number of school districts	220	65	155

Note: Full sample includes all student test score observations; Four-day Only sample includes student test score observations from school years in which the district operated on a four-day school week; Five-day Only sample includes student test score observations from school years in which the district operated on a traditional five-day school week. Standard Deviations are given in parentheses. Per pupil variables are given in 2013 $.

5. Analysis of the Effect of Four-Day School Weeks on Student Achievement

5.1. Difference-in-Differences Results

Although the descriptive statistics presented in Table 1 show there are noticeable differences in math and reading test scores, student absences, and discipline incidents between four-day school week districts and those with five-day school weeks, it is hard to determine whether these differences are causally linked to the adoption of a four-day school week. Given the differences in the size and demographic make-up of these four-day school week districts, these differences in the raw summary statistics could be driven by underlying differences in the types of students, preferences for education, or other factors. Thus, to analyze the causal effect of four-day school weeks on student standardized test score performance, I estimate the following difference-in-differences regression:

$$A_{igsdt} = \alpha + \beta_1 Fourday_{dt} + \gamma \mathbf{X}_{igsdt} + \delta \mathbf{Z}_{sdt} + \lambda_{isd} + \theta_{gt} + \epsilon_{igsdt} \quad (1)$$

where A_{igsdt} is student i's standardized math or reading test score in grade g in school s in district d during school year t. Test scores are standardized within subject, grade, and school year. The $Fourday_{dt}$ variable is a dummy variable that is equal to one if the school district was operating on a four day school week during school year t. The $\mathbf{X}_{isdt}$ vector contains student-level characteristics including the student's gender, race, special education/gifted status, English as a second language (ESL) status, free and reduced price lunch (FRL) eligibility status, number of days absent, number of discipline incidents. The $\mathbf{Z}_{isdt}$ vector contains school-level and district-level controls including the fraction of teachers in the school with 0-3, 4-10, and 11 or more years of teaching experience, the fraction of teachers in the school with an advanced degree, the fraction of teachers in the school who are licensed, the school's teacher turnover rate, and total district enrollment. The λ_{isd} vector includes student, school, and district fixed effects, with the combination of these fixed effects depending on he specification used.[7] The θ_{gt} vector includes school year by grade fixed effects, while ϵ_{igsdt} is an idiosyncratic error term.

The results of this analysis are presented in Table 2. With no fixed effects included, the results suggest that four-day school week adoption reduces math test scores by 0.05 standard deviations. This result becomes insignificant when school district fixed effects or school fixed effects are included. However,

[7]Four different specifications are considered: (1) a baseline case with no fixed effects; (2) a specification with school district fixed effects included; (3) a specification with school fixed effects included; and (4) a specification with school district fixed effects and individual student fixed effects included. Given that the student fixed effects capture a great deal of unobservable variation in test scores and is not impacted by changes in composition of students across grades over time, specification (4) is the preferred specification.

Table 2: Effects of Four-Day School Week Adoption on Student Achievement

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Panel A: Math Scale Score				Panel B: Reading Scale Score			
Four-day	-0.050*	-0.022	-0.028	-0.117*	-0.034	-0.001	-0.011	-0.087
	(0.027)	(0.056)	(0.040)	(0.063)	(0.025)	(0.058)	(0.040)	(0.056)
School District FE		X		X		X		X
School FE			X				X	
Student FE				X				X
Observations	1,991,670	1,991,670	1,991,670	1,991,670	1,985,455	1,985,455	1,985,455	1,985,455
R-squared	0.312	0.328	0.350	0.843	0.315	0.328	0.343	0.853

Each specification contains student-level characteristics (student's gender, race, special education/gifted status, English as a second language status, free and reduced price lunch eligibility status, number of days absent, number of discipline incidents), school-level and district-level controls (the fraction of teachers in the school with 0-3, 4-10, and 11 or more years of teaching experience, the fraction of teachers in the school with an advanced degree, the fraction of teachers in the school who are licensed, the school's teacher turnover rate, and total district enrollment), and school year and grade fixed effects. Robust standard errors, clustered at the school district-level are given in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

in the preferred specification that includes both school district fixed effects and student fixed effects, I find that math test scores fall by 0.117 standard deviations when a school district switches to a four-day school week. Although the point estimates are of similar magnitude to the math results, they are statistically insignificant across all of the specifications examined.

Although the above finding that overall math test scores fall by just over one-tenth of a standard deviation, is quite striking, policymakers and school officials are likely to be more greatly concerned with whether students are meeting proficiency targets that are often associated with the accountability system. Thus, I also examine equation (1) using indicators for whether a particular student met the thresholds to be either proficient or advanced or had a score that fell below the threshold for being low performing. The results of this analysis are presented in Table 3 and again show much stronger effects on math achievement than reading achievement. Regardless of the specification used, the direction of the effects remain the same, but the preferred estimates are again from the specification with school district fixed effects and student fixed effects included. This specification finds that marginal students near the low performing and proficiency thresholds are negatively affected by the switch to four-day school weeks. In fact, students are 4.6 percentage points more likely to score at or below the low math performance threshold if they are in a four-day school week district than if they were in a school district with a five-day school week. However, there are no statistically significant impacts on students falling below this threshold in reading. In terms of meeting the proficiency standards, students are 7.1 percentage points less likely to meet those standards in math and 5.1 percentage points less likely to meet those standards in reading if they are in a four-day school week district than if they were in a school district with a five-day school week. Students who are on the margin of achieving the advanced

Table 3: Effects of Four-Day School Week Adoption on Meeting Performance Thresholds

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Panel A: ≤ Low Math Cutoff				Panel B: ≤ Low Reading Cutoff			
Four-day	0.005	0.032**	0.033**	0.046***	0.000	-0.000	0.001	0.013
	(0.008)	(0.014)	(0.015)	(0.017)	(0.005)	(0.012)	(0.009)	(0.010)
R-squared	0.176	0.183	0.192	0.671	0.170	0.175	0.182	0.693
	Panel C: ≥ Math Proficiency Cutoff				Panel D: ≥ Reading Proficiency Cutoff			
Four-day	-0.021**	-0.049**	-0.049***	-0.071***	-0.011	-0.013	-0.017	-0.051**
	(0.011)	(0.023)	(0.017)	(0.027)	(0.009)	(0.027)	(0.019)	(0.025)
R-squared	0.196	0.205	0.217	0.702	0.217	0.224	0.233	0.722
	Panel E: ≥ Math Advanced Cutoff				Panel F: ≥ Reading Advanced Cutoff			
Four-day	-0.030***	0.003	0.001	-0.026	-0.017*	-0.000	-0.003	-0.038
	(0.010)	(0.025)	(0.019)	(0.027)	(0.009)	(0.020)	(0.018)	(0.029)
School District FE		X		X		X		X
School FE			X				X	
Student FE				X				X
R-squared	0.180	0.193	0.209	0.699	0.189	0.199	0.211	0.702
Observations	1,991,670	1,991,670	1,991,670	1,991,670	1,985,455	1,985,455	1,985,455	1,985,455

Each specification contains student-level characteristics (student's gender, race, special education/gifted status, English as a second language status, free and reduced price lunch eligibility status, number of days absent, number of discipline incidents), school-level and district-level controls (the fraction of teachers in the school with 0-3, 4-10, and 11 or more years of teaching experience, the fraction of teachers in the school with an advanced degree, the fraction of teachers in the school who are licensed, the school's teacher turnover rate, and total district enrollment), and school year and grade fixed effects. Robust standard errors, clustered at the school district-level are given in parentheses.

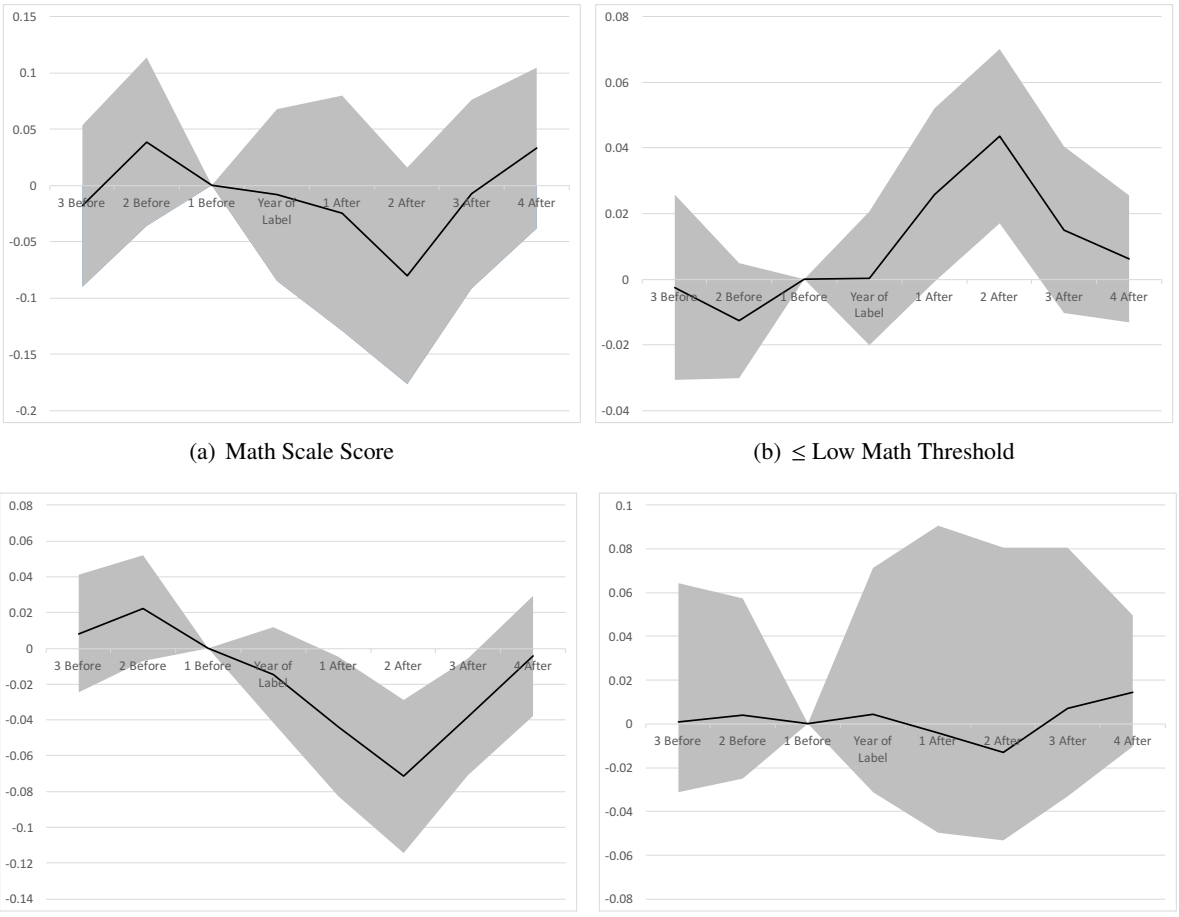
distinction in reading or math do not appear to be substantially impacted by the switch to a four-day school week, as all of these results are statistically insignificant.

The validity of the above difference-in-differences results relies on the assumption that prior to the switch to the four-day school week, the four-day school week districts had student achievement that was trending similarly to achievement in five-day school week districts. To more explicitly examine whether this assumption holds in this context, I examine a flexible event study framework of the following form:

$$A_{igsdt} = \alpha + \sum_{k=-3}^{4} \beta_k Fourday_{jtk} + \gamma \mathbf{X}_{igsdt} + \delta \mathbf{Z}_{sdt} + \lambda_d + \theta_{gt} + \epsilon_{igsdt} \tag{2}$$

where $Fourday_{jtk}$ is an indicator for k years before or after adoption of the four-day school week schedule, with $k = 0$ signifying the year of policy adoption. Figure 2 depicts the point estimates of the β_k's from equation (2) when A_{igsdt} is the standardized math scale score, the indicator for falling below the low performance threshold, the indicator for achieving the proficiency threshold, or the indicator for achieving the advanced threshold. In each subfigure the black line represents the point estimates for each year relative to policy adoption dummy variable and the grey shaded region represents the 95%

Figure 2: Event Study Results – Math Achievement



(a) Math Scale Score

(b) ≤ Low Math Threshold

(c) ≥ Proficiency Math Threshold

(d) ≥ Advanced Math Threshold

Grey shaded region depicts the 95% confidence interval for the estimated effect in each year relative to label receipt. Y-axis gives point estimate from eq. (2) using math scale score, indicator for falling below low performance threshold, indicator for achieving proficiency threshold, and indicator for achieving advanced threshold as dependent variables.

confidence interval using standard errors clustered at the school district level.[8]

The results suggest that there is no statistically significant difference in student achievement between the four-day and five-day school week districts prior to the policy adoption date. This provides evidence that the difference-in-differences estimator used in the previous section is valid in this context.[9] Following the adoption of the four-day school week the achievement effects appear to be somewhat transitory. During the first two years after implementation, the likelihood of falling below the low math threshold increases by 4 percentage points and the likelihood of achieving the proficiency threshold falls bay around 7 percentage points. However, by four years after the policy four-day school week students are achieving at a similar level to what they were prior to the policy being implemented. These results suggest that after several years of observing the policy in action school districts may be able to make adjustments to the implementation of the policy to mitigate the negative achievement effects. Students may also better learn how to navigate the four-day school week schedule after having been exposed to that schedule for several years.

5.2. Differential Effects by Student Types

The above analysis and those conducted in previous studies speak largely to the aggregate effects of four-day school weeks, but say very little about the heterogenous effects of these policies for different types of students. There are many reasons to think that certain types of students would be more greatly affected by this change than others. For example, special education and ESL students who require much more intervention in their learning may suffer more than other students, if the instruction they receive in school cannot be simulated in other settings on the additional day off. Low-income and minority students may also fare worse if resource constraints limit the amount of educational activities these students are able to pursue on the additional day off, although anecdotal evidence suggests that community organizations may provide some of the school functions for these students, such as serving food to free and reduced priced lunch students on the off day. To examine heterogeneous effects of

[8]To ease interpretation of the coefficients, I drop the policy adoption indicator for $k = -1$ (i.e. year prior to adopting the four-day school week). Thus the β_k coefficients identify treatment effects relative to the effect for the year prior to the policy adoption. The figures signify that this zero is imposed, by including a zero point estimate without an associated confidence interval.

[9]Given that visually these event study graphs seem to be showing some slight pre-trends, I also do a more formal test to assess the validity of the parallel trends assumption in each case. To test for this, I conduct a joint hypothesis test that $\beta_{-2} = 0$ and $\beta_{-3} = 0$, with a rejection of this test signifying that the parallel trends assumption does not hold. In each of the cases, we fail to reject the null hypothesis at the 5% significance level, suggesting that the parallel trends assumption does hold in this context. The F-statistics (p-values in parentheses) for the four dependent variables, math scale score, indicator for falling below low performance threshold, indicator for achieving proficiency threshold, and indicator for achieving advanced threshold are 1.01 (0.3654), 1.14 (0.3217), 1.12 (0.3278), and 0.04 (0.9632), respectively.

four-day school weeks on different types of students, I estimate the following equation:

$$A_{igsdt} = \alpha + \beta(Fourday_{dt} * \mathbf{X}_{igsdt}) + \gamma\mathbf{X}_{igsdt} + \delta\mathbf{Z}_{sdt} + \lambda_{isd} + \theta_{gt} + \epsilon_{igsdt} \quad (3)$$

where $Fourday_{dt} * \mathbf{X}_{igsdt}$ is the interaction of the $Fourday_{dt}$ variable with specific student characteristics from the $\mathbf{X}_{isdt}$ vector. It should be noted that I drop the $Fourday_{dt}$ variable itself and instead interact each subgroup of a given category (e.g., race) with the $Fourday_{dt}$ variable. This follows the approach taken by McMullen and Rouse (2012) and allows for the β's to be interpreted as the advantage or disadvantage the four-day school week provides each student subgroup relative to students of that same subgroup in school districts with traditional five day school weeks.

The results of this analysis is presented in Table 4 for the specifications that include school district and student fixed effects. Panel A gives the differential effects by minority status, while Panel B further breaks out the minority group into the smaller racial subgroups. While the overall effect on scale scores of white students is statistically insignificant, there are statistically significant impacts on white students meeting the various performance targets. In particular, white students in four-day school week districts are 3.7 percentage points more likely to fall below the low performing cutoff in math, 5.9 percentage points less likely to score above the proficiency threshold in math, and 4 percentage points less likely to score above the proficiency threshold in reading relative to their five-day school week counterparts. Larger negative effects are present for African American students, Asian students, and students of multiple races. Following the switch to a four-day school week, math scales scores fall by 0.21 standard deviations for African American students, 0.19 standard deviations for Asian students, and 0.14 standard deviations for students of multiple races. Similarly, reading scores fall by 0.13, 0.15, and 0.12 standard deviations for each of these racial groups, respectively.

As observed in Panel C of Table 4, male students appear to be more greatly impacted by the change to a four-day school week than female students. Male students score 0.14 standard deviations lower in math following the switch to the four-day school week and 0.1 standard deviations lower in reading. Poorer students, those eligible for free and reduced-priced lunch are also more greatly impacted. Free and reduced priced lunch eligible students are nearly 5 percentage points more likely to fall below the low performing cutoff in math, 7.3 percentage points less likely to score above the proficiency threshold in math, and 5.3 percentage points less likely to score above the proficiency threshold in reading.

Panels E and F examine the differential effects by the whether a student is participating in special

Table 4: Effects of Four-Day School Week Adoption on Student Achievement, Heterogeneous Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Math Achievement				Reading Achievement		
	Score	≤ Low	≥ Proficient	≥ Advanced	Score	≤Low	≥ Proficient	≥ Advanced
Panel A: Differential Effects by Minority Status								
Four-day*White	-0.100	0.037**	-0.059**	-0.022	-0.071	0.012	-0.040*	-0.035
	(0.063)	(0.016)	(0.027)	(0.027)	(0.054)	(0.008)	(0.022)	(0.030)
Four-day*Minority	-0.086	0.031	-0.052*	-0.031	-0.074	-0.002	-0.063**	-0.026
	(0.064)	(0.023)	(0.030)	(0.025)	(0.057)	(0.016)	(0.030)	(0.027)
Four-day*Multi-Race	-0.145**	0.058**	-0.087***	-0.022	-0.120**	0.016	-0.069**	-0.042
	(0.062)	(0.023)	(0.026)	(0.027)	(0.058)	(0.016)	(0.032)	(0.025)
Panel B: Differential Effects by Race								
Four-day*White	-0.100	0.037**	-0.059**	-0.022	-0.071	0.012	-0.039*	-0.034
	(0.063)	(0.016)	(0.027)	(0.027)	(0.054)	(0.008)	(0.022)	(0.030)
Four-day*Black	-0.208**	0.062	-0.099	-0.072	-0.126*	-0.019	-0.139***	-0.037
	(0.100)	(0.055)	(0.068)	(0.055)	(0.069)	(0.047)	(0.044)	(0.037)
Four-day*Hispanic	-0.070	0.023	-0.046	-0.015	-0.072	-0.009	-0.066**	-0.027
	(0.066)	(0.028)	(0.033)	(0.025)	(0.062)	(0.019)	(0.033)	(0.027)
Four-day*Asian	-0.189**	0.064	-0.075	-0.029	-0.153*	0.031	-0.020	-0.075
	(0.094)	(0.046)	(0.053)	(0.047)	(0.084)	(0.043)	(0.049)	(0.046)
Four-day*Other Race	-0.042	0.035	-0.045	-0.033	-0.002	0.032	-0.033	0.022
	(0.086)	(0.042)	(0.045)	(0.035)	(0.075)	(0.024)	(0.032)	(0.040)
Four-day*Multi-Race	-0.141**	0.056**	-0.085***	-0.029	-0.119**	0.014	-0.070**	-0.042
	(0.061)	(0.024)	(0.026)	(0.025)	(0.059)	(0.017)	(0.033)	(0.025)
Panel C: Differential Effects by Gender								
Four-day*Male	-0.136**	0.056***	-0.076***	-0.034	-0.099*	0.017*	-0.053**	-0.035
	(0.066)	(0.015)	(0.027)	(0.030)	(0.058)	(0.010)	(0.024)	(0.030)
Four-day*Female	-0.098	0.036*	-0.066**	-0.018	-0.075	0.008	-0.049*	-0.041
	(0.062)	(0.020)	(0.029)	(0.025)	(0.055)	(0.010)	(0.027)	(0.028)
Panel D: Differential Effects by Socioeconomic Status								
Four-day*Non-FRL Eligible	-0.113*	0.042**	-0.067**	-0.024	-0.073	0.011	-0.046*	-0.038
	(0.067)	(0.018)	(0.028)	(0.029)	(0.057)	(0.011)	(0.026)	(0.030)
Four-day*FRL Eligible	-0.119*	0.049***	-0.073***	-0.027	-0.095*	0.014	-0.053**	-0.038
	(0.062)	(0.017)	(0.027)	(0.026)	(0.055)	(0.009)	(0.025)	(0.029)
Panel E: Differential Effects by Special Education Status								
Four-day*General Education	-0.113*	0.042**	-0.069**	-0.027	-0.082	0.012	-0.047*	-0.038
	(0.062)	(0.017)	(0.027)	(0.026)	(0.055)	(0.009)	(0.025)	(0.030)
Four-day*Special Education	-0.116*	0.059***	-0.074**	-0.021	-0.071	0.015	-0.067**	-0.019
	(0.064)	(0.021)	(0.030)	(0.024)	(0.054)	(0.015)	(0.029)	(0.024)
Four-day*Gifted Education	-0.081	0.040*	-0.056**	0.003	-0.041	0.012	-0.043*	-0.044
	(0.074)	(0.021)	(0.028)	(0.036)	(0.086)	(0.009)	(0.025)	(0.038)
Panel F: Differential Effects by Limited English Proficient Status								
Four-day*Regular Program	-0.118*	0.047***	-0.071**	-0.026	-0.087	0.012	-0.051**	-0.039
	(0.064)	(0.017)	(0.027)	(0.027)	(0.056)	(0.010)	(0.025)	(0.029)
Four-day*ESL Program	-0.087	0.037**	-0.073**	-0.010	-0.075	0.027*	-0.055*	-0.024
	(0.056)	(0.017)	(0.033)	(0.024)	(0.057)	(0.015)	(0.032)	(0.026)
Observations	1,991,670	1,991,670	1,991,670	1,991,670	1,985,455	1,985,455	1,985,455	1,985,455
R-squared	0.843	0.671	0.702	0.699	0.853	0.693	0.722	0.702

Each panel of the table presents results from a separate regression containing the specified interaction terms. Each specification contains student-level characteristics (student's gender, race, special education/gifted status, English as a second language status, free and reduced price lunch eligibility status, number of days absent, number of discipline incidents), school-level and district-level controls (the fraction of teachers in the school with 0-3, 4-10, and 11 or more years of teaching experience, the fraction of teachers in the school with an advanced degree, the fraction of teachers in the school who are licensed, the school's teacher turnover rate, and total district enrollment), and school year, grade, school district, and student fixed effects. Robust standard errors, clustered at the school district-level are given in parentheses.

education, gifted education, or the ESL program. Special education students appear to be slightly more negatively affected by the switch to the four-day school week than other students, while ESL students appear to be affected similarly to non-ESL students. Special education students are 5.9 percentage points more likely to fall below the low performing cutoff in math, 7.4 percentage points less likely to score above the proficiency threshold in math, and 6.7 percentage points less likely to score above the proficiency threshold in reading.

These results suggest that certain students may be differentially harmed by these policies. Most notably, lower income and minority students face the greatest achievement loss as a result of the switch to a four-day school week, exacerbating pre-existing achievement gaps. Due to resource constraints, these students may not have the same level of quality of home inputs into the educational production function as wealthier students and thus the activities engaged in on the day off may not be as effective at promoting student learning. These results also suggest that attention must be paid to special education students when implementing these policies, as they seem to be more greatly affected compared to other students. The fact that ESL students perform similarly to the overall student population suggests that activities that promote English-language learning may be relatively easy to find outside the school setting, while activities that simulate the learning conducted in a special education classroom may not be as abundant in these rural communities.

6. Analysis of Potential Mechanisms

The above results suggest that student achievement fell following the introduction of the four day school weeks, but the above analysis does not delve into the mechanisms through which the school schedule change caused this reduction. As discussed previously, there could be several mechanisms through which student achievement could be negatively impacted. In this section, I consider several of these potential mechanisms including student absences, student disciplinary incidents, teacher quality, and school start times,.

6.1. Student Absences and Discipline

Much of the anecdotal evidence suggests that four-day school weeks improve student attendance. Previous literature has linked student absences to lower student achievement (Aucejo and Romano, 2014; Gershenson, Jacknowitz, and Brannegan, 2017; Goodman, 2014; Gottfried, 2009, 2011; Ready, 2010). Thus, if attendance got worse or stayed about the same with the switch this could negatively

impact achievement as absences in a four-day school week setting mean a greater loss in instructional time than in a five-day school week. Longer school days could also have implications for the incidence of student disciplinary infractions. To assess the impact of switching to a four-day school week on the number of student absences and disciplinary incidents, I estimate equation (1) using both of those as dependent variables. The results of this analysis are presented in Table 5. While the baseline specification without any fixed effects shows that absences were reduced by nearly two absences per student per year, once fixed effects are included the point estimates fall considerably and the effects become statistically insignificant. There is a slight reduction in discipline incidents after the switch to a four-day school week, but this seems unlikely to explain the drops in math and reading achievement.

Table 5: Effects of Four-Day School Week Adoption on Student Absences and Discipline Incidents

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Panel A: Number of Student Absences				Panel B: Discipline Incidents			
Four-day	-1.945***	0.010	-0.376	0.170	-0.122***	-0.023	-0.001	-0.284**
	(0.292)	(0.573)	(0.321)	(0.790)	(0.033)	(0.053)	(0.043)	(0.124)
School District FE		X		X		X		X
School FE			X				X	
Student FE				X				X
Observations	2,076,159	2,076,159	2,076,159	2,076,159	2,076,159	2,076,159	2,076,159	2,076,159
R-squared	0.064	0.071	0.083	0.697	0.017	0.018	0.034	0.322

Each specification contains student-level characteristics (student's gender, race, special education/gifted status, English as a second language status, free and reduced price lunch eligibility status, number of days absent, number of discipline incidents), school-level and district-level controls (the fraction of teachers in the school with 0-3, 4-10, and 11 or more years of teaching experience, the fraction of teachers in the school with an advanced degree, the fraction of teachers in the school who are licensed, the school's teacher turnover rate, and total district enrollment), and school year and grade fixed effects. Robust standard errors, clustered at the school district-level are given in parentheses.

6.2. Impacts on Teacher Quality

Teachers are a major component in student learning and thus, if teacher quality was reduced following the switch to a four-day school week, could help explain the negative achievement effects. Teacher quality could be reduced for a few reason. First, if the switch is made for financial reasons teachers may leave the financially-troubled school districts all together and if these are high-quality teachers leaving the district then overall teacher quality would be reduced by this teacher mobility. Second, longer school days and class periods mean that teachers may have to adjust teaching styles to meet the demands of the lengthened instructional time per day. If teachers have difficulty adapting to this new schedule or fail to use the additional time adequately the quality of their overall teaching could suffer. Given the extensive value-added literature, we would expect the reduction in teacher quality to negatively impact student learning and test score achievement.

Table 6: Effects of Four-Day School Week Adoption on Teacher Characteristics

	(1) Total Teaching Experience	(2) Years in District	(3) Total Exp 0 - 3 Years	(4) Total Exp 4 - 10 Years	(5) Total Exp 11+ Years	(6) Licensed Teacher	(7) Advanced Degree	(8) Base Salary	(9) Leave District
Four-day	0.412	0.122	-0.029	0.035	-0.006	-0.016**	-0.013	-1,445.111	-0.017
	(0.445)	(0.309)	(0.030)	(0.033)	(0.022)	(0.007)	(0.028)	(1,104.162)	(0.019)
Observations	141,204	141,204	141,204	141,204	141,204	141,204	141,204	141,204	141,204
R-squared	0.385	0.345	0.245	0.100	0.373	0.224	0.137	0.441	0.067

Each specification contains teacher-level characteristics, school-level and district-level controls, and school year and school fixed effects. Robust standard errors, clustered at the school district-level are given in parentheses.

To assess the impact of switching to a four-day school week on a number of teacher characteristics (teacher experience, licensure, advanced degree status, salary, and whether a teacher leaves the district), I estimate equation (1) using these characteristics as dependent variables, with the results presented in Table 6 The only teacher characteristic that is statistically significantly impacted is whether the teacher is licensed and shows that the likelihood that a teacher is licensed falls by 1.6 percentage points following the switch to a four-day school week. While these results largely suggest that teacher characteristics are unchanged following the move to a four-day school week, these are weak measures of teacher quality. Due to data constraints, teacher and student linkages are not known and thus I am unable to conduct a more robust analysis of the impact on teacher quality – namely conducting value-added analyses before and after the policy change. Thus, future work using data where these linkages exist is needed to better assess the impact of these policies on teacher quality as a potential mechanism for these achievement effects.

6.3. Earlier Start Times

One major component of these four day school weeks is the change in the overall length of the school day. In order for many of these school districts to keep instructional time the same, school start times are pushed earlier and the school day often also ends later than a school days in a traditional five-day school week. For many districts in Oregon, this means starting the school day prior to 8:00 am, with some districts starting as early as 7:00 am. As discussed in the literature review, previous research has found that starting school an hour earlier would reduce test achievement by between 0.03 to 0.1 standard deviations in reading and 0.06 to 0.09 standard deviations in math. Using these results as a basis, four-day school week policies that move the start time an hour earlier would explain roughly one-half to three-fourths of the point estimate found for math in column (4) of Table 2 and between one-third and the entire point estimate found for reading in column (8) of Table 2.

To further investigate whether these reductions in achievement may be related to start time differ-

Table 7: Effects of Early Start Times vs. Late Start Times in Four-day School Weeks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Panel A: ≤ Math Score				Panel B: ≤ Reading Score			
Four-day	-0.001	0.078	0.065	0.010	0.002	0.036	0.024	0.020
	(0.041)	(0.058)	(0.045)	(0.067)	(0.044)	(0.081)	(0.070)	(0.119)
Four-day*Start Before 8:00	-0.060	-0.118	-0.111*	-0.151*	-0.052	-0.052	-0.049	-0.117
	(0.044)	(0.081)	(0.060)	(0.088)	(0.048)	(0.102)	(0.082)	(0.128)
R-squared	0.312	0.328	0.350	0.843	0.316	0.330	0.346	0.854
	Panel C: ≤ Low Math Cutoff				Panel D: ≤ Low Reading Cutoff			
Four-day	-0.011	0.011	0.013	0.028	0.001	-0.007	-0.007	0.009
	(0.017)	(0.022)	(0.022)	(0.031)	(0.008)	(0.028)	(0.023)	(0.038)
Four-day*Start Before 8:00	0.020	0.025	0.024	0.022	-0.002	0.009	0.010	0.002
	(0.019)	(0.026)	(0.027)	(0.034)	(0.010)	(0.031)	(0.025)	(0.039)
R-squared	0.176	0.183	0.192	0.671	0.170	0.175	0.182	0.694
	Panel E: ≥ Math Proficiency Cutoff				Panel F: ≥ Reading Proficiency Cutoff			
Four-day	0.008	-0.002	-0.008	-0.011	0.001	-0.017	-0.024	-0.044
	(0.020)	(0.029)	(0.023)	(0.043)	(0.013)	(0.046)	(0.042)	(0.057)
Four-day*Start Before 8:00	-0.035	-0.056	-0.049*	-0.071	-0.020	-0.002	0.003	-0.008
	(0.022)	(0.037)	(0.029)	(0.050)	(0.015)	(0.054)	(0.046)	(0.063)
R-squared	0.196	0.205	0.217	0.702	0.222	0.230	0.240	0.722
	Panel G: ≥ Math Advanced Cutoff				Panel H: ≥ Reading Advanced Cutoff			
Four-day	-0.015	0.044***	0.038***	0.017	0.001	0.019	0.013	0.030
	(0.016)	(0.016)	(0.014)	(0.016)	(0.020)	(0.016)	(0.016)	(0.024)
Four-day*Start Before 8:00	-0.019	-0.048	-0.044*	-0.051	-0.024	-0.027	-0.022	-0.077**
	(0.016)	(0.030)	(0.025)	(0.031)	(0.021)	(0.027)	(0.025)	(0.035)
R-squared	0.180	0.193	0.209	0.699	0.190	0.201	0.213	0.703
School District FE		X		X		X		X
School FE			X				X	
Student FE				X				X
Observations	1,991,670	1,991,670	1,991,670	1,991,670	1,985,455	1,985,455	1,985,455	1,985,455

Each specification contains student-level characteristics (student's gender, race, special education/gifted status, English as a second language status, free and reduced price lunch eligibility status, number of days absent, number of discipline incidents), school-level and district-level controls (the fraction of teachers in the school with 0-3, 4-10, and 11 or more years of teaching experience, the fraction of teachers in the school with an advanced degree, the fraction of teachers in the school who are licensed, the school's teacher turnover rate, and total district enrollment), and school year and grade fixed effects. Robust standard errors, clustered at the school district-level are given in parentheses.

ences, I also estimate equation (1) interacting the $Fourday_{dt}$ variable with an indicator for whether the district has a start time before 8:00 am. The results of this analysis are presented in Table 7 and, although suffering from low precision, generally shows that the negative achievement effects associated with four-day school are driven by four-day school weeks that have school days starting before 8:00 am. The main implication of these results seems to be that if school days started later in these districts, four-day school weeks could be effective at promoting student learning or at the very least not harm student learning.

7. Conclusion

This paper used a difference-in-differences analysis to analyze panel data on student-level test scores to examine the effects of the adoption of these four-day school weeks on student achievement in Oregon. I generally find that student achievement declines following the switch to a four-day school week, as math test scores fall by around one-tenth of a standard deviation and fewer students are likely to meet proficiency targets. Looking at differential effects across student groups, minority, low-income, and special education students seem to be the most affected by these policies, possibly exacerbating pre-existing achievement gaps in these districts. The event study results suggest, however, that these effects are largely transitory and by four years after the policy is introduced the average student is scoring at the same level the were prior to the policy. One potential mechanism for these effects, may be the early start times associated with longer school days under a four day school week schedule, but more evidence is needed on the role of teacher quality on these achievement losses.

This study's results provide a comparison to those from the only other quasi-experimental study on four-day school weeks – Anderson and Walker (2015) – and largely finds opposite results. So what might be underlying this difference in the effects of Oregon and Colorado? The daily school start time plays a role and it may be the case that Colorado districts do a better job of avoiding early start times when switching to thee policies. Some Colorado districts, once financial pressures diminish, offer programs for gifted students, remedial programs, and disciplinary programs (Dam, 2006) during the non-school day of the week. These types of programs essentially provide additional instruction beyond the typical in-class instruction time and this increase in overall instruction time is likely to have a positive effect on student performance. It is not clear from the Oregon data whether similar types of programs are being operated in Oregon districts, but the results suggest that they are likely not being used. Thus, for policymakers and school officials considering these types of policies, finding ways to avoid starting school days earlier and providing some additional gifted or remedial education services on days off may

go a long way towards promoting positive achievement effects through these policies. However, the fact that these two studies obtain contradictory results suggests that more research in other institutional settings and further analysis on the mechanisms driving the achievement results is warranted before strong policy recommendations can be made.

Achievement on standardized tests is also only one metric on which to gauge the effectiveness of these policies. Other educational outcomes may also be of interest to future studies, including graduation rates and dropout rates. These policies also likely have large implications for families, as they shift the financial burden of childcare and other activities from the school district to the parents and local communities. Certain types of families may feel this burden more than others and so other interesting outcomes to examine would be the effect of these policies on childcare costs, parental labor supply, and housing prices in the local community. These policies have been grossly understudied and the need for future work is great in order to better inform policymakers about how best to implement these policies.

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