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Less is More? The Causal Effect of Four-Day School Weeks on Employee Turnover

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Abstract

The use of four-day school weeks (4dsw) in the United States has expanded rapidly over the past two decades. Previous work examines the impact of 4dsw on student outcomes, but little research to date examines the effect on school employees even though schools in some locales have adopted 4dsw to recruit and retain staff. This paper examines the effect of 4dsw adoption in Oregon, a state with widespread 4dsw use, on teacher and other school staff retention by leveraging a staggered roll-out of the schedule using a difference-in-differences design. We find that adopting a four-day week increased turnover among teachers, but that turnover among non-teaching staff was largely unaffected. The findings suggest that policymakers interested in implementing 4dsw for improved school employee retention should exercise caution and be attentive to the full set of incentives offered to staff.

Keywords: Educator labor markets, Four-day school week, Difference-in-differences

Less is More? The Causal Effect of Four-Day School Weeks on Employee Turnover

Dramatic shifts to the working routines of millions of adults across the globe during the COVID-19 pandemic have generated substantial interest in possible reformulations of traditional work structures (Barrero et al., 2023). One such idea that has risen to prominence, in particular, is the four-day work week. Large national trials have demonstrated the efficacy and popularity of these schedules among employees (Lewis et al., 2023). Given recent historic declines in the supply and retention of teachers in the U.S. (Goldhaber & Theobald, 2023; Kraft & Lyon, 2024), schools too are turning to four-day school weeks as a strategy to attract and retain staff, particularly in high needs regions and positions (Heubeck, 2022). Evidence from states that offer four-day school weeks suggests that these schedules are indeed attractive to educators (Kilburn et al., 2021; Turner et al., 2018). However, it remains an open question whether four-day school weeks actually improve the retention outcomes of school employees.

As of 2019 there were over 1,600 schools across 24 states in the U.S. that utilized four-day schedules, having increased from just 257 schools in 1999 (Thompson et al., 2021). Since the pandemic, however, this figure has ballooned further to 2,100 schools in over 850 districts (Ordway, 2024). The vast majority of districts with four-day school weeks (4dsw) are in rural localities, though interest among suburban districts has increased in recent years (Heyward, 2018). Typically, schools with a 4dsw have slightly longer school days with either Mondays or Fridays off. Some schools offer enrichment and remedial services for students or professional development for staff on these days, but many do not and generally staff either have the days off or time for planning (Thompson et al., 2021). Adoption of a 4dsw is most often motivated by reducing district expenditures and, as a result, there was a large uptick in the use of 4dsw in the period surrounding the Great Recession (Thompson et al., 2021).[1]

[1] The extent to which 4dsw adoption successfully reduces costs is likely minimal. Estimates place cost

Recently, however, districts have increasingly reported changing schedules in order to improve the recruitment and retention of educators (Anglum & Park, 2021; K. Barnes & McKenzie, 2023; Heubeck, 2022). Staffing concerns are particularly salient in rural contexts where consistently attracting and retaining highly qualified teachers and other staff is a persistent challenge (Ingersoll & Tran, 2023; Monk, 2007). Rural districts often are not able to attract employees by increasing salaries because they face greater financial challenges than their larger suburban or urban counterparts who benefit from economies of scale (Odden & Picus, 2019). Indeed, 4dsw districts typically offer lower teacher salaries, on average, compared to 5dsw districts (Anglum & Park, 2021; Nowak et al., 2023). Thus, without the ability to provide financial incentives, 4dsw districts can seek competitive advantage through offering the benefit of a shortened work week.

Whether adopting a four-day schedule improves staff retention is important for policymakers to know as growing evidence suggests that adoption of a 4dsw presents various trade-offs that decision-makers must weigh. While the initial research was positive (Anderson & Walker, 2015), more recent evidence documents null (Morton, 2021, 2023) or negative effects of 4dsw adoption on achievement for grade 3 through 12 students (Kilburn et al., 2021; Morton et al., 2024; Thompson, 2021b; Thompson & Ward, 2022) or for certain subgroups of students therein (Thompson et al., 2022; Thompson et al., 2023).[2] On the other hand, 4dsw are quite popular among students, parents and staff (Kilburn et al., 2021; Turner et al., 2018, 2019) and may have positive effects on student behavior and well-being (Israel et al., 2020; Kilburn et al., 2021; Morton, 2023). There may be other unintended negative consequences of 4dsw, however, with documented increases in juvenile

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savings of school district 4dsw adoption between zero and three percent (Morton, 2021; Thompson, 2021a)

[2] Though the achievement effects of 4dsw likely depend on the amount of instructional time students receive, with schools that cut more instructional minutes when switching from four to five-day weeks demonstrating larger negative effects (Thompson & Ward, 2022). It also appears that the achievement effects are more negative for elementary and middle school students as opposed to high school students and for non-rural as opposed to rural students (Morton, 2023; Thompson et al., 2022).

crime (Fischer & Argyle, 2018), reductions in maternal labor supply (Ward, 2019), and reductions in home prices (Nowak et al., 2023).

In this paper, we focus on the effect of four-day schedules on the turnover rates of teachers and other school employees by studying the expansion of four-day school weeks in the state of Oregon. Between 2007 and 2023, over 100 schools in the state newly adopted the schedule. We use detailed administrative records covering all public school employees in the state of Oregon and leverage the staggered roll-out of the schedule using a difference-in-differences design to estimate the causal effect of 4dsw adoption on school employee turnover. Upon 4dsw adoption, we observe an immediate increase in turnover of about 2 percentage points among teachers. In the short term (1 to 4 years later) teacher turnover is not statistically different in treated schools. However, over the long-term (more than 5 years post-adoption), the total turnover rate is about 4 percentage points higher among teachers on average in adopting schools due to higher exit rates among retirement-aged teachers and higher movement rates among mid-career teachers. Teacher salaries in four-day schools, which were already lower to begin with, fall further behind those in comparable five-day districts, though the salary differences can only partially explain the long-term effects. Turnover among non-teaching staff is largely unaffected by the schedule change.

Our findings add to a growing body of work documenting the effects of four-day weeks on a host of student, school, and community outcomes (Fischer & Argyle, 2018; Kilburn et al., 2021; Morton, 2023; Thompson et al., 2022; Ward, 2019). While teacher retention has been a primary goal of adopting the policy in recent years (Heubeck, 2022; Morton et al., 2024), credibly causal evidence on the efficacy of 4dsw for improving teacher retention is thin, and the evidence we do have is mixed (Camp, 2024; Nowak et al., 2023). We contribute to the evidence base by examining 4dsw effects in a state where four-day school schedules have become relatively common and by tracing out the effects of the policy up to a decade after implementation. These results portend what may happen over

the longer term in states where 4dsw are currently expanding rapidly. Further, to our knowledge, we are the first to examine the effect of 4dsw adoption on employees other than teachers. Overall, our results suggest that adopting a 4dsw in a context where four-day schedule use is already prevalent and salary differentials are large is unlikely to improve school employee retention over the long term. Additionally as one of few studies examining the causal effect of changes to working conditions on teacher turnover, these findings more broadly have implications for policymakers concerned with addressing issues of teacher retention as they weigh the trade-offs of providing different packages of benefits to school employees.

Background

Influences on turnover

Staff turnover in public schools, particularly among teachers, is a long-standing concern given its detrimental impacts on student learning (Ronfeldt et al., 2013), its contribution to the inequitable distribution of skilled educators across schools (Lankford et al., 2002), and the substantial cost to districts when employees must be replaced (G. Barnes et al., 2007). As such, scholars have worked to understand the drivers of educator turnover, dividing the factors that affect teachers' labor supply decisions into pecuniary (salary) and non-pecuniary (working conditions) benefits (Boyd et al., 2003). A large body of work documents a correlation between teacher salary and retention (Hanushek et al., 2004; Murnane & Olsen, 1989; Nguyen et al., 2020). Evidence from studies of large-scale policy shifts (Biasi, 2021; Hanushek et al., 2023; M. Sun et al., 2024) and from naturally occurring variation in salary schedules within and between districts (Candelaria et al., 2024) demonstrates that the link between salary and teacher retention is likely causal. Beyond base salaries, studies of other financial incentive programs such as bonuses or loan forgiveness have shown these tools to also be effective at improving teacher retention (Clotfelter et al., 2008; Cowan & Goldhaber, 2018; Feng & Sass, 2018). Given the potential efficacy of pay reforms and that teachers often cite dissatisfaction with pay as the

key factor driving their movement or exit (Carver-Thomas & Darling-Hammond, 2017; Ingersoll, 2001), conversations about how to better retain teachers and other school staff often center around issues of financial compensation.

Pay, however, is only part of the equation determining where and for how long school employees choose to work at a given site. Working conditions, too, are highly predictive of educator mobility and attrition above and beyond salary (Grissom et al., 2016; Nguyen et al., 2020). Unlike pay, working conditions represent a more diffuse set of factors that can be difficult to observe or quantify. When studying working conditions, some scholars have examined structural factors like the cleanliness and quality of facilities, access to instructional materials, class sizes, course assignments, the structure of teachers' days and access to planning time (Bruno et al., 2020; Buckley et al., 2005; Ladd, 2011; Loeb et al., 2005). Others have focused on factors that are more organizational and interpersonal in nature, such as effective school leadership, positive school culture, instructional autonomy, shared decision-making, positive colleague relationships, and access to professional growth opportunities (Johnson et al., 2012; Kraft et al., 2021; Miller et al., 2023; Williams et al., 2021). Both types of working conditions are meaningfully correlated with teacher turnover (Nguyen et al., 2020), though the organizational features, like school leadership, appear to be more consequential (Johnson et al., 2012; Kraft et al., 2016; Ladd, 2011).

While scholars generally emphasize that working conditions are malleable (Loeb et al., 2005; Miller et al., 2023), it can be difficult to design policies or interventions that meaningfully change them, particularly at scale. For example, given the importance of administrators to creating working conditions, interventions have provided professional development to principals in order to improve their school leadership practices. The impact of these programs on teacher turnover and school climate, though, have been mixed (Herrmann et al., 2019; Jacob et al., 2015; Steinberg & Yang, 2019). Another strategy to improve working conditions has been to improve teachers' sense of being supported and their collaboration with colleagues through mentoring programs. These programs too have

had mixed results for retention (Glazerman et al., 2010; Liu, 2023; Rockoff, 2008). Generally, few causal studies have identified policies targeting interpersonal aspects of working conditions that are effective at reducing turnover.

Given the difficulties of improving subjective perceptions of working conditions, policies aimed at reducing turnover may better be able to target structural aspects of working conditions. Evidence suggests that reducing class sizes can reduce teacher turnover (Isenberg, 2010). Teachers further report that having more staff such as special education teachers, counselors, or paraprofessionals would draw them to a school (Lovison & Hyunjung Mo, 2024), though there is little causal evidence that investments in staff have effects on the retention of other employees in the school. These investments in class size reductions or specialized staffing, along with other structural changes such as reducing course loads or updating facilities, however, can be quite costly to districts which may prevent their enactment. Part of the popularity of four-day school weeks as a tool for employee retention is that they are straightforward to implement and may result in cost-savings (Morton, 2021; Thompson, 2021b). But why might a 4dsw affect school employee turnover?

Turnover and the four-day school week

Moving to a 4dsw represents a relatively large change in working conditions compared to other potential structural changes. Employees are given a three-day weekend most weeks in exchange for working longer days, having a longer school year, or some combination of both. Employees will weigh this benefit against their current compensation package and other working conditions. How much they value the additional day off relative to these other factors and the costs that come with the schedule change (longer days or school years), will determine the effect of the 4dsw on retention.

Employees may find a 4dsw to be particularly valuable. Surveys of teachers and administrators find widespread support of the idea in principle (Peetz, 2024). Teachers in rural schools, in particular, are more likely to report dissatisfaction with working

conditions as a reason for leaving (Ingersoll & Tran, 2023). By adopting a 4dsw, districts can provide teachers with greater flexibility in their time use during the week. Teachers report using the day off for appointments, tending to family obligations, relaxation and planning for school (Kilburn et al., 2021). Given that having sufficient time for planning and collaboration are associated with teacher retention (Johnson et al., 2012; Ladd, 2011) and that burnout due to overwork can similarly drive attrition (Madigan & Kim, 2021), adoption of a 4dsw could induce more teachers to stay in their schools by providing additional planning or leisure time relative to a five-day schedule.

Because employees will be weighing their personal value of the four-day week against other aspects of their job, it is possible that the schedule change may have no effect on retention or conversely increase turnover. Typically, four-day districts offer lower salaries than five-day districts (Anglum & Park, 2021; Nowak et al., 2023). For teachers, the policy is not designed to reduce their salary further but for some employees, like transportation or food services staff, their hours may be reduced as their services are utilized one fewer day per week. If the value an employee places on the four-day schedule and any changes to compensation is less than the additional compensation provided by a nearby five-day or other four-day district, then the 4dsw may not help to decrease turnover. Similarly, teachers at the end of their careers evidence sensitivity to salary for deciding whether they will remain in the workforce (Candelaria et al., 2024). If these teachers near retirement do not value the 4dsw as much as the extra compensation needed to keep them in the profession, then, again, turnover rates may not improve.

Further, adopting a four-day week may impose additional costs that could increase turnover. As discussed, in order to maintain a relatively similar number of instructional hours, schools must either increase the length of the school day, the length of the school year, or a combination of both. Some employees may prefer shorter working days with longer summers or other breaks. Indeed, causal evidence from districts with multiple schedules suggests that teachers are averse to school calendars with longer but fewer school

days (Pope & Landon, 2023). Employees may also struggle to adjust to the 4dsw. For example, teachers might struggle to adapt a curriculum built for a five-day schedule into four days. Thus, depending on salary dynamics and how employees view the costs of the schedule change, adopting a 4dsw could lead to no change in or an increase in turnover.

Previous research on the effect of 4dsw on employee retention is more limited compared to research on other 4dsw effects. Qualitative interviews with teachers and administrators in Idaho, Oklahoma, New Mexico and Missouri suggest that both believe it has helped with retention for newer teachers and for teachers close to retirement (Kilburn et al., 2021; Turner et al., 2018). The only quantitative studies on the topic come to opposing conclusions. Nowak et al. (2023) demonstrate that when a large suburban district in the Denver area implemented the policy there was a 3.5 percentage point increase in the probability of turnover for teachers, with the increases driven by teachers with 5 to 15 years of experience. In contrast, Camp (2024) examines the effect of 4dsw adoption in Arkansas, which recently allowed for the schedule to be used, and finds a 1.4 percentage point decline in the probability that a teacher moves districts.

These studies are notable but have several limitations that the current work hopes to build upon. For one, the Denver-area district studied was the largest ever district in the country to adopt a 4dsw and, thus, is not representative of the mostly rural schools where the policy has typically been implemented. This is particularly relevant given the opposing results in Arkansas, raising questions about whether these results are unique to the district or the large, suburban context and whether we might observe increases in turnover in other contexts as well. Several studies find important differences in the effect of 4dsw on student outcomes in rural versus non-rural localities, with non-rural adopters driving negative effects in most cases (Morton et al., 2024; Thompson et al., 2022). Thus, exploring differences in turnover effects by context (rural versus non-rural) might help to resolve these divergent findings. Further, both studies only look at a relatively short implementation window (1 to 4 years) and cannot trace the evolution of effects over time.

Finally, the authors do not explore the effect on other staff besides teachers and do not examine sources of heterogeneity besides experience. By contrast, this paper uses a nearly two decade panel to trace out the effects of 4dsw adoption among a broad set of school employees in the state of Oregon.

Oregon 4dsw Context

The site for this study is the state of Oregon which is one of the earliest and most wide-spread adopters of the 4dsw. The schedule began being used in the state in the 1980's and by the 2018-19 school year Oregon had among the highest use of 4dsw in the country with 40% of school districts on a four-day calendar.[3] Only Colorado and New Mexico had a greater percentage of districts implementing the schedule as of 2020 (Kilburn et al., 2021). Because Oregon does not require a certain number of instructional days and only requires a minimum number of hours, 4dsw districts vary widely in the number of yearly instructional hours offered, school start times, hours per day, and number of school days, though the vast majority elect to take Fridays off (Thompson, 2021b; Thompson et al., 2021). Most schools in Oregon, like those in other states, reported adopting the schedule for financial reasons and to address rural specific issues around transportation and athletics. However, compared to other states, districts in Oregon were somewhat less likely to report that teacher retention was a primary motivation for adopting the schedule (Thompson et al., 2021). Four-day schools in Oregon also offer fewer instructional hours than those in other states (Thompson, 2021b). In many other respects, though, including the rurality of schools, the heterogeneity in school schedule configuration, and the financial motivations, Oregon 4dsw schools are similar to others across the country. Given its longstanding and widespread use of 4dsw, Oregon is an important context to study 4dsw effects on employee turnover as it may have implications for what will happen in other states that are currently expanding 4dsw use rapidly.

[3] Even though a sizeable number of schools districts use the schedule, they are disproportionately smaller districts. Thus, 4dsw districts account for only about 15% of the student population in the state.

Data and Methods

Data & Sample

To explore the impact of 4dsw adoption we use administrative data from the Oregon Department of Education for the universe of public school students and employees from the 2006-07 to 2022-23 school years.[4] The nearly 1.1 million employee-year records provide detailed information about both personal demographics, such as gender, race, education level and age, and professional characteristics, such as job position, years of experience, licensure status, salary, and school assignment. We code any employee in a teaching position (including special education and head teachers) as teachers and all other employees as staff.[5] For any analyses for teachers, we restrict the sample to only those with greater than 0.5 FTE in a teaching position. This is because we aim to capture employees who spend a majority of their time specifically in a teaching role and to exclude any teachers who are employed as contractors or on a part-time basis, though we do not make any restrictions for staff based on FTE.[6] We use detailed student records to construct measures of school-level demographics to characterize the working environments of employees.

Importantly, by observing the school and district assignments of employees each year, we are able to construct a measure of employee turnover based on whether an employee in time t is observed in the same district in time $t + 1$. Thus, if an employee has

[4] We exclude students and employees from virtual charter schools from the analyses as these calendar decisions are not pertinent to the operation of their schools.

[5] Alternatively, we distinguish between teachers, administrators, paraprofessionals and other staff in supplementary analyses (see Figure A1). The other staff category is the broadest and includes licensed staff like librarians and counselors as well as non-licensed staff such as office personnel or cafeteria workers. Results separating out the licensed from non-licensed staff are similar so we pool the groups together.

[6] Results using various FTE cut points for teachers are similar (see Figure E6), however, when teachers with low FTEs (<0.25) are included, the estimated effects are inflated. We elect to go with the more conservative estimates from using teachers employed at least half time in teaching. We also present effects for staff by FTE levels in Figure E7.

moved districts or exited public education employment (i.e. they are no longer observed in the data at any school), then they are coded as 1 for turnover and 0 otherwise. This measure of turnover is the key dependent variable for analysis.[7]

The key independent variable is whether a school operated on a four-day schedule. Oregon has seen three major periods of expansion of four-day weeks: one from 1998 to 2003, another from 2009 to 2013, and a third after the onset of the COVID-19 pandemic. As the earliest adoption period pre-dates our data, we omit these schools (i.e. the always treated) from the analysis and focus on the latter periods. Further, as no school districts in urban areas ever adopted the schedule, we exclude urban schools from the sample in our main analyses and focus on suburban, town and rural schools following previous work (Morton, 2021; Thompson, 2021b).[8] We collected data on the implementation of 4dsw from state legislative documents including whether each district operated on a four-day schedule and the year they began this schedule.[9] Figure 1 shows the number of schools that adopted or ended their four-day schedule between 2007 and 2023. Overall, 116 schools began a 4dsw and 40 schools ended their 4dsw during this period.

[7] We focus on measuring turnover that occurs at the district level as opposed to school level because 4dsw adoption occurs mostly at the district level and, thus, district officials arguably care about whether they are retaining teachers within their district. Theoretically, levels of turnover between schools *within* a district should not be affected by 4dsw adoption, which we find to be the case.

[8] Results are similar when pre-period 4dsw adopters are included or when urban schools are included (see Figure E2)

[9] Some districts were not identified in the legislative documents as adopting a 4dsw because they had started and ended before the document was produced. Through news sources and personal communication with Thompson (2021b), who collected these data from districts directly, we identify more districts and correct adoption year dates. We further validate these adoption data by examining discontinuities in student attendance data for the number of official school days. When we observe a large drop or gain in official school days, we look for school district documentation or news reporting to confirm whether a school is operating on a 4dsw. Through this method we also identify individual schools that adopted a 4dsw even if their district did not, including for charter schools.

[Figure 1 about here]

Table 1 compares the demographics of schools in the state that were always on a 5dsw compared to those that ever adopted a 4dsw at any point after 2008 and during our study window.[10] We use demographic information from 2007 and 2008 before the schools in our study began implementing a 4dsw. We conduct Welch's two-sample t-tests on the differences between the eventually treated and control schools and report the results of these tests in column 3. On average, 4dsw adopters have smaller student populations (319 versus 436), fewer students of color (18% versus 24%), lower average achievement (-0.13σ versus -0.03σ), higher proportions of economically disadvantaged students (50% versus 45%) and slightly more students receiving special education services. In regards to employees, eventual 4dsw schools have 5 fewer teachers and staff but, notably, have nearly identical teacher turnover rates (13.5%), statistically indistinguishable staff turnover rates (16% versus 15%, p>.1), and similar proportions of novice teachers with fewer than 5 years of experience (16%). A greater proportion of treated schools are in rural localities (40% versus 20%). Overall, it is clear that the schools that adopted a 4dsw were qualitatively different than those that did not. Thus, any method for identifying the effect of the 4dsw on employee turnover must account for potential sources of selection.

[Table 1 about here]

Methods

To examine the effects of 4dsw adoption on teacher and staff turnover, we utilize a quasi-experimental difference-in-differences (DiD) design. Comparing differences in turnover outcomes before and after the policy (a pre-post analysis) may inappropriately attribute changes in turnover to the 4dsw as opposed to other secular changes common to schools across the state. Furthermore, comparing outcomes of four-day schools to five-day

[10] We focus on schools that adopt a 4dsw in 2009 and later so that there are some years of pre-trend data for all of the schools. As such, all schools are not yet treated in the 2007 and 2008 school years.

schools in a cross-sectional design neglects unobservable confounding sources of selection that affect both the choice to adopt the schedule and the outcome. DiD overcomes these challenges by examining differences between treated and control schools before and after policy adoption to difference out common changes and sources of selection. Under certain assumptions, namely that treated and control schools would have followed similar trends in outcomes in the absence of the policy change, or parallel trends, estimates can be interpreted as causal effects. This approach allows for selection on levels as long as there is not selection on trends in the outcome (Roth et al., 2023). DiD designs have been used to evaluate 4dsw effects in a variety of contexts (Camp, 2024; Fischer & Argyle, 2018; Kilburn et al., 2021; Morton, 2023; Morton et al., 2024; Thompson, 2021b).

Historically, researchers have operationalized the DiD estimator through the use of two-way fixed effects (TWFE) models that include a treatment indicator and fixed effects for both time periods and units. However, recent work has demonstrated that when there is staggered treatment adoption (units receiving treatment at different time periods) and heterogeneous treatment effects across time and adoption cohort, the TWFE estimator may be substantially biased (for an overview see Roth et al., 2023). The bias arises from negative weights that are assigned to some group-time comparisons that, in the extreme, can lead the sign of the treatment coefficient to reverse even if all estimated period effects are uniformly in the opposite direction (de Chaisemartin & D'Haultfœuille, 2020). Dynamic estimators that explicitly account for heterogeneity in treatment effects over time (i.e. event studies), however, are not immune to these problems because negative weights may still be applied as estimated period effects can be contaminated by estimates from other periods (L. Sun & Abraham, 2021).

To mitigate these concerns, we implement the two-stage DiD approach proposed by Gardner (2022). Given that heterogeneity by group (adoption cohort) and period (years relative to treatment receipt) threaten to bias estimated effects, we first estimate a first stage regression predicting the outcome as a function of group and period fixed effects for

the sample of untreated units (both not yet treated and never treated units). Next, in the second stage, the group and period effects are subtracted from observed outcomes and then the adjusted outcomes are regressed on treatment status. Specifically, we estimate the following first stage using Ordinary Least Squares:

$$Y_{isdt} = \alpha + \rho_s + \theta_t + \epsilon_{isdt} \tag{1}$$

where Y_{isdt} is an indicator for whether employee i in school s in district d in time t left their district or exited public education in the state. We include school fixed effects, ρ_s, and year fixed effects, θ_t and cluster the idiosyncratic error term, ϵ_{isdt}, at the district level because this is the level where treatment is largely assigned. In these models we do not include any school-level covariates as controls even if they are time varying and, thus, not absorbed by the school fixed effects. We do this because 4dsw adoption could affect these covariates directly.

The second stage takes the form:

$$\tilde{Y}_{isdt} = \sum_{\tau=-5}^{-3} \beta_\tau FourDay_{sd,t+\tau} + \sum_{\tau=-1}^{9} \beta_\tau FourDay_{sd,t+\tau} + \epsilon_{isdt} \tag{2}$$

estimated as discussed previously in accordance with Gardner (2022) where $\tilde{Y}_{isdt}$ is the adjusted outcome after subtracting out group and period effects ($Y_{isdt} - \hat{\rho}_s - \hat{\theta}_t$). $FourDay_{sd,t}$ is an indicator for whether the district was operating on a 4dsw schedule and τ represent the number of years before or after the start of the 4dsw. Thus, β_τ represents the effect of 4dsw τ years before or after adoption with 2 years before as the omitted category.[11] We utilize 2 years before as the omitted category because turnover is measured at the end of the year going into the next. Accordingly, $\tau = -2$ represents the turnover rate going from 2 years before 4dsw adoption into the school year just before the 4dsw

[11] We trim the periods to only include 5 years before through 9 years post adoption to focus only on years where there is a relatively large and similarly-sized treated sample. See Appendix Table F1 for sample sizes by relative year.

began ($\tau = -1$). If we used -1 as the omitted category, this would represent turnover going from the year before adoption into the adoption year. Because of this, year -1 could also be considered part of the treatment effect and may not be representative of pre-treatment trends, as employees may make decisions about employment for the following year when they have knowledge that the policy will be implemented. This prospect, however, can be assessed directly through the model in Equation 2. Unless otherwise noted, we present coefficients from the relative period indicators from this second stage equation. We also present results from some models that pool post-treatment years into periods. Specifically, we include immediate effects (year 0), short-term effects (years 1 to 4), and long-term effects (years 5 to 9). Pooling across years helps to increase power and to more parsimoniously summarise the path of treatment effects.

As demonstrated in Figure 1, some schools that adopted the schedule subsequently went back to a five-day week. In all main analyses, we do not treat $FourDay_{sd,t}$ as an absorbing treatment and allow the treatment indicator to turn off. In the appendix materials, however, we present results from an Intent-to-Treat style analysis that codes 4dsw adoption as absorbing and from analyses that focus on the permanent as opposed to transitory adopters of the schedule (e.g., Thompson, 2021b, see Figure E1).

Another threat to inference in this context is that the labor market for the employees in treated schools does not exist in isolation. In other words, it is possible that if one school adopts the schedule then it may affect the behavior of staff nearby in five-day schools depending on whether they view the schedule as desirable or not. If, for example, the 4dsw increases turnover in nearby 5dsw schools and reduces turnover in treated schools, then the treatment-control difference in turnover would be magnified and we could overstate the effect of the the 4dsw on treated staff. To account for possible spatial spillovers we implement the method proposed by Butts (2023) and add spillover treatment indicators for time until being in a spillover school located 0-5, 5-10, 10-20, or 20-30 miles away from treated four-day schools to the second stage equation estimated in Equation 2

and present the results in the appendix. Under the assumption that spillover effects decay with distance, this method not only identifies the potential existence of spillovers but also accounts for them in estimating the treatment effects (see Appendix D for more details).

To examine heterogeneous treatment effects we estimate the models above on different subsets of the data. We split teachers from other staff and run the models separately on each sub-sample. To examine heterogeneity by individual characteristics we focus on teachers, in particular, because they have the most complete covariate data and they are the largest group. We estimate the models separately on sub-samples of teachers based on their characteristics including: experience (less than 5 years, 6-15 years, more than 15 years), position type (general education or special education), gender (woman or man), age (less than 30, 31 to 40, 41 to 50, older than 50) and race (white or person of color).[12]

Finally, we also estimate the models above on a host of of student and staff characteristics at the school level. This helps us to assess if 1) there were factors changing before adoption of the 4dsw and 2) if school-level factors were changing after adoption. If aspects of the school environment were changing prior to 4dsw adoption, then this might suggest that changes in turnover after adoption may be due to factors other than the schedule change. Conversely, if we do not see changes, then this helps to corroborate the parallel trends assumption. Further, if we observe changes in characteristics only after adoption of a 4dsw, and not before, this may present evidence of factors that could potentially explain any effects of the schedule change on employee turnover.

[12] Although we would prefer to examine variability in 4dsw impact across various educator communities of color, we split the sample by white and people of color to increase power. Oregon's teacher workforce is predominantly white with 88% of teachers identifying as White in 2023. Given that the 4dsw sample of teachers is already a sub-sample of the broader population and that 4dsw teachers are disproportionately whiter than other schools across the state, we combine teachers of color together rather than look at them separately by race. This is an important limitation to the generalizability of our work.

Results

First, we present evidence that the policy indeed affected the working conditions of teachers. This is important for understanding what the treatment entailed and for demonstrating a first stage. One promise of the 4dsw as a benefit for staff is that it will provide more time off. However, adoption of a 4dsw for students does not always mean fewer working days for employees as there is vast heterogeneity in design and implementation of 4dsw across districts with some opting for teachers to work five-days on many of the weeks (Thompson et al., 2021). In Figure 2, we plot the coefficients from a model estimated using the same two-stage strategy described above but replacing the dependent variable with the number of contracted days for teachers. On the x-axis is the years relative to the start of the 4dsw in a school with year 0 being the initial year of adoption. The y-axis is the change in the number of contracted days that teachers had to work. The dashed line represents when the treatment of the 4dsw begins. Confidence intervals represent whether the the change is significantly different from 0 at the .05 level.

[Figure 2 about here]

As evident in Figure 2, prior to 4dsw adoption, the number of contracted days for teachers was trending similarly for treated and control schools. Once the 4dsw is implemented, there is an immediate decline in contracted days by about 15 and over time this grows to be about 17 fewer teaching days per year on average. In the appendix materials we show that the 4dsw reduced the number of school days for students by about 20 per year and reduced staff contracted days by around 15 to 22 days (see Appendix Figures B3 and C1). Thus, we see that the policy meaningfully affected employee working conditions by reducing the number of days throughout the year that they reported to work. We do not have data to assess changes to daily or weekly work schedules or total hours, but the change in contracted days does suggest a notable difference in employees' jobs. It is this change in conditions that we seek to understand the impact of in the succeeding sections.

Overall effects on employee turnover

In Figure 3 we plot the coefficients for the time to treatment indicators (β_τ) predicting turnover for teachers in panel 3a and all other staff in panel 3b. Again, the x-axis represents the years relative to the implementation of the policy and the y-axis represents the change in the turnover rate among that employee group. Prior to adoption of a 4dsw, trends between the two sets of schools are similar, particularly for teachers. The difference between four-day and five-day schools 2 years before adoption is essentially the same from 5 years before to 1 year before starting a 4dsw as indicated by the near 0 coefficient estimates and the confidence intervals overlapping 0 for teachers. As such, this provides relatively strong evidence for teachers that the 5dsw trends represent a good comparison for what would have happened to turnover had four-day schools not switched, a topic we explore in more detail later. Among staff, all of the confidence intervals also overlap with 0, indicating that none of the years were significantly different from two years prior to adoption, suggesting a parallel trends assumption is plausible. Regardless, we do not observe much of an effect among non-teaching staff after the policy adoption. For staff, nearly all post-period coefficients are estimated to be 0, indicating unchanged turnover.

[Figure 3 about here]

For teachers, on the other hand, we observe an effect of the policy. The year in which a 4dsw is adopted, treated schools saw an immediate increase in teacher turnover of 2.3 percentage points ($p<.01$). Given a base rate of about 13 percent of teachers leaving their school or district each year, the effect represents a relatively sizable 15 percent increase in turnover. After this initial shock, teacher turnover mostly leveled off in the subsequent years after adoption, but it began to increase again more than 5 years later. In years 5 to 9 after adoption, teacher turnover was between 2 to 5 percentage points higher. All of the five coefficients in this longer-term period are positive, two are significant at conventional levels ($p<.05$), and one is marginally significant ($p<0.1$). Thus, it appears

that while turnover was largely unaffected for non-teaching staff, teacher turnover spiked immediately after the policy was implemented, leveled off in the short term, and increased again over the longer term.[13]

Heterogeneity by teacher characteristics

We now turn to examining heterogeneity by teacher characteristics to understand which groups the policy might have affected the most and in what ways. We focus on sources of teacher heterogeneity as teachers are the largest group, have clearer patterns of effects in response to 4dsw adoption, and have the richest set of covariates available in the data. The estimates we present in Figure 3 combine moving districts and leaving public education to construct a single index for turnover. We first disaggregate the two types of turnover and run the two-stage models using indicators for moving districts (mobility) or exiting public education (attrition) as the dependent variable in separate models. Results are displayed in the first three columns in Panel A of Table 2. For mobility, we only observe a statistically significant effect on moving in the longer-term of 1.3 percentage points which represents an approximately 50 percent increase in the probability of moving. While the year 0 immediate estimate for moving is positive, it is not statistically significant. On the other hand, for attrition there is an immediate increase of 1.4 percentage points ($p<.05$) and an increase of 2.6 percentage points in the longer term ($p<.05$).[14] Overall, the pattern of findings suggest that both attrition and mobility drive

[13] In the appendix materials we demonstrate that the teacher turnover effects are not driven by a particular cohort. The estimated year 0 effect is positive for every adoption cohort except the most recent and is statistically significant for most of those cohorts. The long-term results are also more uniformly positive (see Appendix Table E1). For staff, the increase in year 0 appears to be driven entirely by the schools that adopted in 2020 and 2021 where there was a statistically significant increase (see Appendix Table E2 and Figure E5). The effects are also fairly uniform by rurality, although for rural staff there is an increase in turnover driven entirely by the pandemic era adopters (see A1).

[14] It is possible that some of this attrition could be due to layoffs. However, we do not have data to distinguish voluntary from involuntary exits. We argue that changes in other school characteristics in

the overall increases in teacher turnover observed under the 4dsw policy.

[Table 2 about here]

Next, we examine heterogeneity in 4dsw effects on turnover by teacher characteristics with professional characteristics displayed in Panel A of Table 2 and personal characteristics displayed in Panel B of Table 2. We also present heterogeneity in turnover effects by characteristics for mobility and attrition separately in Appendix Tables A2 and A3, respectively. There are several notable patterns of results. First, the immediate increase in turnover after policy adoption is driven by both novice teachers with less than five years of experience and veteran teachers with greater than 15 years of experience. For more experienced teachers, the entirety of the short- and long-term increases are driven by exit whereas for novices the results are mostly due to increased movement (see Appendix Tables A2 and A3). Even though we find similar immediate increases in overall teacher turnover to Nowak et al. (2023), these heterogeneous effects stand in contrast to their finding that mid-career teachers drove the estimated turnover effects.

Additional patterns emerge when we examine other demographic and professional characteristics. Results are relatively consistent across position type, gender identity, and racial identity but somewhat higher in the immediate term for men, special education teachers, and teachers of color. Interestingly, by breaking the results apart into moving and exiting by teacher characteristics in the appendix, we see that the increased movement to other districts is driven almost entirely by men and that almost all of the immediate movement is to five-day districts but in the longer-term teachers move to five-day and other four-day districts (see Table A2). We also observe important patterns by teacher age that largely mirror those observed for experience. Younger teachers (under 30 and 31 to 40) had increased turnover in the immediate term mostly driven by movement. Teachers over 50

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addition to the experience profiles of leavers do not support the idea that layoffs explain these effects but we cannot rule it out definitively.

drive the short-term and long-term effects of 4dsw adoption on exit, though the short-term exit results are also partially driven by teachers under 30 (see Appendix Tables A2 and A3).

Alternative explanations and models

While the results observed here comport with some previous quantitative evidence (Nowak et al., 2023; Pope & Landon, 2023), the finding that teacher turnover increases in 4dsw districts does not fit with the perceptions of participants documented in the qualitative literature and raises questions about why such large negative effects on retention are observed for teachers in particular. As discussed, we can examine various changes to school characteristics surrounding adoption of the policy to understand whether the changes in turnover are a result of the policy change or something else. We examine a host of school-level student characteristics in the appendix materials and do not find changes surrounding 4dsw adoption that would plausibly explain changes to teacher turnover. Importantly, we do not see changes to student enrollment that would necessitate a reduction in the teacher workforce.[15]

We also examine changes in the characteristics of the teaching workforce in schools adopting a 4dsw and highlight four of these factors in Figure 4. Given the increases in teacher turnover observed, a concern is that schools could have been letting go of staff due to financial difficulties, particularly since many of these districts adopted the schedule around the Great Recession to cut costs (Thompson et al., 2021). Even though enrollments remained constant, the number of teacher full-time equivalencies actually *increased* after the policy such that treated schools employed approximately 2 more full-time teachers. Thus, in a period of financial strain, these schools actually decreased the student-to-teacher ratio, something that has in other contexts led to declines in turnover (Isenberg, 2010). The relative increase in teachers may be a consequence of adopting the 4dsw to cut costs;

[15] We observe declines in the proportion students of color in four-day adopters relative to five-day schools. This is consistent with the rest of the state diversifying more rapidly than the more rural schools that adopted a 4dsw and does not, by itself, suggest the schools are not comparable.

in an era of strained budgets other districts may have had to let go of more teachers whereas 4dsw adopter saved costs to hold on to two more teachers on average. In any case, this does not suggest that the increased turnover in 4dsw schools is explained by them disproportionately laying off teachers compared to other districts.

[Figure 4 about here]

Importantly, we see the experience profile of the teachers in treated schools change. Before and after 4dsw implementation, the proportion of veteran teachers (those with more than 15 years of experience) remained constant. However, around 5 years post adoption, the proportion of veterans began to decline such that by 9 years after starting a 4dsw the average treated school had 15 percentage points fewer veteran teachers. Thus, the increased turnover among more seasoned teachers that we observed in Table 2 appears to not have been offset by recruiting experienced teachers, leading to a more inexperienced teacher workforce in treated schools which may beget further turnover among remaining teachers (Lankford et al., 2002).[16]

As discussed previously, many rural districts struggle to provide high teacher salaries which in part motivates adoption of a 4dsw (Anglum & Park, 2021). Given the link between salary and teacher attrition (Nguyen et al., 2020), it is possible that 4dsw schools do not keep pace with other districts in providing a competitive salary to teachers. This is precisely what we find. Figure 4 also plots the changes to average teacher salaries surrounding 4dsw adoption controlling for experience, licensure status, level of education, position type, and FTE.[17] The plot demonstrates that immediately before the policy change, salaries were relatively constant. The difference compared to the omitted year is within $500 and not significantly different. There was an initial decline in salaries once the

[16] Appendix Figure B1 shows a corresponding increase in the proportion of teachers who were novices with less than 5 years of experience.

[17] Salary results using individual fixed effects instead of school-level fixed effects are substantively similar.

policy is adopted but it is not statistically significant and appears to be driven by one district.[18] For the other districts adopting over time there is not an immediate decline in salary and salaries are relatively constant in the short-term which makes sense given that many 4dsw policies are not designed to reduce teacher salaries but rather shift working hours around and compensate for already lower salaries (Anglum & Park, 2021). By 6 years after adoption, however, teacher salaries in 4dsw schools began to fall even further behind those of their five-day peers such that they were about $3,200 further behind by 9 years post-adoption. Because teachers in 4dsw schools already made less money prior to the shift (see Table 1), this implies that a decade after adoption, teachers in treated schools made approximately $6,000 less than their peers in a five-day district who had the same years of experience and qualifications. In part, this may be because budgets began to recover across the state and other districts may have begun to increase salaries at a faster pace than the four-day adopters leading for these increased salary differences to emerge in later years.

Because of these sizable long-term relative salary declines, we seek to understand their role in the 4dsw effects we observe. We include teachers' base salaries into the two-stage models estimated as before. The results are displayed in Appendix Figure E2. The immediate and short-term results for teacher turnover are mostly unaffected by the the inclusion of base salary, but are now marginally significant for the immediate impact ($p<.1$). However, the addition of base salary changes the long-term effect estimates from a 4 percentage point increase ($p<.01$) to a 2.1 percentage point increase that is now only marginally significant ($p<.1$). Thus, these exploratory analyses suggest that the failure of salaries in four-day districts to keep up with the salaries of their five-day peers may explain part, but not all, of the 4dsw effects on turnover.

Further, we examine the robustness of the teacher turnover results to other threats through estimation of several additional models. In the appendix materials, we show that the results are similar when utilizing a balanced panel or when focusing on the set of

[18] As we show in Appendix Figure B2, this initial drop is driven by the district adopting in 2021.

schools that were permanent adopters versus those that adopted the policy temporarily. The results are largely unaffected when accounting for spatial spillovers in untreated school (e.g., Butts, 2023) and we find inconsistent evidence of possible spillovers to control schools (see Appendix D). We test for sensitivity to different definitions of the control group. Specifically, we run models using the not-yet-treated schools and models including urban comparison schools. Defining the control group these different ways does not meaningfully change the results. We test for sensitivity for different levels of fixed effects besides the school level including individual or district-level fixed effects and, again, the results are similar (see Appendix Figure E2). Despite the concerns about the TWFE estimator that led us to use Gardner's (2022) two-stage approach, the results using the TWFE estimator are similar. We consistently observe an immediate increase in teacher turnover, followed by no difference in the short term, and a meaningful increase in the long term regardless of specification.

Discussion

Using almost two decades of employee and student records from Oregon, we study what happens to employee turnover when schools make the switch to a four-day schedule. While many districts have adopted the schedule to better suit the rural lifestyles of the families in their community or as a way cut costs, the 4dsw is increasingly being implemented to recruit and retain school staff (K. Barnes & McKenzie, 2023; Heubeck, 2022). However, questions remain about the efficacy of such efforts. We find that adopting a 4dsw increased teacher turnover immediately and in the longer term but that other employees were not as affected. These teacher turnover effects are due to a combination of moving districts and exiting the state's public education system. The long-term increases are sizable (4 percentage points) and are driven by retirement-age teachers exiting and younger teachers moving.

These results contribute to a small but growing literature on the effects of 4dsw on school employees (Camp, 2024; Kilburn et al., 2021; Nowak et al., 2023; Turner et al.,

2018). Our findings are consistent with what Nowak et al. (2023) find for the suburban Denver, CO district that they study. For the initial year of implementation, they find a 3.5 percentage point increase in turnover while we find a 2.3 percentage point increase for the Oregon schools adopting the schedule. Our results stand in contrast to what Camp (2024) finds in Arkansas. Examining the effect of 4dsw implementation on teachers across 32 adopting districts in the pandemic and post-pandemic period, Camp finds a 1.4 percentage point decrease in the probability that a teacher moves districts. We find, however, a 1.3 percentage point *increase* in the probability of moving districts in the longer term.

One possibility is that the differences in state contexts explain the divergent results between Arkansas and Oregon. The schools in Arkansas that Camp (2024) studies are the first in the state to adopt them after a change in state policy allowed for this possibility. Thus, these schools are the first movers which may confer a particular advantage. In Oregon, on the other hand, 4dsw use began in the 1980's and has become widespread in the state. By the time the schools under study here adopted the schedule, nearly 100 other schools were already operating on a four-day week. If employees desired this schedule, they had options to move to beforehand, particularly since 4dsw use is often clustered amongst neighboring districts (Anglum & Park, 2021). Indeed, we find that teachers who move as a response to the policy by and large go to five-day districts. It is thus possible that there are initially benefits to early adopters, but our results suggest that any benefits do not necessarily scale with broader schedule adoption. This is consistent with anecdotes from district leaders who lamented that any teacher retention benefits to their district disappeared after other districts nearby adopted the schedule (Gottlieb et al., 2024). The ability to trace effects over the course of a decade in a state where 4dsw use is already prevalent is instructive and an important contribution of this study.

Although a potential promise of the 4dsw is that it can provide a non-monetary benefit to attract teachers when raising salaries is difficult, our results cast doubt on the idea that this will always work, especially in the longer term. After the initial increase in

teacher turnover subsided, turnover increased in the long term again when salaries began to fall further behind relative to 5dsw districts, a phenomenon that explains some of the observed effects. Because teachers respond to both pecuniary and non-pecuniary benefits (Boyd et al., 2003), districts, even those that may experience initial success with the 4dsw, neglect maintaining competitive salaries at their own peril. This is especially the case considering *which* teachers districts stand to lose when offering less competitive salaries. In the long term, experienced teachers near retirement age left and younger mid-career teachers moved in response to the 4dsw shift in Oregon, which ultimately led to substantially fewer experienced teachers in the treated four-day schools. Having a greater concentration of novice teachers may have contributed to the greater turnover among the teachers who remained.

That these changes among this select group of teachers are in part motivated by them weighing their compensation relative to alternatives is consistent with previous research. Prior studies of the effect of salary on turnover, including from Oregon, have demonstrated that teachers near the end of their careers are responsive to pay when deciding whether to leave (Candelaria et al., 2024; Hendricks, 2014). Similarly, studies of compensation increases in Washington (M. Sun et al., 2024) and North Carolina (Clotfelter et al., 2008) demonstrate that in response to increased pay, mid-career teachers were less likely to move districts. Thus, finding the right balance between the working conditions and pay needed to satisfy teachers may be critical to preventing mid-career educators from moving and late-career teachers from leaving. Given the link between experience and effectiveness (Papay & Kraft, 2015), understanding how these mid- and late-career teachers make decisions about where to work is particularly important for determining how to create a more equitable distribution of effective teachers across schools, a persistent challenge facing the U.S. education system (Lankford et al., 2002).

While this paper has contributed to the field's understanding of the effect of 4dsw on school employees and the influence of changes in structural working conditions on

turnover more generally, it has several limitations. For one, the current paper examines the effects of 4dsw adoption in a state with a particular history with four-day weeks and studies effects from a unique period of adoption mostly in response to the Great Recession. As discussed, this may be the reason for divergent findings from a state with a relatively recent 4dsw history (Camp, 2024). Future research should examine the effects of 4dsw implementation on school employee turnover in other states with varying histories of 4dsw use and trace out effects over a longer period of time to see if these different contexts appear to matter for success with the policy. Another limitation of the current study is that we are not able to observe how the 4dsw was implemented in each district. We observe changes to the number of school days but do not know which days were taken off, how the length of the school year or length of the school day changed, and how teachers or other employees spent their days off. There may be important heterogeneity in effects based on these implementation factors (Thompson & Ward, 2022).

Conclusion

The strength of the education workforce is a critical determinant of student success (Hanushek et al., 2019), which is why schools and districts are perennially concerned with recruiting and retaining the best employees to serve their students (Carver-Thomas & Darling-Hammond, 2017). Given the popularity of four-day work weeks in other industries and among teachers who experience them (Kilburn et al., 2021; Lewis et al., 2023), abbreviated school weeks have been thought of as an enticing benefit that would attract school employees. The analysis here suggests policymakers should proceed with caution. Both working conditions and pay are important determinants of whether employees remain in schools. The evidence presented here suggests that boosting one and not the other may be insufficient to move the needle on retention in the long-term. Policymakers should be attentive to these potential trade-offs as they figure out packages of benefits to offer to employees as these decisions will likely have consequences for who will enter and stay in schools to serve students.

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Table 1

Descriptive characteristics for treatment and control schools

	(1)	(2)	(3)
	Always 5dsw	Switch to 4dsw	Difference (2) - (1)
Student characteristics			
School enrollment	436	319	-117**
Proportion students of color	0.238	0.177	-0.061**
Proportion SpEd	0.138	0.148	0.01+
Proportion ever ELL	0.157	0.201	0.044
Proportion gifted	0.055	0.051	-0.004
Proportion receiving FRPL	0.448	0.502	0.054**
Average student achievement (SD)	-0.028	-0.128	-0.1**
Proportion ever suspended/expelled	0.036	0.044	0.008
Staff characteristics			
Number of teachers	23	18	-5**
Number of other staff	21	16	-5**
Teacher turnover rate	0.136	0.135	-0.001
Other staff turnover rate	0.145	0.16	0.015
Proportion novice teachers	0.16	0.163	0.003
Average teacher salary (2022 $)	$63,674	$61,207	-$2,467**
Proportion rural	0.214	0.394	0.18**
Number of school days	169	168	-1*
Number of schools	771	116	

Note: Table compares the average of each of the school-level variables for the 2007 and 2008 academic years for schools that were always on a 5dsw and for those that would eventually switch to a 4dsw. SpEd refers to students receiving special education services, ELL refers to English-Language Learners, FRPL refers to students receiving free-or-reduced-price lunch, Novice teachers are those with less than 5 years of experience. Significance codes: '+'0.1 '*'0.05 '**'0.01 '***'0.001

Table 2

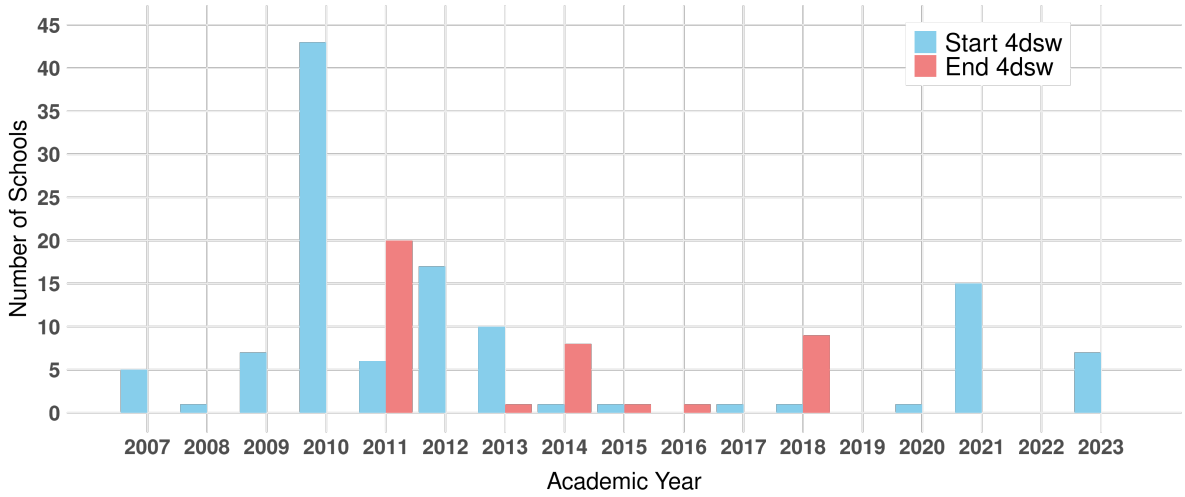
Teacher turnover by source, professional characteristics and personal characteristics

Panel A: Sources and Professional Characteristics								
	Type of Turnover			Experience			Position Type	
	Turnover	Move	Exit	<= 5	6-15	> 15	GenEd	SpEd
0 - Immediate	0.023*	0.009	0.014*	0.039*	-0.007	0.045***	0.022*	0.040
	(0.010)	(0.008)	(0.007)	(0.020)	(0.011)	(0.013)	(0.009)	(0.041)
1-4 - Short term	0.002	0.004	-0.002	-0.007	0.003	-0.014	-0.001	0.039
	(0.009)	(0.006)	(0.008)	(0.024)	(0.013)	(0.014)	(0.010)	(0.034)
5-9 - Long term	0.039**	0.013*	0.026*	0.005	0.004	0.033	0.039**	0.045
	(0.013)	(0.007)	(0.011)	(0.024)	(0.017)	(0.029)	(0.014)	(0.064)
Baseline rate	0.123	0.025	0.098	0.168	0.086	0.122	0.120	0.152
Num.Obs.	250891	250891	250891	71504	92459	86755	226251	24557
Panel B: Personal Characteristics								
	Gender Identity			Age			Racial Identity	
	Women	Men	<= 30	31-40	41-50	> 50	POC	White
0 - Immediate	0.013	0.045**	0.037	0.028*	0.014	0.019	0.062	0.021*
	(0.013)	(0.014)	(0.023)	(0.014)	(0.020)	(0.014)	(0.055)	(0.010)
1-4 - Short term	0.003	0.000	-0.011	0.012	-0.014	-0.012	0.023	0.003
	(0.012)	(0.013)	(0.032)	(0.016)	(0.014)	(0.015)	(0.033)	(0.010)
5-9 - Long term	0.039**	0.034	-0.012	0.016	-0.009	0.040+	0.045	0.045**
	(0.014)	(0.024)	(0.030)	(0.024)	(0.029)	(0.023)	(0.054)	(0.014)
Baseline rate	0.123	0.124	0.183	0.106	0.074	0.153	0.139	0.122
Num.Obs.	175161	75666	35967	71298	69204	74169	17277	233323

Note: Table displays the effect of 4dsw adoption at year 0, years 1-4 pooled and years 5-9 pooled from two-stage DID event study models. The move and exit columns predict moving districts or exiting public education and all others predict total turnover including both. Each column for characteristics represents a regression run on the specific sub-sample. GenEd is General Education, SpEd is Special Education, and POC is person of color. Significance codes: '+'0.1 '*'0.05 '**'0.01 '***'0.001

Figure 1

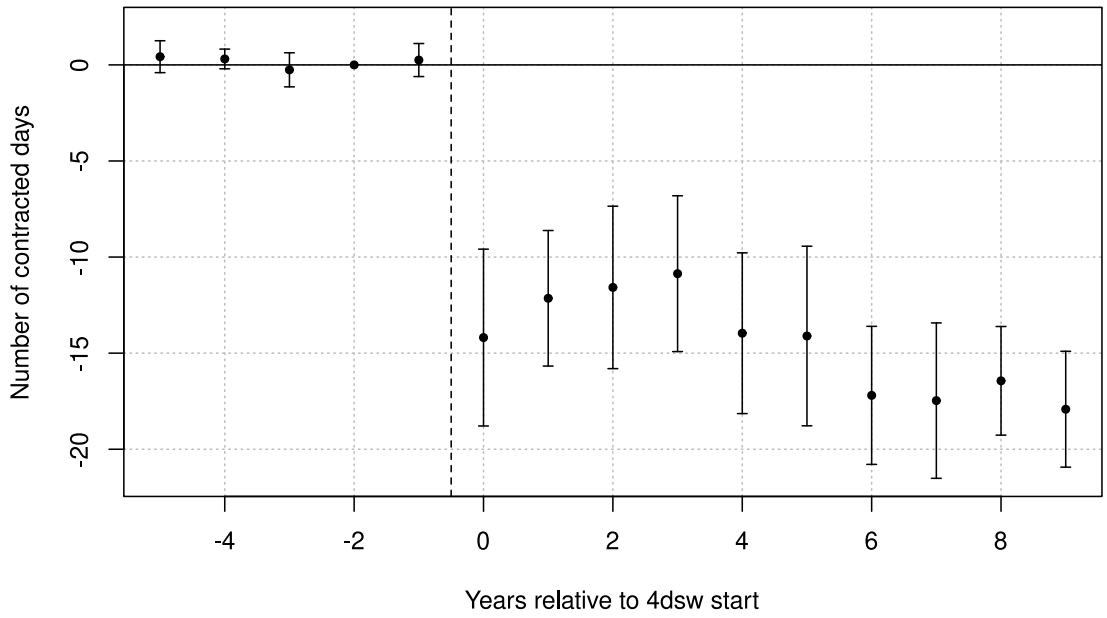
Number of schools beginning and endings a 4dsw from 2006-07 to 2022-23



Note: Figure includes traditional public or charter schools that began or ended a four-day schedule during this period. Years refer to the spring of that academic year (i.e., 2007 is the 2006-2007 school year).

Figure 2

Changes in number of contracted days for teachers after 4dsw adoption

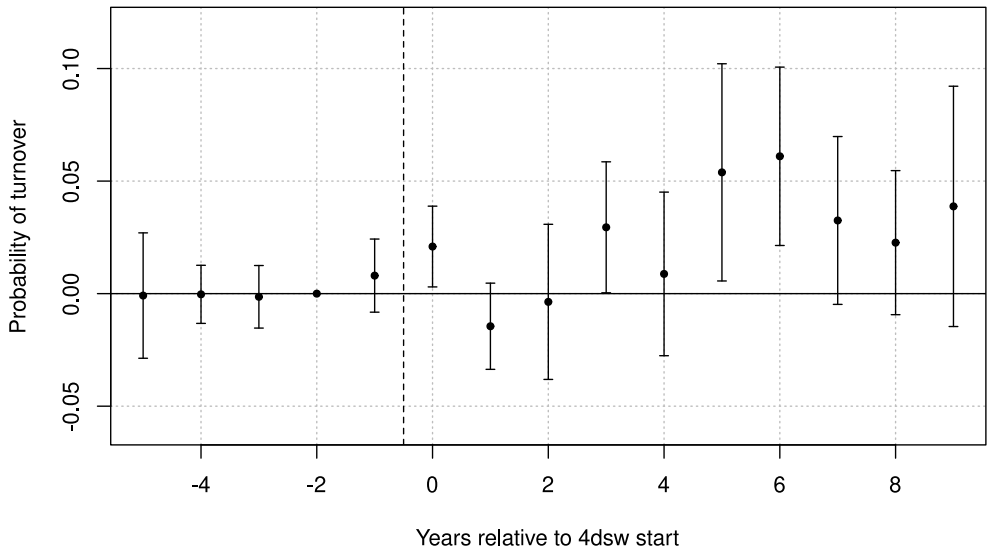


Note: Figure displays coefficients and 95% confidence intervals from a two-stage DiD event study model predicting the number of contracted days for teachers with 2 years before adopting a 4dsw as the omitted category.

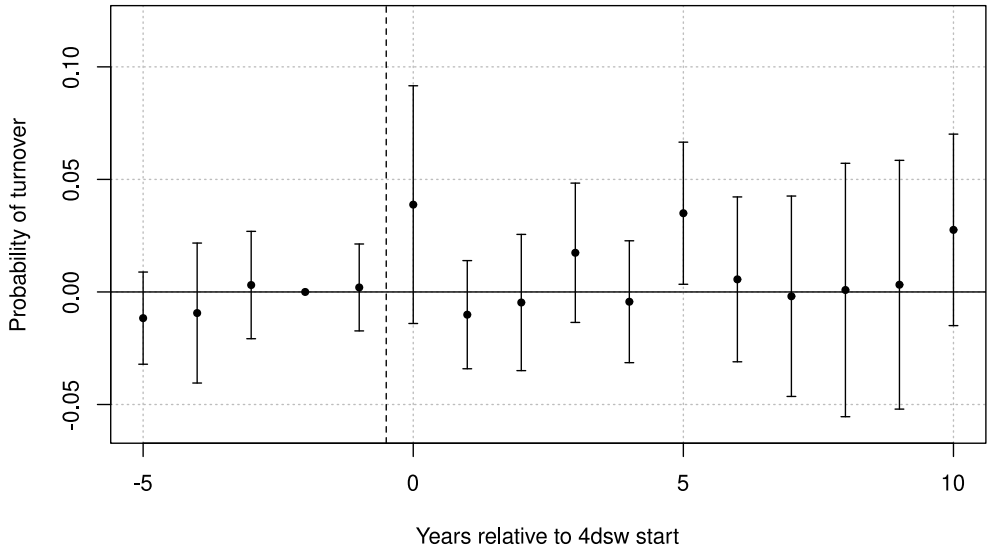
Figure 3

Event study of teacher and staff turnover surrounding adoption of a 4dsw

(a) *Teacher Turnover*



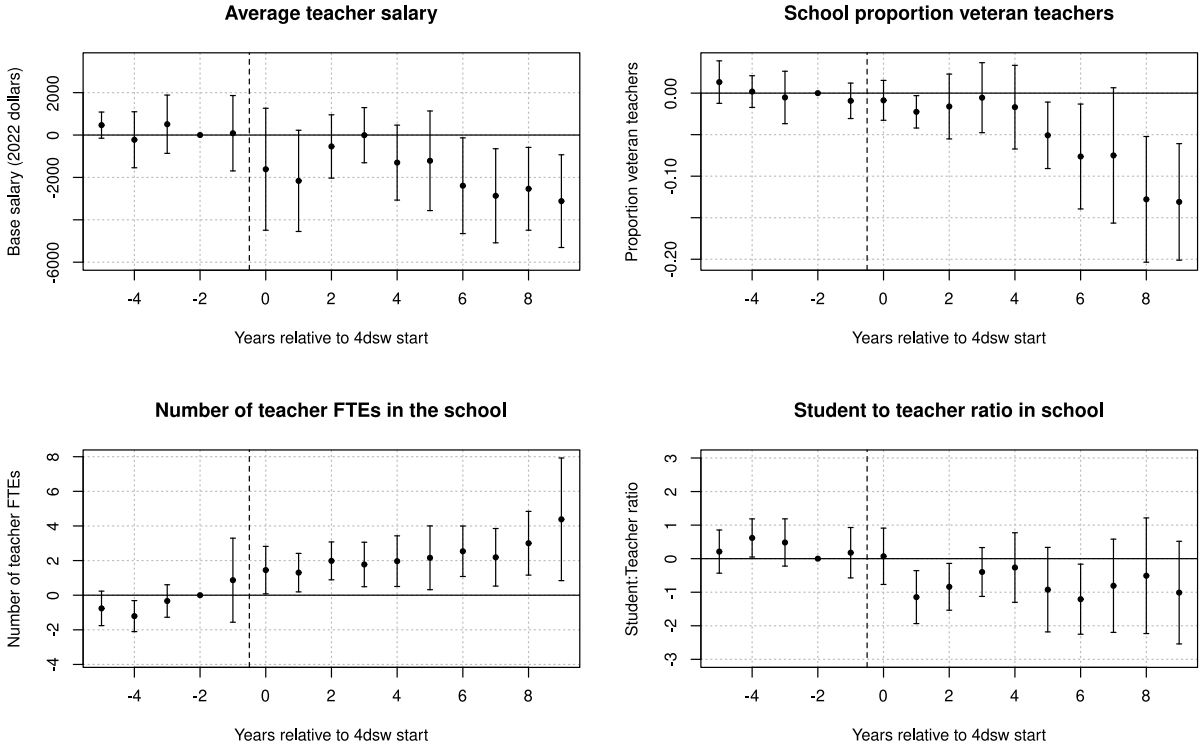
(b) *Other Staff Turnover*



Note: Figure displays coefficients and 95% confidence intervals from two-stage DiD event study models predicting a binary indicator of turnover for all teachers in panel A and all other staff in panel B with 2 years before adopting a 4dsw as the omitted category.

Figure 4

Event study of teacher characteristics surrounding adoption of a 4dsw



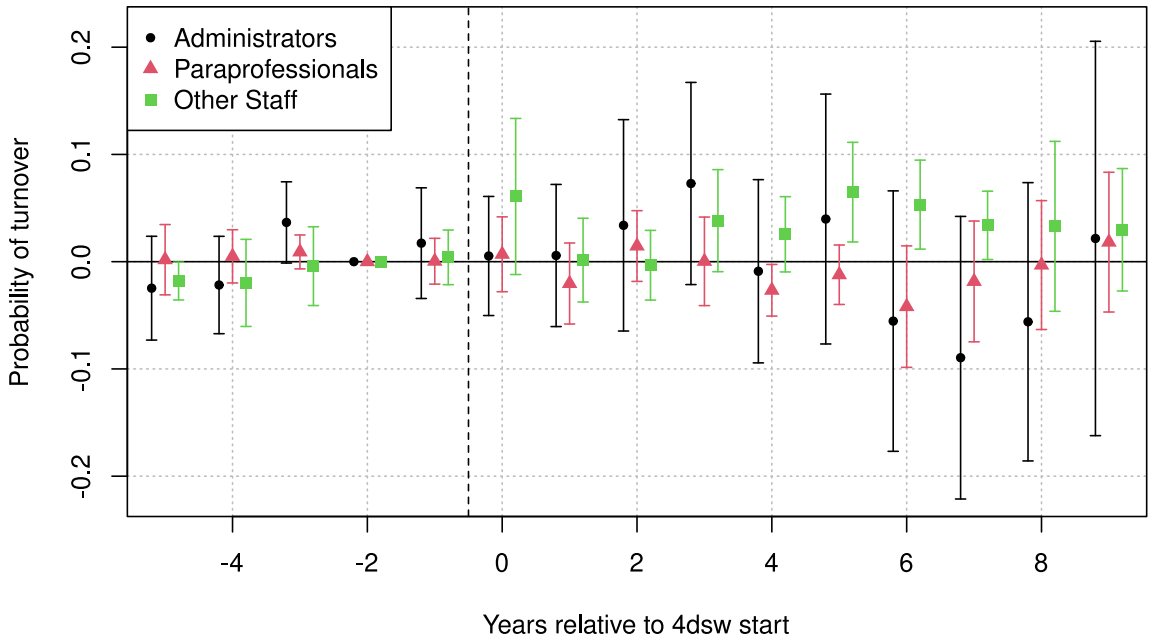
Note: Figure displays coefficients and 95% confidence intervals from four separate two-stage DID event study models predicting the teacher characteristic in the title of the plot with 2 years before adopting a 4dsw as the omitted category. The model for salary additionally controls for experience, licensure status, whether a teacher works in a special education position, FTE, and level of education. Salaries are expressed in terms of 2022 dollars. Veteran teachers refers to those with greater than 15 years of experience.

Appendix A

Heterogeneity of Turnover

Figure A1

Event study of turnover by type of staff



Note: Figure displays coefficients and 95% confidence intervals from three separate two-stage DID event study models predicting a binary indicator of turnover with 2 years before adopting a 4dsw as the omitted category.

Table A1

Teacher and staff turnover by school rurality

	Teacher			Other staff		
	All	Non-rural	Rural	All	Non-rural	Rural
0 - Immediate	0.023*	0.023*	0.024	0.039	0.006	0.106*
	(0.010)	(0.012)	(0.015)	(0.027)	(0.010)	(0.048)
1-4 - Short term	0.002	0.001	0.003	-0.002	0.007	-0.019
	(0.009)	(0.014)	(0.008)	(0.011)	(0.013)	(0.018)
5-9 - Long term	0.039**	0.023+	0.059*	0.009	0.019	-0.013
	(0.013)	(0.013)	(0.025)	(0.016)	(0.020)	(0.026)
Baseline rate	0.123	0.133	0.111	0.134	0.135	0.133
Num.Obs.	250891	243141	229594	342799	329987	311829

Note: Table displays the effect of 4dsw adoption on turnover at year 0, years 1-4 pooled and years 5-9 pooled from two-stage DID event study models. Non-rural includes adopters that are classified as suburban or town. Significance codes: '+'0.1 '*'0.05 '**'0.01 '***'0.001

Table A2

Teacher movement by professional and personal characteristics

Panel A								
	Destination of move			Experience			Position	
	All	4-day	5-day	<= 5	6-15	> 15	GenEd	SpEd
0 - Immediate	0.009	0.000	0.009	0.023+	0.005	0.000	0.007	0.022
	(0.008)	(0.002)	(0.007)	(0.014)	(0.010)	(0.006)	(0.008)	(0.018)
1-4 - Short term	0.004	0.002	0.005	-0.006	0.001	0.003	0.003	0.021
	(0.006)	(0.002)	(0.006)	(0.012)	(0.008)	(0.004)	(0.005)	(0.020)
5-9 - Long term	0.013*	0.004*	0.009	0.010	0.013	-0.002	0.013+	0.011
	(0.007)	(0.002)	(0.006)	(0.015)	(0.011)	(0.007)	(0.007)	(0.036)
Baseline rate	0.025	0.002	0.022	0.046	0.021	0.012	0.024	0.039
Num.Obs.	250891	249701	249701	71504	92459	86755	226251	24557
Panel B								
	Gender identity			Age			Racial Identity	
	Women	Men	<= 30	31-40	41-50	> 50	POC	White
0 - Immediate	0.002	0.024	0.004	0.018	0.007	-0.001	0.007	0.009
	(0.006)	(0.014)	(0.018)	(0.012)	(0.013)	(0.005)	(0.018)	(0.008)
1-4 - Short term	0.004	0.009	-0.011	0.009	-0.010	0.008+	-0.010	0.004
	(0.007)	(0.008)	(0.017)	(0.017)	(0.010)	(0.004)	(0.020)	(0.006)
5-9 - Long term	0.007	0.024*	-0.003	0.011	-0.002	0.005	-0.028	0.014*
	(0.007)	(0.010)	(0.024)	(0.024)	(0.016)	(0.008)	(0.046)	(0.007)
Baseline rate	0.023	0.029	0.056	0.029	0.025	0.010	0.035	0.025
Num.Obs.	175161	75666	35967	71298	69204	74169	17277	233323

Note: Table displays the effect of 4dsw adoption on moving districts at year 0, years 1-4 pooled and years 5-9 pooled from two-stage DID event study models. Each column for characteristics represents a regression run on the specific sub-sample. GenEd is General Education, SpEd is Special Education, and POC is person of color. Significance codes: '+'0.1 '*'0.05 '**'0.01 '***'0.001

Table A3

Teacher exiting by professional and personal characteristics

Panel A							
	Turnover	Position		Age			
	Exit	GenEd	SpEd	<= 30	31-40	41-50	> 50
0 - Immediate	0.014*	0.014*	0.018	0.033	0.010	0.007	0.021
	(0.007)	(0.007)	(0.037)	(0.021)	(0.012)	(0.011)	(0.014)
1-4 - Short term	-0.002	-0.003	0.018	0.001	0.003	-0.004	-0.020
	(0.008)	(0.008)	(0.035)	(0.026)	(0.012)	(0.010)	(0.014)
5-9 - Long term	0.026*	0.026*	0.034	-0.009	0.006	-0.006	0.035+
	(0.011)	(0.011)	(0.052)	(0.027)	(0.023)	(0.019)	(0.020)
Baseline rate	0.098	0.097	0.113	0.127	0.077	0.049	0.143
Num.Obs.	250891	226251	24557	35967	71298	69204	74169
Panel B							
	Experience			Gender identity		Racial identity	
	<= 5	6-15	> 15	Women	Men	POC	White
0 - Immediate	0.016	-0.012	0.044***	0.011	0.021	0.055	0.011
	(0.015)	(0.008)	(0.013)	(0.010)	(0.013)	(0.049)	(0.008)
1-4 - Short term	-0.001	0.002	-0.017	-0.001	-0.009	0.033	-0.001
	(0.020)	(0.014)	(0.012)	(0.010)	(0.012)	(0.032)	(0.009)
5-9 - Long term	-0.005	-0.009	0.035	0.032**	0.010	0.073***	0.030**
	(0.027)	(0.015)	(0.023)	(0.011)	(0.023)	(0.019)	(0.011)
Baseline rate	0.122	0.065	0.111	0.100	0.095	0.104	0.097
Num.Obs.	71504	92459	86755	175161	75666	17277	233323

Note: Table displays the effect of 4dsw adoption on exiting public education at year 0, years 1-4 pooled and years 5-9 pooled from two-stage DID event study models. Each column for characteristics represents a regression run on the specific sub-sample. GenEd is General Education, SpEd is Special Education, and POC is person of color. Significance codes: '+'0.1 '*'0.05 '**'0.01 '***'0.001

Table A4

Staff turnover by professional and personal characteristics

Panel A: Sources and Professional Characteristics								
	Type of Turnover			Role			Position Type	
	Turnover	Move	Exit	Admin	Para	Staff	GenEd	SpEd
0 - Immediate	0.039	0.001	0.038	0.005	0.007	0.061	0.050	-0.009
	(0.027)	(0.003)	(0.030)	(0.028)	(0.018)	(0.037)	(0.032)	(0.015)
1-4 - Short term	-0.002	0.001	-0.003	0.023	-0.010	0.014	0.000	-0.006
	(0.011)	(0.002)	(0.011)	(0.022)	(0.011)	(0.014)	(0.012)	(0.017)
5-9 - Long term	0.009	0.008*	0.001	-0.024	-0.012	0.044**	0.014	-0.004
	(0.016)	(0.004)	(0.018)	(0.048)	(0.018)	(0.016)	(0.018)	(0.021)
Baseline rate	0.134	0.011	0.123	0.171	0.144	0.125	0.135	0.130
Num.Obs.	342799	342799	342799	18782	112448	212841	268291	74462
Panel B: Personal Characteristics								
	Gender Identity		Age				Racial Identity	
	Women	Men	<= 30	31-40	41-50	> 50	POC	White
0 - Immediate	0.035	0.048	0.043	0.042+	0.032*	0.044	0.035	0.041
	(0.022)	(0.050)	(0.037)	(0.023)	(0.014)	(0.039)	(0.032)	(0.026)
1-4 - Short term	-0.010	0.022	-0.021	-0.014	0.004	-0.004	0.016	0.001
	(0.010)	(0.020)	(0.046)	(0.023)	(0.016)	(0.012)	(0.018)	(0.012)
5-9 - Long term	0.004	0.026	-0.082	-0.026	0.009	-0.015	-0.003	0.017
	(0.015)	(0.021)	(0.100)	(0.032)	(0.021)	(0.021)	(0.076)	(0.018)
Baseline rate	0.128	0.158	0.338	0.154	0.101	0.128	0.143	0.132
Num.Obs.	259301	83414	29262	56296	95480	161426	41305	300960

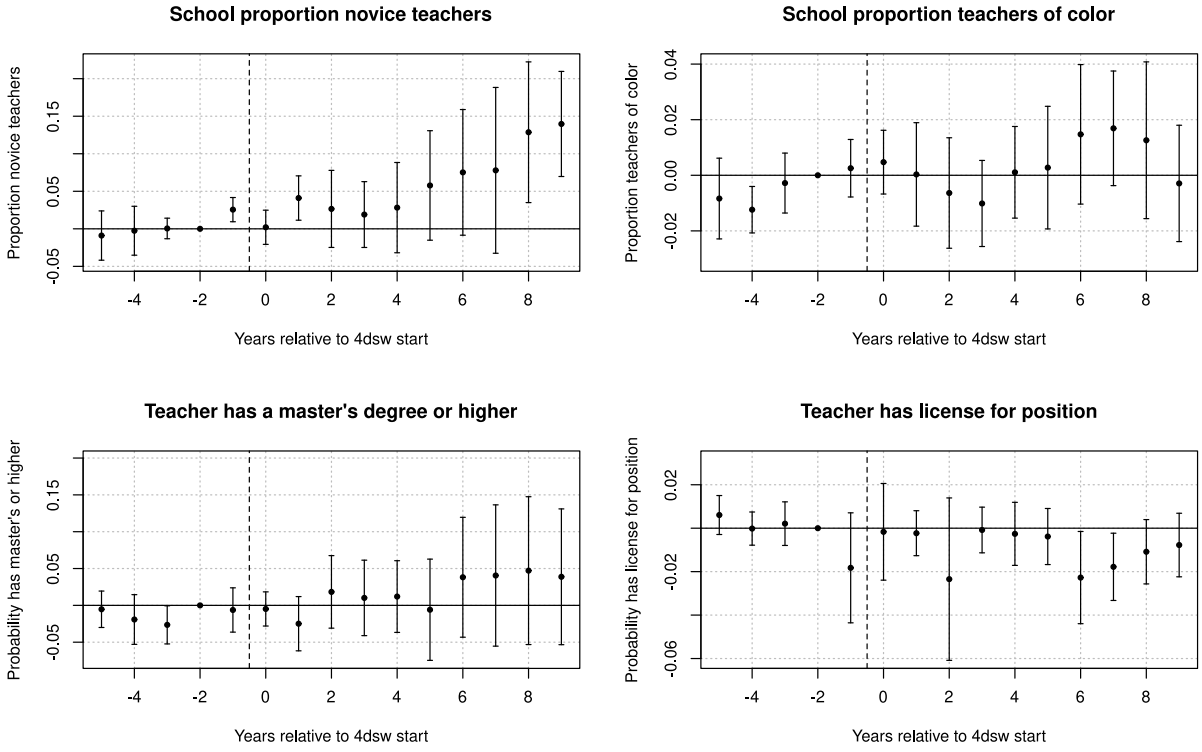
Note: Table displays the effect of 4dsw adoption on turnover at year 0, years 1-4 pooled and years 5-9 pooled from two-stage DID event study models. Each column for characteristics represents a regression run on the specific sub-sample. GenEd is General Education, SpEd is Special Education, POC is person of color, Admin is Administrator and Para is Paraprofessional. Significance codes: '+'0.1 '*'0.05 '**'0.01 '***'0.001

Appendix B

Parallel Trends for Teacher Characteristics

Figure B1

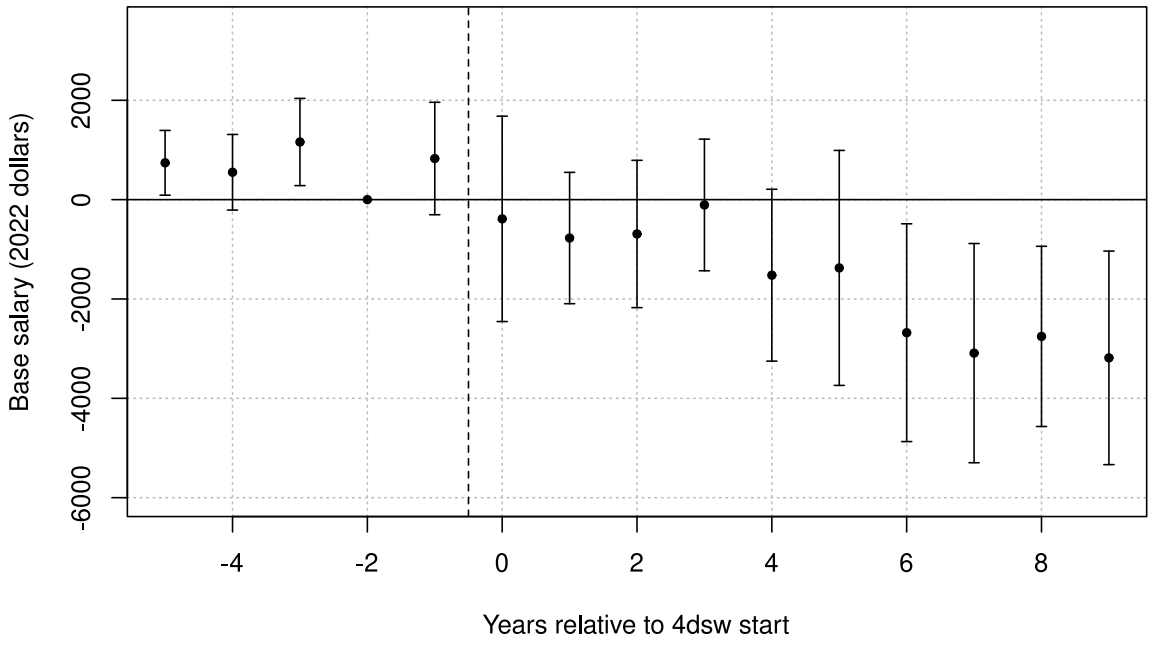
Event study of teacher characteristics surrounding adoption of a 4dsw



Note: Figure displays coefficients and 95% confidence intervals from four separate two-stage DID event study models predicting various teacher characteristics at the school level with 2 years before adopting a 4dsw as the omitted category. Novice teachers refers to those with fewer than 5 years of experience.

Figure B2

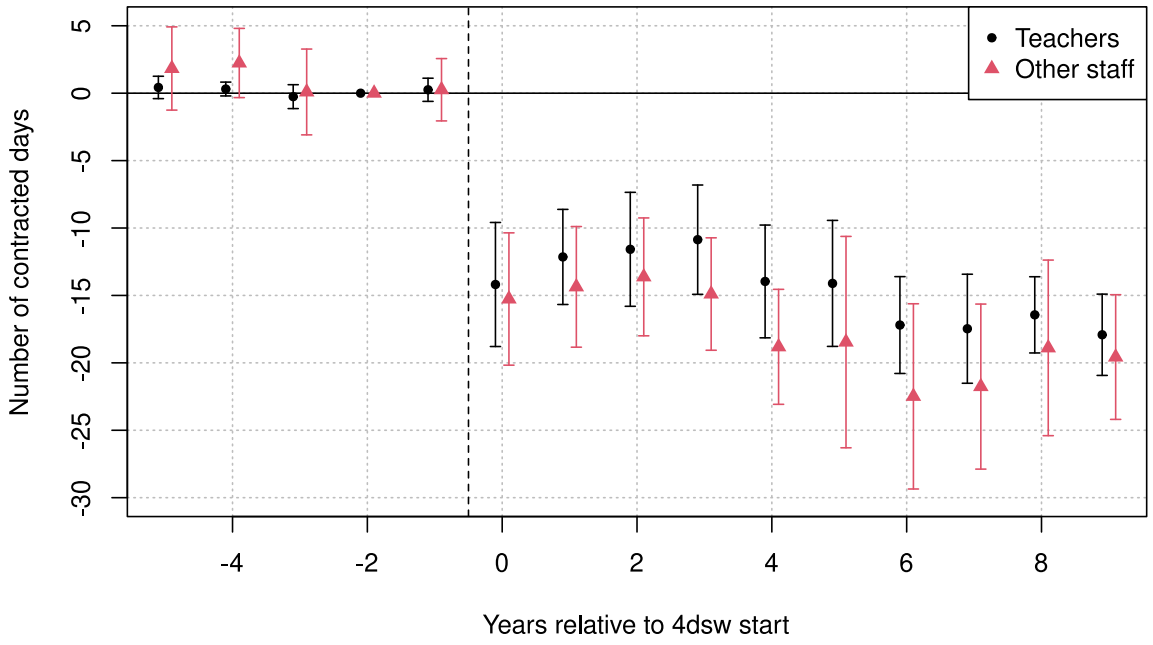
Change in teacher salaries surrounding 4dsw adoption excluding 2021 adopters



Note: Figure displays coefficients and 95% confidence intervals from separate a two-stage DiD event study model predicting the salary for teachers in 2022 dollars with 2 years before adopting a 4dsw as the omitted category. Confidence intervals at the 95% level are shown for the difference between the estimate in a given year and the treatment control difference as measured two years prior to policy adoption. Controls are included for position type, FTE, experience, degree and whether the employee has a license for their role. The schools adopting in 2021 (n = 15) are excluded from the sample.

Figure B3

Change in number of contracted days for teachers and staff surrounding adoption of a 4dsw



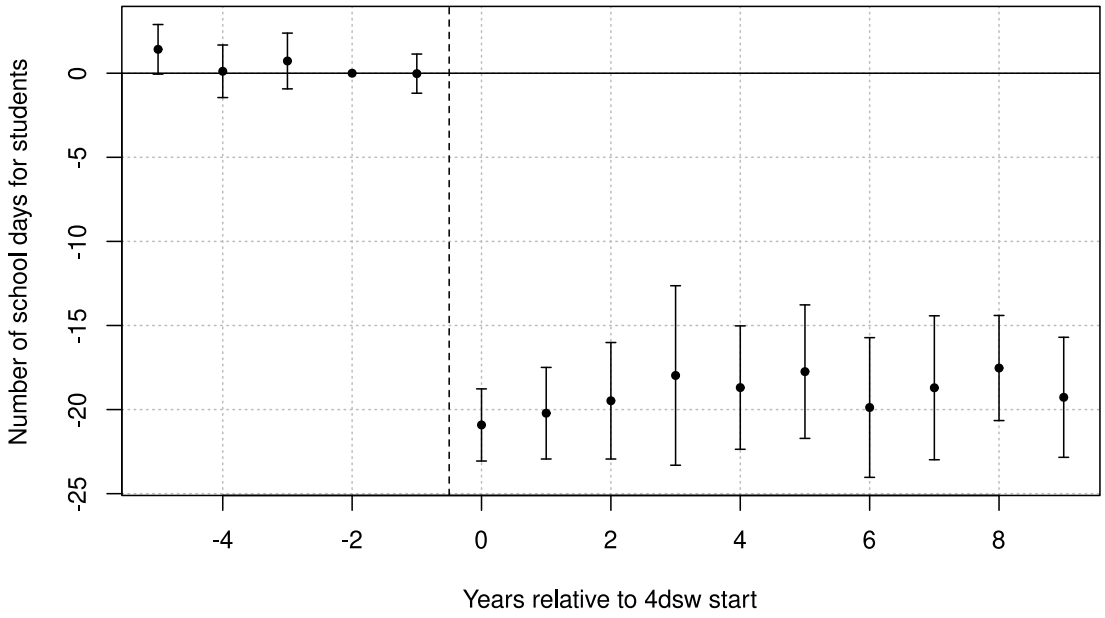
Note: Figure displays coefficients and 95% confidence intervals from separate two-stage DiD event study models predicting the number of contracted days for teachers and other staff with 2 years before adopting a 4dsw as the omitted category.

Appendix C

Parallel Trends for School Characteristics

Figure C1

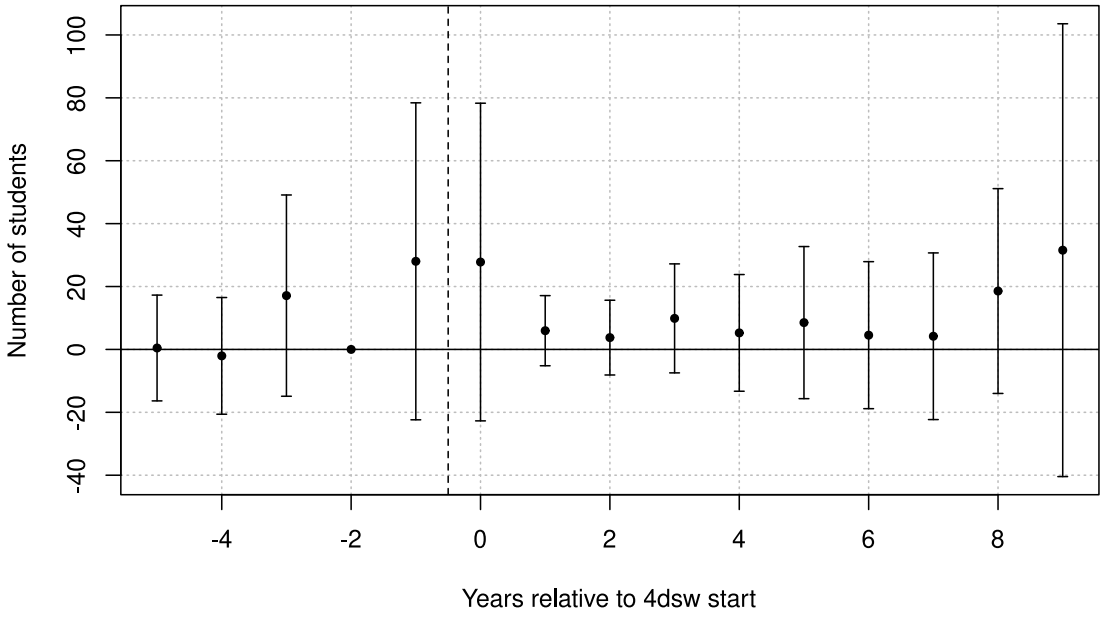
Changes to the number of school days for students after 4dsw adoption



Note: Figure displays coefficients and 95% confidence intervals from a two-stage DID event study model predicting number of school days for students with 2 years before adopting a 4dsw as the omitted category.

Figure C2

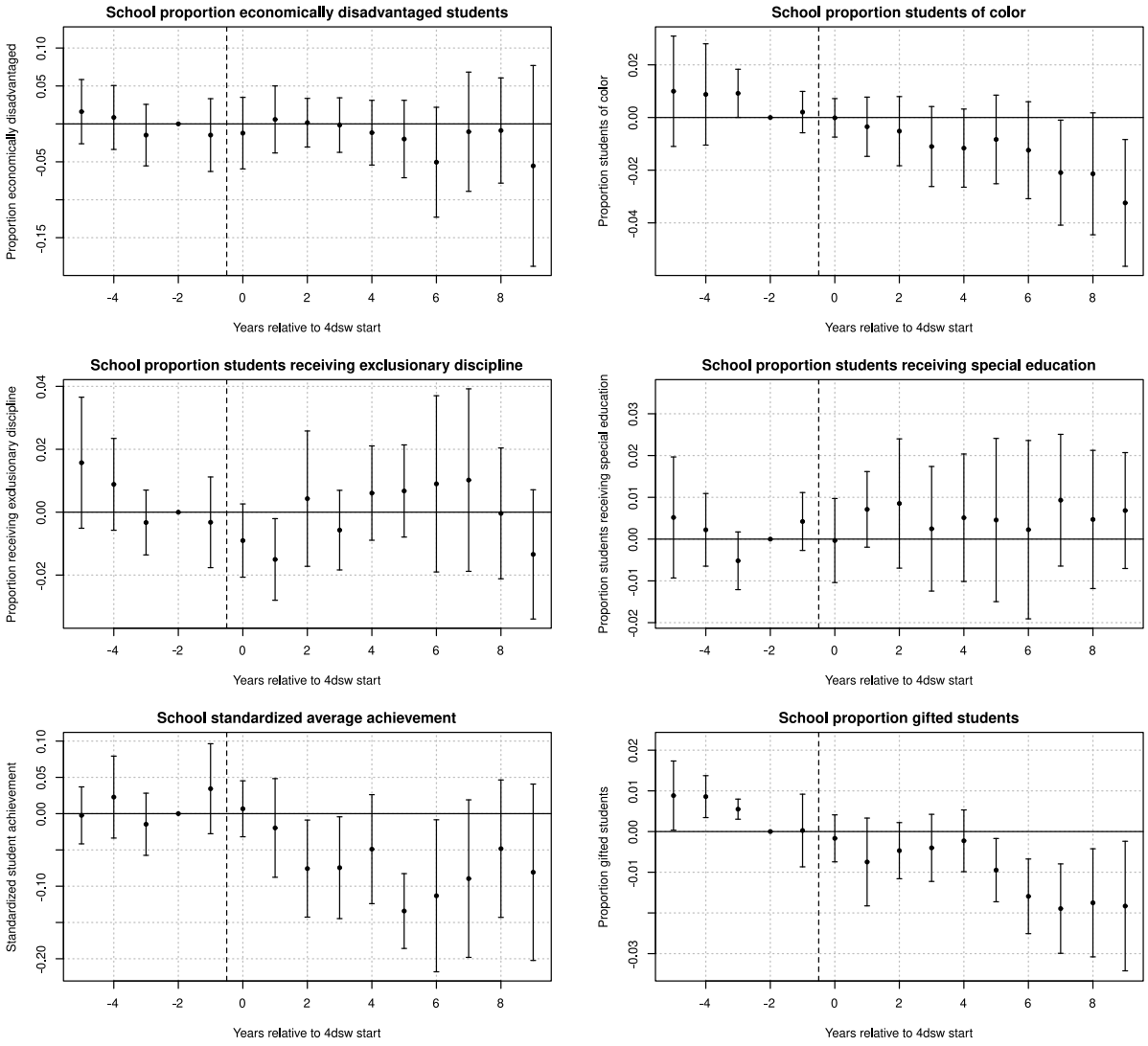
Event study for school-level student enrollment surrounding adoption of a 4dsw



Note: Figure displays coefficients and 95% confidence intervals from a two-stage DID event study model predicting number of students enrolled in a school with 2 years before adopting a 4dsw as the omitted category.

Figure C3

Event study for school-level student characteristics surrounding adoption of a 4dsw



Note: Figure displays coefficients and 95% confidence intervals from different two-stage DID event study models predicting various school-level student characteristics with 2 years before adopting a 4dsw as the omitted category.

Appendix D

Accounting for Spatial Spillovers

Because school districts do not operate in isolation, they may be affected by the decisions of nearby districts, it is possible that the control districts may be affected by the four-day adopters. This is particularly the case in terms of teacher retention. A teacher in a five-day district may observe the change to a four-day school week and make career decisions based on this information. This schedule change may make it more likely that they move to a new district if they view the 4dsw as desirable or it could be less likely that they move if they do not want the four-day schedule. If there indeed are spillovers onto control schools, then the treatment effect might be over- or under-stated depending on the direction of the spillover.

Butts (2023) proposes a method to account for these spillovers. Essentially, by adding into the traditional TWFE model an indicator for schools within the spillover threshold or sets of indicators for distances at various thresholds that may be subjected to spillover effects to varying degrees, then this creates a set of true control schools so long as spillover effects decay with distance. By adding these indicators into the model, we can also examine if there appears to indeed be spillover effects. This approach also can be incorporated into an event study framework or into modern DiD approaches such as the two-stage approach used here (Butts, 2023).

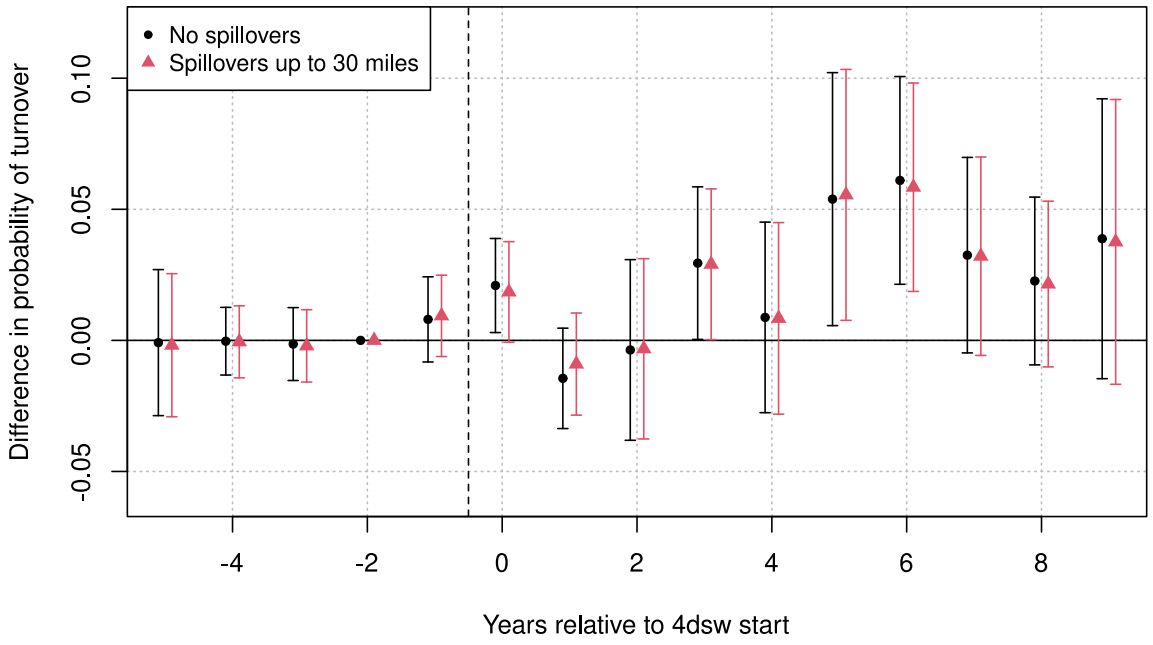
First we create concentric rings of 5, 10, 20 and 30 miles from the treated four-day schools using the geodesic distance and identify the control schools that fall within these rings. We assign schools to the closest distance they are to a treated school if they fall in multiple rings. Then we create years to spillover indicators based on when the nearby four-day school was treated. We then estimate the same two-stage models described in the main text but in the second stage include the time to spillover indicators for the 0-5, 5-10, 10-20, and 20-30 thresholds.

We present the main treatment effects in Figure D1 that include the years to spillover indicators. Accounting for the spillovers makes little difference for the estimated

treatment effects. The year 0 effect declines to 1.9 percentage points but is still significant at the 0.1 level. In Figure D2 we plot the coefficients from the time to spillover indicators. We do not observe consistent spillover effects. Teacher turnover is lower in year 0 for schools that are 5-10 and 10-20 miles away but over time there is less consistency. Turnover is lower between years 6 to 9 in schools 5 to 10 miles away. Importantly though, as demonstrated in Figure D1, any possible spillovers do not affect the estimated treatment effects. This provides reassurance that the effects we observe are not an artifact of spatial spillovers in nearby schools.

Figure D1

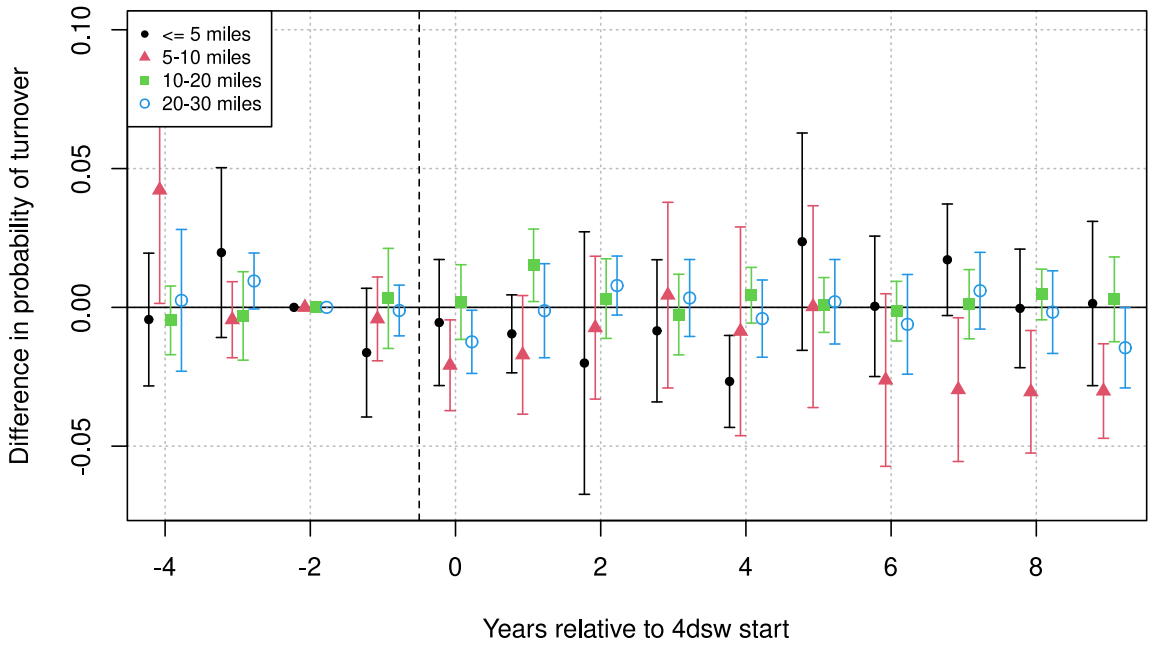
Event study of teacher turnover accounting for potential spatial spillovers



Note: Figure displays coefficients and 95% confidence intervals from two-stage DID event study models predicting a binary indicator of turnover for teachers with 2 years before adopting a 4dsw as the omitted category. The model accounting for spillovers add time to spillover indicators in the second stage of the model for schools that 0-5, 5-10, 10-20 and 20-30 miles away from treated 4-day schools following Butts (2023).

Figure D2

Event study of effects on teacher turnover in spillover schools near treated 4-day schools



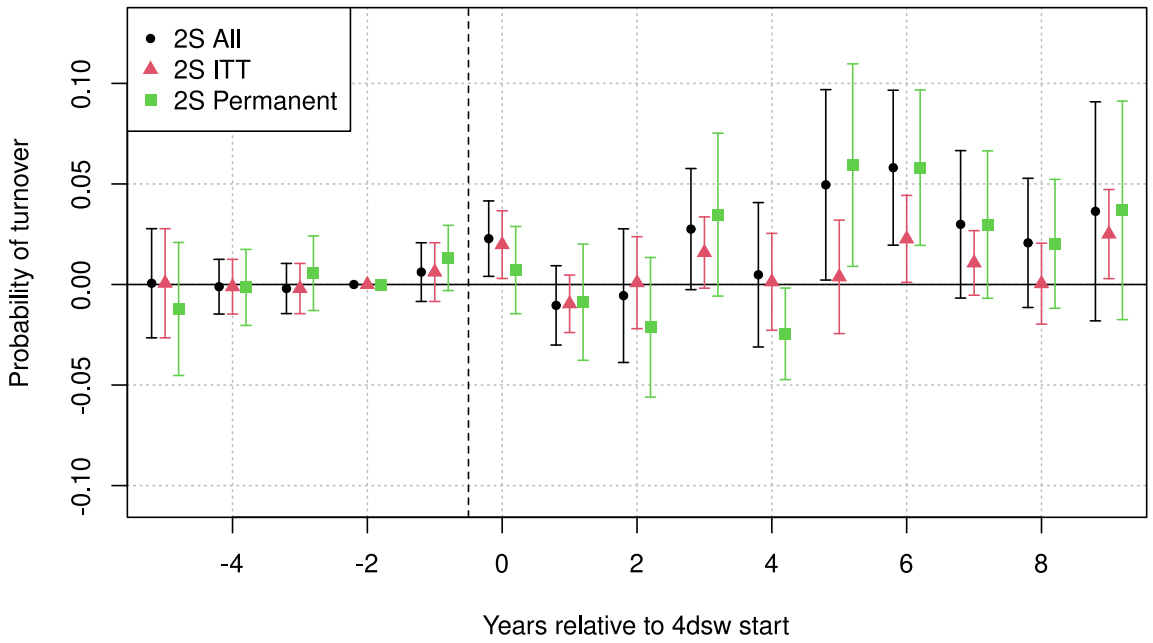
Note: Figure displays coefficients and 95% confidence intervals from a two-stage DID event study models predicting a binary indicator of turnover for teachers with 2 years before being a spillover school as the omitted category. Following Butts (2023), the model includes the main time to 4dsw treatment indicators with time to spillover indicators in the second stage of the model for schools that are 0-5, 5-10, 10-20 and 20-30 miles away from treated 4-day schools. The figure displays these event study spillover coefficient from the spillover model estimates in Figure D1.

Appendix E

Robustness to Alternate Estimators

Figure E1

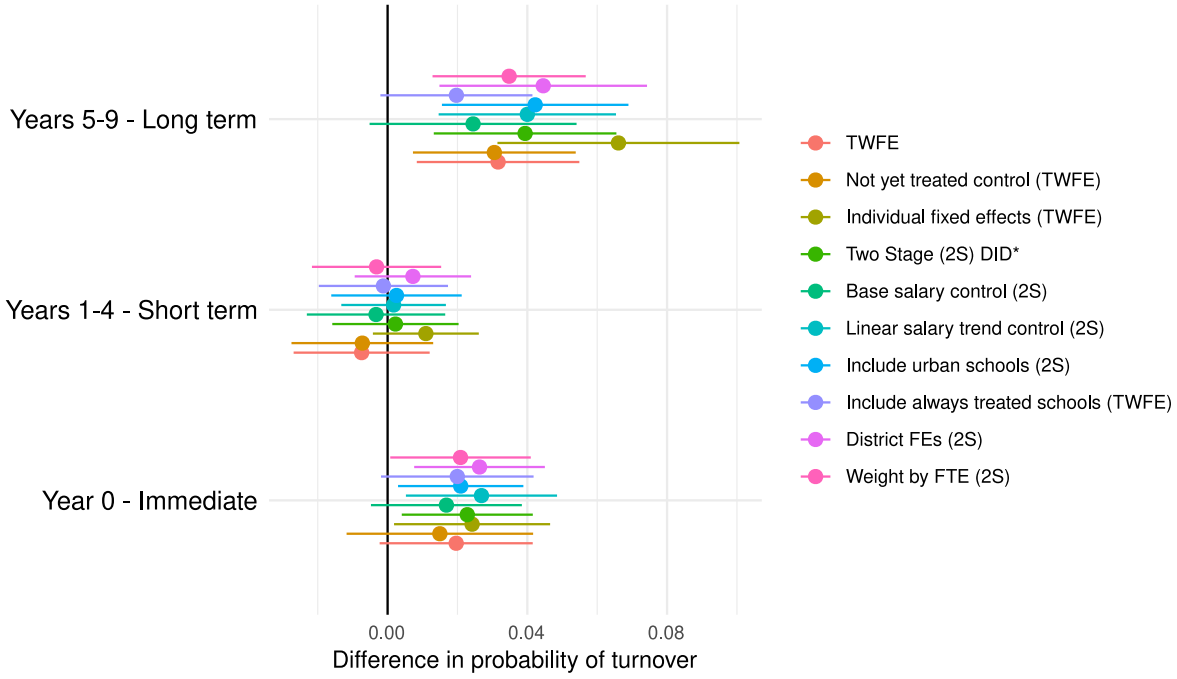
Event study of teacher turnover for different ways of constructing the treatment group



Note: Figure displays coefficients and 95% confidence intervals from two-stage DID event study models predicting for teachers a binary indicator of turnover with 2 years before adopting a 4dsw as the omitted category. All refers to the primary specification presented in the main text using all adopters but allowing treatment to turn off. ITT is an intent-to-treat coding where temporary adopters are coded as treated even when they have ended 4dsw use. Permanent excludes temporary adopters and estimates the effects only on the sample of those that remain on the schedule throughout the panel.

Figure E2

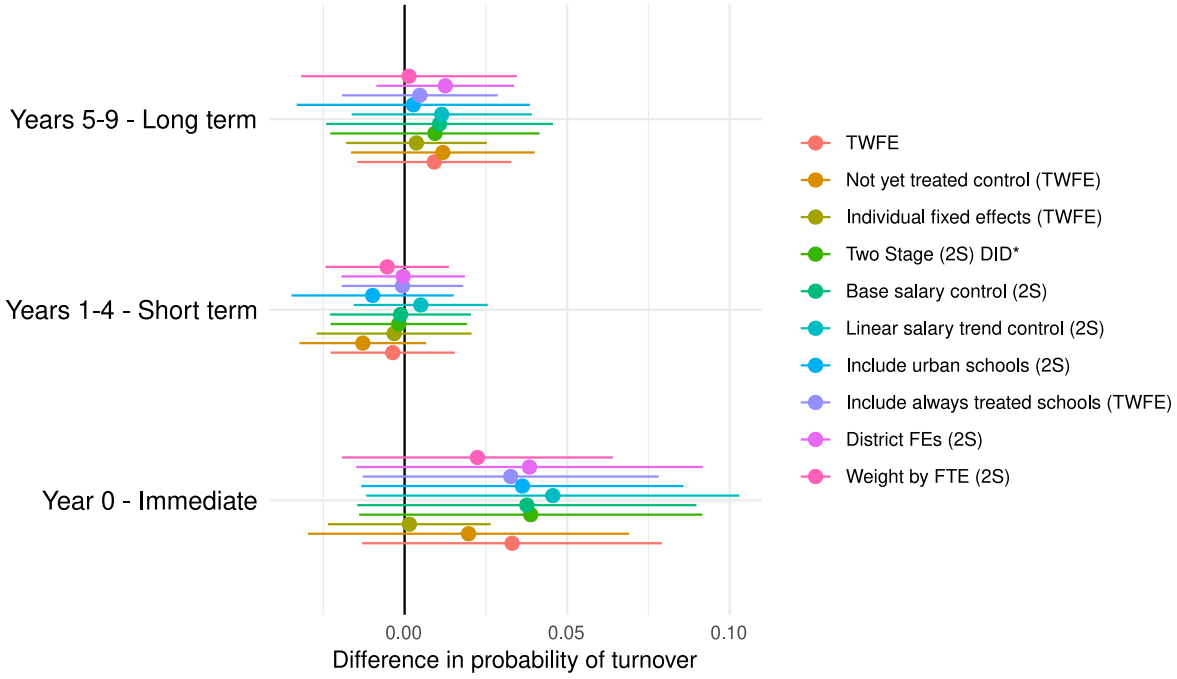
Event study for teacher turnover using different estimation strategies



Note: Figure displays coefficients and 95% confidence intervals from 10 separate models predicting a binary indicator for teacher turnover. Coefficients are displayed for year 0, years 1 to 4 pooled, and years 5 to 9 pooled. The asterisks * represents the specification from the main results presented in the body of the paper. TWFE refers to two-way fixed effects and 2S refers to Gardener's two-stage difference-in-differences estimator.

Figure E3

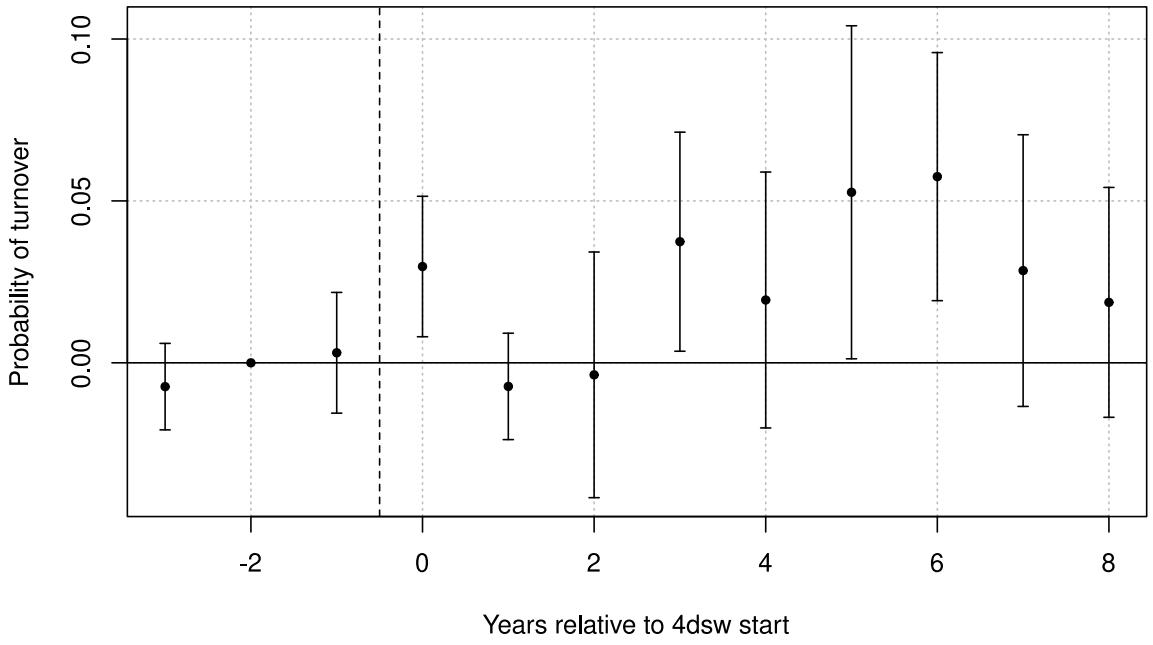
Event study for other staff turnover using different estimation strategies



Note: Figure displays coefficients and 95% confidence intervals from 10 separate models predicting a binary indicator for staff turnover. Coefficients are displayed for year 0, years 1 to 4 pooled, and years 5 to 9 pooled. The asterisks * represents the specification from the main results presented in the body of the paper. TWFE refers to two-way fixed effects and 2S refers to Gardener's two-stage difference-in-differences estimator.

Figure E4

Event study for teacher turnover using a balanced panel



Note: Figure displays coefficients and 95% confidence intervals from a two-stage DID event study model predicting a binary indicator for teacher turnover. The sample is restricted to schools in the treatment group that adopted a 4dsw between 2010 and 2014 to create a balanced panel of observations from 3 years before to 8 years after treatment.

Table E1

Teacher turnover by adoption cohort

	All	2009	2010	2011	2012	2013	2014-2018	2020-2021
0 - Immediate	0.023*	0.078*	0.015	0.129*	0.049*	0.035**	0.017	-0.016
	(0.010)	(0.034)	(0.010)	(0.065)	(0.021)	(0.012)	(0.099)	(0.013)
1-4 - Short term	0.002	-0.004	0.020*	-0.022	-0.025***	0.041***	-0.005	-0.032
	(0.009)	(0.020)	(0.010)	(0.063)	(0.007)	(0.005)	(0.059)	(0.036)
5-9 - Long term	0.039**	0.091***	0.047**	0.076	0.003	0.059*	0.101	
	(0.013)	(0.009)	(0.017)	(0.085)	(0.004)	(0.025)	(0.145)	
Average annual N treated	851	47	255	51	199	97	39	163
Num.Obs.	250891	222892	234441	222238	227748	224350	222493	227797

Note: Table displays the effect of 4dsw adoption on turnover for each cohort of adoption at year 0, years 1-4 pooled and years 5-9 pooled from two-stage DID event study models. Each column for characteristics represents a regression run on the specific cohort excluding the other adopters. 2014-2018 cohorts and the 2020 and 2021 cohorts are pooled due to sample size. Significance codes: '+'0.1 '*'0.05 '**'0.01 '***'0.001

Table E2

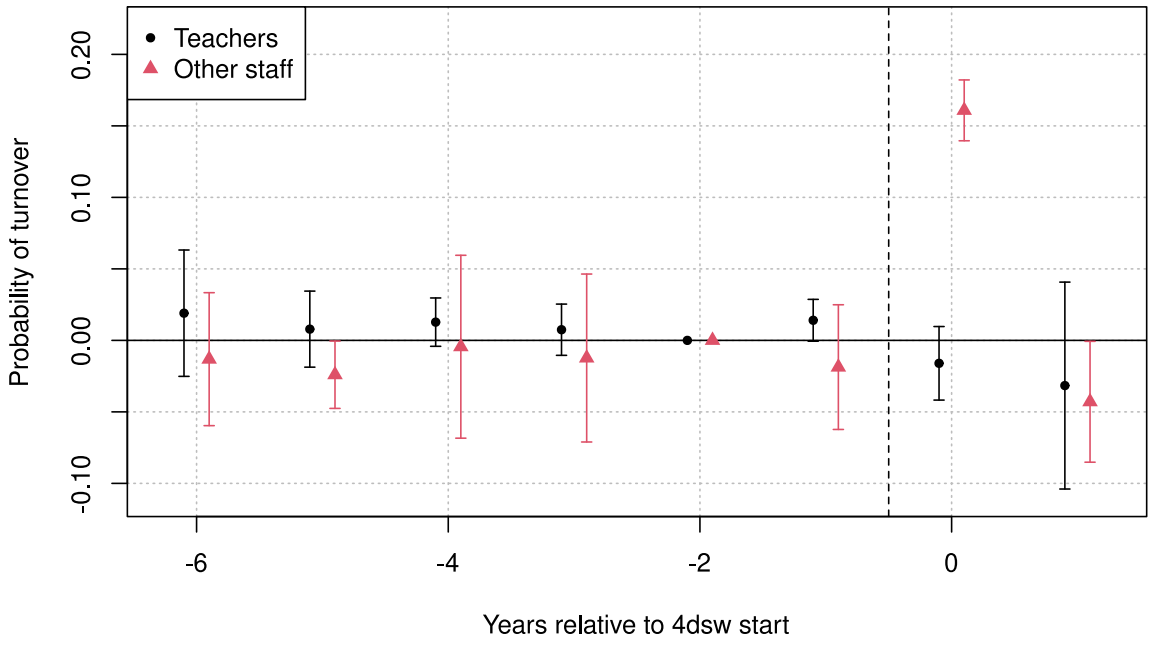
Staff turnover by adoption cohort

	All	2009	2010	2011	2012	2013	2014-2018	2020-2021
0 - Immediate	0.039	-0.015	0.017+	0.018	-0.014	0.034***	-0.037	0.161***
	(0.027)	(0.022)	(0.010)	(0.068)	(0.010)	(0.008)	(0.045)	(0.011)
1-4 - Short term	-0.002	-0.117*	0.007	0.059	-0.006	0.028	0.032	-0.040*
	(0.011)	(0.051)	(0.019)	(0.070)	(0.009)	(0.033)	(0.030)	(0.020)
5-9 - Long term	0.009	-0.203***	0.030	-0.091	0.020	-0.014	0.113	
	(0.016)	(0.053)	(0.019)	(0.094)	(0.013)	(0.020)	(0.078)	
Average annual N treated	1314	56	385	74	307	158	28	306
Num.Obs.	342799	300444	317390	299461	307526	303232	299534	309314

Note: Table displays the effect of 4dsw adoption on turnover for each cohort of adoption at year 0, years 1-4 pooled and years 5-9 pooled from two-stage DID event study models. Each column for characteristics represents a regression run on the specific cohort excluding the other adopters. 2014-2018 cohorts and the 2020 and 2021 cohorts are pooled due to sample size. Significance codes: '+'0.1 '*'0.05 '**'0.01 '***'0.001

Figure E5

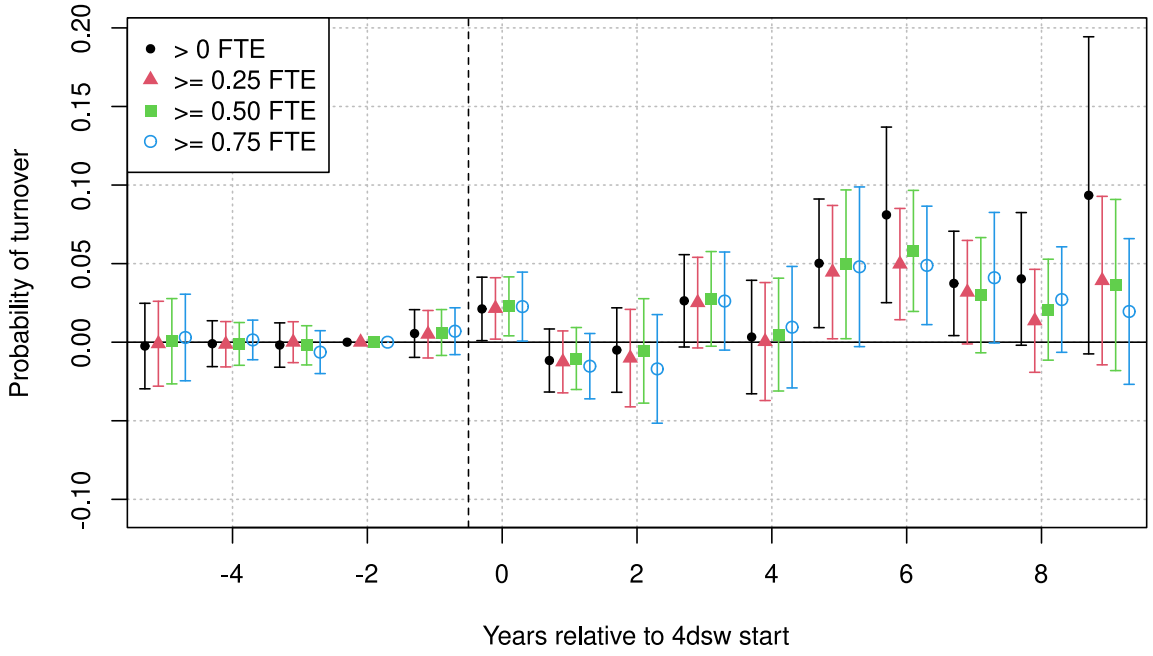
Event study teacher and staff turnover for pandemic adopting cohorts (2020 and 2021)



Note: Figure displays coefficients and 95% confidence intervals from two-stage event study models predicting an indicator for turnover for teachers and staff in the schools that adopted a 4dsw in the 2020 or 2021 school years. This includes 2 charter school and 1 school district comprised of 14 schools.

Figure E6

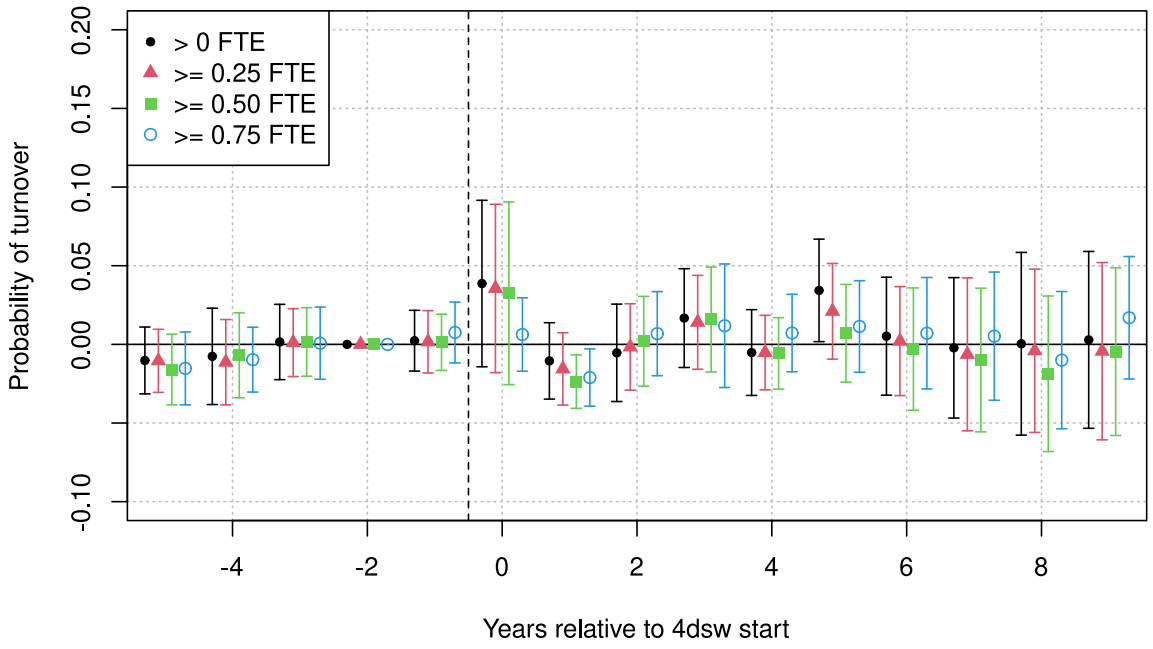
Event study teacher turnover by FTE



Note: Figure displays coefficients and 95% confidence intervals from 4 two-stage event study models predicting an indicator for turnover including teachers of any FTE level then those working at least a quarter of full time, those working at least half of full time and those working at least three-quarters of full time.

Figure E7

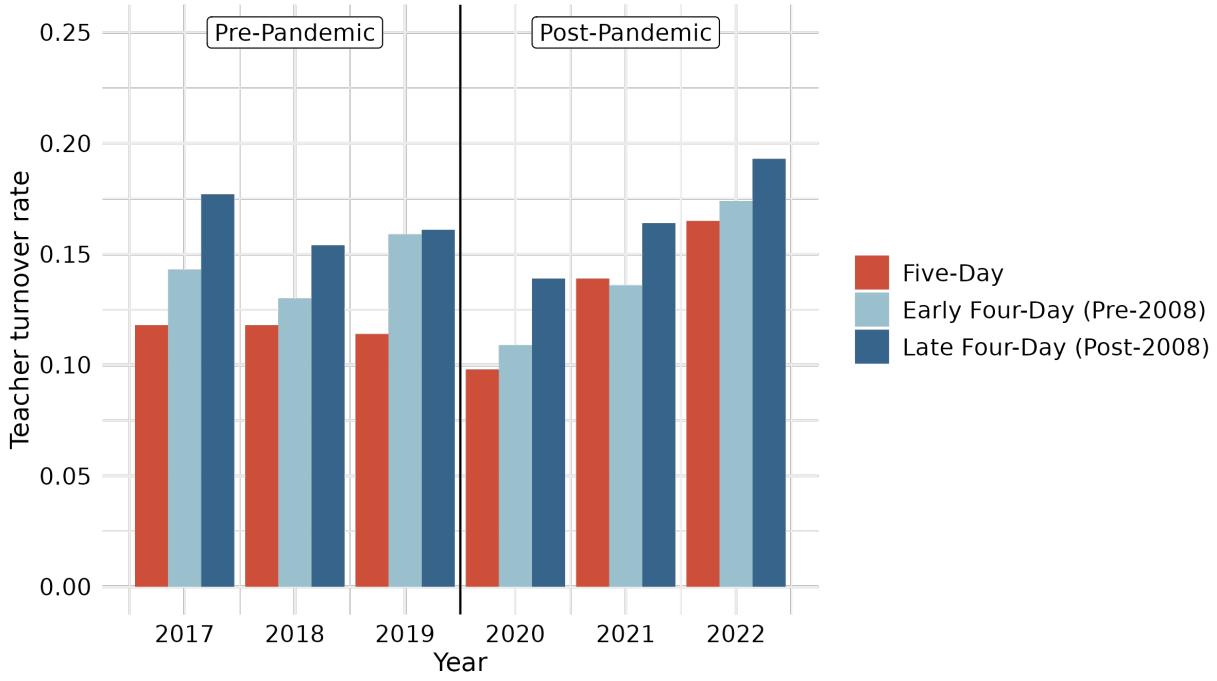
Event study staff turnover by FTE



Note: Figure displays coefficients and 95% confidence intervals from 4 two-stage event study models predicting an indicator for turnover including non-teaching staff of any FTE level then those working at least a quarter of full time, those working at least half of full time and those working at least three-quarters of full time.

Figure E8

Teacher turnover rates before and after the pandemic by 4dsw status (FTE >= 0.50)



Note: Figure displays turnover rates for all teachers in suburban, town, and rural schools for years 2017 to 2022. The early 4dsw adopters are the always treated and thus excluded from the analysis. The late 4dsw adopters are the main treated sample that is used for estimating longer term effects of 4dsw adoption.

Appendix F

Sample Characteristics

Table F1

Treated sample by relative years to treatment with trimming

Years to 4dsw start	N Teachers	N Teachers FTE>=0.5	N Other staff	N Other staff FTE>=0.5	N schools	N districts	Trimmed sample
-14	264	262	415	370	18	1	X
-13	260	250	413	364	19	2	X
-12	252	251	428	372	20	3	X
-11	239	235	429	384	20	4	X
-10	249	246	449	400	21	5	X
-9	220	219	409	369	20	5	X
-8	231	226	430	387	21	6	X
-7	230	229	420	376	20	6	X
-6	409	407	680	615	30	9	X
-5	834	822	1232	1130	51	13	
-4	843	835	1261	1172	57	16	
-3	1694	1647	2232	1968	106	28	
-2	1748	1727	2395	2118	109	31	
-1	1724	1707	2520	2191	113	32	
0	1642	1631	2474	2142	114	33	
1	1119	1106	1665	1472	89	31	
2	748	733	1018	902	66	29	
3	721	707	1030	909	65	28	
4	745	728	1080	927	67	28	
5	597	583	829	704	57	25	
6	534	504	752	642	51	23	
7	514	502	743	652	49	23	
8	531	498	770	667	49	22	
9	556	499	736	663	43	22	
10	512	470	753	679	42	19	X
11	330	327	500	472	33	18	X
12	266	265	414	365	27	13	X
13	48	48	39	34	6	3	X

Note: Table displays the number of treated teachers, staff, schools and districts for each relative time point. X denotes years trimmed from the analysis sample.