The Impact of Teacher Unions on School District Finance and Student Achievement: Evidence from the Great Recession

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Abstract

I examine whether the impact of the Great Recession on school district spending, the allocation of resources and student achievement varied depending on the strength of state's teachers' unions. Employing a diff-in-diff-in-diff identification strategy, I find that school districts in states with strong teachers' unions experienced significantly larger declines in per-pupil expenditures during the economic downtown compared to otherwise similar districts in states with weak teachers' unions. The larger decline in expenditures in strong union states, however, did not lead to a differential decline in student achievement relative to weak union states.

JEL-Codes: I2, J5, H7

Keywords: Great Recession, Teachers Unions, Student Achievement, Collective Bargaining

1. Introduction

The Great Recession of 2007–2008 marks one of the most extensive and severe economic downturns in U.S. history, and led to a steep decline in employment, earnings, and property values. As a result, state and local governments experienced sharp decreases in tax revenue, which forced them to limit expenditures to balance their budgets. Expenditures on K-12 education were no exception; real K-12 per-pupil revenue fell in 38 states in the 2008–2010 period, with 18 states experiencing a decrease in revenue per-pupil of over 18 percent (Evans, Schwab, and Wagner 2019). These declines in revenue eventually forced school districts to lay off approximately 350,000 teachers and other K-12 employees (Leachman et al. 2016).[i]

Several recent studies have examined how the Great Recession affected school district spending, the allocation of resources, and student outcomes. Perhaps not surprisingly, these studies find that the Great Recession led to sharp declines in school spending, increases in class size and declines in student achievement and educational attainment (Evans, Schwab, and Wagner 2019; Jackson, Wigger, and Xiong 2021; Shores and Steinberg 2019).[ii] Despite the significant scholarly attention to how the Great Recession affected school spending and student outcomes, the question of whether and how teachers' unions influenced local responses to the economic downturn remains relatively unexplored.

In this paper, I examine whether strong union states could protect teacher employment and compensation during a period of financial duress, and ultimately, whether such decisions had any impact on student achievement. What evidence is available comes primarily from studies that examine the relationship between teacher unions and education expenditures and resource allocations during the Great Recession. Swain and Redding (2019) use state-level data and a difference-in-differences identification strategy to examine the effects of mandatory collective

bargaining (CB) laws on state-level current spending per-pupil during the Great Recession. Similarly, using data from California, Strunk and Marianno (2019) examine how teachers' collective bargaining agreements, teachers' pay, and class sizes transformed during the Great Recession. The present study expands on these two studies in several ways. First, in contrast to Swain and Redding (2019) my analysis is done at the district level using the universe of school districts in the United States. This allows for the inclusion of district-fixed effects that capture any time-invariant district-specific education policies, labor market conditions, and other unobservables that may be correlated with both the strength of local teachers' unions and the outcomes of interest. Second, in an attempt to isolate the impact of recession-induced spending cuts unrelated to changes in other economic conditions, I utilize states' historical reliance on state aid, following Jackson, Wigger, and Xiong (2021). Finally, I link nationally representative test score data to district spending data to examine whether the differences in spending according to teachers' union power translated into differences in student achievement.

This paper also contributes to the large literature on the effects of teachers' unions on education spending and student achievement. Most of the studies in this literature focuses on the effect of unionization on education spending during periods when districts were financially sound (e.g., Hoxby 1996; Strunk 2011; Brunner, Hyman, and Ju 2020). While it is useful to learn how unions influence resource allocation decisions during periods when school district budgets are typically growing, the implications can be quite different when districts face negative revenue shocks (Swain and Redding 2019). For instance, during the normal time periods when districts are financially prosperous, unions may be much more capable of extracting rents and easily altering resources in favor of maximizing the benefits of their members. However, in times of mounting fiscal pressure, unions might not be able to exert their collective bargaining power, acknowledging

the local district's financial struggle. Whether the impact of teachers' unions on education spending and student achievements are symmetric to those from positive financial shock remains an open empirical question.

To examine whether the effects of the Great Recession varied depending on the strength of state's teachers' unions, I use district-level finance data (F-33) from the National Center for Education Statistics (NCES) and student-level test score data from the National Assessment of Educational Progress (NAEP). My primary measure of the power of teachers' unions is an index assembled by Winkler, Scull, and Zeehandelaar (2012), that incorporates five different factors related to teachers' union strength. To gauge the magnitude of the recessionary shock on district education spending, I follow Jackson, Wigger, and Xiong (2021) and exploit the fact that districts that were hit the hardest by the Great Recession tended to be located in states that funded their pre-recession school budgets primarily from state sources such as the state income and sales tax (Evans, Schwab, and Wagner 2019).[iii]

Using both event study and difference-in-difference-in-differences (DDD) methodologies, I find that the financial impact of the Great Recession differed across states with various levels of teachers' union strength. Specifically, I find that school districts in states with strong teachers' unions experienced significantly larger declines in per-pupil total expenditures compared to otherwise similar districts located in weaker union states. Moreover, the analyses of the sub-categories of spending suggest that teachers' benefits and employment decreased while average class size increased by about 0.25 students, or 1.6 percent more in states with strong unions, when compared to states with weaker unions. Finally, in terms of student achievement, results based on restricted-access NAEP data provide no evidence that additional spending cuts in states with strong unions led to a differential impact on students' test scores.

A series of robustness checks indicate that these results are highly robust. For instance, the results persist across specifications that include state-level labor market controls for several factors that might affect district spending, such as the propensity to vote for the Democratic Party presidential candidate. They also persist across specifications that use more traditional measures for teacher union strength, such as whether a state mandates collective bargaining for K-12 teachers. In a falsification test that examines whether the strength of teachers' unions had any relationship with labor market indicators, I find no such evidence.

The remainder of this paper is organized as follows. The next section provides an overview of the literature on the impact of teacher unions on school district budgets, resource allocations, and student outcomes. Section 3 describes the datasets used in this study. Section 4 explains the empirical framework. Section 5 presents the main results, robustness checks, and falsification tests, and Section 6 concludes.

2. Literature Review

This study relates to three strands of literature on teachers' unions. The first includes studies that have examined the relationship between teachers' unions and school district expenditures. The second includes studies that have focused on the impact of teacher unions on productivity, often measured using student achievement. Finally, this study is most closely related to the literature that examines relationship among teachers' unions, resource allocation, and efficiency.

Researchers typically find that there exists a positive relationship between teachers' union power and educational spending.[iv] For example, Chambers (1977) finds that bargaining school districts spend approximately 5-8 percent more when compared to non-bargaining school districts. Eberts and Stone (1984) show that stronger collective bargaining agreements are associated with

increases in education spending overall. The findings of Strunk (2011) indicate that districts with more restrictive collective bargaining agreements in California are associated with higher spending, driven by administrative compensation and instruction-related expenditures. Similarly, Rose and Sonstelie (2010) and Brunner and Squires (2013) find that strong teachers' unions can help increase teachers' pay, particularly more for senior teachers while decreasing the teacher-pupil ratio; thus, their argument is consistent with the rent-seeking view of teachers' unions. In contrast to these studies, Lovenheim (2009) finds that unionization has little impact on teacher salaries.

Following this literature, numerous studies have further examined the relationship between teachers' unions and productivity, often using educational outcomes. Studies in this literature provide more mixed evidence. Earlier studies that mostly relied on cross-sectional variation in union status, tend to find that teachers' unions have a positive effect on student achievement (e.g., Ebert and Stone 1986, 1987). More recently, Baron (2018) uses Wisconsin's adoption of Act 10, which significantly limited the power of teachers' unions in the state, to show that the law reduced average test scores by approximately 20 percent of a standard deviation. Han and Keefe (2020) also provide evidence that student test scores were higher when strong unions prevailed. In contrast, Marianno and Strunk (2018) find no evidence that more restrictive collective bargaining agreements are not associated with an improvement in student performance on average. Similarly, Lott and Kenny (2013) explore variations in union dues and union expenditure and find that strong unions are associated with a significant decrease in student test scores. More recently, Lovenheim and Willén (2019) examine the long-term consequences of enacting collecting bargaining laws for K-12 teachers and conclude that such laws significantly reduce students' adult earnings and employment.

This study is most closely related to literature that seeks to identify the relationship between teachers' unions and school district efficiency. These studies examine the impact of unions on district spending and educational outcome simultaneously to evaluate the efficiency of resources allocated. Empirical results provided by Hoxby (1996) indicate that teacher unions are successful in raising educational expenditures while increasing student dropout rates, suggesting that teacher unions are associated with a decrease in district efficiency. Using a dataset from California, Marianno, Bruno, and Strunk (2021) also examine the relationship between teachers' union contracts and school district efficiency, defined as the ratio of student test scores to expenditures. In contrast to these findings, other studies suggest that unions and their bargaining power help districts use resources more efficiently and raise the productivity of teachers. Brunner et al. (2020) find that larger expenditure increases in strong union states in response to school finance reforms translated into better student performance. Previous studies tend to focus on the effect of unionization during periods when districts were financially sound (Hoxby 1996; Strunk 2011; Brunner, Hyman, and Ju 2020). While it is useful to learn how unionization affects resource allocation decisions during periods when school district budgets are typically growing, the implications can be quite different when districts face negative revenue shocks (Jackson, Wigger, and Xiong, 2018). The focus of this paper is to examine the effect of teachers' union influence on school district resource allocation and student test scores during periods when districts faced financial duress.

3. Data

3.1 School District Finance Data

My primary source of data is the annual School District Finance Survey (F-33) conducted by the NCES. While the survey was administered annually from 1992 onward, I focus on the

period 2002–2015 to avoid the potentially confounding influence of the earlier economic downturn that lasted until the fourth quarter of 2000.[v] The F-33 provides comprehensive data on the revenues and expenditures by category for each school district in the United States. In the empirical work that follows, I focus on state revenue, total expenditures, capital outlay, and current expenditures, and divide each measure by the total number of students in the district to provide a per-pupil estimate. Furthermore, I combine the district-level finance data with district-level student demographic characteristics from the NCES Common Core of Data (CCD) from which I construct a measure of the student-to-teacher ratio using the total district enrollment and the number of full-time equivalent teachers (FTE) for each school district.[vi] Finally, I merge the NCES financial data with district-level data on the total population, the school-aged population, and the child poverty rates taken from the U.S. Census Bureau's Small Income and Poverty Estimates (SAIPE).

I restrict the primary analytical sample in several ways. First, because the F-33 school district financial data tends to be noisy, particularly for smaller districts, I exclude districts with a total student enrollment of less than 250 students (Gordon 2004; Lafortune et al. 2018). Second, Hawaii, Alaska, and the District of Columbia are removed from the sample due to their unique locations and political characteristics. Third, I remove charter schools, college-grade systems, vocational education systems, non-operating school systems, and educational service agencies, thereby limiting the sample to traditional school districts, namely elementary, secondary, and unified school systems. Finally, I impose restrictions based on the school district financial variables. Specifically, for each finance outcome measure, I exclude district-year observations if the reported values are less than zero. Furthermore, I follow Jackson, Wigger, and Xiong (2021) and exclude district-year observations that are 200 percent greater than the 99th percentile of per-

pupil expenditures or less than 50 percent of the 1st percentile. The full sample comprises 12,594 unique elementary/secondary or unified school districts in the contiguous 48 states.

3.2 Union Power Measure

My primary measure of teacher union power is based on an index constructed by Winkler, Scull, and Zeehandelaar (2012). To measure the union strength at the state level, the authors went through administrative and self-constructed survey data across five different fields related to union influence as follows: (1) resource and membership, (2) involvement in politics, (3) scope of bargaining, (4) state policies, and (5) perceived influence. However, the resource and membership category of the index is potentially endogenous to school spending during the Great Recession. Therefore, I exclude this category and recalculate the index following Brunner et al. (2020). Figure 1 presents a state map showing states' overall union power, with states ranging from weakest teacher union power (white) to strongest teacher union power (dark grey). As the map indicates, states located in the northeast, mid-west, and west generally have strong teachers' unions, while southern states have weak teachers' unions.

I supplement the main analysis with two alternative measures for teachers' union power. The first measure is a more widely used measure that simply indicates whether a state has a mandatory collective bargaining law for teachers. The benefit of this measure is that it is less likely to be subject to endogeneity concerns as most state legislation governing teachers' CB rights were passed between the 1960s and 1980s and have remained relatively stable since then. The second alternative measure was constructed by Brunner et al. (2020) and incorporates information on the state's CB laws with information on state right-to-strike (RTS) and right-to-work (RTW) statuses. To construct the measure, the authors assign states a value of two if they required CB, add a value of one if they were not RTW, and add a value of one if they were RTS. The score ranges from 0

to 4, where 0 represents the weakest union power states and 4 represents the strongest union power states. Appendix Figure 1A shows a map of states that mandate teacher collective bargaining, while Appendix Figure 1B presents a map showing states' overall union power rank by 5 tiers. As expected, the overall geographical pattern follows that of the primary union power measure shown in Figure 1. While I use the continuous index as my preferred measure for teachers' union power to exploit more variation across states, I also show that the baseline results are robust to the alternative union power measures.

Table 1 presents summary statistics for the key variables for all districts combined, dividing the districts into strong (above median) and weak (below median) union states. On average, districts in strong union states have a greater total population but lower district enrollment and child poverty rates. Districts in stronger union states also have higher per-pupil total expenditures, median household income, and are more likely to vote for a Democratic Party presidential candidate.

3.3 Student Achievement

In order to examine how district resource allocation decisions during the Great Recession affected student achievement, I use restricted-access microdata from the NAEP. The NAEP is administered by the NCES every two years to nationally represent samples of 4th, 8th, and 12th graders and their teachers. Unlike state assessments formulated under the No Child Left Behind Act, which allows each state to design its own assessment system, the NAEP assessments are based on the same test administered in every state, providing reliable student achievement data comparable across districts, states, and years.[vii] Although the assessment essentially stays the same, the subject areas tested vary year by year and have included 10 different subjects at one time or another. For consistency, I focus on 4th and 8th grade mathematics and reading scores, as the two

tests were administered every two years between 2003 and 2015.[viii] Following Lafortune, Rothstein, and Schanzenbach (2018) and Jackson, Wigger, and Xiong (2021), I standardize the scores by subject and grade to the year 2003. The extracted dataset contains detailed information on student characteristics, such as race, gender, free/reduced lunch status, and English learner status. The entire analytic sample comprises 3.9 million individual observations of NAEP test scores linked to over 11,000 unique school districts in the contiguous 48 states.

4. Empirical Framework

4.1 Diff-in-Diff-in-Diff

A potential challenge to this study is that strong union states may have been differentially impacted by the Great Recession. For example, it is possible that financial disruptions during the recession were concentrated in states with strong teachers' unions. To address such concerns, I utilize a third level of variation which represents the share of state revenues that came from state sources in 2007 (pre-recession). As mentioned previously, this measure proxies for the magnitude of the educational spending shock during the Great Recession based on the logic that school districts located in states that relied more heavily on state income and sales taxes to fund K-12 education were hit the hardest by the economic downturn (Evans, Schwab, and Wagner 2019). The variable is constructed following Jackson, Wigger, and Xiong (2021):

$$\rho_s = \frac{\sum_{d \in s} State\ Revenue_d}{\sum_{d \in s} Total\ Revenue_d} \quad (1)$$

Figure 2 presents a map of the U.S. by share of states' revenue from state sources in 2007; it suggests that the degree to which states relied on state aid is evenly spread out across the U.S. An immediate concern arises that this measure may be highly correlated with the union power measure. While the two measures seem uncorrelated upon comparing Figures 1 and 2, I formally address

this concern by plotting the share of K-12 revenue from state sources with the standardized union power index. Figure 3A illustrates that states' reliance on state revenue is largely unrelated to the union power measure with a correlation of 0.0546. Another concern is that other dimensions of economic conditions, such as state unemployment rates during the Great Recession, may be correlated with either pre-recession reliance on state aid or state union power. To mitigate this concern, I plot state unemployment rates by reliance on state revenue as well as by the union power measure. Both Figures 3B and 3C show that state unemployment rates during the Great Recession were largely unrelated to either the reliance on state aid or teachers' union power.

Incorporating the third level of variation that represents the recessionary shock, I begin by estimating a DDD model which links changes in educational outcomes to states' union power and their reliance on state aid:

$$(2) \quad Y_{dst} = \alpha_0 + \alpha_1(\rho_s * I^{Post}) + \alpha_2(Union_s * I^{Post}) + \alpha_3(\rho_s * Union_s * I^{Post}) + \pi X_{dst} + \delta_d + \lambda_t + \varepsilon_{dst},$$

where Y_{dst} is the outcome of interest that includes various categories of per-pupil expenditures, full-time teacher employment, and the student-to-teacher ratio for district d, state s, in year t; I^{Post} is a post-Great Recession indicator variable for the years 2008 and beyond;[ix] ρ_s is the pre-recession fraction of revenue from state sources (normalized to mean zero, standard deviation one); $Union_s$ is a measure of the teacher union power in state s (also normalized to mean zero, standard deviation one); X_{dst} is a vector of district-level control variables including total residential population, fraction of child poverty, school-age population, and a Bartik predictor to account for possible direct effects of the recession itself (Yagan 2019).[x] δ_d and λ_t are the district and year-

fixed effects, respectively, and ε_{dst} is a random disturbance term. I cluster the standard errors from Equation (2) at both the district and state-by-year level.

The key parameters of interest in Equation (2) are α_1, α_2, and α_3. Specifically, α_1 represents the difference-in-differences (DD) effect of a one standard deviation (SD) increase in the level of pre-recession reliance on state aid post the Great Recession for school districts located in a state with the average level of pre-recession reliance on state aid. The parameter α_2 represents the effect associated with a one SD increase in union power for a district located in a state with the average level of pre-recession reliance on state aid. Finally, α_3 is the DDD estimate and measures how the DD effect (α_1) changes for states with relatively stronger teachers' unions. By utilizing this third difference that incorporates the severity of spending shock, I essentially utilize strong states that were less reliant on state aid as an additional control group. Therefore, the total effect of the Great Recession (more vulnerable to spending shock) for strong union states is represented by $\alpha_1 + \alpha_3$.

The validity of my DDD identification strategy relies on the assumption that in the absence of the Great Recession, the difference in outcomes between strong versus weak union states with high reliance of state aid after 2007 would have been similar to that in outcomes between strong versus weak union states with low reliance of state aid before 2007. To assess the validity of this assumption, I also estimate event study models and complement the main findings by conducting a series of robustness checks and falsification tests.

4.2 Event Study

To examine the dynamic treatment effects of the Great Recession by the pre-recession share of state revenue on school finances and staffing, I first replicate the event study results of Jackson, Wigger, and Xiong (2021). To further examine the potential heterogeneous effect across

teachers' union strength, I estimate the following model separately for strong and weak union states:

$$(3) \qquad Y_{dst} = \sum_{2002}^{2015} \gamma_t \cdot (\rho_s \times I_t) + \pi X_{dst} + \delta_d + \lambda_t + \mu_{dst},$$

where I_t is an indicator variable denoting whether the observation is for fiscal year t, and ρ_s represents the standardized log fraction of state aid. The 2007 (the year prior to the onset of the recession) coefficient is set to zero by design so all estimated coefficients are relative to this year. The coefficients of interest are the γ_t's, which capture the year-by-year difference in outcome between high and low pre-recession state-aid reliance. The estimated coefficients on the lead treatment indicators ($\gamma_{2002}, \ldots, \gamma_{2006}$) provide evidence regarding how the different categories of school spending and other education outcomes change prior to the Great Recession, while the lagged treatment indicators ($\gamma_{2008}, \ldots, \gamma_{2015}$) indicate how they evolve during and after the Great Recession. If pre-recession reliance on state aid induced exogenous variation in school district outcomes, the lead treatment indicators should be small in magnitude and remain statistically insignificant.

I also estimate DDD event study models expanding Equation (3) by including a series of nonparametric indicators for *Union* and *SSRev* × *Union*, each. Formerly, I estimate triple difference event study models of the following form:

$$(4) \qquad Y_{dst} = \sum_{2002}^{2015} \gamma_t \cdot (\rho_s \times I_t) + \sum_{2002}^{2015} \varphi_t \cdot (Union_s \times I_t) + \sum_{2002}^{2015} \beta_t \cdot (\rho_s \times Union_s \times I_t) + \pi X_{dst} + \delta_d + \lambda_t + \mu_{dst},$$

where the coefficients for φ_t map out the dynamic treatment effects of a one standard deviation increase in union power. The coefficients of interest are the β_t, which estimate how γ_t changes as

teachers' union power increases by one standard deviation. If the identification assumption for Equation (2) is satisfied and the pre-recession reliance on state revenue leads to exogenous shock in school spending, the lead indicators ($\beta_{2002}, \ldots, \beta_{2006}$) should be close to zero and statistically insignificant.

5 Results

5.1 Baseline Results

I begin by presenting the results from nonparametric DD model provided by Equation (3) to examine whether any pre-recession trends exist in the per-pupil total expenditures. All models include district and year-fixed effects, controls for total district population, fraction child poverty, school-age population, school district enrollment, and the Bartik predictor. Figure 4A illustrates that for all states, a one SD increase in state aid reliance reduces per-pupil total expenditure by about 5 percentage points, 3 years after the onset of the Great Recession. This estimate represents a 19.8 percent decrease in the per-pupil spending associated with one percent increase in reliance on state revenue, which is similar in magnitude compared to the findings of Jackson, Wigger, and Xiong (2021). As mentioned previously, I estimate the same model separately for strong and weak union states to examine whether heterogeneous effects exist across teachers' union strength. The black and yellow line represents DD event study estimates for strong (above median) and weak (below median) union states, respectively. The figure indicates that a one SD increase in the share of state revenue in strong union states leads to a greater decline of approximately 4 percentage points in per-pupil total expenditure compared to weaker union states.

As discussed previously, the validity of my identification strategy relies on the assumption that in the absence of the Great Recession, the effect of state-aid reliance would have no differential impact across states with various levels of teacher union strength. Following Equation (4), I present

the DDD event study graph in Figure 4B to test the assumption of no pre-recession trends in district spending. Each estimate in the figure essentially represents differences between the event study estimates for strong and weak unions states, as shown in Figure 4A. Although there exists a marginally significant pre-treatment effect at the 5-percent level in 2005, there is no discernible overall trend. The effects within five years prior to the Great Recession are not statistically significant at the 10-percent level and it is evident from the figure that the lead coefficients for per-pupil expenditure remain relatively flat (i.e., strong and weak union states had similar pre-trends), followed by a steep decline after the onset of the recession. In summary, the two-event study figures for per-pupil total expenditure provide no evidence of pre-trends in total spending.

The DDD regression results confirm these event study findings. Table 2 presents the results from the estimation of Equation (2) that controls for total district population, school-age population, the Bartik predictor, and a set of district-level student demographic controls.[xi] All estimates are weighted by district enrollment and standard errors are clustered at the district and state-year level.[xii] Consistent with the event study results, the coefficient for *SSRev* × *GR* indicates that a one SD increase in reliance on state aid is associated with a decrease in per-pupil spending by about $100 \times (e^{0.0343} - 1) = 3.5$ percent, a result qualitatively similar to Jackson, Wigger, and Xiong's (2021) findings. Similarly, the coefficient for *Union* × *GR* captures the differential effects associated with union power during the Great Recession. The estimated DD coefficient is essentially zero (0.005) and statistically insignificant, indicating that districts in strong union states with an average level of reliance on state aid did not experience any differential effects on per-pupil spending. Finally, the parameter of interest is the coefficient on *SSRev* × *Union* × *GR*, which shows how the DD estimate for *SSRev* × *GR* changes as state's teacher union power increases by one SD. The DDD estimate of *SSRev* × *Union* × *GR* suggests that for strong union states, a one

SD increase in reliance on state aid led to a decrease in per-pupil spending by 1.7 percent. Provided that per-pupil total spending was about $13,100 on average, the estimate translates to spending cuts of about $220 per pupil. For a district with an average size of student enrollment, this is equivalent to about $832,700. To examine which sub-categories were most affected, I estimate Equation (2) by replacing the dependent variable with capital outlay, current expenditures, average teacher salaries, and average teacher benefits. The results reported in columns 2 and 3 of Table 2 reveal that much of the differential decrease in total spending came from current expenditures. Specifically, one SD higher union power was associated with a 1.7 percent decrease in operating expenses but had statistically insignificant relationship with capital spending.

Next, I turn to similar analyses for the average teacher salary and benefit, in which the two variables are constructed by dividing the total current instructional salary and benefit expenditures by the number of FTE teachers, respectively. The results presented in columns 4 and 5 indicate that the primary source of reduction in operating expenses was accounted for by reduced instructional benefit spending. Specifically, the DD estimate of $SSRev \times GR$ in column 4 shows that a one SD increase in pre-recession state reliance on state revenue was associated with a decrease in average teacher salaries of 1.8 percent. The positive and statistically significant DDD estimate, however, suggests that teachers in states with strong teachers' unions might have fared better during the recession. Column 5 of Table 2 reports the estimates for the average teacher benefits. While a one SD higher reliance on state aid led to a reduction in average teacher benefits by 3 percent, the negative DDD estimate suggests that teachers in strong union states experienced an additional reduction in benefits by 4.1 percent, equivalent to $291,400 savings for an average size school district.[xiii] This estimate is also statistically significant at the 1% level and indicates that the significant decrease in total spending faced by strong union states was primarily driven by

benefit reductions. As in columns 4-5, the DDD event study results for average instructional salary and benefit expenditures presented in Figure 5A and 5B show a gap in salary and benefit spending between weak and strong union states that emerges after the Great Recession. Furthermore, these results indicate little evidence of pre-trends, bolstering the claim that pre-recession reliance on state aid is likely exogenous.

Regarding the effects on non-financial outcomes, Figure 5C and Figure 5D present the DDD event study results from Equation (4) for log of full-time teacher employment and student-to-teacher ratio (class size), respectively. Focusing on the DDD event study results for the teacher employment shown in Figure 5C, full-time teacher employment in strong union states decreases by about 1 percentage points more after the onset of the recession and remains at this level over time. Unless student enrollments changed significantly, the significant decline in teacher employment would have resulted in an increase in the average class size. The results for student-to-teacher ratio shown in Figure 5D confirm this hypothesis and suggest that there exists an upward post-recession trend for strong union states only. The DDD regression results presented in columns 6–7 of Table 2, again, confirm these event study results. A one SD increase in pre-recession reliance on state revenue led to a decrease in the employment of full times teachers by almost 1 percentage point in states with strong teachers' unions. Correspondingly, the DDD estimate for the student-to-teacher ratio is 0.246 and statistically significant, implying that strong union states with greater reliance on state revenue experienced much more sizeable increases in class size.

Overall, my results suggest that districts in strong unions states obtained substantial savings from spending cuts on benefit expenditures, perhaps by reducing the generosity of benefit packages. These results align with Fitzpatrick's (2015) finding that teachers are willing to pay just 20 cents of current compensation for each expected dollar of future compensation. Despite these

efforts, the findings suggest that districts in strong union states still experienced a decrease in the number of full-time equivalent (FTE) teachers, increasing the average class size by about 0.25 students compared to districts in weak union states.

5.2 Effects on Academic Achievement

To examine whether the differences in spending cuts by teachers' union power translated into differences in student performance, I use restricted-access microdata from the NAEP and begin by estimating the event study model of the following from:

$$(5) \quad NAEP_{idst} = \sum_{2002}^{2015} \gamma_t \cdot (\rho_s \times I_t) + \sum_{2002}^{2015} \varphi_t \cdot (Union_s \times I_t) + \sum_{2002}^{2015} \beta_t \cdot (\rho_s \times Union_s \times I_t) + \pi X_{idst} + \delta_d + \lambda_t + \mu_{idst}$$

where $NAEP_{idst}$ represents the NAEP math or reading scores for student i, in district d, in state s during year t. In addition to the controls and fixed effects mentioned in Equation (3), I also include a set of student demographics, namely gender, race, individualized educational plan (IEP) status, and limited English proficiency (LEP) status. All NAEP test scores standardized to have a mean of zero and standard deviation of one.[xiv]

Figures 6A and 6B present DDD event study results for NAEP math and NAEP reading, respectively. For math assessments, the DDD event study results presented in Figure 6A suggests that while strong union states perform slightly better prior to the onset of the Great Recession, the post-recession estimates provide no evidence that strong and weak union states faced differential impact on student achievement. In contrast to math scores, Figure 6B reveals a slightly different pattern for reading assessments. A greater decline in education expenditure in strong union states led to a *better* reading achievement during the first two years after the Great Recession. Overall, the DDD event study estimates (and their 90 percent confidence intervals) presented in Figures 6A

and 6B illustrate that the gap between strong and weak union states appears statistically indistinguishable from zero. Figures 6C-6E present separate DDD event study results for individual NAEP assessment tests. As the figures suggest, the differential impact of the Great Recession in strong vs. weak union states was generally small, the only exception being 4th grade math scores. The event-study result for 4th grade reading scores, however, does raise a cautionary note about potential pre-trends before the start of the Great Recession. Despite this, the preponderance of evidence indicates that the large expenditure decreases in strong union states did not pose greater harm to the academic performance of K-12 students.

The DDD regression results presented in Table 3 confirm these findings. Again, each column in Table 3 comes from a separate estimation of Equation (2) in which the dependent variable is listed in the column header. I also include controls for student characteristics in addition to the district-level controls and fixed effects.[xv] Across all NAEP subjects, I begin by estimating DD models without including the union interaction terms to demonstrate that my results are comparable to those presented by Jackson, Wigger, and Xiong (2021). As expected, columns 1 and 3 of Table 3 show that one SD increase in the share of state revenue reliance is associated with a decrease in math scores by 0.0289 SDs and in reading test scores by 0.0175 SDs. Once the union interaction terms are added, the estimated coefficient on DDD term reported in column 2 suggests that there is a small and statistically insignificant relationship between union power and NAEP math scores. Moreover, even with much greater spending cuts, reading scores actually *improved* by 0.00796 SDs in states with high union power compared to otherwise similar states with low union power.[xvi]

Drilling down to each subject by grade, columns 5 through 12 indicate that there exists substantial heterogeneity across the assessments. The most notable effects are observed for 4th-

grade math and 8th-grade reading. The DDD estimate reported in column 6 indicates that student performance in 4th-grade math scores decreased by about 0.0216 SDs. On the other hand, there exist statistically insignificant positive effects for 4th-grade math, 4th-grade reading, and 8th-grade reading scores associated with strong union states. This pattern is consistent with previous studies that have shown that math scores, compared to reading scores, are more elastic to school spending (e.g., Jackson, Rockoff, and Staiger 2014).

Taken together, these results with the results from Table 2 indicate that there is little evidence of an overall negative effect on student achievement associated with greater spending cuts in strong union states.

5.3 Average Teacher Pay and Experience

In this section, I use two different individual-level survey datasets to evaluate the effects on full-time teachers' average hourly wage and age composition. While the average teacher salary results presented in Table 2 provide suggestive evidence on how teachers' earnings have changed, the findings may be driven by several possible mechanisms. For instance, the increase in average salary in strong union states relative to weak union states might have been driven by 1) an evenly distributed increase in salary for all teachers or 2) a shift in the age (and thus experience) of the teacher workforce by laying off younger teachers. To further examine these possibilities, I utilize the American Community Survey - Public Use Microdata Sample (ACS-PUMS) and the Current Population Survey - Merged Outgoing Rotation Group (CPS-MORG). The advantage of using the ACS is its large sample size, while the disadvantage is its lack of availability before 2005. Therefore, only three years of pre-recession data (2005–2007) and three years of post-recession (2008–2015) data are available. On the other hand, the sample size of the CPS-MORG is much smaller but is available from 1990. Restricting the datasets to full-time public-school teachers with

an inflation-adjusted wage greater than minimum wage for the given year, I ended up with a sample size of 298,223 for ACS-PUMS and 68,256 for CPS-MORG.

Using ACS and CPS, I estimate the following triple differences model:

$$(6)\quad y_{ist} = \beta_0 + \beta_1(\rho_s * I^{Post}) + \beta_2(Union_s * I^{Post}) + \beta_3(\rho_s * Union_s * I^{Post}) + \eta X_{ist} + \pi Z_{st} + \theta_s + \lambda_t + \varepsilon_{ist},$$

where y_{ist} represents log real hourly wage or age for teacher i, in state s, in year t. I include state and year-fixed effects and control for individual-level as well as state-level demographic characteristics.[xvii]

Table 4 provides the ACS and CPS results of log wage and age from a separate estimation of Equation (6). Focusing on the wage results in columns 1 and 3, the estimated coefficients on the triple interaction term based on both the ACS and CPS samples are close to zero and statistically insignificant. These results reveal that teachers' conditional wages remained comparable across states with various levels of union strength.[xviii] Turning to the effects on the average age, columns 2 and 4 both show that the average teachers' age increased in states with strong teachers' unions. These results indicate that either weak union states hired more teachers or strong unions dismissed relatively younger and inexperienced teachers. Considering the magnitude of teacher layoffs during the Great Recession (Evans et al. 2019; Leachman et al. 2016), the latter is more likely than the former.

Overall, the experience level for teachers in strong union states increased significantly, while hourly wages remained stable compared to weaker union states.[xix] Taken together, the results reported in Table 2 and Table 4 raise possibility that school districts in states with strong unions were protecting senior teachers' interests at the expense of the employment of inexperienced teachers and staffing ratios.

5.4 Robustness and Falsification Test

As mentioned previously, I use two alternative union power measures to further evaluate the robustness of the baseline results. I start by replacing my primary measure of union power with a variable that indicates whether a state has a duty-to-bargain law for teachers. The results are reported in Panel A of Appendix Table 2. Although the estimated coefficient on the DDD parameter for average salary appears statistically insignificant, the overall pattern of results persists across all other outcomes. Essentially, districts in CB-mandatory states experienced a differential impact of a 5 percent decrease in total expenditure during the Great Recession, which led to decreases in the number of FTE teachers and increases in the average class size. Considering the NAEP test score results in columns 6–7, all DDD coefficients qualitatively resemble the results from the primary analysis and remain statistically indistinguishable from zero.

The second alternative measure for union power incorporates the presence of duty-to-bargain law, RTW status, and RTS status. This measure is based on the idea that RTW status significantly weakens teacher unions' ability to retain members and collect fees. Similarly, the presence of a state law that prohibits a strike eliminates a powerful tool for the teachers' unions to gain leverage on contract negotiations. Combining the three categories that possibly reflect union influence, the alternative measure is created by awarding a score of 2 to the states with a mandatory collective bargaining law, a score of 1 to those without RTW status, and finally a score of 1 to those allowing strikes. Therefore, the measure ranges from 0 to 4, with 0 representing the weakest and 4 representing the strongest union states. Panel B of Appendix Table 2 presents the results based on this alternative union power measure, and the overall pattern of estimated coefficients remains mostly consistent compared to the baseline results. Specifically, I found that among strong union states, a one SD increase in reliance on state revenue is associated with a differential effect

of a 2 percent decrease in per-pupil expenditures. Similar to the baseline results, the DDD estimate in column 3 shows that teachers in strong union states faced benefit cuts that were approximately 4.7 percent greater than otherwise similar teachers in weak union states. Most importantly, these additional spending cuts did not result in any notable negative impact on student achievement. Finally, I follow Lott and Kenney (2013) and replace union power index with two additional measures associated with teacher union strength: 1) union expenditure per student and 2) union dues per teacher. Once again, the estimates presented in Panels C and D fluctuate to some extent, but remain qualitatively quite similar to that found using my preferred measure, thus mitigating concerns of endogeneity and subjectivity.

As noted by Frandsen (2016) among others, teacher union power is potentially endogenous, and the triple-difference strategy may pick up other differences across districts that are correlated with union power. For instance, my results may be biased if residents living in more prosperous states with higher median household income are more generous to teachers' unions. Moreover, these states may have struggled more economically during the recession which might have altered their manner of spending resources compared to otherwise similar states with weaker teachers' unions.

I first attempt to address this concern by controlling directly for observable characteristics that are highly correlated with both teacher union power and district spending preference. Specifically, I expand Equation (2) by including additional DD and DDD terms that replace the *Union* variable with three state characteristics: 2000 household income, 2004 presidential election Democratic Party vote share, and 2000 unemployment rate. To examine whether α_3 withstands the addition of these state characteristics, I formulate equations that include each set of these variables separately.

Panel A of Appendix Table 3 presents estimates based on the specification that includes the median household income from 2000 and its interaction terms. While the point estimates fluctuate to some extent, controlling for heterogeneity by median household income does not change the general pattern of results for expenditures, full-time teacher employment, class size, nor student achievement. In Panels B and C, I replace household median income with the 2004 presidential election Democratic Party vote share and 2000 unemployment rate, respectively. Although the DDD coefficients for full-time teacher employment become attenuated, all other results remain robust with the inclusion of these additional controls and their interactions.

Another potential concern is that several states implemented substantial reforms to teacher-related laws and policies that could have influenced both the outcomes and teachers' union power. For example, Florida eliminated tenure for teachers hired after July of 2011, while Louisiana went through a major revamping of its tenure law in 2012 (Carruthers et al. 2018; Strunk et al. 2017). Furthermore, Tennessee changed its collective bargaining law in 2011 from mandatory to allowed, while several other states, including Idaho, Indiana, Michigan, Ohio, and Wisconsin enacted a series of reforms in 2011-2012 that substantially reduced the rights of teachers' unions to collectively bargain over certain conditions of employment (e.g., Anderson et al. 2019; Baron 2018; Jorgensen and Moul 2019; Roth 2019). In the second set of robustness checks, I start by including additional DD and DDD terms that now replace the *Union* variable with an indicator variable for CB and tenure reform states. The results are reported in Panel E. Controlling for such states does not change the main results on total expenditure, benefits, class size, teacher employment, or test scores. I next drop those same set of states that implemented major changes to teacher-related laws and policies. Again, the point estimates shown in Panel F vary somewhat in magnitude, but the overall pattern remains the same.

Finally, it could be the case that the influence of the Great Recession in strong union states was more pronounced in comparison to weaker union states due to reasons other than teachers' union influence. For instance, the steep declines in the total and current expenditures in strong union states might reflect lower consumer expenditure, which in turn reduces state sales tax revenue, and public-school revenues. A natural way to address this possibility is to repeat the estimation procedure, replacing the dependent variable in Equation (2) with the following state-level economic variables: 1) private sector unemployment, 2) tax revenue, 3) median income, 4) unemployment rate, and 5) real gross domestic product (GDP) per capita.[xx] These economic variables should not have changed depending on the strength of teachers' unions during the recession, so significant estimates would indicate potential bias. Appendix Table 4 presents the results from this falsification test analysis. All the estimated coefficients on $SSRev \times Union \times GR$ reported in Appendix Table 4 are small and statistically indistinguishable from zero. While this test cannot completely rule out the possibility of omitted variable bias, the overall pattern of small coefficients for economic variables supports the validity of my main results.

6. Conclusion

The Great Recession was one of the most extensive and severe economic downturns in U.S. history and led to significant declines in employment, earnings, and property values. Building on the relevant literature focusing on the relationship between the Great Recession and student outcomes, in this paper I examine whether the impact of the Great Recession on school district spending, the allocation of resources and student achievement varied depending on the strength of state's teachers' unions.

My results suggest that districts in strong union states effectively reallocated resources in ways that minimized the negative impacts of spending cuts on student achievement. Specifically,

I find that among districts in strong union states, a one SD increase in reliance on state revenue is associated with a differential impact of approximately 1.7 percent, or approximately a $220 decrease in per-pupil spending. These spending cuts were primarily driven by cuts in teacher benefits and reductions in the number of FTE teachers, which, as a result, raised average class size. Although districts in strong union states made larger cuts to educational spending, I find little evidence that these larger spending cuts resulted in larger declines in student achievement. My subsequent analysis using survey datasets also suggests that school districts in states with strong unions retained positions for high-paid experienced teachers at the expense of staffing ratios, a finding consistent with the recent literature finding that returns to experience are most pronounced in districts where union activity is high (e.g., Brunner and Squires 2013).

There are two possible explanations behind the results in this study. The first is that teachers' unions are indeed efficiency-enhancing and help school districts appropriately implement cost-effective measures to protect student achievement. After all, teachers work closest with students and thus, may have better knowledge than school district officials on how resources could be used most efficiently. Therefore, giving teachers a voice to influence their compensation and working environment can not only increase their work morale but also help schools' ability to attract and retain more qualified teachers and increase overall productivity (Loeb and Page 2000; Brunner and Squires 2013). Alternatively, the results of Hoxby (1996) and numerous other studies suggest that teachers' unions are rent-seeking. Accordingly, school districts under union pressure might not spend their resources in an efficient manner, especially during time periods when they are financially well off. If teachers' unions distorted resource allocations prior to the Great Recession, successfully redesigning budgets in times of financial duress might help districts preserve students'

learning environment. The increase in efficiency in strong union states could reflect either a more efficient use of available resources or reduction in wasteful spending.

That said, the results presented are subject to several caveats. First, the financial situation changed rather quickly and unexpectedly during the Great Recession and the possibility remains that actions taken by state governors and local school board officials might have influenced teachers' collective bargaining power. While the results are robust to analysis dropping states that had gone through extensive revamping of educational policies, it is still possible that other unobservable factors may have impacted the strength of teacher unions, ultimately influencing educational outcomes. Second, studies suggest that there exists significant within-state variation in union strength and their negotiating terms (e.g., Strunk and Reardon 2010). Provided that the union measures are at the state level, the estimates presented in this paper cannot speak to the local union's ability to alter district spending decisions nor student achievement. Finally, it is also noteworthy that the findings presented in this study should be interpreted as purely short-term and might not have similar effects in the long run. For instance, temporary benefit reductions during period of financial struggle might not foster teachers' decision to leave the profession, thereby preventing the loss of high-quality teachers. However, the effects of permanent decrease in teacher compensation could motivate high-quality teachers to look for alternatives, which could adversely impact student achievement.

[i] Evans, Schwab, and Wagner (2019) also documented the impact of the Great Recession on K-12 school spending, employment, and class size. They showed that between the start of the recession and January 2013, employment in public K-12 education fell by 3.7 percent while the teacher-to-student ratio increased by 5.1 percent.

[ii] Exploring cohort variation in the years of exposure to the Great Recession, Shores and Steinberg (2019) demonstrated that the recession adversely affected student achievement. Jackson, Wigger, and Xiong (2021) developed a simple model and examined a similar question leveraging the fact that states with high reliance on state revenue were more vulnerable to financial hardship due to considerable decreases in income and sales taxes. Similar to Shores and Steinberg (2019), they also found that negative shock to state government finances induced by the Great Recession led to worse educational outcomes, as measured by test scores and college-going rates. These studies are consistent with the literature that suggests that school spending improved student outcomes (Jackson, Rucker, and Persico 2016; Candelaria and Shores 2017; Card and Payne 2002; Lafortune, Rothstein, and Schanzenbach 2018).

[iii] An obvious concern with using the pre-recession share of state K-12 spending that came from state sources to measure the magnitude of the recessionary shock is that this measure might be correlated with state teacher union power and changes in economic conditions such as unemployment during the Great Recession. I show that the share of state spending that came from state sources is largely unrelated to both the power of teachers' unions and state unemployment rates during the Great Recession.

[iv] Please see Cowen and Strunk (2015) for a comprehensive review of earlier findings on this literature.

[v] Henceforth, I index school years by the calendar year in which a school year ends, i.e., 2002 refers to the school year 2001–2002.

[vi] These variables include a share of free lunch-eligible students, of students in Individualized Education Plan, of students in the English Language Program, and of Black, Hispanic, and Asian students.

[vii] In addition to administering the assessments to nationally representative samples, the NAEP assessments make modest changes every 10 years and seek to maintain broad comparability across time.

[viii] The NAEP test scores used in this paper start from 2003 as the sample size increased 10 times than any previous NAEP administration (Lubienski and Lubienski 2006).

[ix] Based on NBER recession dates, which indicate that the Great Recession began during the 4th quarter of 2007. http://www.nber.org/cycles.html

[x] The recession intensity measure was constructed using the steps outlined by Jackson, Wigger, and Xiong (2021).

[xi] District-level student demographic controls include child poverty rate, fraction female students, fraction Asian students, fraction Hispanic students, fraction black students, fraction SPED students, and fraction LEP students.

[xii] Dropping the district enrollment weight led to results that are qualitatively similar to the main results presented in Table 2. The only exception being the estimated triple interaction coefficient for the number of teachers and average salary, which has attenuated and is no longer statistically significant. Results are available upon request.

[xiii] Average instructional benefit was about $30,000 during the sample period. The DDD estimate suggests that school districts in strong union states cut spending on average instructional benefits by $100 \times (e^{0.0405} - 1) = 4.133\%$, or $1,240. For an average size school district, this is equivalent to a $\$1{,}240 \times 235\ FTE = \$291{,}400$ decrease in their total spending.

[xiv] As discussed by Jacob and Rothstein (2016), the NAEP microdata aggregated to the district-level may be potentially biased due to inappropriate construction of the underlying test scores. I leave the data at the district-year level to be consistent with the prior analyses, which are all at the district level. The overall results are robust to aggregating the NAEP data to the state-by-year-by-assessment level and are available upon request.

[xv] As before, all standard errors are clustered at the district and state-year level to account for potential correlation of the residuals over time.

[xvi] The results for expenditures, FTE, and class size are robust to restricting to the NAEP sample of district-years and are available upon request.

[xvii] Individual-level controls include age, sex, education, race, and marital status. State-level controls include total population and fraction of students under poverty. All regressions are weighted by individual earnings weight provided by each survey.

[xviii] While I cannot completely rule out the possibility of within-state migration of teachers, evidence also suggests that this may not be a major concern. Studies showed that there exist significant barriers to cross-state mobility of public-school teachers (Kim et al. 2016; Goldhaber et al. 2015). This is primarily due to 1) licensing requirements that differ across states and 2) non-competitive features of collective bargaining agreements that govern employment conditions, pay scale, and pension benefits. For example, Black et al. (2014) find that the female labor force participation is particularly sensitive to commute times, while Boyd et al. (2005) show that teachers have strong preferences to teach nearby to where they grew up.

[xix] To ensure that age is a valid proxy for experience, I use the publicly available School and Staffing Survey (SASS) from 1999-2000 and find that teachers' age and experience are highly positively correlated with a correlation of 0.7404.

[xx] These variables are constructed by taking averages from the years 2007 to 2009. State-level private employment data comes from the Quarterly Census of Employment and Wages (QCEW) of the Bureau of Labor Statistics website. State-level tax revenue data comes from the Common Core Data (CCD) of the NCES. Median income data comes from the U.S. Census Bureau website. GDP per capita comes from the Bureau of Economic Analysis website.

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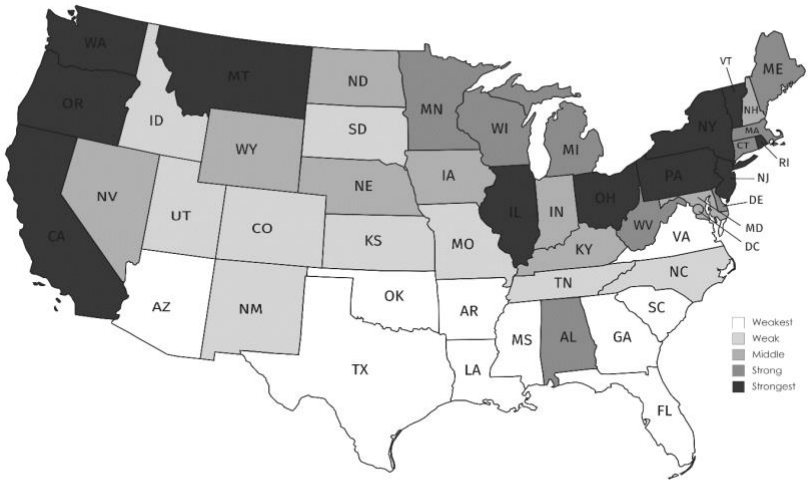
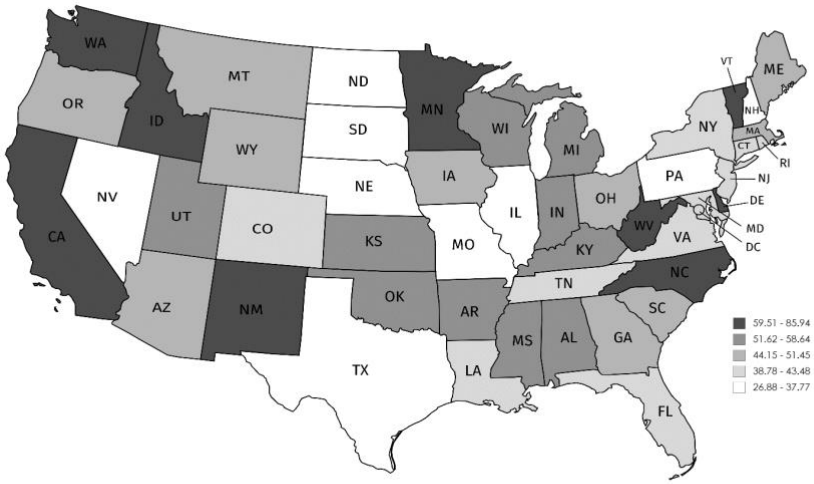
Figure 1: State Union Power Measure



Notes: Map shows states by their values of the continuous teacher union power index provided by the Fordham Institute (2012). The index incorporates thirty-seven different variables across four different fields: 1) involvement in politics, 2) scope of bargaining, 3) state policies, and 4) perceived influence.

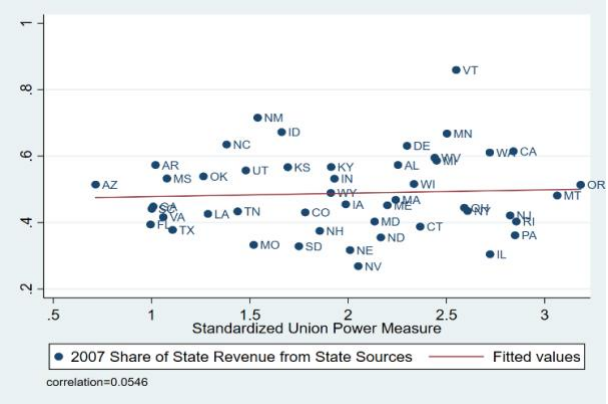
Figure 2: 2007 Fraction of State Revenue from State Sources



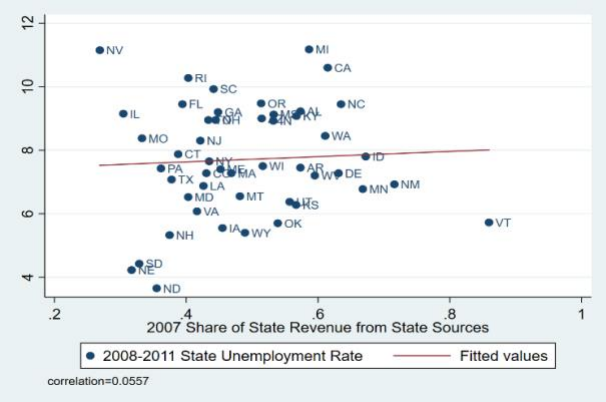
Notes: Map shows states by 2007 fraction of state total revenue from state sources, calculated following Jackson, Wigger, and Xiong (2021)

Figure 3: Share of K12 Revenue from State Sources, State Unemployment Rate and Union Power Measure

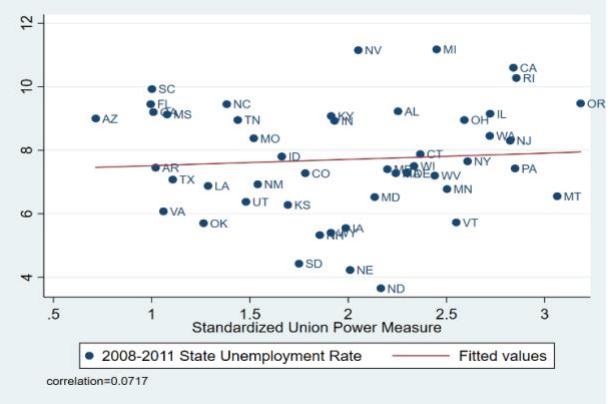
(A) 2007 Share of State Revenue, by Union Power Measure



(B) 2008-2011 State Unemployment Rate, by 2007 Share of State Revenue



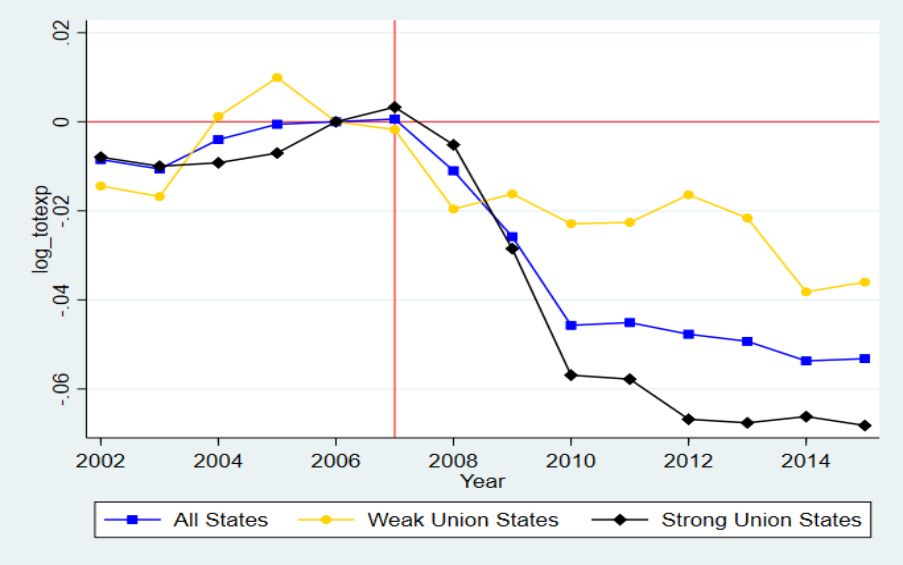
(C) 2008-2011 State Unemployment Rate, by Union Power Measure



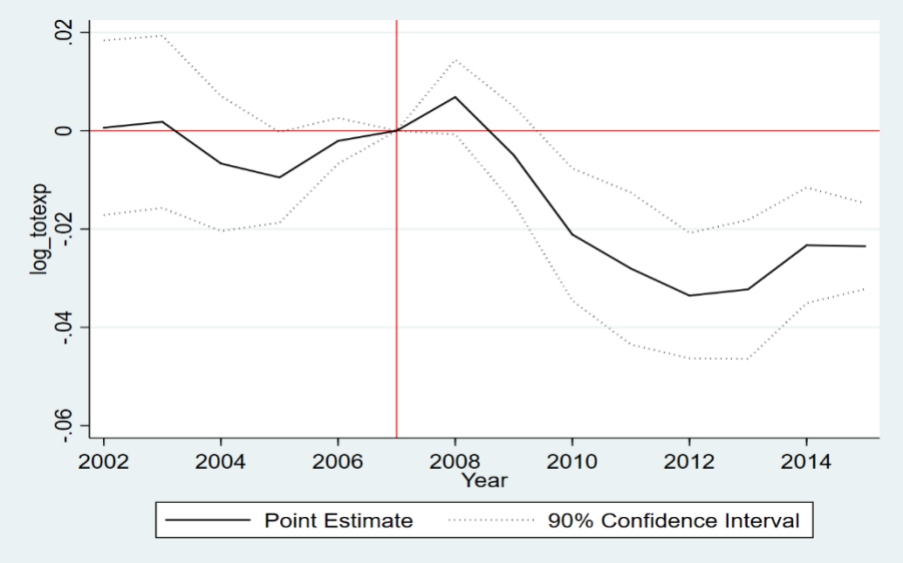
Notes: Panel A plots 2007 share of state revenue that came from state sources by the continuous union power measure. Panel B plots the state average unemployment between 2008 and 2011 by 2007 share of state revenue that came from state sources. Panel C plots the state average unemployment between 2008 and 2011 by the continuous union power measure. These figures exclude Hawaii, Alaska, and the District of Columbia due to their unique locations and political characteristics.

Figure 4: Effects of the Great Recession on Per-Pupil Total Expenditures

(A) DD Event Study by Teachers' Union Power



(B) DDD Event Study (Strong Union States – Weak Union States)



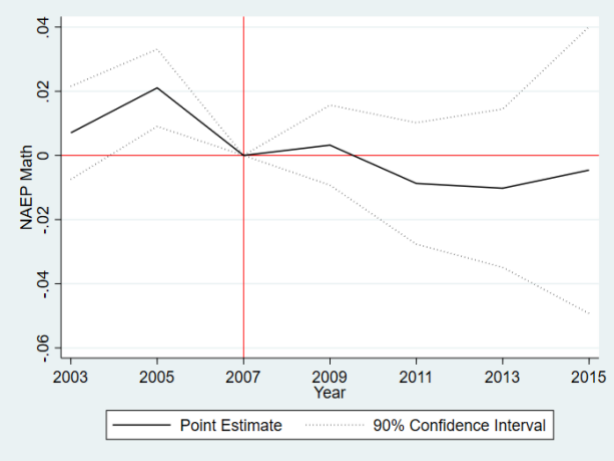
Notes: Panel A plots γ_t for each calendar year from Equation (3) together (blue) and separately for strong (black) and weak (yellow) union states. Panel B plots estimated triple-diff coefficient, β_t, for each year from Equation (4) relative to the coefficient for 2007. The dashed connected line depicts the 90 percent confidence interval for each individual year interactions. Dependent variable is per-pupil total expenditure, calculated by dividing the total school district expenditure by the student enrollment. All regressions control for district characteristics, district fixed effects, year fixed effects. All regressions are weighted by enrollment, and standard errors are clustered at the state level.

Figure 5: Effects of the Great Recession on Teachers' Average Compensation, Employment, and Class Size

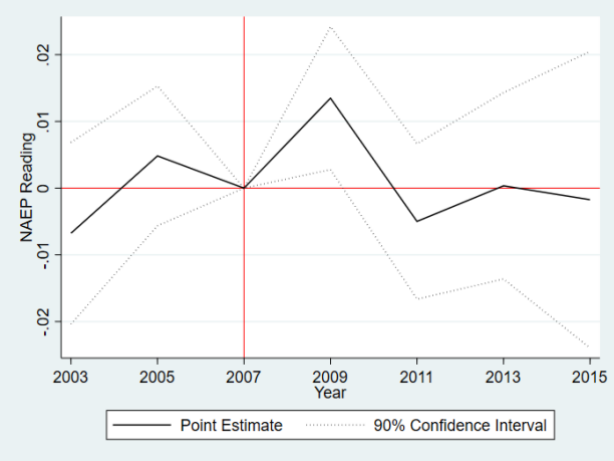
Notes: All figures plot estimated triple-diff coefficient, β_t, for each year from Equation (3) relative to the coefficient for 2007. The dashed connected line depics the 90 percent confidence interval for each individual year interactions. Dependent variables are average teacher salary (Panel A), average teacher benefits (Panel B), number of full-time-equivalent teachers (Panel C), and student-to-teacher ratio (Panel D). All regressions control for district characteristics, district fixed effects, and year fixed effects. Standard errors are clustered at the state level.

Figure 6: Effects of the Great Recession on NAEP Math and NAEP Reading

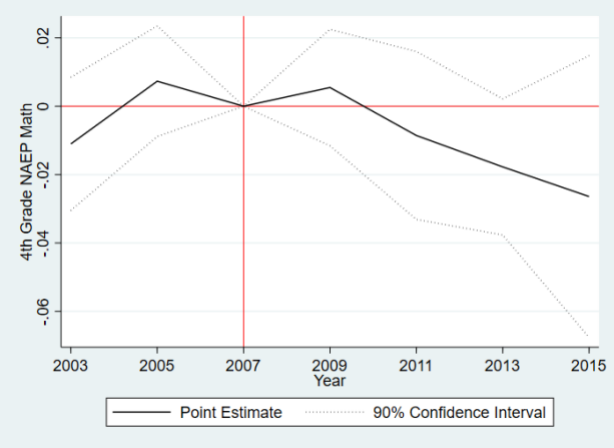
(A) NAEP Math



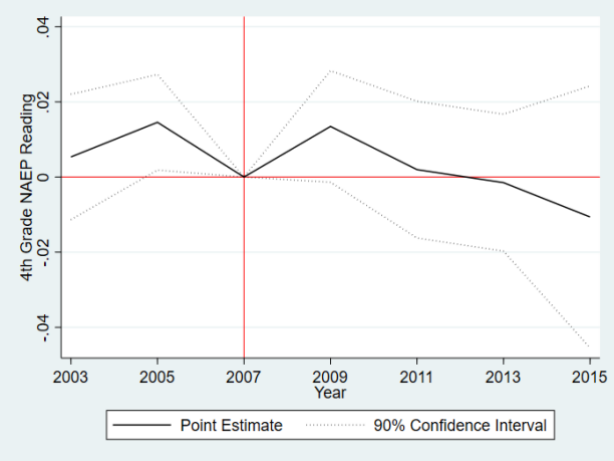
(B) NAEP Reading



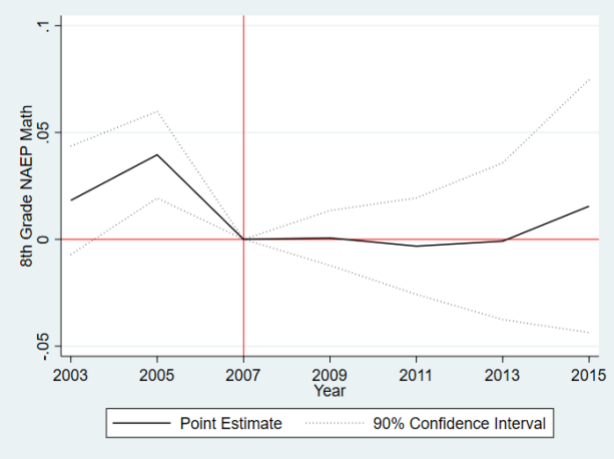
(C) 4th Grade NAEP Math



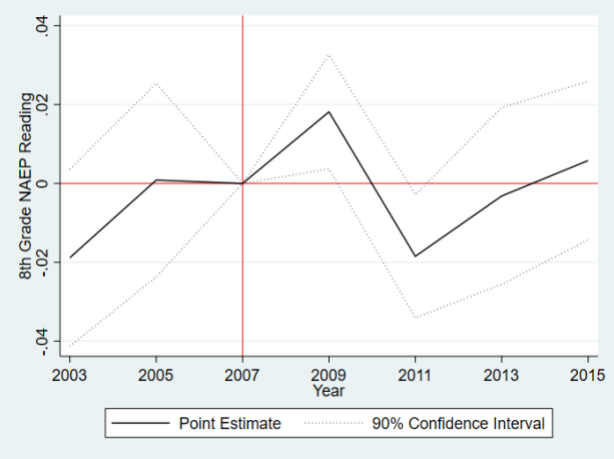
(D) 4th Grade NAEP Reading



(E) 8th Grade NAEP Math



(F) 8th Grade NAEP Reading



Notes: Analysis based on restricted-use individual-level NAEP test scores from the NCES. All figures plot estimated triple-diff coefficient for each year relative to the coefficient for 2007. The dashed connected lines depict the 90 percent confidence interval for each individual year interactions. Dependent variables are NAEP Math Assessment scores (Panel A), NAEP Reading Assessment scores (Panel B), 4th grade NAEP Math assessment scores (Panel C), 4th grade NAEP Reading assessment scores (Panel D), 8th grade NAEP Math assessment scores (Panel E), and 8th grade NAEP Reading assessment scores (Panel F). All regressions control for district characteristics, student characteristics, state-level economic variables, district fixed effects, and year fixed effects. Standard errors are clustered at the state level.

Table 1: Summary Statistics

	Full Sample		Strong Union States		Weak Union States	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Per-Pupil Spending (District)						
Total Expenditure	12,082	5,692	13,133	5,901	10,692	5,081
Total Capital Expenditure	1,099	2,314	1,098	2,267	1,100	2,373
Total Current Expenditure	10,094	3,900	10,976	4,429	8,927	2,646
Instructional Salary Expenditure	4,110	1,529	4,444	1,784	3,667	934
Instructional Benefit Expenditure	1,391	810	1,675	892	1,016	473
Other District Level Variables						
District Population	25,622	112,463	24,977	127,669	26,474	88,434
School Age Population	4,198	18,470	3,876	20,648	4,625	15,107
Child Poverty Rate	0.16	0.10	0.14	0.09	0.20	0.10
District Enrollment	3,785	15,349	3,448	16,703	4,230	13,337
Fraction Female Student	0.47	0.07	0.47	0.08	0.48	0.06
Fraction Asian Students	0.02	0.04	0.03	0.06	0.01	0.02
Fraction Black Students	0.07	0.16	0.06	0.14	0.09	0.18
Fraction Hispanic Students	0.11	0.19	0.10	0.18	0.13	0.21
Fraction LEP Students	0.04	0.25	0.04	0.18	0.04	0.32
Fraction SPED Students	0.14	0.72	0.14	0.51	0.14	0.92
Pupil-Teacher Ratio	14.77	4.73	15.45	5.31	13.88	3.67
Observations	167,715		94,015		73,700	
State Level Variables						
Frac. of Rev. from State 2007	49	12	50	13	47	11
Real Median Income 2007	56,714	8,905	59,949	9,691	53,977	7,294
Dem. Party Vote Share 2004	45.70	8.45	51.26	7.07	41.00	6.49
Dem. Party Vote Share 2008	50.33	8.99	56.30	7.33	45.28	6.99
Observations	48		22		26	

Note: Summary statistics for district level revenue and expenditure variables are from the 2005-2015 District Finance Survey (F-33) Data maintained by National Center for Education Statistics (NCES). Data on district level enrollment characteristics data is from the NCES Common Core Data. District level child poverty rate, school age population and district population are from the Small Area Income and Poverty Estimates (SAIPES). State level presidential vote tallies for the 2004 and 2008 presidential elections come from the Federal Election Commission.

Table 2: Main Results

	Total Exp.	Capital Ex.	Current Exp.	Avg. Inst. Salary	Avg. Inst. Benefit	Log (FTE)	Class Size
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
SSRev × GR	-0.0343***	-0.0323	-0.0243***	-0.0179***	-0.0301***	-0.00888**	0.147**
	(0.00472)	(0.0210)	(0.00414)	(0.00349)	(0.00896)	(0.00349)	(0.0587)
Union × GR	0.00428	-0.0759***	0.0190***	0.0152***	0.0414***	-0.0167***	0.0341
	(0.00474)	(0.0237)	(0.00408)	(0.00363)	(0.00897)	(0.00406)	(0.0722)
SSRev × Union × GR	-0.0167***	0.000259	-0.0165***	0.00806**	-0.0404***	-0.0102**	0.245***
	(0.00541)	(0.0252)	(0.00465)	(0.00389)	(0.0102)	(0.00410)	(0.0710)
Observations	167,715	167,715	167,715	167,715	167,715	167,715	167,692

Notes: Data from the District Finance Survey Data (F-33) and Common Core of Data (CCD) 2002-2015. Each column presents results from a separate regression where the dependent variable is listed in the column headers. SSRev is the share of state education funding from state sources in 2007, GR is a dummy variable equal to 1 if the observation is after 2007, and Union is the continuous union power index. All specifications include total district population, school age population, district enrollment, child poverty rate, district-level Bartik Instruments, fraction female students, fraction Asian students, fraction Hispanic students, fraction black students, fraction SPED students, fraction LEP students, district fixed effects, and year fixed effects. Robust standard errors in parentheses and clustered at the district and state-year level.
*** p<0.01, ** p<0.05, * p<0.1

Table 3: Effect of Union Power on Educational Outcomes

	NAEP Math		NAEP Reading		4th Grade Math		8th Grade Math		4th Grade Reading		8th Grade Reading	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
SSRev × GR	-0.0289***	-0.0253***	-0.0175***	-0.0172***	-0.0272**	-0.0242**	-0.0345***	-0.0316***	-0.0198**	-0.0204***	-0.0189**	-0.0162**
	(0.00828)	(0.00788)	(0.00563)	(0.00563)	(0.0127)	(0.0118)	(0.00761)	(0.00848)	(0.00773)	(0.00785)	(0.00827)	(0.00665)
Union × GR		-0.00201		-0.00877		0.00983		-0.0121		0.000435		-0.0198**
		(0.00702)		(0.00640)		(0.00962)		(0.00911)		(0.00763)		(0.00899)
Union × GR × SSRev		-0.00934		0.00796		-0.0216*		0.00332		0.00132		0.0123
		(0.00725)		(0.00580)		(0.0126)		(0.00845)		(0.00707)		(0.00901)
Observations	1,946,134		1,973,641		1,056,849		889,242		1,055,485		918,106	

Note: Test score analyses are at the individual level. Each column presents results from a separate regression where the dependent variable is listed in the column headers. All test scores are normalized to mean zero with standard deviation of one. All specifications include controls for total district population, school age population, district enrollment, child poverty rate, district-level Bartik Instruments, district fixed effects, year fixed effects, and student characteristics (race, sex, grade, LEP and Free/Reduced Lunch eligibility). Robust standard errors in parentheses and clustered at the district and state-year level.
*** p<0.01, ** p<0.05, * p<0.1

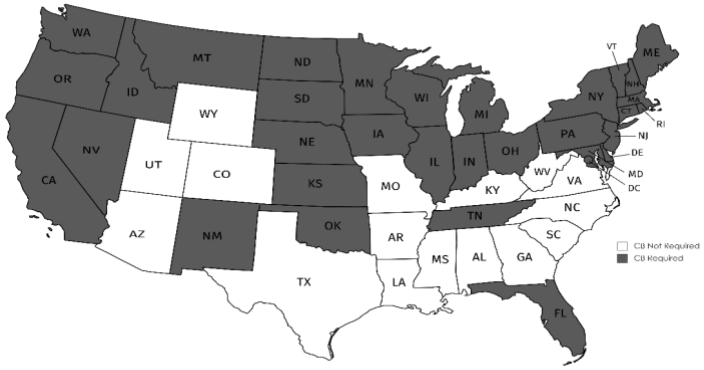
Table 4: Teachers' Average Wage, and Age

	ACS		CPS	
	Log (Wage)	Age	Log (Wage)	Age
	(1)	(2)	(3)	(4)
SSRev × GR	-0.00761**	0.0600	0.000818	-0.129
	(0.00362)	(0.0491)	(0.00498)	(0.101)
Union × GR	0.0102**	-0.148**	-0.0115***	-0.0581
	(0.00387)	(0.0600)	(0.00425)	(0.111)
SSRev × Union × GR	0.00110	0.129**	0.00430	0.319***
	(0.00392)	(0.0546)	(0.00561)	(0.0981)
Observations	298,223	298,223	68,256	68,256

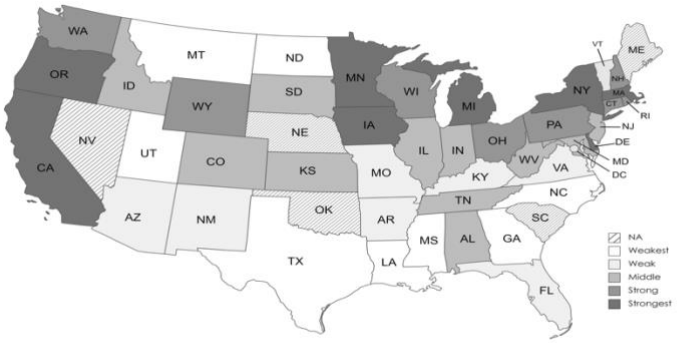
Notes: Each column presents results from a separate regression where the dependent variable is listed in the column headers. Columns 1-2 are based on data from the American Community Survey (ACS) 2005-2015, while columns 3-4 are based on data from the Current Population Survey (CPS) 2002-2015. SSRev is the share of state education funding from state sources in 2007, GR is a dummy variable equal to 1 if the observation is after 2007, and Union is the continuous union power index. All specifications include the controls listed in the Table 2 notes aggregated to the state level, state fixed effects and year fixed effects. All regressions are weighted by individual weight provided by the survey. Robust standard errors in parentheses and clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Appendix Figure 1: Alternate Union Power

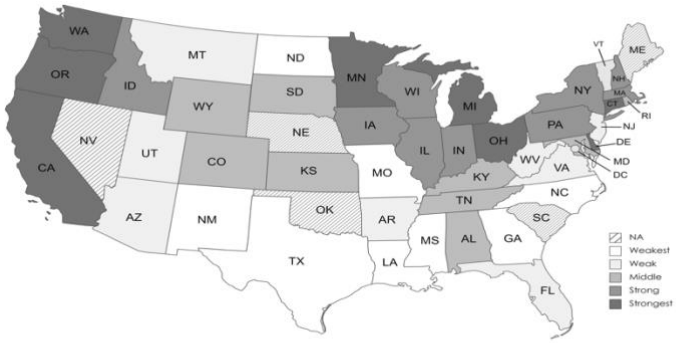
(A) CB Required vs. Not Required



(B) Union Spending per Student

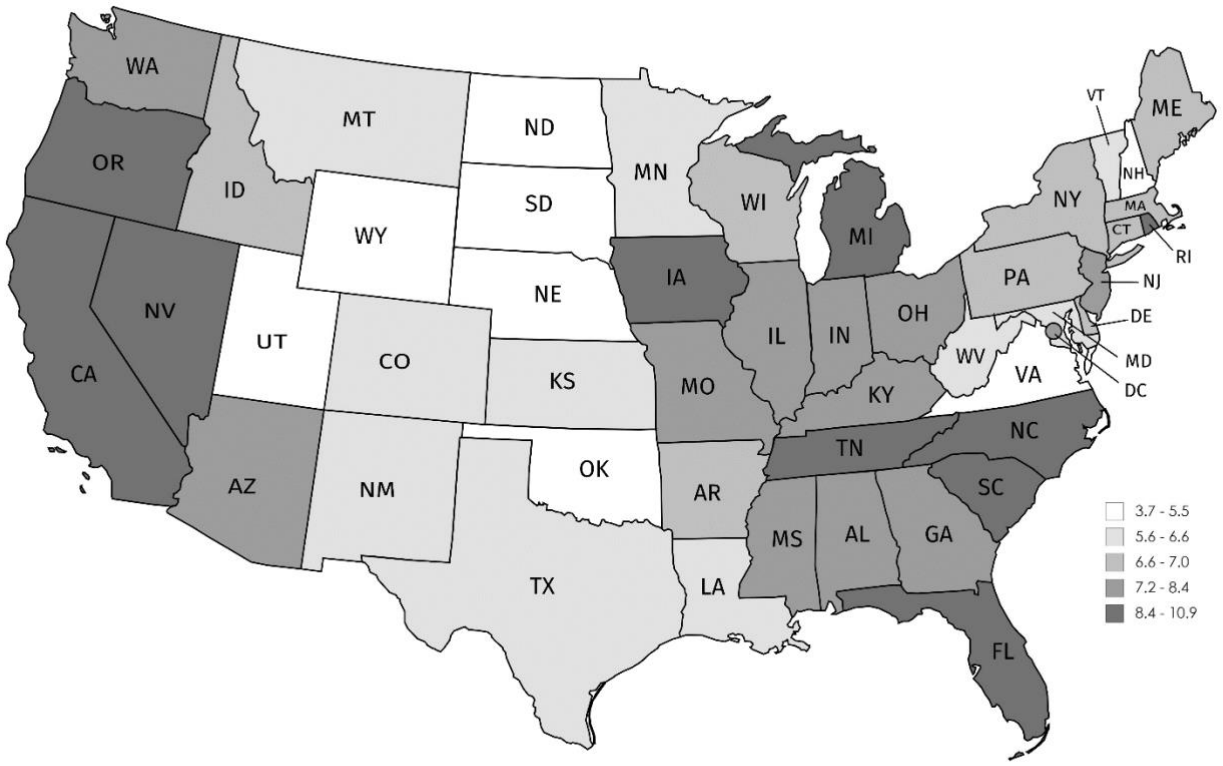


(C) Union Dues per Teacher



Notes: Map shows states by their values for the two alternative teacher union power measures. Figure (a) shows states by their public sector collective bargaining (CB) law status, Figure (b) shows state by union expenditures per student, and Figure (c) shows state by union dues per teacher.

Appendix Figure 2: 2008-2011 Average State Unemployment Rate



Notes: Map shows states by 2008-2011 average state unemployment rate. Data obtained from the Bureau of Labor Statistics (BLS) - Local Area Unemployment Statistics (LAUS) website: https://www.bls.gov/lau/data.htm

Appendix - Table 1: State Union Power and Share of State Revenue

State Name	Share of State Revenue (%)	Cont. Union Power Without Spending	CB Mandatory	CB+RTS+RTW
Alabama	57.34	2.25		0
Arizona	51.45	0.72		1
Arkansas	57.33	1.02		1
California	61.47	2.84	x	3
Colorado	43.06	1.78		2
Connecticut	38.78	2.37	x	3
Delaware	63.11	2.30	x	3
Florida	39.42	0.99	x	2
Georgia	44.83	1.01		0
Idaho	67.24	1.66	x	2
Illinois	30.45	2.72	x	4
Indiana	53.21	1.93	x	3
Iowa	45.50	1.99	x	2
Kansas	56.67	1.69	x	2
Kentucky	56.72	1.91		2
Louisiana	42.61	1.29		1
Maine	45.21	2.20	x	3
Maryland	40.30	2.13	x	3
Massachusetts	46.84	2.24	x	3
Michigan	58.64	2.45	x	3
Minnesota	66.79	2.50	x	4
Mississippi	53.27	1.08		0
Missouri	33.29	1.52		1
Montana	48.14	3.06	x	4
Nebraska	31.71	2.01	x	1
Nevada	26.88	2.05	x	2
New Hampshire	37.47	1.86	x	3
New Jersey	42.14	2.82	x	3
New Mexico	71.58	1.54	x	2
New York	43.48	2.61	x	3
North Carolina	63.49	1.38		0
North Dakota	35.52	2.17	x	2
Ohio	44.46	2.59	x	4
Oklahoma	53.89	1.26	x	3
Oregon	51.37	3.18	x	4
Pennsylvania	36.16	2.85	x	4
Rhode Island	40.31	2.86	x	3
South Carolina	44.15	1.00		1
South Dakota	32.86	1.75	x	2
Tennessee	43.36	1.44	x	2
Texas	37.77	1.11		1
Utah	55.69	1.48		1
Vermont	85.94	2.55	x	4
Virginia	41.64	1.06		0
Washington	61.09	2.72	x	3
West Virginia	59.51	2.44		2
Wisconsin	51.62	2.33	x (up to 2011)	4
Wyoming	48.91	1.91		0

Notes: Share of state revenue is the state reliance on state revenue in 2007. Continuous union power index built following Author (2020). Information on state CB status obtained from NBER Public Sector Collective Bargaining Law Data Set, developed by Valletta and Freeman (1988) and updated by Kim Reuben. Information on RTS and RTW status obtained from the National Conference of State Legislature.

Appendix - Table 2: Using Alternate Union Power Measure

	Log (Total Exp.)	Log (Avg. Sal.)	Log (Avg. Ben.)	Log (FTE)	Class Size	NAEP Math	NAEP Reading	4th Gr. Math	4th Gr. Reading	8th Gr. Math	8th Gr. Reading
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
A. Collective Bargaining Required vs. Collective Bargaining Not Required (0, 1)											
CB × GR × SSRev	-0.0545***	-0.0108	-0.0651***	-0.0173**	0.281**	-0.00481	-0.0110	-0.0302	0.0236	-0.0315*	0.00252
	(0.0101)	(0.00789)	(0.0205)	(0.00825)	(0.122)	(0.0157)	(0.0132)	(0.0254)	(0.0184)	(0.0165)	(0.0205)
B. Index Based on Collective Bargaining, Right-to-Work, and Right-to- Strike (0, 1, 2, 3, 4)											
Union × GR × SSRev	-0.0203***	0.00511	-0.0466***	-0.00855**	0.178***	-0.000511	0.00250	-0.0139	0.0131	-0.00861	0.0102
	(0.00543)	(0.00413)	(0.0100)	(0.00431)	(0.0637)	(0.00738)	(0.00582)	(0.0120)	(0.00878)	(0.00770)	(0.00891)
C. Index Based on 2004 IRS Form 990 (Total Expenditure/Enrollment)											
Union × GR × SSRev	-0.0320***	-0.0100**	-0.0420***	-0.00960**	0.248***	-0.00719	0.00349	-0.0245	0.0111	-0.000686	0.00290
	(0.00508)	(0.00441)	(0.00869)	(0.00402)	(0.0829)	(0.00912)	(0.00659)	(0.0152)	(0.00900)	(0.00828)	(0.00920)
D. Index Based on 2004 IRS Form 990 (Total Membership Dues/FTE)											
Union × GR × SSRev	-0.0271***	-0.00787*	-0.0424***	-0.00499	0.251***	-0.00520	0.00367	-0.0229	0.0132	-0.00140	0.00435
	(0.00505)	(0.00423)	(0.00960)	(0.00393)	(0.0774)	(0.00871)	(0.00682)	(0.0153)	(0.00994)	(0.00917)	(0.0105)
Observations - Panel A-B	167,715	167,715	167,692	167,715	167,692	1,946,134	1,973,641	1,056,849	889,242	1,055,485	918,106
Observations - Panel C-D	152,466	152,466	152,466	152,466	152,447	1,755,086	1,779,029	952,916	802,136	951,315	827,676

Notes: Data from the District Finance Survey Data (F-33) and Common Core of Data (CCD) 2002-2015. Each column presents results from a separate regression where the dependent variable is listed in the column headers. All specifications include the controls and fixed effects listed in the Table 2 notes. Robust standard errors in parentheses and clustered at the district and state-year level. *** p<0.01, ** p<0.05, * p<0.1

Appendix - Table 3: Robustness Check

	Log (Total Exp.)	Log (Avg. Ben.)	Log (FTE)	Class Size	NAEP Math	NAEP Reading
	(1)	(2)	(3)	(4)	(5)	(6)
A. 2000 Median Income						
SSRev × Union × GR	-0.0239***	-0.0474***	-0.0212***	0.313***	-0.0159	-0.00408
	(0.00701)	(0.0122)	(0.00531)	(0.0962)	(0.0105)	(0.00823)
B. 2004 Democratic Vote Share						
SSRev × Union × GR	-0.0186***	-0.0495***	-0.00869**	0.263***	-0.00330	0.0163**
	-0.00568	-0.0108	-0.0044	-0.075	(0.00791)	(0.00768)
C. 2000 Unemployment Rate						
SSRev × Union × GR	-0.0182***	-0.0411***	-0.00891**	0.226***	-0.00842	0.00946
	(0.00538)	(0.0102)	(0.00428)	(0.0734)	(0.00748)	(0.00585)
D. State-Level Clustering						
SSRev × Union × GR	-0.0167*	-0.0404**	-0.0102	0.245*	-0.00880	0.00870
	(0.00965)	(0.0157)	(0.00715)	(0.136)	(0.00793)	(0.00747)
E. Control CB/Tenure Reform States						
SSRev × Union × GR	-0.0188***	-0.0421***	-0.0112***	0.239***	-0.00746	0.00661
	(0.00542)	(0.0100)	(0.00411)	(0.0711)	(0.00771)	(0.00606)
F. Drop CB/Tenure Reform States						
SSRev × Union × GR	-0.0189***	-0.0470***	-0.0109**	0.276***	-0.00520	0.00953
	(0.00568)	(0.0106)	(0.00421)	(0.0712)	(0.00770)	(0.00653)
Observations - Panel A-E	167,715	167,715	167,715	167,692	1,946,134	1,973,641
Observations - Panel F	138,818	138,818	138,818	138,795	1,648,384	1,672,258

Notes: Each column presents results from a separate regression where the dependent variable is listed in the column headers. All specifications include the controls and fixed effects listed in the Table 2 notes. Panel A controls simultaneously for 2000 median income interacted with both the Great Recession indicator variable and fraction of state revenue, along with 2000 median income interacted with Great Recession indicator variable. Panels B and C replaces 2000 median income with 2004 state share voting for the Democratic presidential candidate and 2000 unemployment rate, respectively. Panel D estimates the main model clustering the standard errors at the state level. Panel E includes an indicator variable for FL, ID, IN, MI, OH, and TN. Panel F excludes FL, ID, IN, MI, OH, TN, WI. Robust standard errors in parentheses and clustered at the district and state-year level for Panels A-C and E-F and at the state level for Panel D. *** p<0.01, ** p<0.05, * p<0.1

Appendix - Table 4: Effect of Union Power on Potentially Correlated Variables

	Log (Priv. Employment)		Log (Tax Rev. PC)		Log (Median Income)		Unemployment Rate		Log (Real GDP PC)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
SSRev × GR	-0.00169	-0.00124	-0.00935	-0.00694	-0.00551	-0.00317	-0.0685	-0.0784	-0.00626	-0.00423
	(0.00288)	(0.00197)	(0.0210)	(0.0179)	(0.00634)	(0.00299)	(0.184)	(0.138)	(0.0119)	(0.00768)
Union × GR	-0.00259	-0.00110	0.0437***	0.0396***	0.00428	0.00283*	0.0482	0.0871	0.0157*	0.0119**
	(0.00249)	(0.00152)	(0.0127)	(0.0100)	(0.00501)	(0.00151)	(0.145)	(0.109)	(0.00840)	(0.00501)
SSRev × Union × GR	0.000532	-0.000942	-0.0119	-0.0164	0.00163	0.000131	-0.0807	-0.0711	-0.00270	-0.00330
	(0.00250)	(0.00162)	(0.0166)	(0.0154)	(0.00513)	(0.00271)	(0.168)	(0.115)	(0.00794)	(0.00524)
Observations	672	672	672	672	672	672	672	672	672	672
State Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

Notes: Each column presents results from a separate regression where the dependent variable is listed in the column headers. SSRev is the share of state education funding from state sources in 2007, GR is a dummy variable equal to 1 if the observation is after 2007, and Union is the continuous union power index. All specifications include state fixed effects and year fixed effects. State controls include the controls listed in the Table 2 notes aggregated to the state level. Robust standard errors in parentheses and clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1