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THE CAUSES AND CONSEQUENCES OF U.S. TEACHER STRIKES

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ABSTRACT

The U.S. has witnessed a resurgence of labor activism, with teachers at the forefront. We examine how teacher strikes affect compensation, working conditions, and productivity with an original dataset of 772 teacher strikes generating 48 million student days idle between 2007 and 2023. Using an event study framework, we find that, on average, strikes increase compensation by 8% and lower pupil-teacher ratios by 0.5 students, driven by new state revenues. We find little evidence of sizable impacts on student achievement up to five years post-strike, though strikes lasting 10 or more days decrease math achievement in the short-term.

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I. Introduction

Organized labor has experienced a substantial decline in the U.S. over the last half century. The percent of unionized workers has fallen by more than 60% since 1970 (Naidu 2022). Labor activism experienced an even starker drop in past decades, with estimates of a 90% decline in worker participation in strikes (Massenkoff and Wilmers 2024). President Reagan's decision to fire and permanently replace striking air traffic controllers in 1981 opened the doors for many firms to adopt hardline responses to strikes (Rosenfeld 2006). Technological change and offshoring of traditional union sector jobs have further undercut union strength. Massenkoff and Wilmers (2022) find that in the post Professional Air Traffic Controllers Organization (PATCO) strike era, striking has not resulted in real wage gains for workers, on average (see also Rosenfeld 2006). Such trends have caused observers to pronounce America's unions "basically dead" (Ghilarducci 2015). However, a broad-based resurgence of labor activism in the U.S. in recent years among teachers, graduate students, hotel workers, actors, and autoworkers belies these historical trends and raises new questions about the efficacy of strikes as a core source of union power.

In this paper, we revisit the question of how strikes affect wages, working conditions, and productivity in the context of the U.S. K-12 public education sector. K-12 teacher activism offers an advantageous and important context to study the effect of strikes for several key reasons. First, public school teachers comprise one of the largest occupational fields in the United States, making up approximately 5% of the college educated workforce with over 3.7 million teachers nationally. Second, teachers constitute a sizable fraction of all unionized workers in the United States where nearly one in five union members (18%) is a public school teacher. Third, teachers have been at the forefront of the resurgence in labor activism. A wave of high-profiles teacher

strikes in 2018 gave rise to the "RedforEd" movement and resulted in the largest work stoppages in the United States in a generation (Bureau of Labor Statistics 2018; Milbank 2019). At least 78% (379,000 of 485,200) of workers participating in large work stoppages in 2018 were public school teachers, including many who were not unionized (Bureau of Labor Statistics 2018). Fourth, we can observe direct measures of wages and working conditions across the K-12 public education sector, which allows us to examine the effect of all teacher strikes regardless of whether they resulted in new collective bargaining agreements. Fifth, student scores on state standardized tests provide a direct measure of productivity which is rarely available in other labor sectors (Barth, Bryson, and Dale-Olsen 2020). Finally, teachers matter. A well-established body of research documents the large impacts that teachers have on the short- and long-term outcomes of both individual students and the economy as a whole (Chetty, Friedman, and Rockoff 2014; Hanushek 2011; Jackson 2018; Jackson, Rockoff, and Staiger 2014).

We construct and analyze an original database of 772 teacher strikes over the past 16 years. We use this novel dataset to describe the landscape of teacher strikes between the 2007-2008 and 2022-23 school years, finding that teacher strikes have been a recurring phenomenon over the last 16 years, particularly in the West Coast, mid-Atlantic, and Midwest. The median number of strikes per year is 12.5, resulting in a yearly national average of 89 days of canceled school. Most strikes are brief, with the modal strike lasting a single day. Cumulatively, teacher strikes have impacted roughly 11.5 million students, leading to the cancellation of a total of 3,403 days of school (48 million student days idle) over the past 16 years.

We next explore the causes of teacher strikes. We compile data from news reports on unions' stated motivations and analyze the empirical predictors of teacher strikes. Our findings demonstrate that compensation has been a key focus, with teachers advocating for higher wages

and benefits in 89% of strikes. Additionally, over half of the strikes were motivated by teachers advocating for improvements in working conditions, including lower class sizes, increases in educational expenditures and non-instructional staff (e.g., school nurses), and improvements to school buildings and school facilities. Roughly one in ten strikes focused on "common good" issues such as immigration and housing, issues that were more common in coordinated strikes across districts, as in the #RedforEd strikes in 2018 and 2019. Relative to other school districts, striking districts tend to be larger, more urban and suburban, and have lower levels of educational spending. The student population of striking districts is also more racially diverse and less economically advantaged, with higher student-teacher ratios. Politically, strikes tend to take place in more conservative states, largely due to the large-scale coordinated strikes across districts. Individual (non-coordinated) district strikes tend to take place in more politically liberal areas where strikes are more likely to be legal.

We examine the causal effects of teacher strikes on wages, working conditions, and productivity using doubly robust differences-in-differences estimators in an event study framework (Callaway and Sant'Anna 2020; Sant'Anna and Zhao 2020). We find that strikes lead to large increases in teacher compensation (i.e., salaries and benefits). Specifically, strikes increase annual teacher compensation by roughly 8% ($10,000 in real 2018$), on average, by the fifth year after a strike. Working conditions also appear to improve, with pupil-teacher ratios decreasing by 0.5 students (3.2%) and approximately a 7% increase in expenditures dedicated to the compensation of non-instructional staff who support the work of teachers. We find that these improvements in compensation and working conditions are funded from increasing the level of district expenditures, rather than reallocations of funds within existing budgets. Increases in district expenditures are funded by state revenues (rather than local taxes or federal education

aid), consistent with the notion that teacher strikes publicly signal the need for educational change to state political leaders (Lyon and Kraft 2024).

We also examine how strikes affect school district productivity, measured by student achievement. On the one hand, teacher strikes could improve productivity if districts are better able to attract and retain high-performing teachers as a result of strike-induced improvements to salary, benefits, and working conditions. These improvements might also allow teachers to be more productive by reducing the need to work second jobs, relieving financial stress, and reducing teacher burnout. On the other hand, strikes could decrease productivity through channels such as lost instructional time, acrimonious relationships that undercut teacher motivation and effort, or inefficient allocation of education funding. Prior studies of teacher strikes in Canada, Belgium, and Argentina find negative effects of strikes on student outcomes (Baker 2013; Belot and Webbink 2010; Jaume and Willén 2019; Johnson 2011); however, these occurred in different contexts with prolonged strikes that led to considerable amounts of lost instructional time. In the U.S. the median strike is 2 days, whereas the average Argentinian student in Jaume and Willén's (2019) study lost 88 school days to strikes.

We find no evidence of sizable positive or negative effects of strikes on student achievement, on average, and can rule out negative effects as small as -0.06 standard deviations (SD) and positive effects as small as 0.04 SD up to five years after a strike. We do find that strikes lasting two or more weeks cause math achievement to decline by .03-.05 SD in the year of the strike and the following year. These declines are not sustained beyond the first year after a strike. We explore longer-run effects in a balanced subsample of strikes occurring early in our panel given the delayed rollout of strike-induced spending increases and find suggestive evidence of small positive effects on math achievement, but small negative effects in reading.

We view these results as broadly consistent with the recent school finance literature (Jackson and Mackevicius 2024) given that it finds sustained increases in per pupil expenditures of $1,000 result in small achievement gains (0.03 SD) that are well within the confidence intervals of our estimates.

This study makes several important contributions to the literature. We introduce a new dataset that presents a national picture of teacher strikes from 2007 to the present— elucidating for the first time a central feature of the evolving U.S. labor movement (Cowen & Strunk, 2015; Naidu, 2022). While the Bureau of Labor Statistics tracks all strikes involving more than 1,000 employees, 97% of school districts employ fewer than 1,000 teachers. Our novel data bridge this gap in federal record-keeping, subsequently allowing us to build on prior studies of prolonged teacher strikes in the international arena that identify the joint effect of substantial lost instructional time alongside outcomes from bargaining processes (Baker, 2013; Belot & Webbink 2001; Jaume & Willen 2018; Johnson 2011).

We present the first credible estimates of the effect of teacher strikes on student achievement in the U.S. The high frequency and variable duration of teacher strikes in the U.S. combined with policies that require schools to make-up lost instructional days allow us to gain a clearer picture of how strikes affect productivity through the bargaining process, political channels, and public opinion, both with and without the effects of lost instructional time. Our finding that teacher strikes result in large and sustained increases in teacher compensation illustrates that strikes remain powerful tools for public sector organized labor to advance its interests. This stands in stark contrast to the decline in the effectiveness of all types of strikes in the 1980s and 1990s (Massenkoff and Wilmers 2024; Rosenfeld 2006). Finally, our paper contributes to the active literature on the ways in which teachers' unions affect production in the

public education sector (Baron 2018; Biasi 2021; Hart and Sojourner 2015; Hoxby 1996; Lovenheim 2009; Lovenheim and Willén 2019; Lyon 2021; Brunner, Hyman, and Ju 2019).

II. Background, Framework, and Literature

A. Teacher Strikes & the Law

Teacher strikes, defined as coordinated labor actions that involve the withholding of teacher labor, have been a persistent feature of American labor movements at least since the late 1920s. One of the earliest recorded instances of such strikes occurred in Wilkes-Barre, Pennsylvania, in October of 1929, when a group of 146 educators went on strike due to lack of pay for six months (*The New York Times* 1929). In the following decades, teachers across the United States organized and went on strike in increasing numbers, demanding better working conditions, higher pay, and autonomy from gendered inequalities embedded in administrative mandates (Perrillo 2012). Although the exclusion of public sector employees from the 1935 National Labor Relations Act impeded their growth, teachers began to secure collective bargaining rights on a state-by-state basis in the 1960s and 1970s.

The formation of two large, federated teachers' unions, the National Education Association (NEA) and the American Federation of Teachers (AFT), played a critical role in the rapid expansion of teachers' labor representation between 1970 and 1990. Figure 1 shows longitudinal membership counts for the NEA and AFT over the past century from archival and present-day NEA handbooks and original data provided to us from the AFT.[1] From 1960 to 1990, NEA membership increased from 750,000 to 2.1 million, and AFT membership increased 13-fold from 59,000 to 750,000. Teachers within districts increasingly became organized under the banner of a single local teachers' union with the exclusive right to collectively bargain on

[1] Membership counts are not mutually exclusive because the AFT and NEA have merged in several states.

their behalf. Since 1990, the pace of membership gains has slowed, and in some years, membership has declined. Teachers' union density has more consistently declined since the 1990s. According to federal data, 85% of public school teachers reported that they were union members in 1990, a figure that fell to 79% in 1999 and then to 68% by 2020.[2]

At present, collective bargaining is required if teachers have voted for union representation in 33 states and the District of Columbia, permitted in 10 states, and explicitly illegal in six.[3] Public school teachers often secured the right to collectively bargain as part of compromise legislation that granted these rights in exchange for the prohibition of strikes (Paglayan 2019). Today, teacher strikes are illegal in most states (37), though the majority of the public supports teachers having the right to strike (Henderson et al. 2019).

In states where strikes are legal, union leadership generally proposes the strike to the union membership. Union members then vote, and if approved, the union will set a date for the strike and notify the local school district. If the district and union still have not come to an agreement by the set date, then the teachers in that district are authorized to go on strike, often with some restrictions on the length of the strike. In the state of Illinois, for example, the general procedure for a teacher strike is determined by state law (the Illinois Educational Labor Relations Act), which allows for teacher strikes under certain circumstances (*Act 5* 1998). Teachers must be represented by an exclusive bargaining representative (i.e., a union) and must not have an active contract. The district and union must have attempted to resolve their differences through mediation. The teachers' union must have held a vote to authorize a strike in which three-fourths of union members supported the strike. The union must have provided the school district,

[2] Source: Schools and Staffing Survey; National Teacher and Principal Survey

[3] This accounts for 49 states because Tennessee recently replaced collective bargaining with "collaborative conferencing," and it is unclear at this time how this fits into the categories above.

regional superintendent, and the Illinois Educational Labor Relations Board with notice of its intent to strike at least 10 days in advance of the strike. The length of the strike can vary, but the strike will typically end when a settlement is reached or the school district is able to get a court injunction.

Illegality, however, is not enough to deter teacher strikes (Paglayan 2019). Teachers have engaged in various forms of work stoppages in many states where striking is not permitted. For example, thousands of teachers prominently chose to go on strike in 2018 and 2019, despite strikes being illegal in nearly every one of the "#RedforEd" states (e.g., Arizona, Kentucky, Oklahoma, North Carolina, and West Virginia). The processes for illegal teacher strikes differ even more widely across states and districts than those for legal strikes. In states where striking is illegal, teachers' unions can effectively strike when teachers collectively walk out of their classrooms (a "walk-out"). Another option is a "sick out," in which teachers call in sick *en masse*. In some instances, as seen during the 2018 and 2019 strikes, teachers may stage coordinated, statewide strikes targeting state legislatures, framed as a form of political expression protected as free speech. Teachers may also choose to go on an illegal strike even in a state where striking is permitted by state law. Illustrating this tactic, some California teachers have organized so-called "wildcat strikes," i.e., strikes that occur without the support of union leadership and do not undergo the state's processes for legal strikes.

In illegal teacher strikes, organizers often attempt to mobilize such a large-scale collective action that imposing legal penalties becomes unmanageable or impractical. Teachers and their unions can sometimes negotiate away penalties in the context of their collectively bargained agreements (e.g., agreeing that striking teachers will not be fined), or via other less formal agreements ending a teacher strike if collective bargaining is not in place. In 2023,

teachers in Newton, Massachusetts went on strike for two weeks with the Massachusetts Teacher Association stepping in to pay the fines for their illegal action. These practices are reflective of the maxim among labor organizers that "there is no such thing as an illegal strike, only an unsuccessful one" (Reddy 2021).

B. Conceptual Framework

Strikes, Wages, and Working Conditions.—The study of industrial labor actions often frames strikes as a result of an information asymmetry whereby the workforce lacks knowledge of the extent of firm surplus (Card 1990; Cramton and Tracy 1992; Krueger and Mas 2004; Mas 2008). Sustained disruptions caused by strikes can compel firms to disclose information regarding their profit margins and capacity to enhance wages and benefits (Cramton and Tracy 1992). However, the mechanics of teacher strikes differ meaningfully from strikes in the private sector (Lyon and Kraft 2024). Instead of a two-party negotiation with a firm, wage determination in the public sector is shaped through both collective bargaining with governmental bodies and the overall size of public investments. Unlike the revenue-maximizing operations of the private sector, public sector services function within the bounds of a fixed budget and no profit margins. Unions in the public sector can attempt to increase compensation via budget reallocation or unfunded commitments. They also have the ability to lobby government officials who control public sector spending allocations. Lyon and Kraft (2024) show that teacher strikes publicly signal the need for educational change to the public and elected leaders. They increase the probability of political ads mentioning education by more than double in U.S. House of Representatives races.

There are a range of reasons why one might expect strikes among public school teachers to be a high-leverage negotiating tactic compared to strikes in other unionized sectors of the

economy. Several features of the job make it far less likely that striking teachers can be easily replaced with non-unionized workers. Relative to most blue-collar jobs, there are higher barriers to entry into the teaching profession given state laws that require public school teachers to hold a bachelor's degree and a state teaching license. Licensure requirements differ but typically involve earning a teaching certificate from a teacher preparation program, passing tests covering general pedagogy and/or subject-specific content knowledge, and completing a student teaching practicum (Kraft et al. 2020).

Although states can and do grant emergency licensures that waive many of these requirements, the sheer size of the teacher labor market makes larger scale strikes particularly effective. Steady declines in enrollment in teacher preparation programs combined with stagnant teacher wages and longstanding localized shortages in certain regions, grade levels, and subject areas limit the potential supply of replacement teachers (Kraft and Lyon in press; Edwards et al. 2024). Unlike many private sector union jobs, teachers are not easily replaced or made more efficient with technological advancement. Class sizes have either remained stable or decreased over time, even as technology use has increased (Kraft and Lyon in press). The custodial nature of teacher work also means that it is very difficult to move teaching and learning offshore. Uniform teacher salary scales based on experience (i.e., years of teaching) and education also serve to enhance solidarity among union members despite substantial differences in job tasks and outside earning potential across teacher licensure types.

Teachers' unions also use strikes to advocate for better working conditions. Research that employs discrete choice experiments documents teachers' substantial willingness to pay for improved working conditions such as smaller class sizes, and additional support staff (Lovison and Hyunjung Mo 2024; Johnston 2022). These studies affirm that teachers' experience on the

job are meaningfully improved when they can count on the support of special education paraprofessionals, teachers' assistants, nurses, and teachers' aides. Advocating for better working conditions can also result in dynamic tradeoffs. For example, concessions by districts to increase teacher compensation may be funded by hiring fewer teachers and slightly increasing class sizes.

In some districts, teachers' unions also negotiate contracts alongside other unions representing other instructional staff (e.g., paraprofessionals) and noninstructional staff (e.g., cafeteria workers, guidance counselors, school nurses, clerical staff). Workers can even all be covered under the same collective bargaining agreement with different unit salary schedules. Collective negotiation strategies increase union leverage in bargaining but also can be difficult to achieve due to differing starting points and the tendency to renegotiate an agreement relative to a past agreement (i.e., teachers may be satisfied with a 3% raise, whereas cafeteria staff who are starting at a lower average base pay may prefer a $3,000 pay increase). In other districts, unions develop less formal alliances, though they still use their combined power to push for similar goals across collective bargaining cycles.

Public school teachers' central role in developing the knowledge and skills of almost 50 million students in the U.S. make their working conditions salient and important for parents as well. As educators have long argued, "teacher working conditions are student learning conditions." This slogan illustrates the unique opportunity teachers' unions have to galvanize and leverage a broad coalition of support in the political arena and public debate that extends far beyond their own members.

Strikes and Teacher Productivity.—The theoretical effects of teacher strikes on productivity, as measured by student achievement, are also decidedly ambiguous. Jackson and Mackivicious (2024) review the school financial literature and find that four years of increased

spending by $1,000 per pupil per year improves test scores by 0.03 SD, on average. However, the effects of strikes are best thought of as a bundle of treatments realized in very specific contexts that may include increased spending, a reallocation of existing fundings, and lost instructional time. We might expect strikes to have short-term negative consequences for student learning given the negative effect of lost instructional time on academic achievement (Kraft and Novicoff 2024). In theory, declines in student achievement in the short run could be mitigated in the medium term because schools typically make up days lost to strikes by canceling school breaks or adding extra days at the end of the school year. Still, attendance and instructional rigor during these make-up days are likely only partial substitutes for the days lost to strikes. Further, in instances where teachers' demands are not met, we might expect a failed strike to lead to lower morale and effort on the part of teachers, decreasing their productivity and student achievement.

Even if teachers secure wage increases following a strike, the effects these concessions will have on student achievement are still ambiguous in this context. Efficiency wage theory suggests that if teachers are compensated at their marginal product, then any increases in compensation should lead to increases in teacher productivity (Akerlof 1982; Shapiro and Stiglitz 1984). Higher wages can attract more qualified job candidates and increase morale and retention among existing staff (Katz 1986; Figlio 2002; Hendricks 2014). Compensation increases might also provide more resources to support other aspects of teachers' lives that otherwise might have interfered with their productivity (e.g., if teachers took on additional work outside of teaching that may no longer be necessary in light of strike-induced salary increases).

Wage increases secured via strikes may not translate into productivity gains (as measured by student test scores) if teachers are already maximizing their effort in the pre-strike period but

are not compensated equivalent to their marginal product. For many educators, selection into the profession is driven by intrinsic motivation to support students rather than pay. If teacher effort has already been capitalized in test scores in the pre-strike period, districts may be realizing rents by not paying teachers commensurate with their productivity. In this context, where teachers view their compensation as so inadequate that they are willing to strike, wage gains may not drive further effort. Wage gains may also have differential effects due to how they are structured. If union leaders, who tend to be veteran educators, prioritize salary increases at the back end of the salary schedule and improvements to teacher pensions, then these gains may do little to attract new educators or impact the effort and retention of early-career teachers. Even for those teachers who are motivated by newly won compensation, wage gains alone without corresponding investments in on-the-job skill development may not affect teachers' abilities to increase productivity (Murnane and Cohen 1985).

Finally, the effect of additional compensation and/or working conditions won by teachers likely depends on whether these concessions are funded through new resources or a reallocation of existing resources. New resources likely come from local or state funding sources such as local bond initiatives or an increase in local property taxes or state sales or income taxes. Federal revenues comprise less than 10% of U.S. educational revenues—largely to provide funding support for districts serving large concentrations of disadvantaged students—and are unlikely to be affected by strikes. The ultimate impact of reallocating existing dollars towards teachers' salaries and working conditions will depend upon the relative efficiency of how those dollars were previously being spent.

C. Effects of Teacher Strikes

Existing research on the consequences of teacher strikes largely centers around their short- and long-run effects on students' educational and economic outcomes. Early studies that explore the association between strikes and student achievement at the cross-section of these outcomes find a somewhat mixed and inconclusive pattern of results (e.g., Lytle and Yanoff 1973; Caldwell and Jeffreys 1983; Thornicroft 1994). In several more recent studies, scholars attempt to take advantage of variation across localities and over time to generate more credible estimates of the effect of teacher strikes. And yet, much of this literature comes from studies of prolonged teacher strikes *outside* of the U.S.

Two studies of Canadian teacher strikes use fixed effects approaches to demonstrate that strikes lasting more than 10 days reduce student achievement in certain grades[4] by roughly three percent of a SD, particularly in the year that the strike occurs (Baker 2013; Johnson 2011). Two additional studies of exposure to strikes in Belgium (Belot and Webbink 2010) and Argentina (Jaume and Willén 2019) use differences-in-differences (DiD) approaches to demonstrate that the loss of roughly 4-5 months of instructional time has long-term negative consequences for students' human capital development and long-run labor market outcomes. These studies improve upon prior efforts by removing important sources of bias in earlier descriptive studies but may not generalize to the U.S., where teacher strikes tend to be much shorter and less common (Jaume and Willén 2019; Allende 2021; Baker 2013; Johnson 2011).

To our knowledge, no study has examined the direct effect of teacher strikes on teacher compensation or working conditions. Two recent studies document how teacher strikes in the U.S. have important implications for the broader political economy. Lyon and Kraft (2024) and Hertel-Fernandez, Naidu, and Reich (2021) leverage DiD and regression discontinuity

[4] Baker (2013) finds negative effects in grades five and six, and Johnson (2011) finds negative effects in grades three and six.

approaches to demonstrate that strikes have notable political effects on campaign priorities and public opinion, dramatically increasing the prevalence of education in politics and elevating support for teacher demands. This is consistent with broader trends in public opinion in the U.S. where the percentage of the public who view teachers' unions as a positive influence on schools has risen from 32% in 2013 to 43% (Henderson et al. 2019). The percentage who approve of labor unions generally also has increased from a historic low of 48% in 2009 to 67% in 2023 (Saad 2023).

III. Data

A. Original National Strike Database

We construct an original database of teachers' strikes in the United States from July 2007 to 2023. We define a teacher strike as a coordinated labor action involving the withholding of teacher labor and resulting in at least one day of school closure. This includes legal, illegal, coordinated, and individual strikes, as well as "wildcat" strikes, "walk-outs," or "sick-outs" that lead to school closures.

In total, we find 772 teacher strikes across 610 unique school districts in 27 states. To create this dataset, our research team of three principal investigators and seven research assistants relied primarily on data collected through our own original search efforts, which necessitated the review of roughly 90,000 news articles. Our original search efforts involved three primary data collection approaches, which we describe in detail in Online Appendix A: (1) 186 Boolean searches on Google that produced over 42,500 news articles that our team reviewed, (2) 50 Boolean ProQuest searches of news documents producing roughly 43,500 news articles that our team reviewed, and (3) reviews of all NEA and AFT state affiliate websites at three points in time. We focused primarily on news sources because strikes are typically

accompanied by press releases or news reports of closed schools which inform parents not to send their children to school. We validated and supplemented this search process with several additional sources including administrative data from PA and IL, tracking by the office of the Secretary Treasurer at the American Federation of Teachers (AFT), and Cornell University's publicly available labor action tracking since 2021.

For each strike, we coded the school district, state, school year, start date, end date, duration (days), whether the strike was coordinated across districts within a state, the primary data source, and the stated reason(s). We determined stated reasons based on the news articles covering the strikes, grouping them into three categories: (i) compensation; (ii), working conditions; and (iii) common good. We define compensation as comprised of demands related to salary and/or benefits including healthcare, retirement, and time off. Working conditions include class size, infrastructure and maintenance (e.g., new buildings, building new classrooms within old buildings, ventilation, and draining), noninstructional staff (e.g., counselors, nurses, and social workers), labor rights, and/or other general school expenditures not specifically related to salaries and benefits. Common good provisions are defined as out of school conditions that affect communities (e.g., housing affordability, broader social safety net protections, tax increases on higher incomes, Medicaid expansion).

B. Outcomes

We merge our strike dataset with several measures of compensation, working conditions, and productivity at the district-year level. We use data on compensation, working conditions, and district characteristics from the Common Core of Data (CCD), maintained by the National Center for Education Statistics (NCES). Our primary fiscal measure is logged teacher compensation, which we estimate as the average instructional salary and benefit expenditures in

a district divided by the number of full-time equivalent (FTE) teachers.[5] We examine average teacher salary and benefits both together and separately.

We use three primary measures of teacher working conditions: pupil-teacher ratios, working conditions expenditures per pupil, and capital expenditures per pupil. We use pupil-teacher ratios and capital expenditures per pupil calculated by the NCES. Note that capital expenditures are not included in current expenditures and thus independent of all other expenditure measures. We then characterize all current expenditures per pupil, with the exception of teacher salary and benefits, as a proxy measure of the investments that districts make in teacher working conditions, broadly construed. This includes the salary and benefits of all non-teacher district employees as well as funds for professional development, school infrastructure and maintenance, instructional materials, and more. We show results with the two component parts of this measure as well: noninstructional salary and benefit expenditures per pupil and expenditures per pupil not spent on salaries and benefits (i.e., non-salary and benefit expenditures per pupil). We also use CCD information on total revenues per pupil, local revenues per pupil, state revenues per pupil, and federal revenues per pupil. We inflation adjusted all fiscal measures to reflect real 2018$ and then logged them to derive estimates that approximate percent changes. Fiscal measures are available for the school years 2007-2008 to

[5] NCES defines full-time equivalent as "The state's (or district's) FTE value for a teacher. FTE is the amount of time required to perform a teaching assignment stated as a proportion of a full-time position; it is computed by dividing the amount of time employed by the time normally required for a full-time position. FTE is not necessarily linked to contract days" (Noel 2010). The Census of Governments (2017) defines employee benefit expenditures as "the employer share of state or local employee retirement contributions, social security contributions, group life and health insurance, unemployment and worker's compensation, and any tuition reimbursements." The instructional salaries and benefits measures include salaries and benefits for both teachers and instructional assistants and aides. We use the count of FTE teachers as the denominator in our primary measure because the extent to which districts hire and report instructional aides varies wildly, and instructional aides make substantially less than teachers. We also create an alternate measure of average instructional staff compensation measured as instructional salary and benefit expenditures/FTE teachers + instructional aides and paraprofessionals). Results are not meaningfully different with this outcome, as shown in Appendix Figure B1.

2019-2020. Pupil-teacher ratios and data on the number of FTE teachers are available from 2007-2008 to 2021-22.

To measure productivity, we use the Stanford Education Data Archive Version 5.0 student achievement data at the district-by-year level (SEDA; Reardon et al. 2024). These data from state standardized tests have been normed to the National Assessment of Education Progress (NAEP) exam, allowing for cross-state comparisons despite the tests differing across states. SEDA currently includes measures of 3rd- to 8th-grade academic performance in mathematics and reading at the district-grade level across all states for the spring of 2009 to 2019. These test scores are standardized to the nationwide population of school districts. We merge the SEDA data with the subset of our strike data covering the time period included in the SEDA data (2008-2009 to 2018-2019 school years), by generating average district-by-year math and reading achievement averages using precision weights, as described by Shores and Steinberg (2019).

C. Covariates and Predictors of Strikes

We also merge our strike data with district and state-level information for use as control variables in our primary empirical specification and as predictors in our examination of the causes of teacher strikes. As covariates, we include district-level, time-varying measures of student enrollment, unemployment rates, child poverty rates, and socioeconomic status. Student enrollment counts are derived from the CCD as described above. Measures of child poverty are from Urban Institute's Data Explorer. To measure local labor market conditions, we also include SEDA measures of unemployment rates and socioeconomic status (SES) at the district-by-year level. When data are missing on covariates, we use a district-level linear interpolation to estimate the missing value. The socioeconomic measure is calculated by Reardon et al. (2024). SEDA

documentation describes this as the "first principal component score of the following measures (each standardized): median income, percent of adults ages 25 and older with a bachelor's degree or higher, poverty rate for households with children ages 5-17, SNAP receipt rate, single mother headed household rate, and employment rate for adults ages 25-64."

To examine empirical predictors of strikes, we examine district demographic characteristics derived from the CCD, as described above. These include the percentages of special education students; English language learners; White, Black, Hispanic, Asian/Pacific Islander, Native American, and Multi-racial students; the school age population in poverty; and students living in urban, suburban, and town or rural areas. We supplement our panel data with measures of teachers' union strength from our own original data collection efforts. These include whether a state prohibits strikes, whether a state has a policy preventing agency fees (i.e., Right to Work prior to 2018), and a ratio of NEA members to full time teachers. We also examine public opinion on economic and social policy issues with Caughey and Warshaw's (2018) mass economic policy preferences and mass social policy preferences (where a higher number indicates greater liberalism). Finally, as a measure of income inequality, we include the state's Gini coefficient from the U.S. Census.

IV. Econometric Approach

We estimate the effect of strikes on wages, working conditions and productivity by exploiting differences in exposure to strikes across school districts in a dynamic DiD (i.e., event study) framework. We compare changes in schooling inputs in districts that experienced strikes with contemporaneous changes in districts that never, or had not yet, experienced teacher strikes. This strategy estimates the causal effect of strikes under the assumption that changes in outcomes

in school districts that never experienced strikes provide a valid counterfactual for the changes that would have occurred in striking districts had they not experienced strikes.

A. Empirical Specification

To examine the effects of teacher strikes and how they may vary over time, we use dynamic event study estimators as follows:

$$(1) \qquad Y_{dt} = \sum_{r=-5}^{5} \beta_r \mathrm{I}(t - t_d^{strike} = r) + \lambda X_{dt} + \pi_d + \delta_t + \varepsilon_{dt},$$

where *Y* is the average outcome (e.g., teacher compensation, pupil-teacher ratios, or achievement in math or reading) for district *d* during school year *t*, and t_d^{strike} indicates the year of the strike for district *d*. β_r represents the effect of the strike r years later (or before if $r < 0$) relative to the year before the strike. The terms π_d and δ_t represent district and year fixed effects, respectively. A benefit of this approach is that the coefficients β_{-5} to β_{-1} dynamically test for differences in trends prior to strikes between treated and control districts, thus embedding a falsification test for the key assumption noted above. The β_0 to β_5 coefficients then map out the effect of strikes over time non-parametrically. We include a vector of controls for dynamic local labor market conditions, X_{dt}, which includes district-level, time-varying measures of student enrollment, unemployment rates, child poverty rates, and socioeconomic status. In Appendix Tables B1 and B2, we show that our findings are not sensitive to the inclusion of these covariates. Across all our analyses, we censor striking districts that strike in the last year of a given outcome-specific analytic dataset because we have no post-strike outcome data for these districts.

Recent research has also illustrated that two-way fixed effects (TWFE) DiD estimators can be biased in the presence of staggered treatment timing and treatment effect heterogeneity (Callaway and Sant'Anna 2020; Sant'Anna and Zhao 2020; Goodman-Bacon 2021; Sun and

Abraham 2021). To address this issue, we use doubly robust DiD estimation (Callaway and Sant'Anna 2020; Sant'Anna and Zhao 2020). This addresses potential biases from the staggered nature of teacher strikes and potentially heterogeneous strike effects by estimating the average strike effect on striking districts for each cohort of striking districts in each period relative to the strike. This estimator is considered doubly robust because it uses both outcome regression and inverse probability weighting to estimate these group-time average treatment effects on the treated (ATTs; Sant'Anna and Zhao 2020). We then aggregate these separate ATTs according to the weighting specification recommended by Callaway and Sant'Anna (2020). In short, the weights are based on how much information was used to generate the ATT, such that more precise estimates based on more striking districts receive more weight, whereas those based on just a few districts are downweighted.

B. Approach to Multiple Events

Multiple events are fairly common in our panel, with 130 of the 610 striking districts experiencing multiple strikes. Though this is frequently an issue in DiD analyses, a generally accepted strategy for dealing with multiple events in DiD analyses does not exist, and prior literature has tended to favor simple and objective methods for dealing with this challenge (Lafortune, Rothstein, and Schanzenbach 2018; Lyon and Kraft 2024). In our preferred specification, we focus on the first strike in a given district. In Appendix Tables B1 and B2, we confirm that our results are consistent when we model the full set of strikes across our panel, following a procedure outlined by Lafortune and colleagues (2018) and Lyon and Kraft (2024). We create a copy of each school district experiencing multiple events for each strike event after the first one, estimate the effect of each strike separately, and then aggregate all of these effects with weights to correct for overrepresentation of districts with multiple strikes. As detailed in the

robustness section, effects using the full set of strikes are very similar, suggesting that subsequent strikes within a district have similar effects to earlier ones.

V. National Landscape of Teacher Strikes

Teacher strikes have occurred with regular frequency in the United States over the last 16 years. Across our panel, the median annual number of such strikes is 12.5 strikes per year, corresponding to a median of 89 total strike days per year. Over this period, strikes have accounted for the loss of over 48 million student-days in schools. Figure 2 displays the frequency of strikes since 2007. We separate individual and coordinated strikes because coordinated strikes, by definition, involve multiple districts. We count each district strike as a separate strike event. Strikes have occurred in every year of our panel with spikes in activity corresponding with the #RedForEd coordinated strikes of the 2017-18 and 2018-19 school years. The modal strike lasts only a single day, with 65% of strikes ending in five days or less (see Figure 3).

As shown in Figure 4, strikes have occurred in 27 states with notable geographic clustering on the west coast, the mid-Atlantic, and the Midwest. Individual strikes have occurred in 22 states (see Appendix Table B3). The four states with the most frequent number of individual strikes are Pennsylvania (59), Illinois (43), California (38), and Washington (30). Nine states have experienced coordinated strikes. States without strikes may perhaps exhibit even more diverse legal environments than states with strikes. In New York, state law requires district leadership to engage in collective bargaining if a majority of teachers vote for union representation. New York's Taylor Law and subsequent Triborough Amendment instituted twofold penalties for teacher strikes that include the loss of two days' pay for each day on strike and the loss of continuation of benefits after a contract has expired. The state of Texas has also not experienced any strikes. In Texas, collective bargaining is illegal for teachers. Making

collective bargaining illegal is not sufficient to deter strikes, however. Collective bargaining has also been illegal in North Carolina, South Carolina, and (until recently) Virginia, but these states experienced large-scale coordinated strikes in 2018 and 2019.

VI. Causes of Teacher Strikes

Teacher strikes overwhelmingly focus on teacher compensation. Appendix Table B4 shows the distribution of strike reasons in our three broad, non-mutually exclusive categories (compensation, working conditions, and common good), as well as their respective sub-categories. Nine out of every ten (89%) teacher strikes involve demands for increasing teacher salaries or benefits. Over half of strikes (59%) included a focus on working conditions such as general school expenditures, infrastructure and maintenance, noninstructional staff, and/or labor rights. One in six strikes included demands for increases to non-instructional staffing or pay, specifically. "Bargaining for the common good" has also been a focus in some recent high-profile strikes, including one in Chicago in 2019 (Lyon 2023), prompting us to also note when strikes involved demands related to common good issues—defined as out of school conditions that affect communities, such as housing affordability or immigration policy. Common good demands are present in roughly 10% of teacher strikes.

To examine empirical descriptors of strikes, Table 1 shows baseline differences between striking and non-striking districts.[6] Notably, striking districts have similar baseline teacher compensation, though they had larger pupil-teacher ratios and lower current expenditures per pupil. Striking districts also had lower revenues per pupil at the local and state levels. Striking districts were substantially larger and more likely to be urban and suburban. They tended to serve

[6] We use the raw ($) versions of compensation and expenditures variables here for clarity. We impute missing district-year observations using linear interpolation but show that results are nearly identical without the imputation in Appendix Table B5. We use means from the 2007-2008 school year, the first year in which we have strike data.

larger proportions of students who are non-white, in poverty, and English Language Learners. Somewhat surprisingly, districts that went on strike tended to be in states that were less friendly towards teachers' unions, driven by cross-district coordinated strikes in 2012, 2015, 2018, and 2019 (see Appendix Table B6). Almost three quarters of striking districts were in states where strikes are prohibited, compared to two thirds of districts that did not experience a strike. Districts with strikes were also in states with lower relative levels of membership in the nation's largest teachers' union, the National Education Association (NEA). Striking districts also tended to be in more conservative states relative to non-striking districts. However, striking and non-striking districts were equally likely to be in states with state specific Right to Work policies for teachers' unions and were in states with similar average levels of economic inequality.

VII. Consequences of Teacher Strikes

A. Compensation

We first examine whether strikes result in the compensation changes that teachers demand. Panel A in Figure 5 shows that strikes, indeed, lead to substantial and sustained increases in teacher compensation, which comprises roughly 53% of total district expenditures. We present point estimates for this and all other outcomes in Appendix Table B7. Specifically, we find that strikes cause average compensation to increase by 3% ($2,000/teacher) in the year after a strike. Compensation then continues to increase in the following years, reaching an increase of roughly 8% ($10,000/teacher) in the fifth year after a strike. These staggered increases are not surprising given that policymakers often break out salary increases incrementally over three to five years.

We also show in Panels B and C that these increases are distributed proportionately across salaries and benefits. On average, we observe that strikes lead to a 5-8% ($3,000-$7,000)

increase in teacher salaries in the 3-5 years after the strike. Strikes also cause teacher benefits to increase by 6-9% ($2,700- a $3,400) over the same time period.

In Appendix Figure B2, we examine whether these effects on teacher salaries are driven by increases in total expenditures on instructional salaries and benefits (i.e., the numerator) scaled per pupil or by a reduction in total teacher FTE (i.e., the denominator). We find that strikes increase instructional salary and benefit expenditures by 6-10% ($300-$600 per pupil) in the three to five years after a strike. We find no evidence that strikes lead to a reduction in teacher FTE, suggesting that gains in compensation are driven by real increases in wages and benefits rather than by cutting teaching jobs or leaving vacant positions unfilled.

B. Working Conditions

In Figure 6, we examine the effect of teacher strikes on two measures of working conditions: pupil-teacher ratios and district expenditures excluding instructional salary and benefits. We find that, on average, teacher strikes lead to a decline in pupil-teacher ratios of about half of a student in three to five years after a strike (3.2% relative to a base of 15.37 students; see Table 1). This suggests that districts slightly decrease class sizes in response to teacher strikes.

As a proxy measure of working conditions, we examine expenditures per pupil that are *not* spent on instructional salaries and benefits. Figure 6 demonstrates that teacher strikes increase working conditions expenditures by 5-7% in the 3-5 years following the strike. We further disaggregate this proxy measure of working conditions into two funding categories: non-instructional salary and benefit expenditures per pupil (25% of total current expenditures), and expenditures per pupil not spent on salaries and benefits (for either instructional or non-instructional staff; 19% of total current expenditures). We find that strikes increase non-

instructional salary and benefit expenditures per pupil by 7-10% ($200-$400).[7] In contrast, we find that strikes have no effect on non-salary and non-benefit expenditures per pupil (e.g., instructional materials and technology) or capital expenditures per pupil, which NCES measures separately from other expenditures. Taken together, the above results suggest that teacher strikes not only raise teacher compensation but also the compensation of noninstructional staff.

C. Sources of Funding Increases

Funding for the aforementioned compensation and working conditions improvements could either come from new revenues or reallocations of funding from existing sources. Districts could generate new revenues by, for example, increasing local property taxes. States are also key funders of educational services and teacher salaries (see Table 1), and strikes may lead states to increase their funding of public education through direct negotiation and through the public signaling mechanism that strikes provide (Lyon and Kraft 2024).

We first examine the effects of strikes on total expenditures and revenues to determine the sources of compensation increases. Results in Figure 7 show that strikes increase yearly per pupil expenditures and revenues by 5-10% in the 3-5 years after a strike (roughly $600-$1,300 per pupil). This demonstrates that funding for compensation and working conditions improvements secured via strikes came largely from new revenues, not reallocations. To investigate the sources of these revenues, we examine the effect of strikes on local, state, and federal revenues per pupil in Figure 8. We find that the strike-induced increases in per pupil expenditures and revenues are largely driven from state sources. We see that teacher strikes raise

[7] Auxiliary analyses in Appendix Figure B3 demonstrate that these increases reflect real increases in noninstructional compensation, rather than the hiring of new noninstructional staff members. Districts may have raised noninstructional staff compensation alongside teacher compensation as part of coordinated bargaining efforts, or they may have initially attempted to hire additional noninstructional staff but experienced difficulty at pre-strike salary levels and needed to increase compensation.

district revenues from state sources by 15% on average in the fifth year following a strike (~$1,600 per pupil). We find that strikes have no effect on federal revenues per pupil and have a very small, negative effect on local revenues per pupil in the fourth and fifth years after a strike.

These results are not surprising given the important public signaling effects of strikes and the fact that states are large funders of education revenues. Additionally, many of the strikes in our panel were coordinated across districts within states and explicitly targeted the state legislatures; however, in auxiliary analyses we find that individual district strikes *also* led to similar increases in state revenues. This may be because many of the states where individual strikes tended to occur rely heavily on state revenues for education spending, especially for teacher compensation. In California (38 strikes), for example, state revenues comprised 54% of all revenues in 2021, compared to just 33% for local revenues. Similarly, state revenues comprised 68% of revenues in Washington state (30 strikes), compared to 24% for local revenues.

D. Productivity

Figure 9 displays the results of Equation 1 for student achievement in reading and math. Here, we find no evidence that strikes affect reading or math achievement in the year of the strike or in the subsequent five years after the strike, on average. Importantly, these are relatively precise and informative null effects. In the short run where we might expect lost instructional time to negatively affect student achievement, we can rule out average negative effects in the year of the strike as small as -0.019 SD for math and -0.012 SD for reading. In the medium run where we might expect increases in district expenditures to positively affect student achievement, we can rule out average positive effects in the fourth and fifth year post strike as small as 0.020 SD for math a 0.017 SD for reading.

Why didn't increased expenditures and smaller classes drive improvements in achievement?— In a recent meta-analysis of school finance literature, Jackson and Mackevicius (2024) find that increasing *noncapital* expenditure by $1,000 per pupil for four years increases student test scores by 0.034 SD. There is also a long-standing literature on the academic benefits of class size reductions (Angrist and Lavy 1999; Glass and Smith 1979; Hoxby 2000; Krueger 1999; 2003; Schanzenbach 2006; Chetty et al. 2011). Results from the Tennessee STAR class size experiment find that reducing kindergarten class sizes by 7 students, from 22 to 15, raises tests scores by 0.2 SD (Krueger 1999). However, the magnitude of the treatment effects of strikes on expenditures and pupil-teacher ratios are meaningfully different than those analyzed in prior studies. It is not until the fourth year after a strike that we observe treatment effects of increased expenditures per pupil of $1,000 or more. Our estimate of a strike-induced 0.5 student (3.2% reduction) in class sizes, on average, does not even approach the magnitude for which we might expect an effect.

Given that we find a $1,000 per pupil funding increase in years 4 and 5 post-strike, we might expect that, if increases are sustained, we would see a positive effect on student achievement four years after these large increases began, i.e., the eighth year after a strike. There are nine strikes for which we can estimate the effect of the strikes on achievement for eight years following a strike. We show estimated effects on achievement and spending for these nine strikes in Appendix Table B8. First, we find that increases to expenditures are sustained in the full eight years after the strike. In the fourth post-strike year, this subset of districts experiences a 7% increase in per pupil expenditures, equivalent to ~$950. The estimate increases to 11% or ~$1,500 in the fifth year after a strike, where it remains for the following three years. Estimated effects on student achievement in math closely track those from our full sample in the first four

years post-strike and then appear to rise after districts have made sizable increases in per pupil expenditures for multiple years. The point estimates in years five through eight post-strike are closely aligned to the results we might expect from the Jackson and Mackevicius (2024), becoming as large as 0.06 SD in the 7th year post-strike although imprecisely estimated. Estimated effects in reading remain negative through year 8 post-strike, although we cannot rule out smaller positive effects consistent with Jackson and Mackevicius (2024) given the wide confidence intervals. Thus, we cannot rule out that strikes resulted in delayed small positive effects on student achievement.

VIII. Strike Duration

Prior research on strikes has explored how strike duration is related to employment outcomes (see Card 1990 for a review). We explore the degree to which our findings above differ by the length of teacher strikes. A primary reason why duration might matter in the context of teacher strikes is because of the positive effects instructional time has on students' academic acheivement (Kraft and Novicoff 2024). Extant literature on strikes in Argentina and Belgium finds large negative effects for over 3 months of lost instructional time due to strikes (Belot and Webbink 2010; Jaume and Willén 2019); this is very different from the US, where the median strike ends in less than a week. However, studies on strikes in Canada have examined short-run effects on student achievement, finding that strikes lasting more than 10 days cause a roughly 0.03 SD decrease in math achievement for students who were in grades 3, 5, and/or 6 at the time of a strike (Baker 2013; Johnson 2011).

We test whether the effects of US teacher strikes vary depending on the length of the strike by re-estimating our preferred models where we subset the data to include only treated districts that went on strike for either less than 10 days (two weeks), or two weeks or more. We

present results in Figure 10. Consistent with the hypothesis that strike duration is an endogenous outcome that is likely a product of the negotiation context, process, and results, we find no differential effects of strike duration on compensation or pupil-teacher ratios.

We do find evidence that strikes lasting two weeks or more cause student achievement in math to decline in both the year of the strike and the subsequent year. Estimates for reading reveal no negative shocks to achievement in the year of the strike but a similar negative point estimate in the following year that is imprecisely estimated. These differential effects where longer strikes have negative short-term effects on achievement are consistent with prior evidence of the negative effects of longer teacher strikes on student outcomes (Baker, 2013; Belot & Webbink 2001; Jaume & Willen 2018; Johnson 2011). They also align with realities on the ground were strikes of less than two weeks might reasonably be made up at the end of the year or during school breaks whereas it becomes infeasible to make up the full amount of instructional days lost due to strike of two weeks or more.

IX. Robustness

We examine the robustness of our findings to a range of sensitivity checks, which we report in Appendix Tables B1 and B2. First, to address concerns that the effects may be driven entirely by the coordinated strikes across districts, Column 2 demonstrates the point estimates of our four primary outcomes with coordinated strikes dropped. We also show the opposite, estimating the effect of *only* coordinated strikes in Column 3. Some may also be concerned about spillover effects from striking districts to neighboring districts. We anticipate that any potential spillover effects would understate the effects of strikes because of state-level funding increases that benefitted all districts. We test for spillover effects by limiting comparison districts to those only in states that never experienced a strike in our panel. In Column 5, we also do the opposite,

limiting analyses to only states that experience strikes. In Column 6, we address potential concerns that strikes may be associated with –or induce– changes to the composition of students by controlling for additional school sociodemographic characteristics: the percent of students who are English Language Learners, have special needs, live in urban, suburban, and town or rural areas, and are Black, Hispanic, White, or Asian (with other races as the uncoded comparison group). In Column 7, we show results with no covariates, removing the enrollment and local labor market control variables. Finally, in Column 8 we estimate the effect of all strikes in a given district, instead of just the first strike.

Panel A of Appendix Table B1 shows the robustness checks for the estimated strike effect on teacher compensation. We find that our preferred estimates of the effect of strikes on average teacher compensation are very robust to these alternative modeling choices. They are nearly identical across individual and coordinated strikes (Columns 2 and 3), with the addition of student sociodemographic controls (Column 6), the removal of control variables (Column 7) and when estimating effects of all strikes (Column 8), ranging from a 6-9% increase in the fifth year after a strike. We also find suggestive evidence of potential spillovers. When we limit comparison districts to those outside of striking states, we find a 10% increase (Column 4) in teacher compensation. In comparison, when we limit to only striking states, the estimated effect is reduced to 5% (Column 5) suggesting our preferred estimate of 8% may understate the full effect of strikes.

In Panel B, we show robustness checks for the effect of strikes on pupil-teacher ratios. We find that the estimated strike-induced reduction of pupil-teacher ratios by roughly half a student per teacher is very consistent (ranging from 0.46 to 0.65 students per teacher), with the exception of the analyses excluding coordinated strikes (Column 2), in which it is somewhat

smaller and non-significant. This suggests that coordinated strikes drive the findings related to pupil-teacher ratios.

In Appendix Table B2, we examine the robustness of our findings on math and reading achievement across Panels A and B, respectively. These results continue to support the main conclusions described above. We do find a handful of small potential increases and decreases in the years following strikes, which may be due to multiple hypothesis testing. Taken together, we see this as generally consistent with the conclusion that teacher strikes, on average, do not affect student achievement in five years after a strike.

X. Discussion

Teacher strikes have become a potent form of collective action in recent years, particularly within the well-unionized teaching workforce in the U.S. Using an original 16-year database of teacher strikes, we show that strikes and work-stoppages continue to be a tool used by teachers in states across the country—including those where collective bargaining is not permitted, and where strikes are illegal. In contrast to an industrial-era image of prolonged strikes, most modern teacher strikes are relatively brief events often lasting only one or two days. Such strikes largely center around demands for higher compensation and increased educational expenditures during a period where teacher wages have remained stagnant, lagging those of other college educated workers, and education expenditures have yet to fully rebound to their 2008 highs after the Great Recession (Kraft and Lyon in press).

Our causal analysis of the effects of strikes demonstrates that strikes increase teacher compensation by over $10,000 per teacher (8%) after five years. It would be a mistake, however, to interpret our average estimates as suggesting that strikes always lead to wage increases. We find that roughly 23% of districts that went on strike during our panel did not see wage increases

beyond what we might expect from a simple linear projection of their annual wage growth rate. It is not that these strikes had different goals. Those districts that did not see wage gains were actually more likely to press for compensation increases: 95% of the striking districts that did not ultimately experience salary gains had advocated for increasing teacher compensation compared to 88% of districts experiencing post-strike salary gains. Of course, it may be the case that these strikes were able to stave off wage cuts or freezes in the face of budget shortfalls.

Importantly, gains in compensation are not the result of reallocations of existing funds but rather increased revenues coming primarily from state sources. Districts also do not offset higher salaries with larger class sizes or workforce reductions, as we find a small decrease in pupil-teacher ratios and no effects on overall teacher FTEs. Gains in compensation appear to be broadly distributed, benefitting both instructional and non-instructional staff. This may reflect the nature of collective action, whereby teachers coordinate strikes and demands with other district employees to advocate for better compensation across the board.

Lastly, we find no evidence that strikes lead to any sizable, sustained effects on student achievement in math or reading, although prolonged strikes do reduce reading achievement in the year of and immediately following the strike. The lack of detectable effects on student achievement five years after a strike, despite large increases in per pupil expenditures, is not surprising given the temporal dynamics of how increases in per pupil expenditures affect student achievement. Based on Jackson and Mackevicius's (2024) meta-analysis, school districts would expect to experience increases in student achievement after four years of sustained $1,000 per pupil increases to instructional expenditures. When we examine the small subset of districts that strike early in the panel, allowing us to observe such sustained effects, the expected effects on achievement are well within our confidence intervals.

The modern labor movement in the U.S. has faced substantial challenges since the pivotal decision of President Reagan to break the PATCO strike. Unionization among private sector workers has been in decline for decades, while public sector unions have seen their membership grow but their overall coverage begin to erode. Our analyses demonstrate that despite the limited success of labor actions in the decades following the PATCO strike, strikes remain a potent form of leverage for achieving compensation gains in the public sector. Teachers' unions have used strikes to win substantial increases in salaries and benefits across a wide range of district contexts: both small and large, as well as across conservative and liberal states.

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Tables and Figures

TABLE 1. BASELINE SOCIODEMOGRAPHIC CHARACTERISTICS OF STRIKING AND NON-STRIKING DISTRICTS (2007-8)

	Striking Districts	Non-Striking Districts	Striking-Non-Striking Difference	
			Overall	Within States
District Characteristics				
Average Teacher Compensation ($1,000s)	93.56	92.24	1.32	5.02*
Average Teacher Salaries ($1,000s)	69.71	69.20	0.51	3.19+
Average Teacher Benefits ($1,000s)	23.72	23.19	0.53	1.52*
Pupil-to-Teacher Ratio	16.63	15.37	1.26	1.24*
Total Current Expenditures per Pupil ($1,000s)	10.68	12.48	-1.80***	-0.88+
Instr. Salary and Benefit Expenditures per Pupil ($1,000s)	5.74	6.71	-0.97***	-0.20
Working Conditions Expenditures per Pupil ($1,000s)	4.23	5.16	-0.93***	-0.62*
Noninstr.Salary and Benefit Expenditures per Pupil ($1,000s)	2.86	3.11	-0.25***	-0.08
Non-Salary and Benefit Expenditures per Pupil ($1,000s)	2.06	2.82	-0.76***	-0.68***
Capital Expenditures per Pupil ($1,000s)	1.29	1.19	0.10	0.24*
Total Revenues per Pupil ($1,000s)	12.52	15.37	-2.86+	-0.97+
Local Revenues per Pupil ($1,000s)	5.03	7.16	-2.13+	0.35
State Revenues per Pupil ($1,000s)	6.47	7.47	-1.00+	-1.27*
Federal Revenues per Pupil ($1,000s)	1.08	1.19	-0.10	-0.33*
Total Student Enrollment (1,000s)	11.82	2.76	9.06***	10.74***
% Special Education Students	13.73	14.13	-0.40	-0.22
% English Language Learners	7.07	4.08	2.99***	3.26**
% White Students	66.91	70.46	-3.55**	-4.46
% Black Students	9.90	11.57	-1.67+	1.96
% Hispanic Students	15.49	11.76	3.73***	3.67*
% Asian/Pacific Islander Students	2.95	2.15	0.81***	1.37**
% Native American Students	3.57	3.14	0.43	-2.86*
% Multi-Racial Students	0.23	0.48	-0.25+	-0.01
% School Age Population in Poverty	0.16	0.16	0.01*	-0.03**
% Urban	19.52	12.58	6.94***	6.92
% Suburban	27.57	20.45	7.12***	15.05***
% Town/Rural	52.91	66.97	-14.06***	-21.98**
Unemployment Rate	0.06	0.06	0.00***	0.00
Socioeconomic Status (SD)	-0.16	0.01	-0.16***	0.15+
State Characteristics				
% Strikes Prohibited	0.72	0.66	0.06**	
% Right to Work	0.37	0.37	-0.01	
Ratio of NEA Members/Full Time Teachers	0.98	1.09	-0.11***	
Mass Economic Policy Liberalism (SD)	-0.27	0.01	-0.28***	
Mass Social Policy Liberalism (SD)	-0.21	0.01	-0.22***	
Gini Coefficient	0.61	0.61	-0.01***	
Districts	584	14,866		

Notes: All finance measures are in real 2018 dollars. Socioeconomic Status, Mass Economic Policy Preferences, and Mass Social Policy Preferences are standardized (z-scored). Data on district (state) characteristics from missing years are extrapolated at the district (state) level using linear trends within districts. Results without this imputation are presented in the appendix. Differences within states come from a series of OLS regressions with each characteristic regressed on a dichotomous indicator of whether there is ever a strike with state fixed effects.

*** Significant at the 0.1 percent level.

** Significant at the 1 percent level.

* Significant at the 5 percent level.

+ Significant at the 5 percent level.

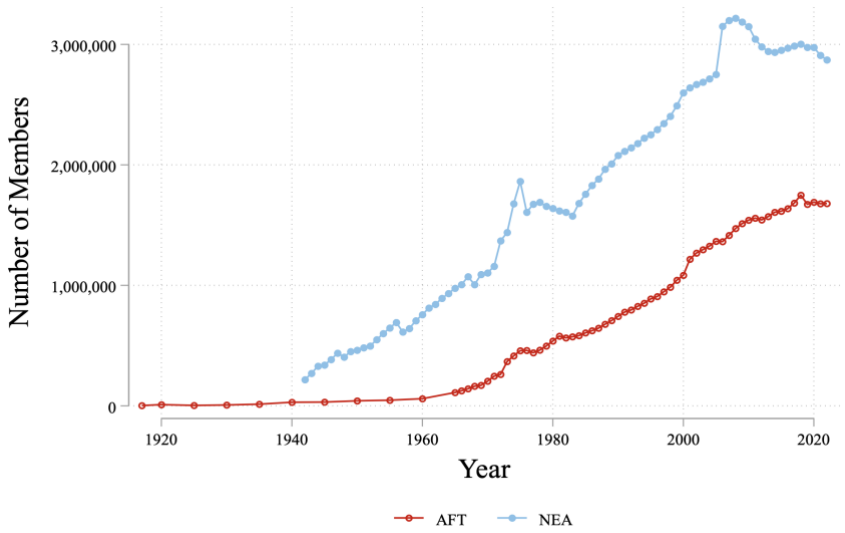


FIGURE 1: NUMBER OF TEACHERS' UNION MEMBERS OVER TIME

Notes: Data are sourced from archival and present-day NEA handbooks and original data provided to us from the AFT. Membership counts are not mutually exclusive because the AFT and NEA have merged in several states.

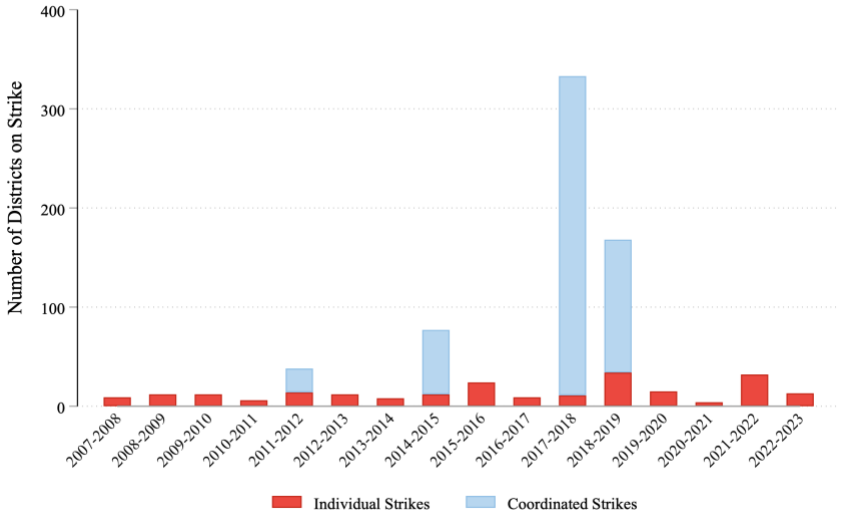


FIGURE 2. NUMBER OF DISTRICTS ON STRIKE OVER TIME

Notes: Figure displays the number of strikes in each school year. Strike data are from the authors' compilation.

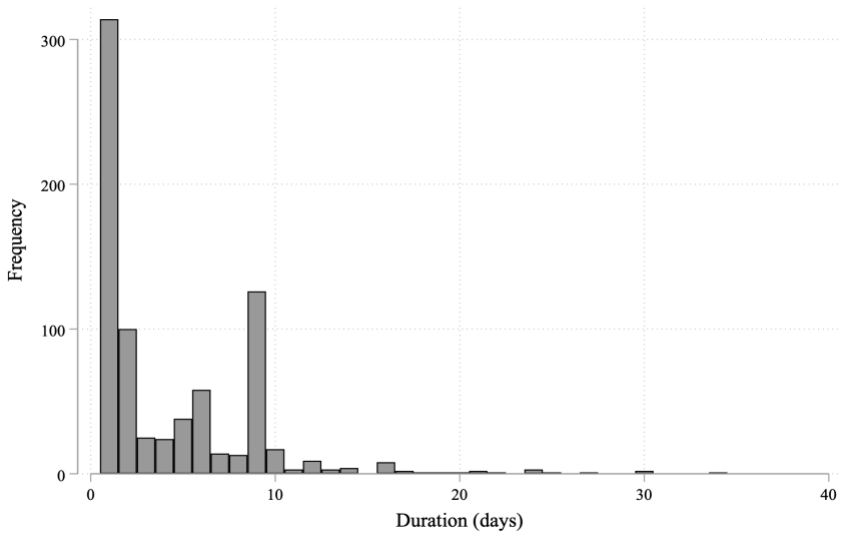


FIGURE 3. COUNT OF STRIKES BY DURATION

Notes: Figure displays the distribution of strikes by duration. Strike data are from the authors' compilation.

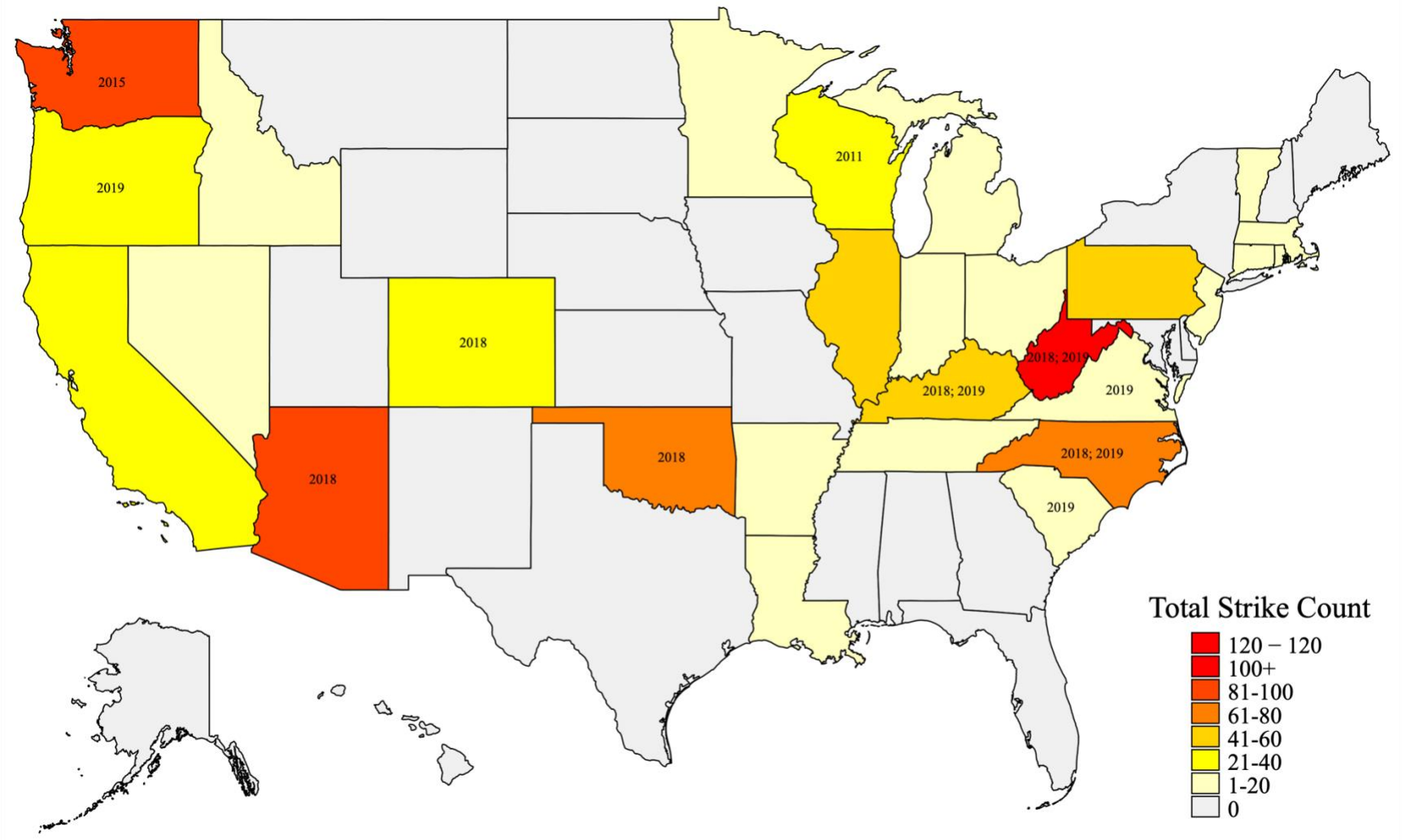
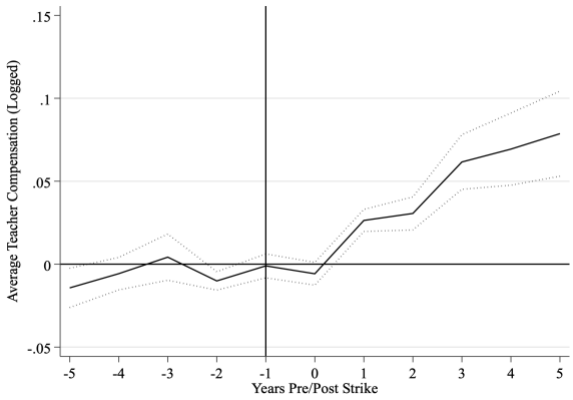


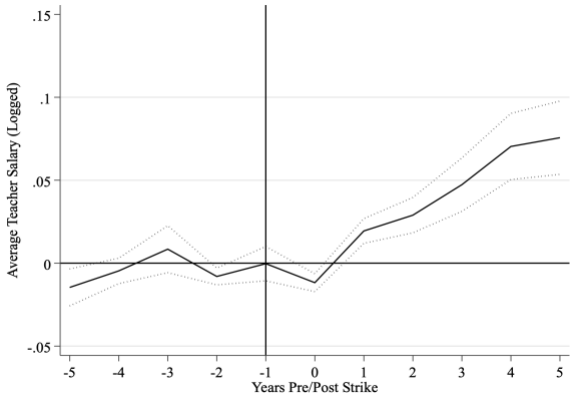
FIGURE 4. NATIONAL MAP OF U.S. TEACHER STRIKES

Notes: Data are from the authors' compilation. Strikes are counted at the district-event level. Dates indicate the year of a coordinated strike across districts within the state.

PANEL A. TOTAL COMPENSATION



PANEL B. SALARIES



PANEL C. BENEFITS

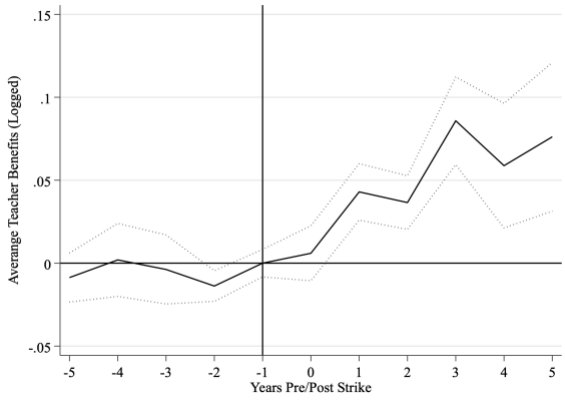


FIGURE 5. EFFECT OF STRIKES ON TEACHER COMPENSATION

Notes: Solid line indicates the estimate from Equation 1 with school-district and school-year fixed effects. We use the specification recommended by Callaway and Sant'Anna (2020) to estimate an average treatment effect across distinct group-time estimates. Dotted line indicates the 95% confidence interval. Data are from the authors' compilation, as well as the NCES.

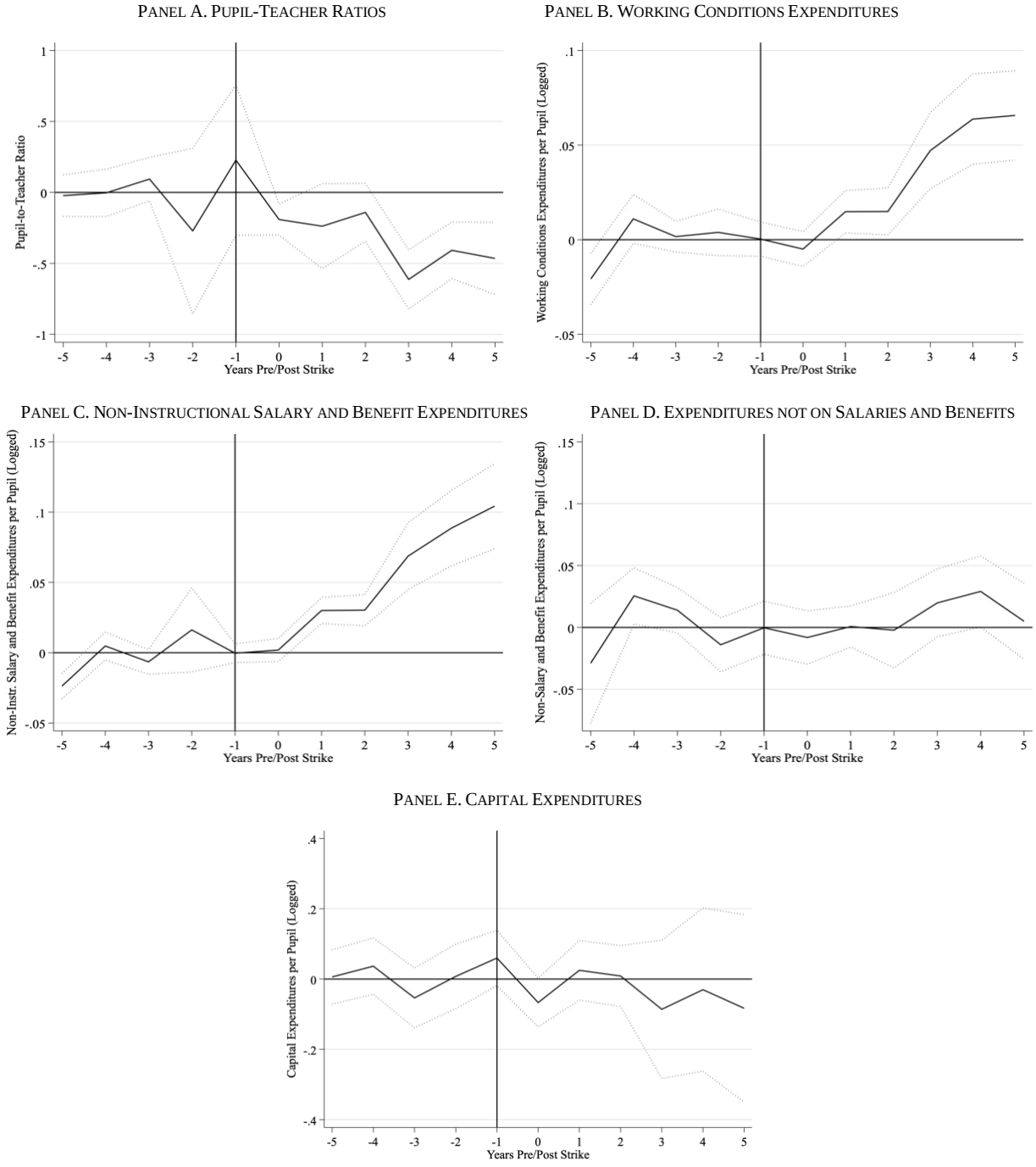
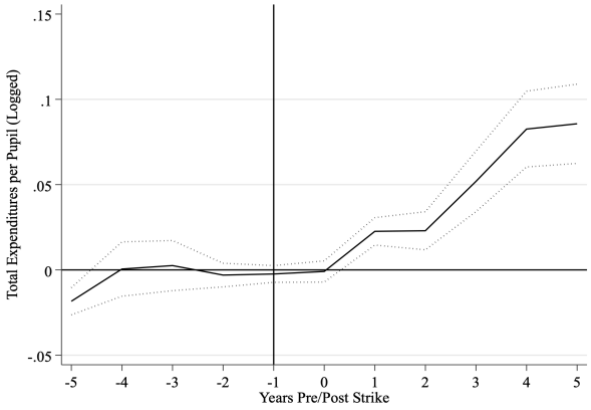


FIGURE 6. EFFECT OF STRIKES ON WORKING CONDITIONS

Notes: Solid line indicates the estimate from Equation 1 with school-district and school-year fixed effects. We use the specification recommended by Callaway and Sant'Anna (2020) to estimate an average treatment effect across distinct group-time estimates. Dotted line indicates the 95% confidence interval. Data are from the authors' compilation, as well as the NCE

PANEL A. TOTAL EXPENDITURES PER PUPIL



PANEL B. TOTAL REVENUES PER PUPIL

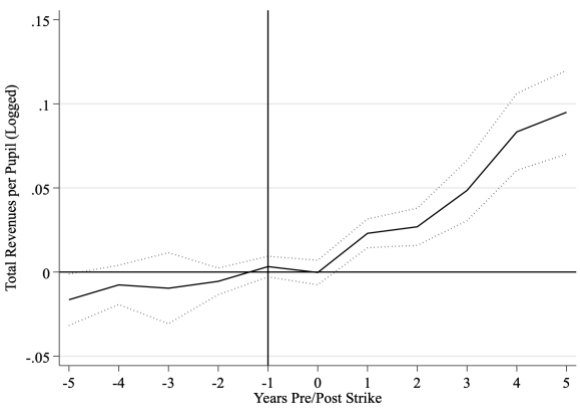


FIGURE 7. EFFECT OF STRIKES ON EXPENDITURES AND REVENUES

Notes: Solid line indicates the estimate from Equation 1 with school-district and school-year fixed effects. We use the specification recommended by Callaway and Sant'Anna (2020) to estimate an average treatment effect across distinct group-time estimates. Dotted line indicates the 95% confidence interval. Data are from the authors' compilation, as well as the NCES.

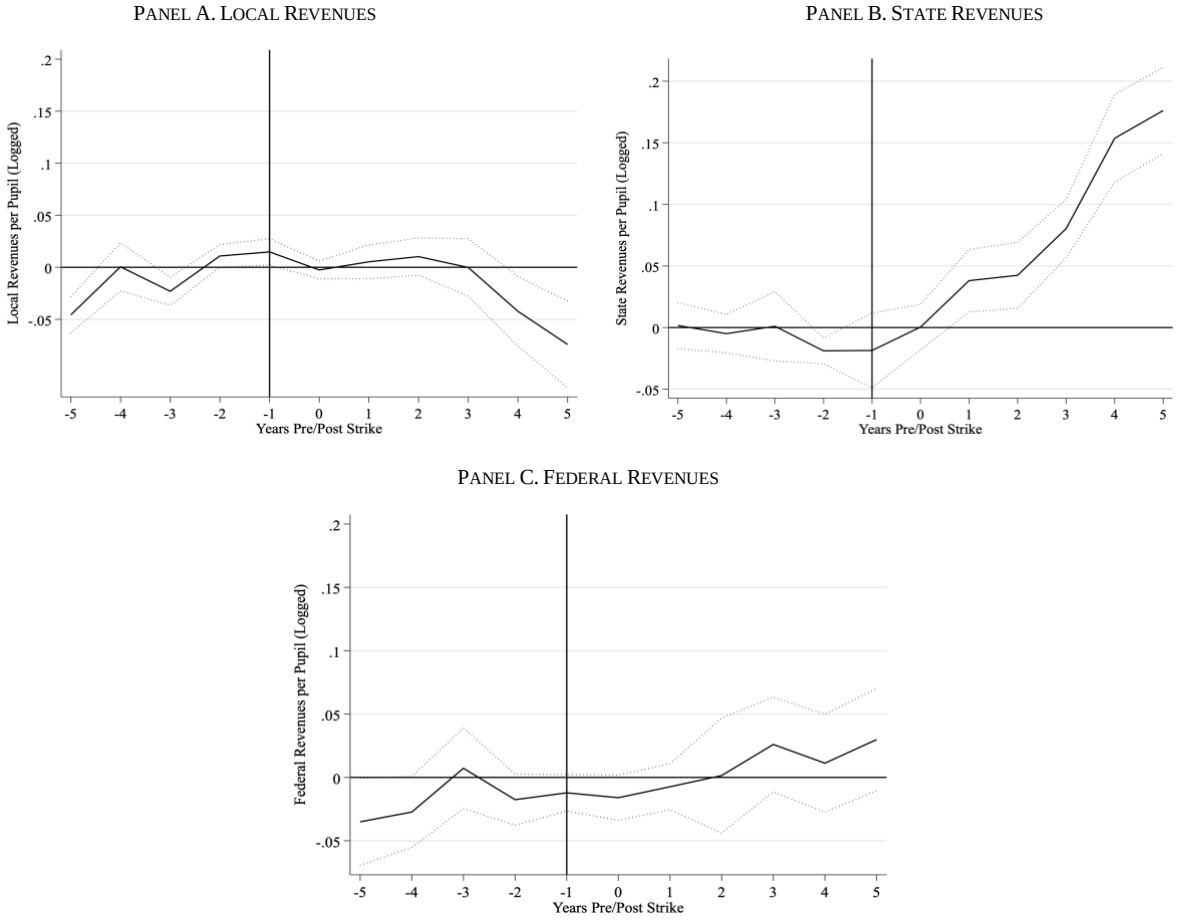


FIGURE 8. EFFECT OF STRIKES ON REVENUE SOURCES

Notes: Solid line indicates the estimate from Equation 1 with school-district and school-year fixed effects. We use the specification recommended by Callaway and Sant'Anna (2020) to estimate an average treatment effect across distinct group-time estimates. Dotted line indicates the 95% confidence interval. Data are from the authors' compilation, as well as the NCES.

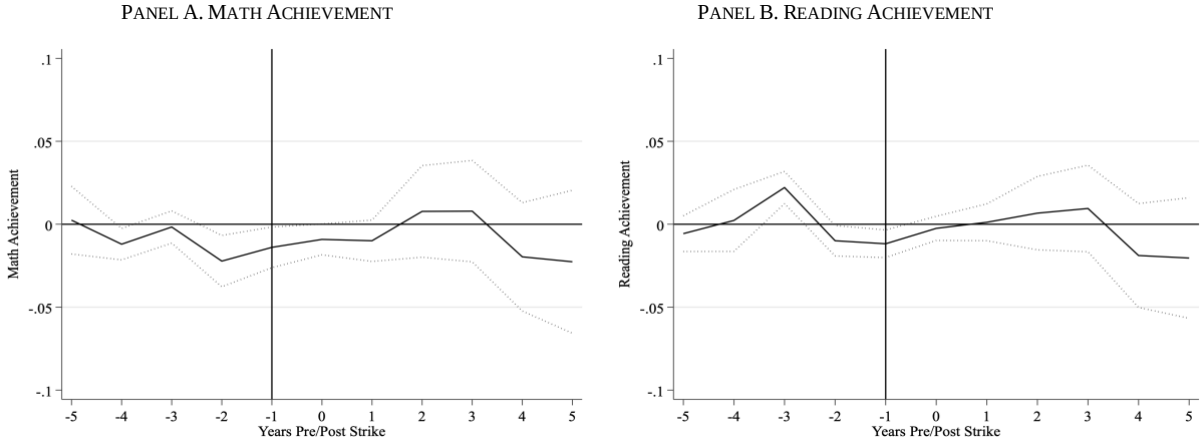


FIGURE 9. EFFECT OF STRIKES ON STUDENT ACHIEVEMENT

Notes: Solid line indicates the estimate from Equation 1 with school-district and school-year fixed effects. We use the specification recommended by Callaway and Sant'Anna (2020) to estimate an average treatment effect across distinct group-time estimates. Dotted line indicates the 95% confidence interval. Data are from the authors' compilation, as well as the SEDA 5.0

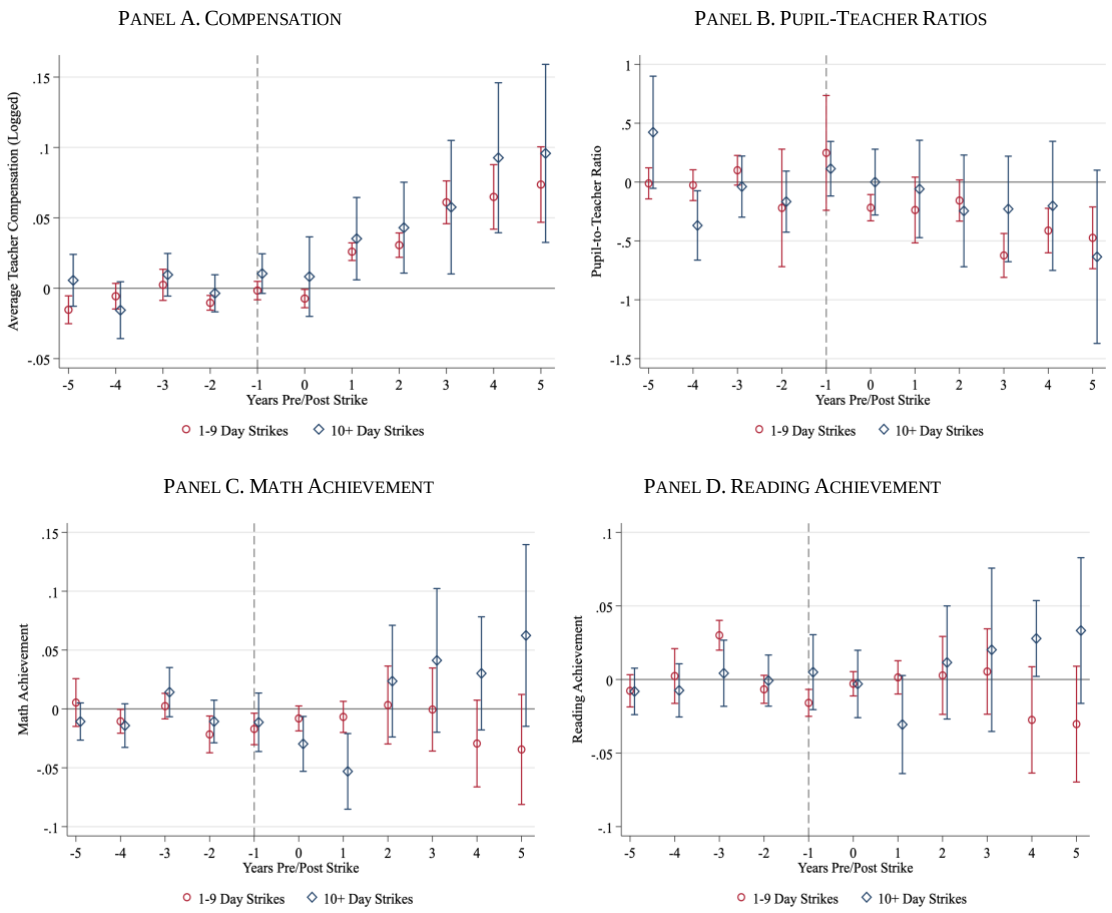


FIGURE 10. HETEROGENEITY BY STRIKE LENGTH

Notes: To produce differential estimates by strike length, we subset the data to include only treated districts that went on strike for either less than two weeks (1-9 days) or two weeks or more (10+ days). For each analysis, we use the specification recommended by Callaway and Sant'Anna (2020) to estimate an average treatment effect across distinct group-time estimates. Capped line indicates the 95% confidence interval. Data are from the authors' compilation, as well as the NCES and the SEDA 5.0.

The Causes and Consequences of U.S. Teacher Strikes

Online Appendix

Appendix A. Data Collection Details

Our original search efforts involved three primary data collection approaches: (1) 186 Boolean searches on Google that produced over 42,500 news articles that our team reviewed, (2) 50 Boolean ProQuest searches of news documents producing roughly 43,500 news articles that our team reviewed, and (3) reviews of all NEA and AFT state affiliate websites at three points in time. We focus primarily on news sources because strikes are typically accompanied by press releases or news reporting of closed schools to inform parents not to send their children school. We then validated and supplemented this search process with several additional sources including administrative data from PA and IL, tracking by the office of the Secretary Treasurer at the American Federation of Teachers (AFT), and Cornell University's publicly available labor action tracking since 2021.

First, our Google searches used the keyword "strike" with the News filter and the additional Tools to customize time ranges for each month and year from the 7/1/2007 to 12/31/2022. A member of our research team read all search results until the content became no longer relevant to labor strikes. On average, each of these monthly searches produced 23 pages of relevant content with 10 articles per page, leading us to review over 42,500 articles. To review these articles, we focused first on the headline and short preview sentences to determine if the article was at all related to labor strikes. If so, a member of the research team read the entire article to look for information regarding teacher strikes. Second, in ProQuest, we searched News Documents between 7/1/2007 and 12/31/2022 using the term: "teacher strike" AND STATE. We read all headlines of search results for each state to determine if it was related to a strike we had not previously identified. Each year that we searched produced, on average, 2,900 articles to review, leading us to review roughly 43,500 articles. Third, we reviewed the NEA and AFT state affiliate websites at three moments in time (in 2017, 2019, and 2022) to check for any documentation of strikes that we had not previously found.

We then cross-referenced and expanded our dataset with several additional sources. We collected administrative data from the states of PA (2007-8 through 2016-17; retrieved through Freedom of

Information Requests) and IL (2010-2021; retrieved from public documentation of the Illinois Educational Labor Relations Board Annual Reports). We were also able to use these sources to validate our search process, suggesting that our search procedures described above uncovered at least 85% of strikes. We also obtained data on teacher strikes provided directly by the Office of the Secretary Treasurer at AFT, and we supplemented and cross-referenced our dataset with the Labor Action Tracker published by Cornell University's School of Industrial and Labor Relations, which has tracked strikes since 2021. We also reviewed the National Bureau of Labor Statistics for additional documentation of teacher strikes, though their efforts focus exclusively on strikes involving over 1,000 workers. We also reviewed the work stoppage information collected and published by the Federal Mediation and Conciliation Service (FMCS) set up in 1947, though we found very few public school teacher strikes reported, perhaps due to the lack of coverage for public sector workers under the National Labor Relations Act of 1935.

Appendix B. Appendix Tables and Figures

Appendix Table B1. Robustness Checks for Effect of Strikes on Avg. Teacher Salaries and Pupil-Teacher Ratios

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Years Since Strike	**Panel A. Logged Average Teacher Compensation**							
-5	-0.01*	0.02*	-0.02***	-0.02***	-0.01	-0.02**	-0.02***	-0.01*
	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)	(0.01)	(0.00)	(0.01)
-4	-0.01	-0.01	-0.00	-0.01	0.03	-0.01	-0.01	-0.01
	(0.00)	(0.01)	(0.00)	(0.00)	(0.02)	(0.01)	(0.00)	(0.00)
-3	0.00	0.03***	-0.00	-0.00	0.03	0.00	-0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)	(0.00)	(0.00)	(0.01)
-2	-0.01***	0.01	-0.01***	0.00	0.01	-0.01**	-0.01***	-0.01***
	(0.00)	(0.01)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)
-1	-0.00	0.01	-0.00	0.00	-0.02	-0.00	-0.01*	-0.00
	(0.00)	(0.01)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)
0	-0.01	0.02*	-0.01**	-0.00	0.01	-0.01	-0.01*	-0.01
	(0.00)	(0.01)	(0.00)	(0.00)	(0.02)	(0.01)	(0.00)	(0.00)
1	0.03***	0.04***	0.02***	0.03***	0.06**	0.02***	0.03***	0.03***
	(0.00)	(0.01)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)
2	0.03***	0.05***	0.03***	0.04***	-0.02	0.03***	0.03***	0.03***
	(0.01)	(0.01)	(0.00)	(0.00)	(0.03)	(0.01)	(0.00)	(0.00)
3	0.06***	0.06***	0.07***	0.08***	0.05***	0.06***	0.06***	0.06***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
4	0.07***	0.08***	0.05**	0.10***	0.05***	0.06***	0.07***	0.07***
	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
5	0.08***	0.09***	0.06**	0.10***	0.05*	0.08***	0.08***	0.08***
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
	Panel B. Pupil-Teacher Ratios							
-5	-0.02	0.01	-0.01	0.00	0.10	-0.04	0.04	-0.02
	(0.07)	(0.20)	(0.07)	(0.07)	(0.24)	(0.07)	(0.07)	(0.06)
-4	-0.00	-0.04	-0.01	-0.03	0.41	-0.07	-0.03	-0.03
	(0.09)	(0.15)	(0.08)	(0.06)	(0.30)	(0.07)	(0.06)	(0.06)
-3	0.09	0.05	0.12	-0.02	-0.82	0.13	0.06	0.08
	(0.08)	(0.13)	(0.07)	(0.05)	(0.60)	(0.08)	(0.07)	(0.07)
-2	-0.27	-0.03	-0.25	-0.04	-1.47	-0.14	-0.01	-0.11
	(0.30)	(0.13)	(0.26)	(0.06)	(1.70)	(0.23)	(0.10)	(0.12)
-1	0.23	-0.05	0.22	-0.06	1.21	0.20	-0.21	0.11
	(0.27)	(0.14)	(0.24)	(0.06)	(1.51)	(0.37)	(0.25)	(0.15)
0	-0.19***	-0.03	-0.21***	-0.28***	0.06	-0.26**	0.20	-0.19***
	(0.06)	(0.11)	(0.06)	(0.06)	(0.27)	(0.08)	(0.32)	(0.05)
1	-0.24	-0.18	-0.22	-0.26***	-0.95	-0.33*	0.07	-0.19
	(0.15)	(0.13)	(0.15)	(0.07)	(1.22)	(0.16)	(0.38)	(0.10)
2	-0.14	-0.34*	-0.13	-0.48***	0.63	-0.19	0.09	-0.21**
	(0.10)	(0.17)	(0.10)	(0.14)	(0.39)	(0.17)	(0.30)	(0.07)
3	-0.61***	-0.17	-0.68***	-1.05***	-0.13	-0.66***	-0.41*	-0.59***
	(0.11)	(0.19)	(0.10)	(0.23)	(0.32)	(0.14)	(0.20)	(0.08)
4	-0.41***	-0.15	-0.42***	-0.86***	-0.06	-0.28*	-0.02	-0.41***
	(0.10)	(0.23)	(0.10)	(0.18)	(0.25)	(0.14)	(0.32)	(0.09)
5	-0.47***	-0.33	-0.66***	-0.73***	-0.45	-0.49**	-0.59***	-0.45***
	(0.13)	(0.24)	(0.15)	(0.15)	(0.23)	(0.15)	(0.17)	(0.12)

Notes: Robust standard errors clustered at the district level are in parentheses. Models include district and year fixed effects, as well as controls for student enrollment and local labor market conditions. Column (1) displays results from the preferred specification estimating the effect of the first strike in a given district. Column (2) drops coordinated strikes. Column (3) drops individual district strikes. Column (4) limits comparison districts to those outside of striking states. Column (5) limits analyses to only states that experience strikes. Column (6) controls for urbanicity, the percent of students with special needs, the percent of students who are English Language Learners, and student race (the percent of students that are Black, Hispanic, White, or Asian, with other races as the uncoded comparison group). Column (7) estimates the effects of all strikes in a given district instead of the first strike. This specification replaces district fixed effects with district-by-event fixed effects. + p<.10, * p<0.05, ** p<0.01, *** p<0.001

Appendix Table B2. Robustness Checks for Effect of Strikes on Student Achievement

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Years Since Strike				**Panel A. Math**				
-5	0.002	-0.015	0.007	0.007	0.019	0.006	0.010*	0.008
	(0.010)	(0.009)	(0.008)	(0.006)	(0.017)	(0.006)	(0.004)	(0.006)
-4	-0.012*	-0.023*	-0.010	-0.014**	0.005	-0.016***	-0.011*	-0.011*
	(0.005)	(0.010)	(0.005)	(0.005)	(0.020)	(0.005)	(0.004)	(0.005)
-3	-0.002	-0.028*	0.003	-0.000	-0.008	-0.003	-0.002	0.001
	(0.005)	(0.011)	(0.006)	(0.005)	(0.019)	(0.005)	(0.005)	(0.005)
-2	-0.022**	-0.016	-0.022**	-0.017***	-0.025	-0.018**	-0.018***	-0.017***
	(0.008)	(0.009)	(0.007)	(0.004)	(0.015)	(0.007)	(0.004)	(0.005)
-1	-0.014*	-0.009	-0.013*	-0.010*	-0.072*	-0.010*	-0.013**	-0.017***
	(0.006)	(0.008)	(0.006)	(0.005)	(0.029)	(0.005)	(0.004)	(0.005)
0	-0.009	-0.012	-0.008	-0.002	-0.036**	-0.008	-0.005	-0.009*
	(0.005)	(0.008)	(0.005)	(0.005)	(0.013)	(0.005)	(0.004)	(0.004)
1	-0.010	-0.002	-0.011	-0.001	-0.025	-0.009	-0.004	-0.003
	(0.006)	(0.012)	(0.007)	(0.007)	(0.017)	(0.007)	(0.006)	(0.006)
2	0.008	-0.005	0.032	0.013	0.005	0.009	0.012	0.006
	(0.014)	(0.017)	(0.025)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
3	0.008	0.013	0.005	0.017	0.006	0.011	0.017	0.010
	(0.016)	(0.018)	(0.033)	(0.016)	(0.016)	(0.015)	(0.016)	(0.016)
4	-0.020	-0.016	-0.016	-0.006	-0.023	-0.013	-0.005	-0.021
	(0.017)	(0.021)	(0.029)	(0.017)	(0.018)	(0.016)	(0.017)	(0.017)
5	-0.023	0.026	-0.078*	-0.003	-0.024	-0.015	-0.006	-0.020
	(0.022)	(0.027)	(0.032)	(0.023)	(0.023)	(0.022)	(0.023)	(0.022)
				Panel B. Reading				
-5	-0.006	-0.005	-0.005	-0.001	0.026	-0.004	-0.002	-0.006
	(0.005)	(0.008)	(0.005)	(0.004)	(0.017)	(0.004)	(0.003)	(0.004)
-4	0.002	-0.018	0.009	0.013**	-0.031	0.009*	0.011**	0.007
	(0.010)	(0.011)	(0.007)	(0.004)	(0.020)	(0.004)	(0.004)	(0.006)
-3	0.022***	-0.022	0.027***	0.024***	0.079**	0.018***	0.019***	0.023***
	(0.005)	(0.012)	(0.005)	(0.005)	(0.027)	(0.005)	(0.004)	(0.005)
-2	-0.010*	-0.018*	-0.008	-0.003	-0.018	-0.008*	-0.006	-0.007
	(0.005)	(0.009)	(0.005)	(0.004)	(0.015)	(0.004)	(0.003)	(0.004)
-1	-0.012**	-0.007	-0.012**	-0.008	0.017	-0.011**	-0.010**	-0.011**
	(0.004)	(0.009)	(0.004)	(0.004)	(0.018)	(0.004)	(0.004)	(0.004)
0	-0.002	-0.018*	0.002	0.008*	0.024	-0.001	0.001	-0.003
	(0.004)	(0.008)	(0.004)	(0.004)	(0.025)	(0.004)	(0.004)	(0.004)
1	0.001	-0.011	0.006	0.018***	0.057	0.006	0.007	0.002
	(0.006)	(0.010)	(0.006)	(0.005)	(0.038)	(0.005)	(0.005)	(0.005)
2	0.007	0.009	0.008	0.016	-0.001	0.008	0.010	0.009
	(0.011)	(0.014)	(0.019)	(0.011)	(0.012)	(0.012)	(0.011)	(0.011)
3	0.010	0.011	0.008	0.022	0.002	0.008	0.015	0.009
	(0.013)	(0.016)	(0.026)	(0.013)	(0.014)	(0.014)	(0.013)	(0.013)
4	-0.019	-0.009	-0.031	-0.002	-0.029	-0.021	-0.013	-0.017
	(0.016)	(0.020)	(0.029)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
5	-0.020	0.004	-0.052	-0.002	-0.027	-0.024	-0.013	-0.021
	(0.019)	(0.023)	(0.032)	(0.019)	(0.019)	(0.018)	(0.019)	(0.019)

Notes: Robust standard errors clustered at the district level are in parentheses. Models include district and year fixed effects, as well as controls for student enrollment and local labor market conditions. Column (1) displays results from the preferred specification estimating the effect of the first strike in a given district. Column (2) drops coordinated strikes. Column (3) drops individual district strikes. Column (4) limits comparison districts to those outside of striking states. Column (5) limits analyses to only states that experience strikes. Column (6) controls for urbanicity, the percent of students with special needs, the percent of students who are English Language Learners, and student race (the percent of students that are Black, Hispanic, White, or Asian, with other races as the uncoded comparison group). Column (7) estimates the effects of all strikes in a given district instead of the first strike. This specification replaces district fixed effects with district-by-event fixed effects. + p<.10, * p<0.05, ** p<0.01, *** p<0.001

Appendix Table B3. Strike Count by State, Fall 2007-Spring 2023

State	Individual Strike Count	Coordinated Strike Count	Total Strike Count
Arizona	1	88	89
Arkansas	2	0	2
California	38	0	38
Colorado	7	27	34
Idaho	1	0	1
Illinois	43	0	43
Indiana	2	0	2
Kentucky	1	48	49
Louisiana	2	0	2
Massachusetts	6	0	6
Michigan	7	0	7
Minnesota	2	0	2
Nevada	1	0	1
New Jersey	3	0	3
North Carolina	1	79	80
Ohio	8	0	8
Oklahoma	0	68	68
Oregon	4	26	30
Pennsylvania	59	0	59
Rhode Island	1	0	1
South Carolina	0	7	7
Tennessee	1	0	1
Vermont	7	0	7
Virginia	0	4	4
Washington	30	65	95
West Virginia	0	109	109
Wisconsin	0	24	24
Total	*227*	*545*	*772*

Table B4. Reported Reasons for Strikes, 2007-2023

	All	Coordinated	Individual
Teacher Compensation	89%	91%	86%
Teacher Salaries	81%	82%	80%
Teacher Benefits	32%	31%	33%
Working Conditions	59%	72%	26%
General School/Student Expenditures	48%	60%	20%
Non-Instructional Staff	16%	21%	6%
Labor Rights	10%	12%	4%
School/Classroom Infrastructure	0%	0%	1%
Common Good (e.g., Housing, Immigration)	10%	14%	1%
Other	52%	63%	24%
Total Strikes	*772*	*545*	*227*

Notes: Data are described at the strike level. Districts experiencing multiple strikes are observed multiple times. Strike reasons are not mutually exclusive. General School/Student Expenditures reasons included general expenditures, class size, or other student-focused demands. Other reasons ranged from ending teacher drug testing to the restoration of electives like art and music.

Table B5. Baseline Sociodemographic Characteristics of Striking and Non-Striking Districts (Non-Imputed)

	Striking Districts	Non-Striking Districts	Striking-Non-Striking Difference	
			Overall	Within States
District Characteristics				
Average Teacher Compensation ($1,000s)	93.56	92.24	1.32	5.02*
Average Teacher Salaries ($1,000s)	69.71	69.20	0.51	3.19+
Average Teacher Benefits ($1,000s)	23.72	23.19	0.53	1.52*
Pupil-to-Teacher Ratio	16.63	15.37	1.26	1.24*
Total Current Expenditures per Pupil ($1,000s)	10.68	12.48	-1.80***	-0.88+
Instr. Salary and Benefit Expenditures per Pupil ($1,000s)	5.74	6.71	-0.97***	-0.20
Working Conditions Expenditures per Pupil ($1,000s)	4.23	5.16	-0.93***	-0.62*
Noninstr.Salary and Benefit Expenditures per Pupil ($1,000s)	2.86	3.11	-0.25***	-0.08
Non-Salary and Benefit Expenditures per Pupil ($1,000s)	2.06	2.82	-0.76***	-0.68***
Capital Expenditures per Pupil ($1,000s)	1.29	1.19	0.10	0.24*
Total Revenues per Pupil ($1,000s)	12.52	15.37	-2.86+	-0.97+
Local Revenues per Pupil ($1,000s)	5.03	7.16	-2.13+	0.35
State Revenues per Pupil ($1,000s)	6.47	7.47	-1.00+	-1.27*
Federal Revenues per Pupil ($1,000s)	1.08	1.19	-0.10	-0.33*
Total Student Enrollment (1,000s)	11.82	2.78	9.05***	10.73***
% Special Education Students	14.44	14.49	-0.05	-0.39
% English Language Learners	6.75	3.66	3.09***	2.25**
% White Students	66.91	70.43	-3.51**	-4.50+
% Black Students	9.90	11.54	-1.64+	1.95
% Hispanic Students	15.49	11.78	3.71***	3.63*
% Asian/Pacific Islander Students	3.00	2.10	0.90***	1.46**
% Native American Students	3.57	3.14	0.43	-2.80+
% Multi-Racial Students	0.18	0.35	-0.17*	0.04
% School Age Population in Poverty	0.16	0.16	0.01*	-0.03**
% Urban	19.52	12.58	6.94***	6.92
% Suburban	27.57	20.45	7.12***	15.05***
% Town/Rural	52.91	66.97	-14.06***	-21.98**
Unemployment Rate	0.06	0.06	0.00***	0.00
Socioeconomic Status (SD)	-0.16	0.01	-0.16***	0.15+
State Characteristics				
% Strikes Prohibited	72.43	66.07	0.06**	
% Right to Work	36.82	37.42	-0.01	
Ratio of NEA Members/Full Time Teachers	0.98	1.09	-0.11***	
Mass Economic Policy Liberalism (SD)	-0.27	0.01	-0.28***	
Mass Social Policy Liberalism (SD)	-0.21	0.01	-0.22***	
Gini Coefficient	0.61	0.61	-0.01***	
Districts	584	14,866		

Notes: All finance measures are in real 2018 dollars. Socioeconomic Status, Mass Economic Policy Preferences, and Mass Social Policy Preferences are standardized (z-scored). Data reflect the first year of data for a given district. Differences within states come from a series of OLS regressions with each characteristic regressed on a dichotomous indicator of whether there is ever a strike with state fixed effects. + p<.10, * p<0.05, ** p<0.01, *** p<0.001

Table B6. Baseline Sociodemographic Characteristics of Striking Districts (2007-8)

	Coordinated Striking Districts	Individual Striking Districts
District Characteristics		
Average Teacher Compensation ($1,000s)	88.21	109.89
Average Teacher Salaries ($1,000s)	66.03	80.89
Average Teacher Benefits ($1,000s)	21.98	28.68
Pupil-to-Teacher Ratio	16.61	16.96
Total Current Expenditures per Pupil ($1,000s)	10.12	12.18
Instr. Salary and Benefit Expenditures per Pupil ($1,000s)	5.41	6.63
Working Conditions Expenditures per Pupil ($1,000s)	4.03	4.77
Noninstr.Salary and Benefit Expenditures per Pupil ($1,000s)	2.78	3.11
Non-Salary and Benefit Expenditures per Pupil ($1,000s)	1.94	2.36
Capital Expenditures per Pupil ($1,000s)	1.35	1.18
Total Revenues per Pupil ($1,000s)	11.74	14.59
Local Revenues per Pupil ($1,000s)	4.23	7.13
State Revenues per Pupil ($1,000s)	6.38	6.79
Federal Revenues per Pupil ($1,000s)	1.14	0.90
Total Student Enrollment (1,000s)	10.40	17.02
% Special Education Students	13.12	14.99
% English Language Learners	7.59	5.92
% White Students	66.72	67.29
% Black Students	8.53	13.24
% Hispanic Students	16.53	13.01
% Asian/Pacific Islander Students	2.66	4.11
% Native American Students	4.55	0.66
% Multi-Racial Students	0.00	0.82
% School Age Population in Poverty	0.17	0.14
% Urban	20.18	21.60
% Suburban	21.09	45.68
% Town/Rural	58.73	32.72
Unemployment Rate	0.06	0.06
Socioeconomic Status (SD)	-0.23	0.12
State Characteristics		
% Strikes Prohibited	0.89	0.30
% Right to Work	0.47	0.06
Ratio of NEA Members/Full Time Teachers	0.89	1.27
Mass Economic Policy Liberalism (SD)	-0.47	0.28
Mass Social Policy Liberalism (SD)	-0.41	0.48
Gini Coefficient	0.61	0.60
Districts	441	162

Notes: Coordinated strikes are cross-district teacher work stoppages, typically directed at state government. Individual strikes are those for which teachers in a single district went on strike, typically as part of stalled collective bargaining negotiations. See Table 1 for other notes.

Table B7. Event Study Point Estimates

Years Since Strike	Logged Teacher Compensation	Logged Teacher Salary	Logged Teacher Benefits	Pupil-Teacher Ratios	Logged Working Conditions Expenditures	Logged Per Pupil Non-Instr. Salary & Benefit Expenditures	Logged Per Pupil Non-Salary & -Benefit Expenditures	Logged Capital Expenditures	Logged Per Pupil Expenditures	Logged Per Pupil Revenues	Logged Per Pupil Local Revenues	Logged Per Pupil State Revenues	Logged Per Pupil Federal Revenues	Math Achievement	Reading Achievement
-5	-0.01*	-0.01*	-0.01	-0.02	-0.02**	-0.02***	-0.03	0.01	-0.02*	-0.02***	-0.05***	0.00	-0.04*	0.002	-0.006
	(0.01)	(0.01)	(0.01)	(0.07)	(0.01)	(0.00)	(0.02)	(0.04)	(0.01)	(0.00)	(0.01)	(0.01)	(0.02)	(0.010)	(0.005)
-4	-0.01	-0.00	0.00	-0.00	0.01	0.00	0.03*	0.04	-0.01	0.00	0.00	-0.00	-0.03	-0.012*	0.002
	(0.00)	(0.00)	(0.01)	(0.09)	(0.01)	(0.01)	(0.01)	(0.04)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.005)	(0.010)
-3	0.00	0.01	-0.00	0.09	0.00	-0.01	0.01	-0.05	-0.01	0.00	-0.02***	0.00	0.01	-0.002	0.022***
	(0.01)	(0.01)	(0.01)	(0.08)	(0.00)	(0.00)	(0.01)	(0.04)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.005)	(0.005)
-2	-0.01***	-0.01**	-0.01**	-0.27	0.00	0.02	-0.01	0.01	-0.01	-0.00	0.01	-0.02***	-0.02	-0.022**	-0.010*
	(0.00)	(0.00)	(0.00)	(0.30)	(0.01)	(0.02)	(0.01)	(0.05)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.008)	(0.005)
-1	-0.00	-0.00	0.00	0.23	0.00	-0.00	-0.00	0.06	0.00	-0.00	0.01*	-0.02	-0.01	-0.014*	-0.012**
	(0.00)	(0.01)	(0.00)	(0.27)	(0.00)	(0.00)	(0.01)	(0.04)	(0.00)	(0.00)	(0.01)	(0.02)	(0.01)	(0.006)	(0.004)
0	-0.01	-0.01***	0.01	-0.19***	-0.00	0.00	-0.01	-0.07	-0.00	-0.00	-0.00	0.00	-0.02	-0.009	-0.002
	(0.00)	(0.00)	(0.01)	(0.06)	(0.00)	(0.00)	(0.01)	(0.04)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.005)	(0.004)
1	0.03***	0.02***	0.04***	-0.24	0.01**	0.03***	0.00	0.02	0.02***	0.02***	0.01	0.04**	-0.01	-0.010	0.001
	(0.00)	(0.00)	(0.01)	(0.15)	(0.01)	(0.00)	(0.01)	(0.04)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.006)	(0.006)
2	0.03***	0.03***	0.04***	-0.14	0.01*	0.03***	-0.00	0.01	0.03***	0.02***	0.01	0.04**	0.00	0.008	0.007
	(0.01)	(0.01)	(0.01)	(0.10)	(0.01)	(0.01)	(0.02)	(0.04)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.014)	(0.011)
3	0.06***	0.05***	0.09***	-0.61***	0.05***	0.07***	0.02	-0.09	0.05***	0.05***	-0.00	0.08***	0.03	0.008	0.010
	(0.01)	(0.01)	(0.01)	(0.11)	(0.01)	(0.01)	(0.01)	(0.10)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.016)	(0.013)
4	0.07***	0.07***	0.06**	-0.41***	0.06***	0.09***	0.03*	-0.03	0.08***	0.08***	-0.04*	0.15***	0.01	-0.020	-0.019
	(0.01)	(0.01)	(0.02)	(0.10)	(0.01)	(0.01)	(0.01)	(0.12)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.017)	(0.016)
5	0.08***	0.08***	0.08***	-0.47***	0.07***	0.10***	0.01	-0.08	0.09***	0.09***	-0.07***	0.18***	0.03	-0.023	-0.020
	(0.01)	(0.01)	(0.02)	(0.13)	(0.01)	(0.02)	(0.02)	(0.14)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.022)	(0.019)

Notes: Robust standard errors clustered at the district level are in parentheses. Controls include time-varying district-level indicators of student enrollment, unemployment rates, socioeconomic status, and the share of children living in poverty. + p<.10, * p<0.05, ** p<0.01, *** p<0.001.

Appendix Table B8. Estimated Effect After Four Years of $1,000/Pupil Expenditures Increases

Years Since Strike	Logged Per Pupil Expenditures	Per Pupil Expenditures, 2018$	Math Achievement	Reading Achievement
-1	-0.01	-58.28	-0.02	-0.01
	(0.02)	(182.16)	(0.03)	(0.02)
0	0.02**	321.00*	0.01	-0.00
	(0.01)	(145.58)	(0.03)	(0.02)
1	0.02	165.63	-0.00	-0.00
	(0.02)	(192.97)	(0.03)	(0.02)
2	0.02	190.83	-0.04	-0.03
	(0.01)	(162.06)	(0.03)	(0.02)
3	0.06***	724.74**	-0.01	-0.04
	(0.02)	(257.05)	(0.04)	(0.03)
4	0.07*	967.17*	-0.02	-0.05
	(0.03)	(457.80)	(0.04)	(0.04)
5	0.11***	1526.31**	0.03	-0.04
	(0.03)	(466.72)	(0.04)	(0.02)
6	0.12***	1615.96***	0.05	-0.04
	(0.03)	(466.42)	(0.06)	(0.05)
7	0.10	1516.01*	0.06	-0.03
	(0.06)	(772.65)	(0.08)	(0.07)
8	0.10	1456.89	0.04	-0.05
	(0.06)	(795.69)	(0.08)	(0.07)

Notes: Robust standard errors clustered at the district level are in parentheses. Controls include time-varying district-level indicators of student enrollment, unemployment rates, socioeconomic status, and the share of children living in poverty. * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

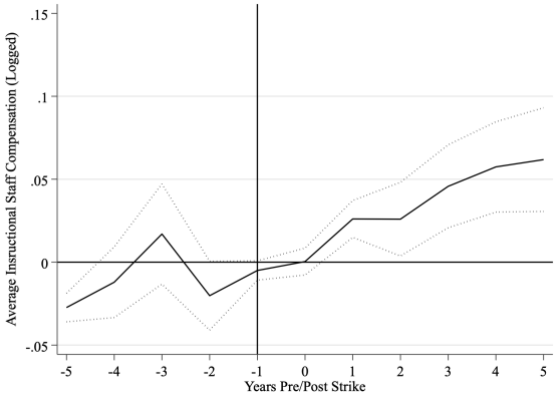


Figure B1. Effect of Strikes on Instructional Salaries and Benefits per Instructional Staff Member

Notes: Solid line indicates the estimate from Equation 1 with school-district and school-year fixed effects. We use the specification recommended by Callaway and Sant'Anna (2020) to estimate an average treatment effect across distinct group-time estimates. Dotted line indicates the 95% confidence interval. Data are from the authors' compilation, as well as the NCES.

Panel A. Instructional Compensation per Pupil

Panel B. Number of FTE Teachers

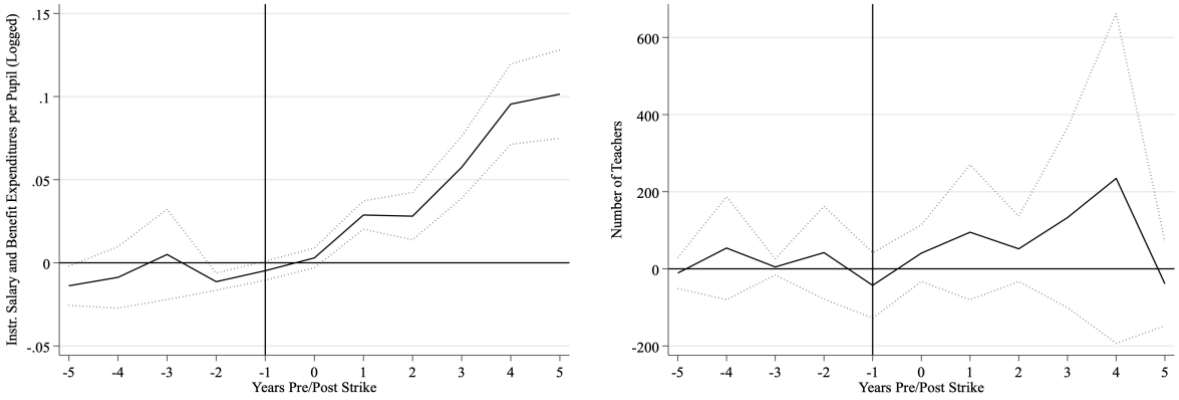
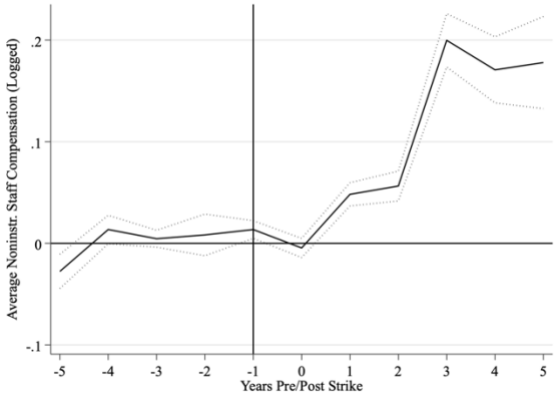


Figure B2. Effect of Strikes on Instructional Salaries and Benefits per Pupil and Number of Teachers

Notes: Solid line indicates the estimate from Equation 1 with school-district and school-year fixed effects. We use the specification recommended by Callaway and Sant'Anna (2020) to estimate an average treatment effect across distinct group-time estimates. Dotted line indicates the 95% confidence interval. Data are from the authors' compilation, as well as the NCES.

Panel A. Noninstructional Compensation



Panel B. Number of Noninstructional Staff

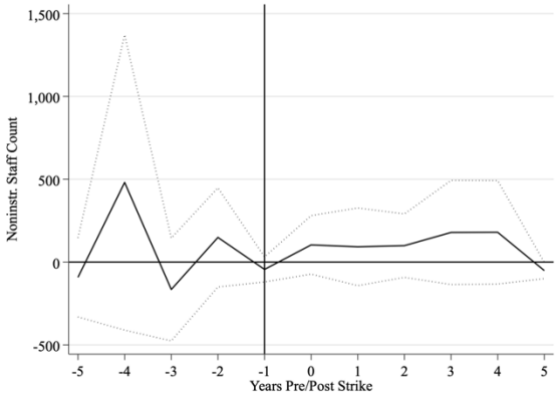


Figure B3. Effect of Strikes on Noninstructional Compensation and Number of Staff

Notes: Solid line indicates the estimate from Equation 1 with school-district and school-year fixed effects. We use the specification recommended by Callaway and Sant'Anna (2020) to estimate an average treatment effect across distinct group-time estimates. Dotted line indicates the 95% confidence interval. Data are from the authors' compilation, as well as the NCES.