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Effects of Four-Day School Weeks on School Finance and Achievement: Evidence from Oklahoma

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ABSTRACT

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Abstract

Motivated by potential financial savings, four-day school weeks have proliferated across the United States in recent years, reaching public schools in 25 states as of 2018. The consequences of the four-day school week for students, schools, and communities are largely unknown. This paper uses district-level panel data from Oklahoma and a difference-in-differences research design to examine the causal effect of the four-day schedule on school district finance and academic achievement. Results indicate that four-day weeks decrease districts' federal and state revenues and their non-instructional and support services expenditures. Decreases are concentrated specifically in food services and transportation expenditures and amount to approximately 1.36% of the average four-day district's budget. I find no detectable effect of the four-day week on academic achievement.

Introduction

Four-day school weeks are widespread and growing across the U.S., as 25 states currently have at least one school operating on a four-day week schedule (Heyward, 2018). Across these 25 states, approximately 550 districts are using the schedule, but information from state departments of education on district adoption exists only for six states and is otherwise sparse or unreliable. Typically, these districts complete at least the same number of instructional hours required of all districts in a given state by lengthening the school day for the four days of the week they are in session. Most of the districts on the schedule are small and rural, but this is not always the case, as one urban Colorado district that serves approximately 18,000 students adopted the schedule at the start of the 2018-2019 school year. Based on responses from a sample of 342 districts nationwide, the most common reason cited as a main rationale for adoption (62.9% of districts), was financial savings; districts argue they are saving money by reducing costs such as transportation, heating, and support staff salaries (Thompson, Gunter, Schuna, & Tomayko, 2019). Districts acknowledge that reducing the school week by one day, or 20%, would not reduce spending by 20%, as teachers technically work the same number of hours, so their contracts, which comprise the greatest cost for the district, are not affected. Though less common, other rationales for adopting four-day weeks were commonly cited (25-50%) as well, such as improved student attendance, teacher retention, long bus rides, and time for students to work on family farms and ranches.

Despite considerable anecdotal information and opinions on the advantages and disadvantages of the four-day week, there remains a paucity of rigorous research examining its effects. The lack of empirical information raises concerns about the unknown potential impacts of the four-day schedule related to a multitude of factors: school finance, student achievement, teacher hiring and retention, student attendance, students' health and well-being, delinquency, student motivation, and community and family resources (e.g., child care). The effect of this schedule change on a student may also depend on the student's age or other demographic characteristics. This paper makes a key contribution to the small body of literature on four-day school weeks by employing quasi-experimental research methods and district-level data from Oklahoma to examine the effect of the four-day week on the factors of primary importance to policymakers and practitioners: school finance and academic achievement.

Effects of the Four-Day School Week on School Finance

Districts' spending, while connected to students' achievement outcomes, is an independently important topic for policymakers and government officials who are responsible for allocating resources across public needs, including education. If a public school district were able to make a change that reduced their spending without any detriment to students, teachers, or communities, the district would certainly make that change. A large body of research has investigated the relationship between school finance and student achievement. Although the relationship was controversial historically (Greenwald, Hedges, & Laine, 1996; Hanushek, 1997), the more recent rigorous quasi-experimental research leveraging exogenous variation in school funding caused by school finance reforms (SFRs) consistently shows a positive relationship between educational resources and student achievement over time (Baker, 2016; Card & Payne, 2002; Gigliotti & Sorensen, 2018; Lafortune, Rothstein, & Schanzenbach, 2018). The magnitude of the effect, however, is unclear: whereas Gigliotti and Sorensen (2018) find that increasing per-pupil spending by $1,000 in New York public school districts was associated with a substantial 0.042 to 0.047 standard deviation increase on state test scores, Lafortune et al. (2018) find a smaller 0.011 to 0.024 yearly standard deviation increase on test scores per $1,000 increase in per-pupil revenues across a national sample. Nevertheless, scholars generally agree that increasing educational resources, especially among low-income districts, predicts increases in student achievement.

Highly relevant to the present study, Thompson's (2019b) working paper uses a differences-in-differences approach and a national dataset to show that four-day school weeks on average reduce operating expenditures per pupil by 3.1% relative to all U.S. public five-day districts over the same time period. He finds statistically significant reductions in district expenditures on transportation (7.0%), food services (6.8%), general administration (4.7%), student services (4.5%), and operations and maintenance (4.5%). To test the sensitivity of his analysis, he conducts several additional analyses restricting the sample in a variety of ways that provide alternative control groups and finds similar point estimates. Using the most restrictive control group, including only districts that ever adopted a four-day school week, he produces very similar point estimates for each expenditure category and estimates that total district expenditures per pupil decrease by 2.1%.

Before Thompson's (2019b) work, Griffith's (2011) report provides the most rigorous descriptive estimates of the potential savings a district realizes from switching to a four-day week. Using national finance data and financial estimates provided by individual districts across several states, he finds that districts on average saved between 0.4% and 2.5% of their budget and a maximum of 5.43% of their budget after making the switch. He further specifies that the cost savings, in order from greatest to least, appeared to be coming from the following categories of expenditures: operations and maintenance, school administration, student support, transportation, and food services. These categories, however, comprised only approximately 29% of districts' budgets, as most of their resources (~65%) were allocated for instructional costs (i.e., teachers' salaries and benefits), which were not significantly affected by the schedule change. For districts that operate their buildings on the fifth day or extend the hours of maintenance staff during the week, the savings would likely come only from student transportation and food service costs, which Griffith (2011) estimates would total to a paltry maximum potential savings of 1.6% of a district's total budget. In Oklahoma, among the districts that ever adopt four-day weeks, the average budget from 2009-2016 was approximately $3 million (in 2016 dollars), making a 1.6% savings equal to $48,000. Though 1.6% of the budget may seem inconsequential, such savings may be impactful for a small, rural district.

Effects of the Four-Day School Week on Academic Achievement

Two studies causally examine the effect of four-day weeks and present conflicting results. Anderson and Walker (2015) use a school-level panel dataset from fourth- and fifth-graders in Colorado and find a 4-7% increase in the percent of students scoring above the proficient threshold in math and English Language Arts (ELA). However, Thompson (2019a), using a student-level panel dataset of students grades 3-8 in Oregon, finds a 5-7% decrease in the in the percent of students scoring above the proficient threshold in math and ELA. He attributes this finding, at least in part, to an average 3.5-hour reduction in instructional time in districts with four-day weeks in Oregon. Furthermore, he finds that the four-day school week is significantly more detrimental for low-income students. These contradictory study results indicate the need for additional quasi-experimental research examining the effect of four-day weeks on achievement.

Other Effects of the Four-Day School Week

Further quasi-experimental research that considers the effects of the four-day school week on other student and community outcomes is recent and sparse: the entirety consists of two working papers respectively examining housing prices (Nowak, Perrone, & Smith, 2019) and parental labor supply (Ward, 2019), and one peer-reviewed publication examining delinquency (Fischer & Argyle, 2018). Based on Colorado housing transaction data from the first urban district to ever adopt a four-day school week, Nowak et al. (2019) find a 2-5% decrease in house prices relative to surrounding school districts as an effect of four-day school week adoption. Though this finding draws attention to an important potential consequence of adopting a four-day school week in an urban district, it is unknown if this finding is generalizable to rural districts, which comprise the vast majority of four-day week districts.

Ward (2019) uses data from all Public Use Microdata Areas (PUMA) across Colorado, Idaho, Oklahoma, and Oregon, to estimate effects of four-day school weeks on parental employment. He finds that increasing the portion of students in a PUMA enrolled in a district with a four-day school week from 0% to 25% causes an 11% decrease in employment (7.6 percentage points) relative to baseline among married mothers whose children are all between the ages of 5 and 13. This negative effect is largely borne by mothers who have a four-year college degree or greater, suggesting that there may be great heterogeneity in the effect at the district-level based on demographics. The four-day school week had no detectable effect on single mothers' or married fathers' employment status.

Fischer and Argyle's (2018) quasi-experimental study exploits variation in the adoption of the four-day school week across rural schools in Colorado to examine the relationship between school attendance and juvenile crime. They find that, on Fridays, the day off for four-day schools, the corresponding police and sheriff agencies where at least one four-day high school was located experienced a 20% increase in overall crime and a 61% increase in property crime among juveniles compared to the agencies in areas composed of high schools with five-day weeks. Perhaps shockingly high, these findings are supported by other research considering the school attendance-crime relationship and strongly suggest that the impact of the four-day schedule extends beyond the school context and into communities (Jacob & Lefgren, 2003; Luallen, 2006). Of course, however, these potentially negative consequences may be offset by financial gains from switching to a four-day week schedule.

Oklahoma Policy Context

Four-day school weeks have particularly proliferated in public schools in Oklahoma over the past ten years. Oklahoma House Bill 1864, effective April 24th, 2009, changed the state requirements on instructional time for traditional public school districts such that they no longer had to have both 180 days and 1,080 hours of classroom instruction in a school year, but only had to fulfill the 1,080 hours (H.B. 1864 (2009)). As a result, districts could have fewer school days per year if they lengthened their days. Schools first recorded the schedule change in the fall of 2010 and increasing numbers of schools have made the switch since then (see Appendix Figure A3 for the timing of four-day school week adoption in Oklahoma). Public records from the Oklahoma State Department of Education indicate that 91 of Oklahoma's 513 (17.7%) public school districts, representing approximately 41,000 of the 640,000 (6.4%) total K-12 public school students, had at least one school on a four-day schedule at the start of the 2017-2018 school year.

Examining the increase in four-day schooling specifically in Oklahoma is critical because of Oklahoma's particular destitution in regard to education funding; over the past several years, the state has consistently ranked among the five states with the lowest spending per pupil, spending only $8,097 per pupil in the 2016 fiscal year, $3,665 short of the national average (U.S. Census Bureau, 2016). Oklahoma has undergone years of tax cuts and consequent decreases in sales tax revenue that have led the state to face one of the largest education budget crises in the history of the U.S. The extremity of the situation has recently been illuminated by teacher walkouts in pursuit of better pay, as Oklahoma teachers were the second lowest paid in the U.S. at the start of the 2017 school year, earning an average annual salary of about $45,000 ($7,000 less than teachers in Texas, a neighboring state). Therefore, any savings a district realizes by switching to this four-day schedule, even if small, could be seen as worthwhile. However, whether the four-day week actually saves money is unclear and controversial.

Research Questions

Given the dearth of research that exists on the four-day school week, its supposed financial motivation, and its potential to significantly impact student achievement, this study provides the first analysis of both the financial and academic effects of the four-day school week using data from Oklahoma. More specifically, the study seeks to answer the two following questions: (1) What is the effect of the four-day school week on district revenues and expenditures per pupil? And (2) What is the effect of the four-day school week on students' math and ELA achievement?

Methods

Data

This study employs six years (2008-09 to 2014-15) of demographic and financial data, and seven years (2008-09 to 2015-16) of achievement data from all K-12 public schools in Oklahoma. The six-year and seven-year panels respectively include 2,400 and 2,800 district-year observations and were constructed using district-level calendar data from the Oklahoma State Department of Education, district-level demographic and achievement data from the Stanford Education Data Archive (SEDA; Reardon et al., 2017), and district-level finance data from the

National Center for Education Statistics Common Core of Data (CCD) Local Education Agency (School District) Finance Survey (F-33).

The district-level calendar data are constructed from K-8 school-level calendar data. None of the four-day week districts in the sample have multiple elementary or middle schools serving the same district, and all K-8 grade levels have adopted the four-day week at the same point in every case; thus, the treatment is effectively adopted at the district-level. The SEDA dataset includes yearly demographic data by district as well as yearly estimates of each district's math and ELA test scores relative to the state-wide standardized test score distributions aggregated over grades 3-8 at the district-level. The demographic data include the number of students enrolled in a district, the racial composition of the district, the percent of students eligible for the NSLP, the percent of English learners, the percent of special education students, and the pupil-teacher ratio. Financial data from the F-33 includes yearly estimates of districts' spring 2009-2015 revenues and expenditures. The mutually exclusive and exhaustive categories of per-pupil revenues (i.e., federal, state, and local) and per-pupil expenditures (i.e., instructional, support service, non-instructional, non-elementary/secondary, capital, and other LEA) are examined as well as several specific categories of per-pupil expenditures selected for their potential relevance to four-day weeks (i.e., operations, food, transportation, administration, student support, and instruction). All financial estimates should be interpreted in 2010 dollar-value unless otherwise noted.

The analytic sample is restricted to include only rural schools because all of schools in Oklahoma on four-day weeks during this period were located in rural areas; therefore, rural five-day schools are likely to provide a better counterfactual than non-rural five-day schools when examining change over time. Oklahoma's 400 rural districts in 2016 comprise approximately

78% of their total districts. Descriptive statistics for four-day districts (all rural), five-day rural districts, and five-day non-rural districts from spring 2009-2016 (grades 3-8) are presented in Table 1. Notable differences include that, on average, rural districts have much smaller enrollments, higher percentages of NSLP-eligible students, higher percentages of white and Native American students, lower standardized test scores, higher funding per pupil, and higher expenditures per pupil than the five-day non-rural (i.e., town, suburban, and urban) districts. These differences support the decision to exclude non-rural districts from the analytic sample.

Empirical Strategy

The present study uses panel data and a quasi-experimental difference-in-differences research design to estimate the impact of four-day school weeks by comparing the changes over time in outcomes of districts with four-day weeks to the contemporaneous changes in districts that never or did not yet have four-day weeks. Specifically, I estimate variations of the following difference-in-differences (DID) specification:

$$Y_{dt} = \lambda_d + \theta_t + \beta Fourday_{dt} + X'_{dt}\gamma + \epsilon_{dt} \quad (1)$$

where Y_{dt} is the dependent variable of interest (e.g., transportation expenditures per pupil), λ_d are district fixed effects, θ_t are year fixed effects, β represents the effect of the four-day week, $Fourday_{dt}$ is an indicator variable that takes on a value of one each year a district has a four-day week schedule, and ϵ_{dt} is an error term that accommodates for clustering at the district level (Bertrand, Duflo, & Mullainathan, 2004). X_{dt} is a vector of covariates that controls for potential shocks vary within districts over time that are historically linked to both finance and achievement outcomes. These covariates include, for each district-year observation, the percent of students eligible to receive free or reduced-price lunch through the National School Lunch Program (NSLP), the percent of English learners, and the percent of special education students.

Embedded in equation (1) are several important assumptions that require scrutiny. First, the specification implies that the effect of four-day school weeks (i.e., the "treatment") will be constant, or "static." However, one might expect that the effect of a four-day week could vary depending on the length of time the district had the schedule. For example, Thompson (2019a) finds students may experience an initial decline in achievement when they switch schedules but then stabilize to pre-switch achievement levels over time. Alternatively, students' achievement may be benefited or harmed by the schedule increasingly each year they are exposed to the treatment, resulting in a growing effect (positive or negative) of the four-day week over time. These considerations are also important in relation to school finance outcomes, as savings may decrease or increase over time as districts adjust to and, ideally, learn how to optimize the schedule for savings. To account for potential time-varying treatment effects, I specify semi-dynamic fixed-effects DID models that allow the schedule to have distinct effects after one year in a district, two years in a district, and three or more years in a district:

$$Y_{dt} = \lambda_d + \theta_t + \sum_{\tau=0}^{2+} \beta_{+\tau} Fourday_{d,t+\tau} + X'_{dt}\gamma + \epsilon_{dt} \quad (2)$$

where τ is the number of years after a school has adopted the four-day schedule (the first year of adoption, $\tau = 0$) and $\beta_{+\tau}$ represents the effect of four-day weeks τ years after a district adopts the schedule. Joint F-tests are additionally employed to test the null hypothesis of a constant treatment effect, $H_0: \beta_0 = \beta_1 = \beta_{2+}$.

Another critical assumption embedded in the DID specification is the "parallel trends" assumption, which requires that changes in the outcomes over time in the "control" districts (i.e., the districts that never had a four-day schedule or had not yet adopted the four-day schedule) are comparable to the changes that would have occurred in districts that switched to the four-day schedule had they never switched. In order to interpret estimates as causal effects, it is essential that the parallel trends assumption is not violated. For example, it would be problematic if districts that eventually switch to four-day weeks had, pre-switch, decreasing transportation expenditures in comparison to districts that never switch. In that case, it would not be possible to attribute any changes in transportation expenditures after adoption of the four-day week to the schedule change as opposed to the different trends existing between the districts before the switch; the districts that never switch to a four-day week would not be a valid counterfactual for the districts that do switch. To examine the empirical validity of this assumption in this study, I use the Granger causality test ("event study") as a falsification check (Angrist & Pischke, 2009) that estimates the effect of the schedule change on the outcome variables for the years before and after the change:

$$Y_{dt} = \lambda_d + \theta_t + \sum_{\tau=1}^{3} \beta_{-\tau} Fourday_{d,t-\tau} + \sum_{\tau=0}^{2+} \beta_{+\tau} Fourday_{d,t+\tau} + X'_{dt}\gamma + \epsilon_{dt} \tag{3}$$

where $\beta_{-\tau}$ represents the "effect" of being τ years prior to adopting a four-day week schedule relative to never switching to the four-day schedule or being four or more years pre-switch. In order to support the parallel trends assumption, the "effect" of eventual four-day week adoption on treated districts relative to control districts should be constant in the years preceding a district's switch to the four-day week. Joint F-tests are employed to test the null hypothesis of a constant pre-treatment "effect" equal to zero, H_0: $\beta_{-1} = \beta_{-2} = 0$.

The causal interpretation of equation (1) also requires that there is not selection on observables into or out of treatment. Concern regarding selection *into* treatment would be warranted if changes over time in treatment districts during the pre-treatment period that differ from the concurrent changes in control districts are driving the treatment districts' switch to a four-day schedule. For example, evidence that enrollments decrease more in districts that eventually switch to a four-day week than in control districts during the pre-treatment period would be suggestive of selection on observables into treatment. Concern regarding selection *out of* treatment would be warranted if districts' characteristics were changing over time in the post-treatment period differently in the treatment and control districts. For example, evidence that the percent of NSLP-eligible students in treatment districts increases more than it does in control districts during the post-treatment period would be suggestive of selection on observables out of treatment. I employ both of the following specifications to examine this assumption:

$$\mathrm{X_{dt}} = \lambda_{\mathrm{d}} + \theta_{\mathrm{t}} + \beta Fourday_{dt} + \epsilon_{\mathrm{dt}} \tag{4}$$

$$\mathrm{X_{dt}} = \lambda_{\mathrm{d}} + \theta_{\mathrm{t}} + \sum_{\tau=1}^{2} \beta_{-\tau} Fourday_{d,t-\tau} + \sum_{\tau=0}^{2+} \beta_{+\tau} Fourday_{d,t+\tau} + \epsilon_{\mathrm{dt}} \tag{5}$$

where $\mathrm{X_{dt}}$ represents time-variant district characteristics. The event study in equation (5) provides a further interrogation of the DID estimates from equation (4).

As an additional robustness check regarding selection into treatment based on observables, I conduct the equation (1) DID analyses with two additional, more restrictive control groups. The first alternative control group is created by predicting each district's likelihood to receive treatment based on their observable characteristics from 2009 using the following specification:

$$EverFourday_d = X'_d \gamma + \epsilon_{\mathrm{d}} \tag{6}$$

where $EverFourday_d$ is an indicator variable that takes on a value of one if the district adopted a four-day school week by 2016 and X_d is a vector of covariates from 2009 plausibly linked to a district's adoption of the four-day school week by 2016. Estimates of $\hat{\gamma}$ are used to generate a matched comparison group of the five-day districts (n=49) who were most likely to receive treatment based on their observable characteristics. The second alternative control group includes the districts that adopted a four-day school week in years following the sample data, 2017 or 2018 (n=51). This control group is a valuable comparison group because districts that have adopted a four-day school week in the past are likely similar in unobservable ways to those that adopt them in the future. The reduced sample sizes of both of these control groups in comparison to the primary control group of all rural districts in Oklahoma reduces the model's power to detect a treatment effect; therefore, the statistical significance of the resulting DID point estimates using the alternative control groups can be interpreted as conservative.

One limitation of this empirical strategy using the present data regards an assumption embedded in DID specifications that have variation in treatment timing. When there is variation in treatment timing and there are heterogeneous treatment effects over time, the fixed effects DID estimator is a weighted average of all two-group/two-period DID estimators (Goodman-Bacon, 2018). The two groups being compared in the DID specification in equation (1) are the treatment group, which consists of districts that switch to the four-day week in a particular year, and the control group, which consists of the districts not treated in the same year. The weights on each 2x2 comparison are proportional to the number of districts in the treatment versus control groups and the variance of treatment status within each pair. Whereas the proportion of districts in treatment versus control will be highest in comparisons made using districts that switch to a four-day week later during the study period, the variance of treatment status within a comparison group will be largest in comparisons made using districts that switch earlier during the study period. Therefore, districts that switch to the four-day schedule in the middle of the study period will have the highest weights and could be overrepresented in the fixed effects DID estimator, which would be problematic if treatment effects were to vary over time. Gibbons, Serrato, and

Urbancic (2018) also demonstrate that fixed effects estimators provide weighted averages of treatment, further arguing that these weighted averages can poorly represent the average treatment effect (ATE) and are particularly likely to if there are heterogeneous treatment effects; they developed an estimator of the ATE that reweights the observations to produce consistent and unbiased point estimates. Implementing this regression-weighted estimator (RWE), I find that, although there are qualitative differences in some of the estimates due to the noisiness of particular estimates, the Gibbons et al. (2018) Wald tests indicate that the none of the differences between the RWE estimates (i.e., the ATE) and the OLS fixed-effects estimates are statistically significant.

Results

Difference-in-Differences Results

DID and semi-dynamic DID analyses were conducted examining the effect of the four-day school week on the following outcomes: the mutually exclusive and exhaustive categories of district revenues (i.e., federal, state, local), the mutually exclusive and exhaustive categories of district expenditures (i.e., instructional, social support, non-instructional, non-elementary/secondary, capital, other), a set of relevant granular categories of district expenditures (i.e., operations/maintenance, food services, student transportation, student support, administration, and instruction), and students' math and ELA test scores.

District Revenues. The DID and semi-dynamic DID point estimates of the effect four-day weeks on the exhaustive categories of district revenues are presented in Table 2. Though the four-day week schedule did not have a significant detectable effect on total per-pupil revenue, it significantly decreased districts' federal revenue per pupil by an average of $113.15, which is approximately 6.36% of a four-day district's federal revenue per pupil before switching schedules. Four-day weeks also decreased districts' state revenue per pupil by an average of $289.93, which is approximately 5.18% of a four-day district's state revenue per pupil before switching schedules, though this result was only marginally significant (*p*<.10). There was no significant detectable effect of four-day weeks on local revenue. The joint F-tests conducted for each semi-dynamic DID specification failed to reject a constant treatment effect over time for all revenue categories.

District Expenditures. The DID and semi-dynamic DID point estimates of the effect of four-day weeks on the exhaustive categories of district expenditures are presented in Table 3. The four-day week did not have a significant detectable effect on total per-pupil expenditures, and had small and insignificant effects on instructional, non-elementary/secondary, capital, and other district per-pupil expenditures. However, four-day weeks significantly decreased non-instructional per-pupil expenditures, a category that includes spending on food services and other enterprise operations, by an average of $84.09 (*p*<.01), which is approximately 10.48% of what four-day districts spent on this category per pupil before switching schedules. The four-day week schedule also decreased support services per-pupil expenditures, a category that includes spending on student transportation and facility operations/maintenance, by an average of $163.66, which is approximately 4.42% of what four-day districts spent on support services per pupil before switching schedules, though this result was only marginally significant (*p*<.10). The joint F-tests conducted for each semi-dynamic DID specification failed to reject a constant treatment effect over time for all expenditure categories.

The DID and semi-dynamic DID point estimates of the effect of four-day weeks on the relevant granular categories of district expenditures are displayed in Table 4. The average decrease in food services expenditures per pupil is estimated to be $94.21 (*p*<.01), which is approximately 14.14% of what four-day districts spent on food services before switching schedules and 0.98% of their average total revenue per pupil. The average decrease in transportation expenditures per pupil is estimated to be $36.94 ($p$<.01), which is approximately 10.5% of what four-day districts typically spent on transportation services before switching schedules and 0.38% of their average total revenue per pupil. There was no detectable effect of the four-day week schedule on per-pupil expenditures for operations, administration, student support, or instruction. The joint F-tests conducted for each semi-dynamic DID specification failed to reject a constant treatment effect over time for each expenditure category.

Academic Achievement. The DID and semi-dynamic DID point estimates of the effect of four-day weeks on students' standardized math and ELA test scores are presented in Table 5. Though the majority of the point estimates are negative, all point estimates in both the DID and semi-dynamic DID models are small and statistically insignificant from zero, indicating there is no detectable effect of the four-day week on academic achievement.

Robustness Checks

The results of the event study specifications used to examine the robustness of the parallel trends assumptions embedded in the specifications used in Tables 4 and 5 are respectively presented in Appendix Tables 1 and 2. The event study provides suggestive evidence about whether, conditional on district and year fixed effects, outcomes of districts that were one, two, or three years away from switching ("1 year lead," "2 year lead," etc.) to a four-day week were trending differently than those of districts that would not switch or were four or more years pre-switch. In support of the parallel trends assumption, the results in Appendix Tables 1 and 2 respectively depicted in Appendix Figures 1(a-b) and 2(a-f) fail to reject the null hypothesis that there are no significant differences between the treatment and control districts before treatment for any of the examined outcomes.

A second set of robustness checks considers the associations between four-day week adoption and district characteristics over time. Because districts voluntarily choose to adopt the four-day week (i.e., the schedule is not randomly assigned), selection bias is a chief threat to the validity of the present study. The inclusion of district fixed effects in my models controls for unobservable heterogeneity between districts (e.g., differences in the percent of students NSLP-eligible) averaged over the total time period of the study. However, selection bias could still exist if treatment districts are experiencing changes within that time period that are different from the changes experienced by control districts that lead to or are results of switching to the four-day week.

As specified in equations (4) and (5), I test for selection bias related to students entering or exiting four-day schools by regressing time-variant district characteristics on the four-day week conditional on time and district fixed effects. The time-variant district characteristics include (a) the demographic composition of districts (Appendix Table 3): the percent of students NSLP-eligible, the percent of students who are Native American, and the percent of students who are White; and (b) other district characteristics (Appendix Table 4): the natural log of district enrollment, the pupil-teacher ratio, and total per-pupil revenue. All of the point estimates in Appendix Tables 3 and 4 are small and statistically insignificant, indicating that I fail to reject the null hypotheses that (1) districts are not selecting into treatment due to changes in district characteristics during the pre-treatment period and (2) districts are not changing with respect to those same characteristics during the post-treatment period. Therefore, I find no evidence for selection into or out of treatment based on observables using this method.

I also test for selection bias by conducting the same DID and semi-dynamic DID analyses respectively specified in equations (1) and (2) with the previously defined two alternative, more restrictive control groups: the matched comparison control group and the future four-day school week adopters (i.e., 2017 or 2018) control group. Descriptive statistics of the original treatment and control groups as well as the two alternative control groups are presented in Appendix Table 5. The alternative control group DID and semi-dynamic DID analyses are presented for the granular district expenditures outcomes in Appendix Table 6 and for the achievement outcomes in Appendix Table 7. The point estimates for each specification are similar in both magnitude and statistical significance to those of the original analyses presented in Tables 4 and 5. If selection bias into treatment were present in the original analysis, one would expect that the analyses with more restrictive control groups would find comparatively smaller and weaker effects of the four-day school week because the treatment and control groups are more similar; thus, these results also provide no evidence for selection into treatment based on observables.

Discussion

As education budgets have tightened across the U.S., increasing numbers of districts have turned to the four-day school week as a cost-saving strategy. The present study used panel data from Oklahoma public schools and a difference-in-differences research design to provide a first rigorous, quasi-experimental analysis of the effects of the four-day school week on both school finance and academic achievement. The results suggest the limited savings from four-day weeks are more likely concentrated in federal revenues (95% CI: -$206.65, -$19.65) than state (95% CI: -$598.13, $18.28) or local (95% CI: -$394.45, $671.76) revenues. More specifically, districts' reduced spending is concentrated in food services expenditures, which decrease by approximately $94.21 (in 2010 dollars; 95% CI: -$131.11, -$57.32) per pupil (a 14% decrease), and transportation expenditures, which decrease by approximately $36.94 (in 2010 dollars; 95% CI: -$62.40, -$11.49) per pupil (an 11% decrease) when a district switches to a four-day school week. Because food services expenditures are heavily subsidized by the federal government in many of these communities (>70%), the decrease in food expenditures aligns with the reductions in federal revenue in four-day week districts. If and how students are accessing healthy meals on the fifth day as well as who absorbs the cost of that meal remain open and important questions. Furthermore, there is no evidence of savings regarding districts' expenditures for operations, administration, or student support, the categories of expenditures that Griffith (2011) argues are likely to generate the most savings. Perhaps the four-day districts in Oklahoma continue to open their buildings to teachers and staff on the fifth day, preventing them from realizing savings related to operations.

Based on these analyses, there is no empirical support for one of the primary motivations for making the switch to a four-day week: that it will preserve *local* revenue. There is no direct financial benefit to the district, but rather a small one to the federal and state governments. The combined decrease in expenditures comprises approximately 1.36% of the average four-day district's revenue (1.36% = $42,000 in 2019 dollars). Though possible, it is unlikely that such savings are of practical significance. Furthermore, in this paper, I find no support for the argument that the savings are being redirected to instruction or other expenditures, as there is no significant positive effect of the four-day week on any expenditure category.

I also find no detectable effect of the schedule on math or ELA achievement. This finding counters that of both Anderson and Walker (2015), who find generally small (4-7%) increase in the percent of fourth- and fifth-grade students in Colorado, and Thompson (2019a), who finds a small (5-7%) decrease in the in the percent of students scoring above the proficient threshold in math and ELA among students grades 3-8 in Oregon. Although these different results could reflect true differences in the average effect of the policy across these states, they more likely reflect the generally large amount of variation in the implementation of the policy and its effects on academics by district, resulting in statistical noisiness in the estimations. One can imagine that whether adopting the four-day school week impacted key factors related to student achievement, such as student attendance, instructional time, teacher quality and retention, or student fatigue, could vary greatly based on a district's specific implementation of the policy.

Nevertheless, for districts motivated to switch to the four-day school week for reasons other than academics, which seems to be most, if not all, districts, the conflicting evidence and null result presented herein may encourage them to persist with a four-day school week. If a district is saving money, even if very little, or realizing some other benefit not observed in the present study, and student achievement is stable, perhaps the concerns about the four-day school week's negative effects on student achievement are not justifiable. Overall, these findings suggest that the four-day week may not reduce district expenditures or have the dramatic effects on student achievement that so many people expect it to.

The generalizability of the results presented herein to states outside of Oklahoma depends on the similarity of the implementation of the four-day school week across states as well as the differences in the experiences of students on their "day off" across states. Although more research is needed to describe the potential differences in the four-day week across states (e.g., maybe all four-day districts in other states do not open the school building on the day off), there is no *a priori* reason to expect that the four-day week is being implemented and experienced by teachers, students, and families in dramatically different ways across states. Additionally, the similar National Center for Education Statistics (NCES)-designated rurality of most four-day districts across states suggests certain commonalities in the experiences of these communities that would bolster the generalizability of the present findings. Nevertheless, Oklahoma is a somewhat unique state due to its previously described desolate state of education funding and teacher shortages, both of which may be larger incentives for adopting the four-day school week in Oklahoma than in other states.

The lack of knowledge about the implementation of the schedule and the variety of unexamined potential impacts the schedule likely has on students, families, and communities necessitate further empirical research. Future work should focus on (1) describing the implementation of four-day school weeks across the U.S., (2) parsing apart the relationship between the schedule and achievement into the many possible mechanisms driving the relationship (e.g., student attendance rates, teacher quality, teacher retention), (3) exploring the factors that cause the schedule switch to save more or less money (e.g., opening the school on the fifth day, start/end times, providing food for the fifth day), and (4) investigating the effect of the schedule on other student, family, school, and community outcomes (e.g., physical and mental health, social-emotional skill development, child care expenses, parental employment choices). The established connection between the four-day school week and increased delinquency indicates the importance of considering how the schedule change impacts students' lives outside the school context. Developmental Systems Theory (Lerner & Castellino, 2002) supports such inquiry, arguing that development is an interactive process occurring as youth regulate and integrate their various relational contexts (e.g., family, school, society). In this case, the student's role in regulating the interactions between these contexts might look like a student choosing to spend time on his/her day off of school to volunteer, to study, or, perhaps, to get into trouble. These different choices could lead to very different developmental outcomes (e.g., identity, motivation, sense of purpose, health, well-being, etc.) for the individual both within school and in other contexts (Larson, Eccles, & Gootman, 2004). Investigating these effects of the four-day week as well as the academic and financial effects is essential for informing policymakers and practitioners about the consequences, both positive and negative, of policies allowing districts to adopt the schedule.

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Table 1: Descriptive Statistics

	Rural districts (analytic sample)				Non-rural districts	
	Four-day (n=49)[a]		Five-day (n=400)		Five-day (n=113)	
District-level variables	Mean	SD	Mean	SD	Mean	SD
District characteristics						
% NSLP-eligible	76.66	15.39	69.15	15.99	66.77	16.30
% ELL	0.65	1.92	2.30	6.44	4.66	7.92
% Special ed.	22.01	8.94	15.91	8.34	13.22	5.81
% White	61.84	19.53	60.63	21.60	57.75	17.45
% Native American	29.76	19.68	28.51	23.21	22.22	16.83
% Asian	0.22	0.88	0.51	1.69	1.23	1.64
% Hispanic	5.09	6.67	7.88	11.39	12.65	12.92
% Black	3.10	6.37	2.47	7.25	6.15	7.82
Enrollment count	205.73	131.10	368.29	348.66	2814.26	5263.97
Pupil-teacher ratio	14.25	3.08	14.84	4.27	15.87	1.58
Standardized test scores						
Math	-0.24	0.36	-0.11	0.31	0.01	0.26
ELA	-0.19	0.28	-0.09	0.26	0.01	0.22
District finances						
Revenues per-pupil						
Total	9,648.62	2,692.00	9,456.44	2,705.58	8,022.72	899.22
Federal	1,312.79	489.32	1,420.04	890.32	1,127.74	533.81
State	5,103.46	1,349.49	4,851.94	1,271.30	4,336.60	760.20
Local	3,232.37	2,844.79	3,184.46	2,538.27	2,558.38	1,061.56
Per-pupil expenditures						
Total	9,530.02	2,148.26	9,393.35	2,580.72	7,989.31	960.69
Instructional	4,782.67	1,015.43	4,753.51	1,050.07	4,144.17	496.06
Support services	3,483.61	942.31	3,220.48	1,118.34	2,631.01	454.97
Student support	498.33	236.48	485.72	217.44	477.31	125.61
Administration	441.20	214.03	410.10	211.61	402.83	96.60
Operations	1,039.32	515.33	1,021.67	503.24	803.10	210.36
Transportation	319.51	169.22	297.43	151.37	223.68	78.48
Other	1,185.24	472.28	1,005.55	516.22	724.09	273.29
Non-instructional	725.47	207.16	706.26	214.78	511.70	108.01
Food services	571.61	192.15	565.52	187.49	432.78	102.26
Other	153.86	77.19	140.74	89.65	78.92	47.49
Non-EL/Sec	18.83	71.37	11.65	42.12	29.27	59.97
Capital outlays	439.49	651.69	603.89	1,050.20	597.72	562.73
Other LEA	79.95	97.73	97.56	211.83	75.45	99.12

[a] Four-day districts are also represented in the five-day districts group when they have not yet switched to a four-day schedule

Notes: The panel data in this table includes 400 public school districts (grades 3-8) in Oklahoma observed annually from school year (SY) 2008-2009 to SY 2015-2016 (N=3,200). Schedule data are from the Oklahoma State Department of Education, 2009-2016. Achievement and demographic data are from the Stanford Education Data Archive (SEDA; Reardon et al., 2017), 2009-2016 (demographic data not yet available for 2016). School finance data are from the National Center for Education Statistics Common Core of Data (CCD) Local Education Agency (School District) Finance Survey (F-33), 2009-2015.

Table 2: Effects of the Four-Day School Week on Per-Pupil Revenues (Exhaustive Categories)

	Per-pupil Revenues							
	Total		Federal		State		Local	
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Four-day week	-264.42		-113.15**		-289.93*		138.66	
	(332.60)		(47.56)		(156.77)		(271.17)	
Adoption year		-258.17		-199.63***		-198.97		140.43
		(355.85)		(46.12)		(127.11)		(317.66)
1 year lag		-88.47		-46.85		-282.35		240.74
		(430.07)		(73.07)		(202.06)		(295.80)
2+ year lag		-408.1		-68.45		-397.02*		57.37
		(341.37)		(60.34)		(207.06)		(316.38)
Adj. R^2	0.742	0.741	0.765	0.765	0.771	0.771	0.829	0.829
p-value: (H_0: $\beta_0 = \beta_1 = \beta_{2+}$)	-	0.357	-	0.262	-	0.996	-	0.063

Notes: Standard errors, clustered at the district level, are in parentheses. All models include district FE, year FE, and the following district-level covariates: the percent of students eligible to receive free or reduced-price lunch, the percent of English learners, and the percent of special education students (coefficients suppressed). The panel data in this table includes 400 public school districts (grades 3-8) in Oklahoma observed annually from 2009 to 2016 (N=2,800). Schedule data are from the Oklahoma State Department of Education, 2009-2016. School finance data are from the National Center for Education Statistics Common Core of Data (CCD) Local Education Agency (School District) Finance Survey (F-33), 2009-2015.
*p<0.1, **p<.05, ***p<.01

Table 3: Effects of the Four-Day School Week on Per-Pupil Expenditures (Exhaustive Categories)

	Per-pupil expenditures													
	Total		Instructional		Support Services		Non-instructional		Non-EL/Sec		Capital Outlays		Other LEA	
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Four-day week	-350.23		-127.71		-163.66*		-84.09***		0.27		24.82		0.14	
	(215.30)		(124.85)		(87.55)		(20.05)		(2.98)		(83.27)		(18.19)	
Adoption year		-157.86		-2.26		-161.50		-59.44***		-3.28		65.05		3.56
		(244.94)		(131.22)		(112.79)		(19.92)		(2.16)		(131.94)		(18.19)
1 year lag		-504.47**		-173.57		-170.91		-88.89***		9.75		-47.67		-33.18
		(251.93)		(173.67)		(104.67)		(19.86)		(13.55)		(95.65)		(20.88)
2+ year lag		-444.42*		-231.65		-160.41		-107.81***		-3.14		36.37		22.22
		(264.34)		(143.38)		(110.18)		(28.00)		(5.45)		(85.72)		(22.25)
Adj. R^2	0.696	0.696	0.724	0.724	0.775	0.775	0.838	0.839	0.728	0.729	0.184	0.184	0.347	0.347
p-value: ($H_0: \beta_0 = \beta_1 = \beta_{2+}$)	-	0.357	-	0.262	-	0.996	-	0.063	-	0.496	-	0.507	-	0.043

Notes: Standard errors, clustered at the district level, are in parentheses. All models include district FE, year FE, and the following district-level covariates: the percent of students eligible to receive free or reduced-price lunch, the percent of English learners, and the percent of special education students (coefficients suppressed). The panel data in this table includes 400 public school districts (grades 3-8) in Oklahoma observed annually from 2009 to 2016 (N=2,800). Schedule data are from the Oklahoma State Department of Education, 2009-2016. School finance data are from the National Center for Education Statistics Common Core of Data (CCD) Local Education Agency (School District) Finance Survey (F-33), 2009-2015.

*p<0.1, **p<.05, ***p<.01

Table 4: Effects of the Four-Day School Week on Per-Pupil Expenditures

	Per-pupil expenditures											
	Operations		Food services		Transportation		Admin		Student support		Instruction	
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Four-day week	-35.23		-94.21***		-36.94***		33.59		-11.79		-127.71	
	(48.43)		(18.77)		(12.95)		(27.63)		(20.93)		(124.85)	
Adoption year		-88.77		-75.89***		-29.05***		17.81		7.52		-2.26
		(59.17)		(17.56)		(9.54)		(27.99)		(21.53)		(131.22)
1 year lag		-4.24		-103.39***		-40.38**		43.08		-18.49		-173.57
		(81.03)		(20.53)		(15.63)		(32.96)		(24.93)		(173.67)
2+ year lag		0.27		-107.48***		-43.05**		43.77		-28.08		-231.65
		(61.15)		(25.19)		(19.48)		(34.95)		(33.70)		(143.38)
Adj. R^2	0.699	0.699	0.845	0.845	0.797	0.797	0.665	0.665	0.720	0.720	0.724	0.724
p-value: (H_0: $\beta_0 = \beta_1 = \beta_{2+}$)		0.384		0.119		0.519		0.593		0.516		0.262

Notes: Standard errors, clustered at the district level, are in parentheses. All models include district FE, year FE, and the following district-level covariates: the percent of students eligible to receive free or reduced-price lunch, the percent of English learners, and the percent of special education students (coefficients suppressed). The data include a panel of 400 districts observed annually from 2009-2015 (N=2,800).
*p<0.1, **p<.05, ***p<.01

Table 5: Effects of the Four-Day School Week on Student Achievement

	Dependent variables			
	Standardized math scores		Standardized ELA scores	
Independent variable	(1)	(2)	(3)	(4)
Four-day	-0.027		-0.008	
	(0.040)		(0.033)	
Adoption year		-0.023		-0.008
		(0.033)		(0.028)
1 year lag		-0.026		0.002
		(0.046)		(0.041)
2+ year lag		-0.031		-0.014
		(0.068)		(0.053)
Adj. R^2	0.661	0.661	0.690	0.690
p-value: $(H_0: \beta_0 = \beta_1 = \beta_{2+})$	-	0.914	-	0.965

Notes: Standard errors, clustered at the district level, are in parentheses. All models include district FE, year FE, and the following district-level covariates: the percent of students eligible to receive free or reduced-price lunch, the percent of English learners, and the percent of special education students (coefficients suppressed). The data include a panel of 400 districts observed annually from 2009-2016, with financial and demographic data from 2015 replicated for the 2016 observations (N=3,200).
*p<0.1, **p<.05, ***p<.01

Appendix

Table A1: Effects of the Four-Day School Week on Per-Pupil Expenditures Over Time Relative to Adoption Year (Event Study)

	Per-pupil expenditures					
	Operations	Food	Transportation	Admin	Student support	Instruction
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)
3 year lead	-78.40	9.20	-5.36	55.37	-28.36	99.68
	(53.55)	(15.33)	(16.63)	(73.31)	(23.03)	(131.01)
2 year lead	-44.58	5.13	-3.24	30.39	-47.64*	122.29
	(52.42)	(20.05)	(19.28)	(61.90)	(27.64)	(205.55)
1 year lead	-91.78**	-5.64	-7.12	67.74	-19.01	152.23
	(46.10)	(21.01)	(17.31)	(67.30)	(28.18)	(264.48)
Adoption year	-94.49	-74.70***	-33.25*	58.24	-18.33	102.18
	(60.09)	(23.84)	(17.44)	(61.43)	(33.90)	(158.39)
1 year lag	-14.04	-102.30***	-44.92**	86.77	-46.37	-60.08
	(83.01)	(26.44)	(21.75)	(66.05)	(35.63)	(232.79)
2+ year lag	-27.40	-106.75***	-48.02*	91.35	-58.73	-105.77
	(73.23)	(30.52)	(24.68)	(67.97)	(43.58)	(221.19)
Adj. R^2	0.709	0.845	0.797	0.666	0.720	0.724
p-value: (H_0: $\beta_{-1} = \beta_{-2} = \beta_{-3} = 0$)	0.123	0.829	0.957	0.524	0.284	0.865
p-value: (H_0: $\beta_0 = \beta_1 = \beta_{2+}$)	0.557	0.114	0.482	0.502	0.430	0.393

Notes: Standard errors, clustered at the district level, are in parentheses. All models include district FE, year FE, and the following district-level covariates: the percent of students eligible to receive free or reduced-price lunch, the percent of English learners, and the percent of special education students (coefficients suppressed). The data include a panel of 400 districts observed annually from 2009-2015 (N=2,800).
*p<0.1, **p<.05, ***p<.01

Table A2: Effects of the Four-Day Week on Achievement Over Time Relative to Adoption Year (Event Study)

	Standardized test scores	
	Math	ELA
Independent variable	(1)	(2)
3 year lead	-0.048	-0.027
	(0.038)	(0.041)
2 year lead	-0.041	0.017
	(0.040)	(0.037)
1 year lead	-0.027	0.020
	(0.043)	(0.040)
Adoption year	-0.048	-0.003
	(0.049)	(0.041)
1 year lag	-0.054	0.010
	(0.059)	(0.050)
2+ year lag	-0.062	-0.004
	(0.077)	(0.062)
Adj. R^2	0.661	0.690
p-value: ($H_0: \beta_{-1} = \beta_{-2} = \beta_{-3} = 0$)	0.547	0.798
p-value: ($H_0: \beta_0 = \beta_1 = \beta_{2+}$)	0.966	0.909

Notes: Standard errors, clustered at the district level, are in parentheses. All models include district FE, year FE, and the following district-level covariates: the percent of students eligible to receive free or reduced-price lunch, the percent of English learners, and the percent of special education students (coefficients suppressed). The data include a panel of 400 districts observed annually from 2009-2016 (N=3,200).

*p<0.1, **p<.05, ***p<.01

Table A3: Effects of the Four-Day School Week on District Demographic Characteristics

	Dependent variables					
	% NSLP-Eligible		% White		% Native American	
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)
Four-day	1.37		3.34		-3.83	
	(0.99)		(2.30)		(2.45)	
3 year lead		-0.98		-0.04		0.67
		(1.33)		(2.53)		(2.61)
2 year lead		-1.91		2.69		-0.30
		(1.30)		(2.43)		(2.06)
1 year lead		-0.17		1.31		-0.85
		(1.53)		(2.34)		(2.11)
Adoption year		0.77		4.63*		-3.46
		(1.55)		(2.66)		(2.57)
1 year lag		-0.27		1.53		-1.50
		(1.74)		(3.05)		(3.01)
2+ year lag		0.79		7.51*		-7.00*
		(1.74)		(4.15)		(3.80)
Adj. R^2	0.885	0.885	0.777	0.778	0.825	0.825
p-value: (H_0: $\beta_{-1} = \beta_{-2} = \beta_{-3} = 0$)	-	0.214	-	0.662	-	0.928
p-value: (H_0: $\beta_0 = \beta_1 = \beta_{2+}$)	-	0.565	-	0.136	-	0.174

Notes: Standard errors, clustered at the district level, are in parentheses. All models include district FE and year FE. The data comprise a panel of 400 districts observed annually from 2009-2015 (N=2,800).

*p<0.1, **p<.05, ***p<.01

Table A4: Effects of the Four-Day School Week on Other District Characteristics

	Dependent variables					
	ln(Enrollment)		Pupil-teacher ratio		Per-pupil revenue	
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)
Four-day	-0.02		0.65		-319.78	
	(0.05)		(0.50)		(294.75)	
3 year lead		-0.01		-0.09		-263.80
		(0.02)		(0.35)		(287.54)
2 year lead		-0.04		-0.47		-12.26
		(0.03)		(0.42)		(321.98)
1 year lead		-0.06**		-0.07		268.18
		(0.03)		(0.54)		(400.42)
Adoption year		-0.03		0.29		-277.76
		(0.03)		(0.69)		(342.64)
1 year lag		-0.07		0.19		-110.99
		(0.06)		(0.66)		(439.27)
2+ year lag		-0.08		0.83		-357.84
		(0.09)		(0.87)		(415.24)
Adj. R^2	0.975	0.975	0.452	0.451	0.745	0.745
p-value: (H_0: $\beta_{-1} = \beta_{-2} = \beta_{-3} = 0$)	-	0.172	-	0.567	-	0.711
p-value: (H_0: $\beta_0 = \beta_1 = \beta_{2+}$)	-	0.569	-	0.327	-	0.603

Notes: Standard errors, clustered at the district level, are in parentheses. All models include district FE and year FE. The data comprise a panel of 400 districts observed annually from 2009-2015 (N=2,800).

*p<0.1, **p<.05, ***p<.01

Table A5: Descriptive Statistics for Alternative Control Groups

	Treatment group		Five-day control groups [b]					
	Four-day districts (n=49)[a]		Original control: All rural districts (n=400)		Matched comparison group (n=98)		2017 and 2018 four-day week adopters (n=100)	
District-level variables	Mean	SD	Mean	SD	Mean	SD	Mean	SD
District characteristics								
% NSLP-eligible	76.66	15.39	69.15	15.99	78.78	12.05	74.59	13.04
% ELL	0.65	1.92	2.30	6.44	1.59	6.05	1.44	4.70
% Special ed.	22.01	8.94	15.91	8.34	18.63	10.75	16.81	9.27
% White	61.84	19.53	60.63	21.60	54.33	23.24	59.27	21.46
% Native American	29.76	19.68	28.51	23.21	37.97	24.99	32.28	22.53
% Asian	0.22	0.88	0.51	1.69	0.28	1.23	0.40	1.76
% Hispanic	5.09	6.67	7.88	11.39	4.55	9.26	4.85	6.47
% Black	3.10	6.37	2.47	7.25	2.87	9.19	3.20	9.08
Enrollment count	205.73	131.10	368.29	348.66	183.88	124.32	308.06	247.85
Pupil-teacher ratio	14.25	3.08	14.84	4.27	14.11	7.80	14.59	2.63
Standardized test scores								
Math	-0.24	0.36	-0.11	0.31	-0.27	0.35	-0.18	0.31
ELA	-0.19	0.28	-0.09	0.26	-0.23	0.28	-0.15	0.26
District finances								
Revenues per-pupil								
Total	9,648.62	2,692.00	9,456.44	2,705.58	10,063.36	2,258.44	9,476.54	2,094.10
Federal	1,312.79	489.32	1,420.04	890.32	1,846.66	1,099.91	1,656.57	1,026.14
State	5,103.46	1,349.49	4,851.94	1,271.30	5,484.97	1,406.62	5,262.46	1,262.57
Local	3,232.37	2,844.79	3,184.46	2,538.27	2,731.73	1,796.61	2,557.52	1,569.64
Per-pupil expenditures								
Total	9,530.02	2,148.26	9,393.35	2,580.72	10,132.52	2,242.98	9,515.09	2,112.52
Instructional	4,782.67	1,015.43	4,753.51	1,050.07	5,078.31	1,047.19	4,855.87	990.72
Support services	3,483.61	942.31	3,220.48	1,118.34	3,678.45	1,141.95	3,349.56	1,050.45
Student support	498.33	236.48	485.72	217.44	476.68	235.10	494.67	218.00
Administration	441.20	214.03	410.10	211.61	398.86	275.46	424.64	234.21
Operations	1,039.32	515.33	1,021.67	503.24	1,102.57	470.42	992.20	425.34
Transportation	319.51	169.22	297.43	151.37	362.17	163.11	320.69	141.23
Other	1,185.24	472.28	1,005.55	516.22	1,338.18	628.81	1,117.36	585.09
Non-instructional	725.47	207.16	706.26	214.78	810.35	202.53	721.44	185.80
Food services	571.61	192.15	565.52	187.49	682.65	193.98	585.25	170.07
Other	153.86	77.19	140.74	89.65	127.70	83.23	136.19	74.32
Non-EL/Sec	18.83	71.37	11.65	42.12	16.86	67.11	11.49	46.50
Capital outlays	439.49	651.69	603.89	1,050.20	444.24	723.63	479.82	687.56
Other LEA	79.95	97.73	97.56	211.83	104.32	240.75	96.92	168.33
Total district-year observations	163		3,037		621		637	

[a] Four-day districts are also represented in the five-day districts group when they have not yet switched to a four-day schedule
[b] All five-day district control groups include district-year observations of districts that were operating on a five-day school week before becoming a four-day school week along with the sample selected for the control group
Notes: The data in this table are drawn from a panel of 400 public school districts (grades 3-8) in Oklahoma observed annually from school year (SY) 2008-2009 to SY 2015-2016. Schedule data are from the Oklahoma State Department of Education, 2009-2016. Achievement and demographic data are from the Stanford Education Data Archive (SEDA; Reardon et al., 2017), 2009-2016 (demographic data not yet available for 2016). School finance data are from the National Center for Education Statistics Common Core of Data (CCD) Local Education Agency (School District) Finance Survey (F-33), 2009-2015.

Table A6: Effects of the Four-Day School Week on Per-Pupil Expenditures Using Alternative Control Groups

	Per-pupil expenditures											
	Operations		Food services		Transportation		Admin		Student support		Instruction	
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A: Control group as the matched comparison group												
Four-day week	7.03		-100.70***		-37.21**		-5.22		16.82		-152.78	
	(52.37)		(23.27)		(14.91)		(35.62)		(22.84)		(159.48)	
Adoption year		-46.86		-80.79***		-29.00**		0.27		30.48		-26.85
		(58.84)		(21.39)		(11.77)		(31.86)		(24.21)		(166.15)
1 year lag		47.76		-108.88***		-38.72**		2.14		12.07		-181.72
		(84.29)		(24.18)		(17.55)		(38.92)		(27.17)		(189.62)
2+ year lag		47.17		-122.69***		-48.21**		-21.30		0.85		-315.50
		(69.44)		(33.97)		(23.24)		(51.92)		(38.50)		(201.48)
Adj. R^2	0.666	0.666	0.729	0.729	0.755	0.755	0.534	0.533	0.732	0.731	0.530	0.530
p-value: ($H_0: \beta_0 = \beta_1 = \beta_{2+}$)		0.577		<0.001		0.090		0.876		0.594		0.285
Panel B: Control group as the 2017 and 2018 four-day school week adopters												
Four-day week	39.44		-92.67***		-34.61***		52.37		7.34		-148.00	
	(50.91)		(19.19)		(13.17)		(32.95)		(22.26)		(143.34)	
Adoption year		-25.22		-75.30***		-28.78***		34.97		19.30		-50.61
		(59.17)		(18.49)		(9.78)		(30.18)		(23.21)		(155.47)
1 year lag		66.68		-104.02***		-36.91**		66.66*		2.08		-149.80
		(83.62)		(21.11)		(16.94)		(36.28)		(27.30)		(179.95)
2+ year lag		108.82*		-107.20***		-41.01*		63.97		-5.25		-292.33*
		(63.47)		(26.61)		(20.71)		(46.96)		(36.36)		(174.03)
Adj. R^2	0.643	0.644	0.818	0.818	0.800	0.799	0.564	0.563	0.757	0.756	0.593	0.593
p-value: ($H_0: \beta_0 = \beta_1 = \beta_{2+}$)		0.238		<0.001		0.037		0.328		0.820		0.289

Notes: Standard errors, clustered at the district level, are in parentheses. All models include district FE, year FE, and the following district-level covariates: the percent of students eligible to receive free or reduced-price lunch, the percent of English learners, and the percent of special education students (coefficients suppressed). The data in Panel A include a panel of 98 districts observed annually from 2009-2015 (N=686), and the data in Panel B include a panel of 100 districts observed annually from 2009-2015 (N=700).

*p<0.1, **p<.05, ***p<.01

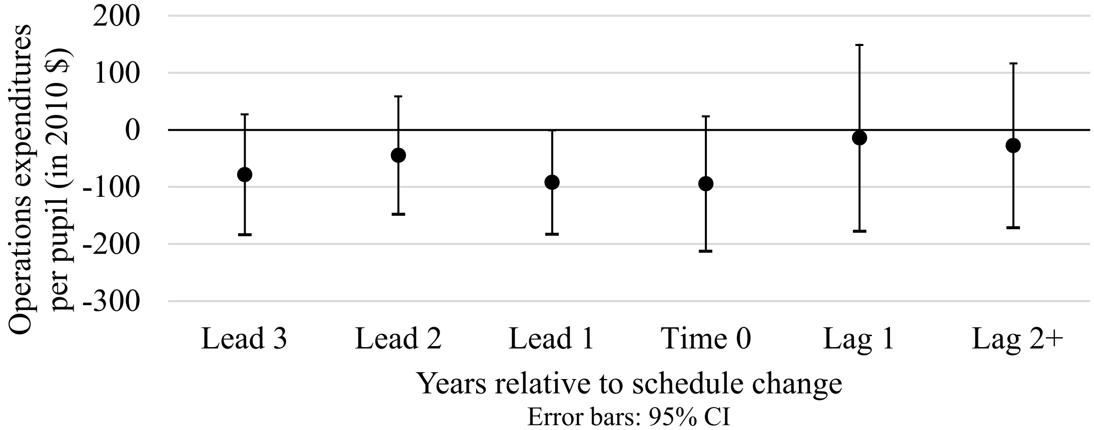
Table A7: Effects of the Four-Day School Week on Student Achievement Using Alternative Control Groups

	Dependent variables			
	Standardized math scores		Standardized ELA scores	
Independent variable	(1)	(2)	(3)	(4)
Panel A: Control group as the matched comparison group				
Four-day	-0.003		0.010	
	(0.046)		(0.036)	
Adoption year		-0.003		0.005
		(0.039)		(0.031)
1 year lag		-0.008		0.017
		(0.052)		(0.045)
2+ year lag		0.001		0.012
		(0.080)		(0.060)
Adj. R^2	0.582	0.581	0.576	0.575
p-value: (H_0: $\beta_0 = \beta_1 = \beta_{2+}$)	-	0.998	-	0.982
Panel B: Control group as the 2017 and 2018 four-day school week adopters				
Four-day	0.013		0.021	
	(0.045)		(0.035)	
Adoption year		0.009		0.017
		(0.038)		(0.030)
1 year lag		0.012		0.028
		(0.051)		(0.044)
2+ year lag		0.021		0.022
		(0.078)		(0.059)
Adj. R^2	0.567	0.566	0.604	0.603
p-value: (H_0: $\beta_0 = \beta_1 = \beta_{2+}$)	-	0.994	-	0.933

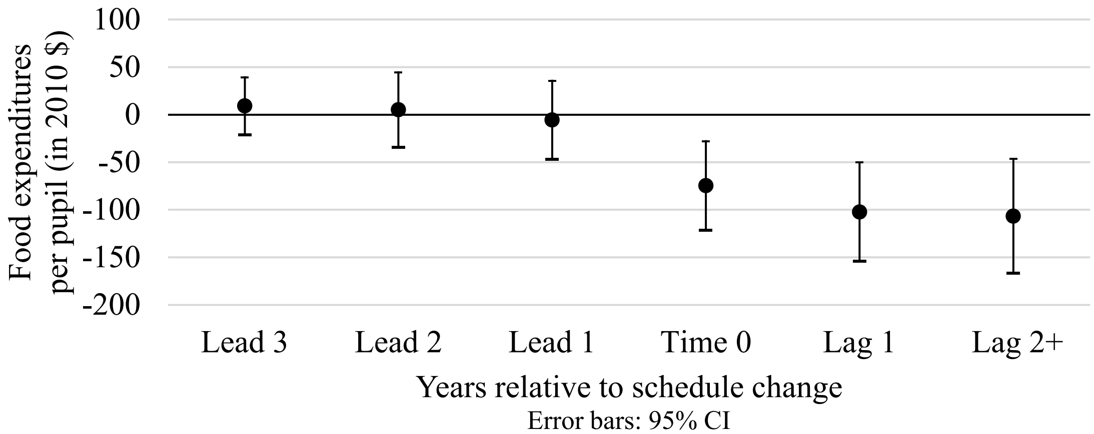
Notes: Standard errors, clustered at the district level, are in parentheses. All models include district FE, year FE, and the following district-level covariates: federal, state, and local revenues per pupil, transportation and operations expenditures per pupil, the natural log of the number of students enrolled in a district, the racial composition of the students, the percent of students eligible to receive free or reduced-price lunch, the percent of English learners, the percent of special education students, and the student-teacher ratio (coefficients suppressed). The data in Panel A include a panel of 98 districts observed annually from 2009-2016 (N=784), and the data in Panel B include a panel of 100 districts observed annually from 2009-2015 (N=800).
*p<0.1, **p<.05, ***p<.01

Figures A1(a-g): Effects of the Four-Day Week on District Expenditures Per Pupil Relative to Adoption Year

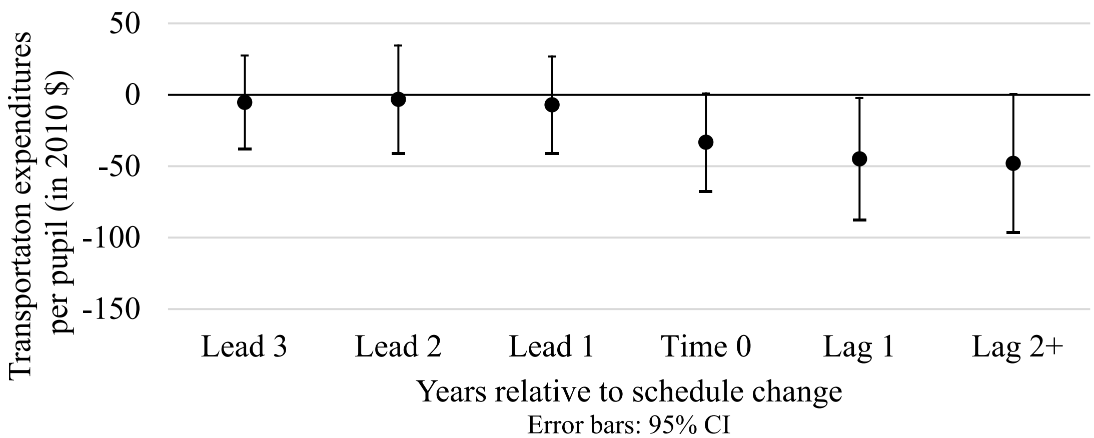
(a) Operations expenditures per pupil



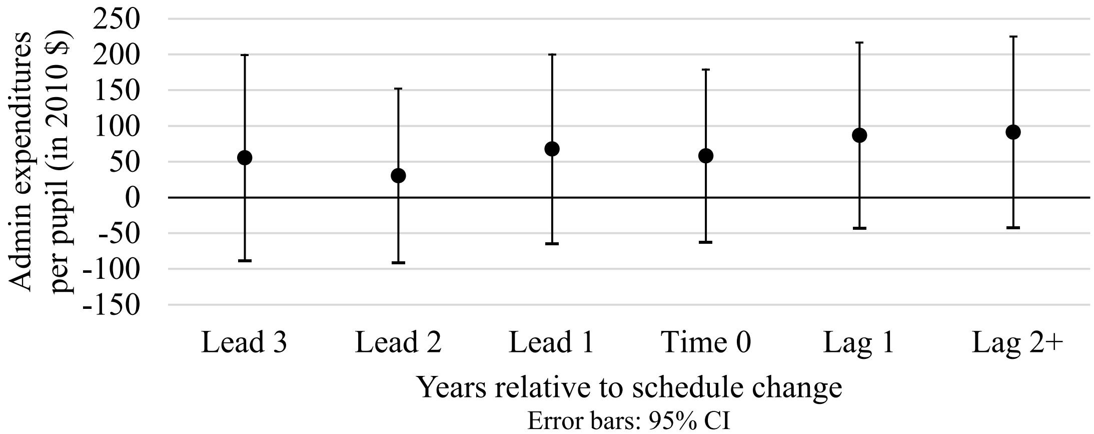
(b) Food services expenditures per pupil



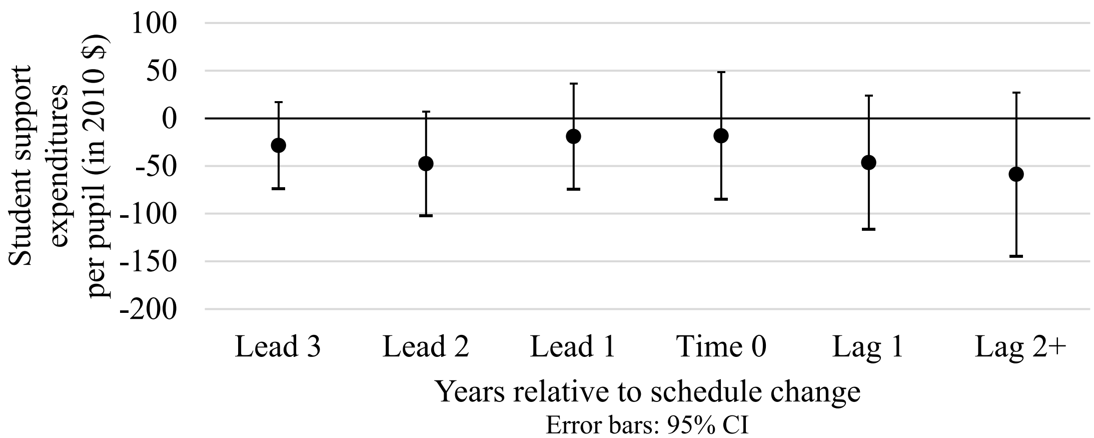
(c) Transportation expenditures per pupil



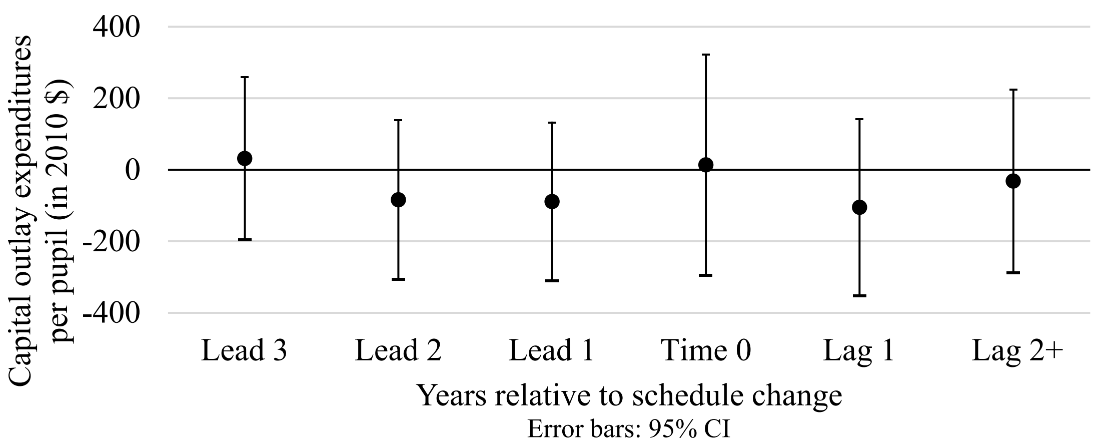
(d) Administration expenditures per pupil



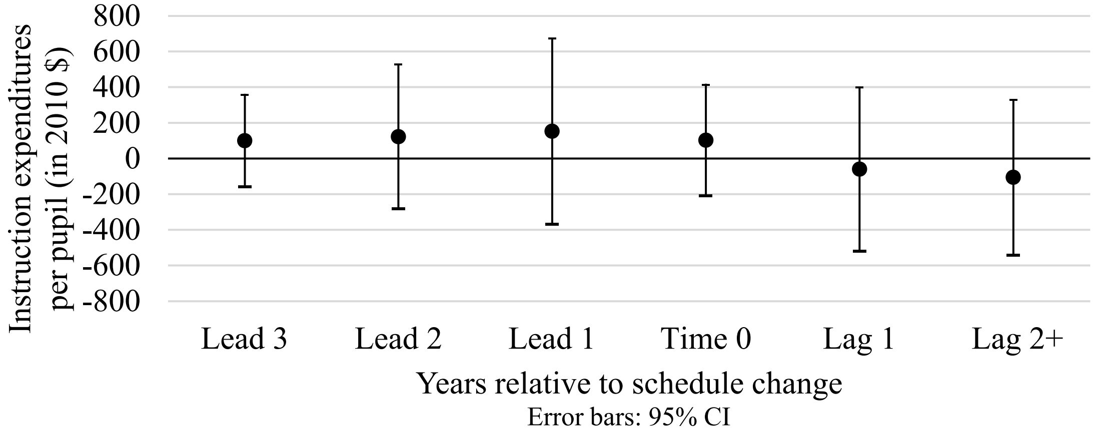
(e) Student support expenditures per pupil



(f) Capital outlay expenditures per pupil

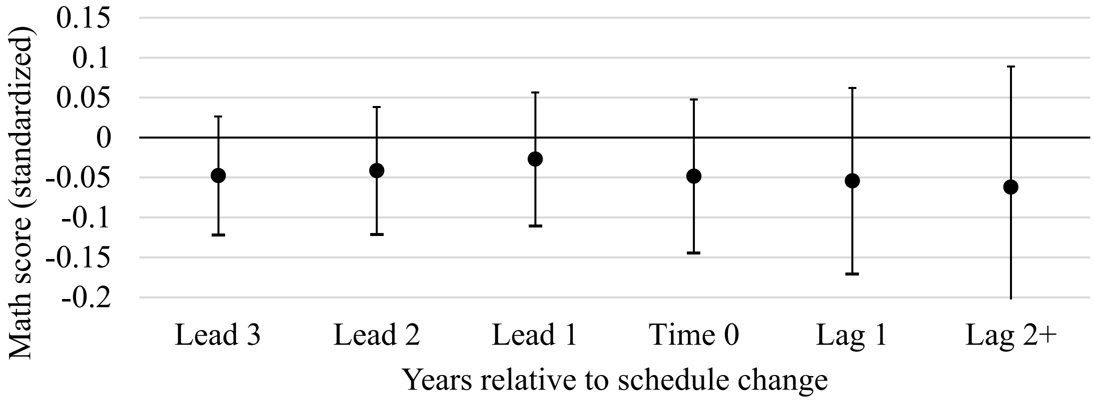


(g) Instruction expenditures per pupil



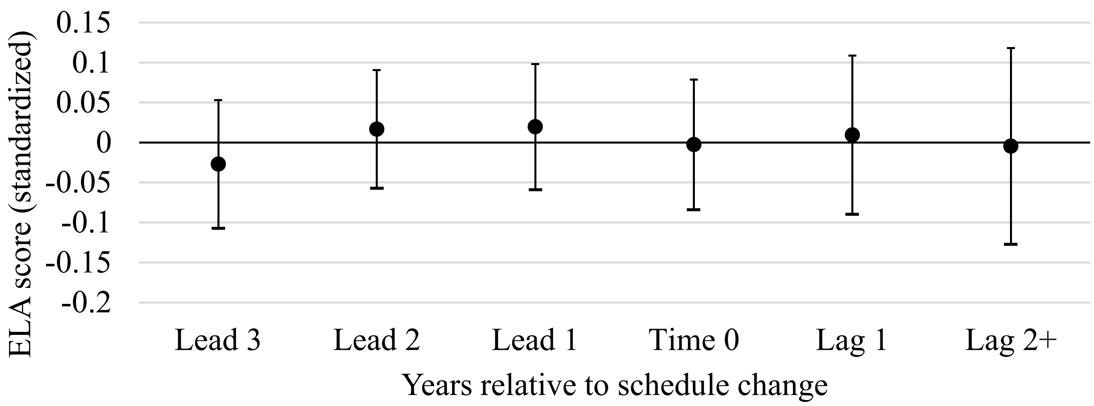
Figures A2(a-b): Effects of the Four-Day Week on Math and ELA Achievement Relative to Adoption Year

(a) Math achievement



Error bars: 95% CI

(b) ELA achievement



Error bars: 95% CI

Figure A3: Timing of Four-Day School Week Adoption in Oklahoma

(a) Number of Oklahoma districts with four-day weeks by year (spring)