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

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September, 2019

Abstract:

Opponents of teachers' unions argue that unions lead to an inefficient allocation of resources that favors salaries and inputs that primarily benefit teachers over other inputs to school quality. In this paper, I examine whether teachers' unions are associated with misallocation of school district resources by analyzing the effect of teachers' unions on district financial outcomes and student achievement during the Great Recession. Employing a diff-in-diff-in-diff (DDD) identification strategy, I find that school districts with strong teachers' unions experienced significantly larger declines in per-pupil expenditures during the economic downtown compared to otherwise similar districts with weak teachers' unions. I also find that strong unions protected teacher salaries and the employment of high-paid senior teachers at the cost of laying off younger teachers, which significantly raised average class size. The larger decline in expenditures in strong union districts, however, did not lead to an additional negative effect on students' academic performance compared to weak union districts. The overall results support the notion that teacher unions' objectives may lead to the misallocation of valuable school resources

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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 across the country experienced sharp decreases in tax revenue, forcing them to cut spending in order to balance their budgets. Spending on K-12 education was no exception; real K-12 per-pupil revenue fell in 38 states between the years 2008-2010, with 18 states experiencing a decrease in revenue per student of more than 18 percent (Evans, Schwab, and Wagner 2017). These declines in revenue eventually forced states and local school districts to layoff approximately 350,000 teachers and other K-12 employees (Leachmen et al. 2016).

A number of recent studies have examined how the Great Recession impacted K-12 expenditures, the allocation of school resources, and student achievement. Evans, Schwab, and Wagner (2017) document the impact of the Great Recession on K-12 school spending, employment and class size. They show 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, wiping out close to 13 years of gains. More recently, Jackson, Wigger, and Xiong (2018) examine how the Great Recession impacted student achievement. Their theoretical model predicts that if budget cuts induce schools to eliminate wasteful spending, spending cuts may have little or no effect on student achievement.[1] However, their empirical results suggest that a 10 percent reduction in school spending reduced test scores by approximately 7.9 percent of a standard deviation and high school graduation rates by approximately 2.6

[1] Several studies support this notion by providing empirical evidence that cost-saving measure do not leave any negative effect on student outcomes (Fitzpatrick and Lovenheim 2014; Ellerson 2010; Anderson and Walker 2015).

percentage points.[2] Given these results, the authors conclude that there is little evidence of wasteful spending in the public education system.

An unexplored question related to the "wasteful spending" hypothesis of Jackson, Wigger, and Xiong (2018), is whether spending cuts have different effects on student achievement and the allocation of resources depending on the power of teachers' unions. Studies that examine the effect of teachers' unions on school spending and the allocation of school resources, typically find that unions raise teacher compensation and enhance teacher job security while increasing the cost of providing K-12 education (Eberts 2007). For example, Hoxby (1996) develops a model that suggests teachers' unions may be either "efficiency-enhancing" or "rent-seeking". Her empirical analyses indicate that teachers' unions are successful in raising educational expenditures, while negatively affecting student performance, a finding consistent with the rent-seeking case.[3] More recently, Lovenheim and Willén (2017) examine the long-term consequences of enacting collective bargaining (CB) laws for K-12 teachers and conclude that such laws significantly worsen students' adult labor market outcomes.[4] If rent-seeking behavior is associated with teachers' unions adding unproductive costs to school district budgets, then budget cuts could potentially have a relatively small impact on student outcomes if targeted correctly.

In this paper, I examine whether teachers' unions are associated with a misallocation resources by analyzing the effect of teachers' unions on school district spending and student educational outcomes during the Great Recession. My primary measure of the power of teachers' unions is an

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[2] Exploiting cohort variation in years of exposure to the Great Recession, Shore and Steinberg (2017) also provide evidence that the recession led to a decline in student achievement.

[3] Similarly, Rose and Sonstelie (2010) and Brunner and Squires (2013) find that strong teachers' unions raise teacher pay, particularly more for senior teachers, while decreasing the teacher-pupil ratio, results they argue are consistent the rent-seeking view of teachers' unions. Lott and Kenny (2013) exploit variations in union dues and union expenditure and find that strong unions are associated with a significant decrease in student test scores.

[4] The authors also find that enacting collective bargaining law leads to reduction in cognitive and non-cognitive skills as well as the occupational skill level for male workers.

index assembled by Winker, Scull, and Zeehandelaar (2012) that incorporates five different factors related to teachers' unions strength. To gauge the magnitude of the recessionary shock on district education spending, I follow Jackson, Wigger, and Xiong (2018) and exploit the fact that districts that were hit 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 2017; Jackson, Wigger, and Xiong 2018). 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 may be correlated with state teacher union power and changes in economic conditions such as unemployment during the Great Recession. I show, however, that the share of state spending that came from state sources is largely unrelated to either the power of teachers' unions or state unemployment rates during the Great Recession.

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 teacher union strength. Specifically, I find that school districts with strong teachers' unions experienced significantly larger declines in per-pupil total expenditures compared to otherwise similar districts located in weaker union states. Analyses of sub-categories for spending suggest that teacher benefits and employment decreased while average class size increased by about 0.25 students in strong union states compared to weaker union states. Furthermore, individual-level analyses using the Current Population Survey and the American Community Survey provide suggestive evidence that districts in strong unions states insulated salaries for senior teachers at the cost of laying off younger teachers. Most importantly, results based on the National Assessment of Educational Progress (NAEP) provide no evidence that additional spending cuts in

strong union states led to a differential impact on students' test scores, suggesting that teachers' unions may be associated with misallocation of valuable school resources.

A series of robustness checks indicate these results are highly robust. For example, the results persist across specifications that include state-level labor market controls for a variety of factors that might affect district spending, such as the propensity to vote for the Democratic presidential candidate. They also persist across specifications that use more traditional measures for teacher union power 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 effect on labor market indicators, I find no such evidence.

This paper makes several contributions to the literature on public-sector unions. First, to my knowledge, this is the first paper to use nationally representative data to examine the effect of teachers' union influence on school district resource allocation during a period when districts experienced a negative financial shock. Previous studies have tended to focus on the effect of unionization on education spending during periods when districts were financially sound (Hoxby 1996; Strunk 2011; Brunner, Hyman, and Ju 2018). 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). Second, my paper contributes to the literature examining the objective function of teachers' unions by examining the prevalence of teacher union rent-seeking behavior during the Great Recession. Specifically, my results suggest that districts in strong union states continued protecting senior teachers' salary and employment at the cost of laying off relatively younger and potentially more cost-effective teachers. Furthermore, my results indicate that even though states with strong teachers' unions faced much greater spending cuts during the

Great Recession, states with weaker teachers' unions experienced a decline in student achievement that was similar in magnitude to those experienced by strong union states. These results are consistent with the hypothesis that teacher unions are primarily rent-seeking, and that such behavior is associated with inefficiencies in the level of school spending and the allocation of school inputs.

This paper proceeds as follows: The next section discusses conceptual framework and provides an overview of the literature on union impacts on schools and district spending. Section 3 describes the datasets used. Section 4 explains the empirical framework. Section 5 presents the main results, robustness checks, and falsification tests. Section 6 concludes.

2. Conceptual Framework

There exists a relatively small body of literature that analyzes the impact of the Great Recession on school districts and student educational outcomes. Exploiting cohort variation in years of exposure to the Great Recession, Shores and Steinberg (2017) provide evidence that the recession adversely affected student achievement. More recently, Jackson, Wigger, and Xiong (2018) (hereafter "JWX") examine how student performance responded to school spending cuts induced by the Great Recession. Although numerous studies provide evidence that an increase in school spending improves student outcomes (Lafortune, Rothstein, and Schanzenbach 2018; Hyman 2017; Candelaria and Shores 2015; Jackson, Johnson, and Persico 2016), the authors theorize that the negative effects of spending cuts on student achievement may be smaller than the positive effects of a similarly sized spending increase. Specifically, they develop a model that assumes 1) districts engage in unproductive spending or "slack", and that 2) districts are punished more for bad outcomes than rewarded for good outcomes. With a sufficiently large penalty associated with poor performance, the model predicts that district administrators will reduce slack such that students'

test scores will not be affected by decreased educational spending. However, in their empirical analysis, the authors find that spending cuts during the Great Recession led to lower student achievement and conclude that there is no evidence of slack in the public education system. An unexplored question related to these findings by JWX, is whether spending cuts have different effects on student achievement and the allocation of resources depending on the power of teachers' unions.

Proponents of teachers' unions claim that "what is good for teachers is good for students," implying that the objective function of teachers' unions compliments the objective function of school district administrators and students. For example, benefits from union protection may enhance teacher productivity through increased work morale (Kube and Puppe 2013). Furthermore, because teachers are the ones in the classroom and have direct contact with students, it may provide them with important experience and knowledge regarding how to properly utilize available school resources (Bascia 1994). Critics of teachers' unions, on the other hand, claim that unions distort education resources while hurting student achievement. Such claims are mostly based on the notion that teachers' unions are rent-seeking as they strive to maximize members' benefits without providing the commensurate benefits to school districts and students they serve (Hoxby 1996).

Most studies that examine the effect of teacher unions on school district resource allocation generally find that unions tend to bargain for an allocation of resources that primarily benefits their members. For example, teacher unions strive to keep class sizes small and make school days and school years short (Cohen and Strunk 2015), while they are generally against using students' test scores for teacher evaluations, preventing school administrators from successfully identifying and removing poorly performing teachers (West and Mykerezi 2009). Moreover, teacher unions promote contracts that prioritize benefits for senior teachers over younger teachers. These benefits

include credential-based compensation schemes that determine a teacher's salary based solely on his/her experience and educational attainment as opposed to quality of teaching (Ballou and Podgursky 2002). Given research findings that teaching skills typically level off beyond the first three-four years of teaching experience (Hanushek 1986), such pay plans are likely inefficient since the marginal return to teacher compensation rapidly decreases as teachers move up on the pay schedule (Lovenheim 2009). With a fixed district budget, if teachers' unions are successful at extracting rents, it may force school district officials to distribute resources toward teacher benefits and away from the other necessary and crucial expenditures, leading to a suboptimal allocation of resources.

Indeed, these arguments align with a small strand of research that finds cost-savings can be achieved without any negative consequences on student academic achievement. This may be the case, especially for the districts facing strong teacher unions since union contracts and the rules they impose on district officials have been blamed as sources of public-school inefficiency (Ballou 1999). For example, Fitzpatrick and Lovenheim (2014) support this claim by exploring the Early Retirement Program (ERI) in Illinois that led to a large increase in retirement, which lowered the overall teacher experience level. Results from their analyses suggest that replacing more senior teachers with younger teachers had little impact on student achievement and did not have any deleterious impact on student test scores. Limiting the bargaining power of teachers' unions, may allow districts to eliminate some of the contract clauses that impede a cost-effective allocation of resources.

In this paper, I seek to address whether districts were able to carry out cost-saving measures without affecting student achievement. Specifically, I examine whether financial difficulties faced by districts affected unions' rent-seeking behavior, given speculations that public-school teachers

receive higher pay and inflated benefits. Furthermore, I explore whether changes in unions' behavior affected student learning environment (i.e. class size) and student outcomes (i.e. test scores).

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 National Center for Education Statistics (NCES). While the survey was administered annually from 1992 onward, I focus on the period 2002 to 2015 in order to avoid potentially confounding influence of the earlier economic downturn that lasted until the fourth quarter of 2000.[5] 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 and current expenditures and divide each measure by the total number of students in the district to provide a per-pupil estimate.[6] 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.[7] Finally, I merge the NCES financial data with district-level data on population and child poverty rates, which are taken from the U.S. Census Bureau's Small Income and Poverty Estimates (SAIPE).

I restrict the main analytical sample in several ways. First, because the F-33 school district financial data tends to be noisy, particularly for smaller districts, I follow Brunner, Hyman, and Ju

[5] Henceforth, I index school years by the calendar year in which a school year end, i.e., 2002 refers to the school year 2001-2002.
[6] All dollar figures are inflation adjusted and converted to 2015 dollar using the Consumer Price Index.
[7] These variables include share of free lunch eligible students, share of students in Individualized Education Plan, share of students in English Language Program, and share of black, Hispanic, and Asian students.

(2018) and exclude districts with total student enrollment of less than 250 students. I further remove charter schools, college-grade systems, vocational education systems, non-operating school systems and educational service agencies and thus limit the sample to traditional school districts, namely elementary, secondary and unified school systems. I also impose restrictions based on school district financial variables. Specifically, for each of the finance outcome measures, I drop district-year observations if the reported values are less than zero. Furthermore, I follow JWX and exclude district-year observations that are 200 percent greater than the 99th percentile of per-pupil expenditures or less than 50 percent of 1st percentile. The full sample consists of 12,594 unique elementary/secondary or unified school districts in the contiguous 48 states.[8]

3.2 Union Power Measure

My primary measure of teacher union power is based on an index constructed by Winker, Scull, and Zeehandelaar (2012). To measure union strength at the state level, the authors go through administrative and self-constructed survey data across five different fields related to union influence. The areas include: (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 drop this category and recalculate the index following Brunner, Hyman and Ju (2018). 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 shows, states located in the Northeast, Midwest, and West generally have strong teachers' unions, while Southern states have weak teachers' unions.

[8] I exclude Hawaii, Alaska, and the District of Columbia from the sample due to their unique locations and political characteristics.

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 CB law for teachers. The benefit of focusing on this measure is that it is less likely subject to endogeneity concerns since most state legislation governing teachers CB rights were passed in between 1960s and 1980s and have remained relatively stable since then. The second alternative measure is constructed by Brunner, Hyman and Ju (2018) and it incorporates information on state CB laws with information on state right-to-strike (RTS) status and right-to-work (RTW) status.[9] To construct the measure, they assign states a value of two if they CB is required, add a value of one if they are not RTW and add a value of one if they are RTS. The score ranges from 0 to 4 where 0 represent the weakest union power states and 4 represents the strongest union power states. Appendix Figure 3.1A shows a map of states that mandate teacher collective bargaining, while Appendix Figure 3.1B presents a map showing states' overall union power rank by 5 tiers. As expected, the overall geographical pattern follows the pattern of the primary union power measure shown in Figure 3.1. While I use the continuous index as my preferred measure for teachers' union power to exploit more variation across states, I show that the baseline results are robust to the alternative union power measures.

Table 3.1 presents summary statistics for key variables for all districts combined, then 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. Stronger teacher union states also have higher per-pupil total expenditures,

[9] Information on CB, RTS and RTW was obtained from the NBER public sector collective bargaining law dataset, originally gathered by Freeman and Valletta (1988), and updated in 1996 by Kim Reuben. This paper uses the extended Reuben data set and augment it with information from Sanes and Schmitt (2014) for the more recent years. As of 2002, there were 34 states with mandatory CB legislation, 6 states that strictly prohibit bargaining activities, and 7 states without any law governing collective bargaining for teachers. Likewise, 11 states gave public employees the right to strike, while 22 states enforced right-to-work laws.

median household income, and are more likely to vote for a Democratic Party presidential candidate.

3.3 Educational Outcomes

In order to examine how district resource allocation decisions during the Great Recession affected student achievement, I use state-level test score data from the National Assessment of Educational Progress (NAEP). The NAEP is administered by the National Center for Education Statistics every two years to nationally representative samples of 4th-, 8th- and 12th graders and their teachers. The NAEP, often referred to as the "Nation's Report Card", provides reliable state-level test score data comparable across states and years.[10] Although the assessment essentially stays the same, the subject areas tested vary year to year and have included ten different subjects at one time or another. For the purpose of consistency, I focus on 4th and 8th-grade mathematics and reading scores since the two tests were administered every two years between 2003 and 2015.[11]

4. Empirical Framework

4.1 Diff-in-Diff-in-Diff (DDD)

A potential challenge to examine the role of teachers' unions on school finances and student educational outcomes 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 make use of 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

[10] In addition to administering the assessments to nationally representative samples, the NAEP assessments makes modest changes every 10 years and seeks to maintain broad comparability across time.
[11] The NAEP test scores used in this paper starts from 2003 since the sample size increased 10 times larger than any previous NAEP administration (Lubienski and Lubienski, 2006)

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 hardest hit by the economic downturn (Evans, Schwab, and Wagner, 2017). The variable is constructed following JWX:

$$\rho_s = \frac{\sum_{d \in s} State\ Revenue_d}{\sum_{d \in s} Total\ Revenue_d} \tag{1}$$

Figure 2 shows a map of the U.S. by share of states' revenue from state sources in 2007, and 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 Figure 1 with Figure 2, I formally address this concern by plotting the share of K-12 revenue from state sources by the standardized union power index. Figure 3A shows 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 difference-in-difference-in-differences (DDD) model which relates changes in educational outcomes to states' union power and their reliance on state aid:

$$Y_{dst} = \alpha_0 + \alpha_1(\rho_s * I^{Post}) + \alpha_2(Union_s * I^{Post}) + \alpha_3(\rho_s * Union_s * I^{Post}) + \pi X_{dst} + \delta_d + \lambda_t + \varepsilon_{dst}, \tag{3.2}$$

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,[12] 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 that includes total residential population, fraction child poverty and a Bartik predictor to account for possible direct effects of the recession itself (Yagan 2017),[13] δ_d and λ_t are district and year fixed effects, respectively, and ε_{dst} is a random disturbance term. I cluster the standard errors from equation 3.2 at both the district and state-by-year level.

The key parameters of interest in equation 2 are $\alpha_1, \alpha_2,$ and α_3. Specifically, α_1 represents the difference-in-differences (DD) effect of a one standard deviation increase in the level of pre-recession reliance on state aid post Great Recession for school districts located in a state with the average level of teacher union power. The parameter α_2 represents the effect of a one standard deviation 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 incorporating 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. Note that the total effect of the Great Recession (more vulnerable to spending shock) for strong union states is represented by $\alpha_1 + \alpha_3$.

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

[13] The recession intensity measure was constructed using the steps outlined by Jackson, Wigger and Xiong (2018).

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 2008 would have been similar to the difference in outcomes between strong versus weak union states with low reliance of state aid before 2008. To assess the validity of the assumption, I also estimate event-study models and complement the findings by conducting a series of robustness checks and falsification tests.

4.2 Event Study

To examine dynamic treatment effects of the Great Recession by the pre-recession share of state revenue on school finances, I begin by replicating the event study results of JWX. To further examine potential heterogeneous effect across teachers' union strength, I estimate the following model separately for strong and weak union states:

$$Y_{dst} = \sum_{2002}^{2015} \gamma_t \cdot (\rho_s \times I_t) + \pi X_{dst} + \delta_d + \lambda_t + \mu_{dst}, \tag{3.3}$$

where I_t is an indicator variable denoting if the observation is for fiscal year t, and ρ_s represents standardized log fraction of state aid reliance. The 2007 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 on how the different categories of school spending and other education outcomes change prior to the Great Recession, while the lagged treatment indicators $(\gamma_{2008}, \ldots, \gamma_{2015})$ show 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 that expands Equation 3.3 by including series of non-parametric indicators for *Union* and *SSRev * Union*, each. Formerly, I estimate triple diff event-study models of the following form:

$$(3.4) \quad Y_{dst} = \sum_{2002}^{2015} \gamma_t \cdot (\rho_s \times I_t) + \sum_{2002}^{2015} \varphi_t \cdot (Union_s \times I_t) + \sum_{2002}^{2015} \beta_t \cdot (\rho_s \times Union_s \times I_t)$$

$$+\pi X_{dst} + \delta_d + \lambda_t + \mu_{dst},$$

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 change as teachers' union power increases by one standard deviation. If the identification assumption for Equation 3.2 is satisfied and that 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 results from nonparametric DD models given by equation 3.3 in order to examine whether any pre-recession trends exist in the outcome variables. These models include district and year fixed effects, controls for total district population, fraction child poverty and the Bartik predictor. Figure 3.4A shows that for all states, a one standard deviation increase in state aid reliance reduces per-pupil total expenditure by about 5 percent, 3 years after the onset of the Great Recession. This estimate represents 19.8 percent decrease in per-pupil spending associated with one percent increase in reliance on state revenue, which is consistent with the findings of JWX. As mentioned previously, I estimate the same model separately for strong and weak union

states in order to examine whether heterogeneous effects exist across teachers' union power. The black and yellow line represents diff-in-diff event-study estimates for strong and weak union states, respectively. The figure shows that a one standard deviation increase in the share of state revenue in strong union states leads to about 4 percentage points greater decline 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 3.4, I present DDD event study graph in Figure 3.4B 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 shown in Figure 3.4A. The figure clearly shows that 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 Great Recession. In sum, the two event-study figures for per-pupil total expenditure provides no evidence of pre-trends in total spending.

To examine the effects of total spending cuts on teacher compensations, I next turn to similar analyses for the average teacher salary and benefit, where the two variables are constructed by dividing total current instructional salary and benefit expenditures by number of full-time equivalent teachers, respectively. For weak union states, Figure 3.5A shows that there is a clear negative trend in average teacher salary 3 years post-Great Recession. On the other hand, average teacher salaries remained relatively steady in strong union states, suggesting that teachers in strong union states weathered the recession better. Turning to the event-study results for non-fringe benefits, Figure 3.5B shows that a one standard deviation increase in state aid reliance was

associated with a decrease in average teacher benefits of approximately 5 percent, 3 years after the onset of the Great Recession. Separate analysis for strong and weak union states reveal that the sharp decline in average teacher benefits was primarily driven by strong union states. DDD event study estimates for average instructional salary and benefit expenditures presented in Appendix Figure 3.3A and 3.3B indicate that there is little evidence of pre-trends, raising confidence that the identification assumptions are valid.

The regression estimates for the three finance outcomes, reported in columns 1-6 of Table 3.2, confirm these results. For each outcome, I report results based on specifications that include district and year fixed effects only without any controls (first column) and results that include a set of district-level controls (second column).[14] First consider the estimated coefficient for *SSRev * G*R, which represents the effect of the pre-recession share of state revenue for states with average union strength during the Great Recession. The estimated coefficient in column 1 suggests that a one standard deviation increase in reliance of state aid is associated with a decrease in per-pupil spending by about 0.0328 log points, a result qualitatively similar to JWX findings. Similarly, the coefficient for *Union * GR* captures the differential effects of strong union during the Great Recession. The estimated DD coefficient is essentially zero (0.00421) and statistically insignificant, indicating that strong union states with 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 standard deviation. The DDD estimate of *SSRev * Union * GR* suggests that for strong union states, a one standard deviation increase in reliance on state aid

[14] District-level controls include total district population, fraction child poverty, Bartik predictor, fraction female students, fraction Asian students, fraction Hispanic students, fraction black students, fraction SPED students, and fraction LEP students

led to a decrease in per-pupil spending by 0.0161 log points. This result suggests that strong union states with greater reliance on state revenue sources to fund education prior to the recession faced larger spending cut. As shown in column 2, adding district-level controls does not affect the estimated coefficients.

Columns 3-6 of Table 2 report results based on equation 3.1 replacing the dependent variable with average teacher salaries and average teacher benefits. The regression estimates presented in columns 3-4 and 5-6 of Table 2 confirm the findings presented in Figures 5A and 5B, respectively. Namely, the DD estimate of *SSRev* * *GR* in column 4 suggests that a one standard deviation increase in pre-recession state reliance on state revenue is associated with a decrease in average teacher salaries of 0.0178 log points. The positive DDD estimate, however, provides evidence that teachers in strong union states may have fared better during the recession. Columns 5-6 of Table 3.2 present estimates for the average teacher benefits. While a one standard deviation higher reliance on state aid led to reduction in average teacher benefits of 0.03 log points, the negative and statistically significant DDD estimate suggests that teachers in strong union states experienced an additional reduction in benefits of 0.0405 log points. This estimate is statistically significant at the 1% level, and it points to the evidence that the sharp decrease in total spending faced by strong union states was primarily driven by benefit reductions.

Turning to effects on non-financial outcomes, Figure 3.5C and Figure 3.5D show the event-study results for effects on full-time teacher employment and student-to-teacher ratio, respectively. Focusing on the event-study results for the log of teacher employment (Figure 3.5C), the estimates for all states combined illustrate a clear trend of decline post-2008. Stratifying by teacher union power, I find that most of the effect was a phenomenon concentrated in strong union states. Namely, full-time teacher employment in strong union states decreases by about 2 percentage points after

the onset of the recession and remains at this level over time. Consistent with the results for teacher employment, the results for student-to-teacher ratio shown in Figure 3.5D provide evidence that there exists an upward post-recession trend for strong union states only. Once again, the DDD results in columns 7-10 of Table 3.2 confirm these results. A one standard deviation increase in pre-recession reliance on state revenue led to a decrease in the employment of full times teachers by close to 1 percentage points in strong union states. Finally, the DDD estimate for the student-to-teacher ratio is 0.246 and statistically significant, which suggests that strong union states with greater reliance on state revenue experienced much greater increases in class size.

Overall my results suggest that districts in strong unions states gained substantial savings from spending cuts on benefit expenditures, perhaps by reducing the generosity of benefit packages and obligating teachers to contribute more towards their benefits. Despite these efforts, districts in strong union states still laid off more teachers, raising average class size by about 0.25 students in contrast to districts in weak union states.

5.2 Effects on Academic Achievement

I now turn to examining the impact of the Great Recession on student academic outcomes and whether any effect of the Great Recession on student achievement varied with state teacher union power. The DDD results on NAEP test scores are presented in Table 3. Again, each column in Table 3.3 comes from a separate estimation of equation 2, except I replace district-level control variables and district fixed effects with state-level control variables and state fixed effects, respectively.[15] All NAEP test scores are standardized to have a mean of zero and standard deviation (SD) of one.

[15] State controls include total population, child poverty rate, Bartik instruments, and student demographics. All standard errors are clustered at the state level to account for potential correlation of the residuals over time.

Across all NAEP subjects, I start by estimating difference-in-differences models without including the union interaction terms to show that my results are comparable to those presented by JWX. The first column for each test subject shows that one standard deviation increase in the share of state revenue reliance is associated with lower NAEP scores. Specifically, the 4th-grade math score decreases by 0.094 SDs, while 4th-grade reading score decreases by about 0.166 SDs. These results are qualitatively similar to the results presented by JWX, who also find strong negative student achievement effects associated with pre-recession reliance on state aid. The finding is quite surprising when DD and DDD union interaction terms are added. Columns 2 and 4 suggest that a one standard deviation increase in pre-recession state aid reliance in strong union states had small and statistically insignificant effects on NAEP math scores. Turning to reading test results in columns 6 and 8, the coefficient on the DDD parameters are again statistically indistinguishable from zero.

Overall, the findings in this section suggest that school districts with strong teachers' unions did not experience any additional negative effect on student achievement, even though they experienced much greater spending cuts. These results are consistent with the notion that rent-seeking behavior by strong teachers' unions is associated with slack and that districts that faced financial pressure take cost-saving measures to minimize the negative impacts on student achievement.

5.3 Average Teacher Pay and Experience

Results from the previous section provide evidence that teachers in strong union states agreed upon benefit concessions to help school districts recover from budget shortfalls. In this section, I make use of two different individual-level survey datasets to evaluate the effects of union influence on full-time teachers' average wage and age composition.

While the average teacher salary results presented in Table 3.2 provide suggestive evidence on how teachers' earnings have changed, the findings may be driven by several possible mechanisms. For example, the increase in average salary in strong union states relative to weak union states may 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 make use of 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 3 years of pre-recession data (2005-2007) and 8 years of post-recession (2008-2015) data are available. On the other hand, the sample size of CPS-MORG is much smaller but is available from 1990. Restricting the datasets to full-time public-school teachers with inflation-adjusted wage greater than minimum wage for the given year, I end 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:

$$(5)\quad y_{ist} = \beta_0 + \beta_1(\rho_s * I^{Post}) + \beta_2(Union_s * I^{Post}) + \beta_3(\rho_s * Union_s * I^{Post}) + \eta X_{ist} + \pi Z_{st} + \theta_s + \lambda_t + \varepsilon_{ist},$$

where y_{ist} represents log real wage or age for teacher i, in state s, in year t. I include state and year fixed effects and control for individual-level demographic characteristics, as well as state-level characteristic.[16]

Table 4 provides ACS and CPS results of log wage and age from a separate estimation of equation 5. Focusing on the wage results in columns 1 and 3, the estimated coefficients on the

[16] 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 the survey.

triple interaction term based on both ACS and CPS samples are close to zero and statistically insignificant. These results reveal that union strength did not have any differential impact on conditional teachers' wage. Turning to the effects on the average teachers' age, columns 2 and 4 both indicate that average teachers' age increased in states with strong teachers' union, suggesting that either weak union states hired more teachers, or strong unions dismissed relatively younger and inexperienced teachers. Considering the number of teachers dismissed during the Great Recession (Leachman et al. 2016), the latter is more likely than the former. Taken together, the experience level for teachers in strong union states rose significantly, while salaries and wages remained stable in comparison to weaker union states. These results provide clear evidence that strong unions were primarily protecting senior teachers, perhaps at the cost of reduced employment of younger and naïve teachers.

5.4 Alternative Union Power Measure

As previously mentioned, 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. Results are reported in Panel A of Table 3.5. Although the estimated coefficient on the DDD parameter for average salary turns statistically insignificant, the overall pattern of results persists across all other outcomes. Namely, districts in CB mandatory states experienced a differential impact of a 0.0544 log points decrease in total spending during the Great Recession, which led to decreases in the number of full-time equivalent teachers and increases in average class size. Turning to the NAEP test score results in columns 6-9, all DDD coefficients qualitatively resemble the results from main analysis and remain statistically indistinguishable from zero.

The second alternative measure for union power incorporates the presence of duty-to-bargain law, right-to-work (RTW) status, and right-to-strike (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 teachers' unions to gain leverage on contract negotiations. Combining the three categories that possibly reflect on 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. Thus, the measure ranges from 0 to 4, where 0 represents the weakest union states and 4 represents the strongest union states. Panel B of Table 3.5 presents the results based on this alternative union power measure, and the overall pattern of estimated coefficients largely remains consistent compared to the baseline results. Specifically, I find that among strong unions, one standard deviation increase in reliance on state revenue is associated with differential effect of a 3.4 percentage points 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 about 3.1 percentage points larger than otherwise similar districts in weak union states. Most importantly, these additional spending cuts did not result in any negative impact on student achievement.

Overall, the pattern of results using these two alternative teacher union power measures is similar to that found using my preferred measure, thus mitigating concerns of endogeneity and subjectivity.

5.5 Robustness and Falsification Test

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 example, my results may be biased if residents living in more prosperous states with higher household median income are more generous to teachers' unions. Moreover, these states may have struggled more economically during the recession, which may have altered the way that they spend their resources compared to otherwise similar states with weaker teachers' union.

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 β_3 withstands the addition of these state characteristics, I estimate equations where I include each set of these variables separately, as well as an equation that includes all three variables simultaneously.

Panel A of Table 6 presents estimates based on the specification that includes household median 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 pattern of results for expenditures, full-time teacher employment, class size, nor student achievement. In Panel B and C, I replace household median income with the 2004 presidential election Democratic party vote share and 2000 unemployment rate, respectively. Although the results for salary expenditure are statistically imprecise in both panels B and C, other DDD coefficients remain robust to the inclusion of these additional controls and their interactions, Finally, Panel D of Table 3.6 estimates models that include all three sets of state-level characteristics and the results resemble findings presented in the previous three panels. As shown across all panels in Table 3.6, there is

no evidence from this analysis suggesting that the baseline results are driven by unobservable variables that are highly correlated with teacher union power.

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 example, the steep declines in total and current expenditures in strong union states may reflect lower consumer spending, 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, but replacing the dependent variable in equation 3.2 with 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.[17] These economic variables should not have changed depending on the strength of teachers' unions during the recession, so significant estimates would indicate a potential source of bias. Table 3.7 presents results from this falsification test analysis. All the estimated coefficients on *SSRev * Union * GR* reported in Table 3.7 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 raises confidence that the findings in this paper indeed represent the effects of teachers' unions.

6. Conclusion

The Great Recession 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. Despite a well-established literature that documents teacher unions' behavior as rent-seeking, there has been no study on whether such behavior influenced the way local governments allocate their resources

[17] 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 Bureau of Labor Statistics website. State level tax revenue data comes from the Common Core Data (CCD) of NCES. Median income data comes from the U.S. Census Bureau website. GDP per capita comes from the Bureau of Economic Analysis website.

when they struggle financially. Motivated by the possibility of inefficient spending in the public education system, suggested by Jackson, Wigger, and Xiong (2018), I examine the role of teachers' unions in determining the extent to which the recession-induced spending cuts impacted district spending, employment, and student achievement.

I provide evidence that previous studies on the Great Recession masks important heterogeneity. Specifically, I find that among strong unions, one standard deviation increase in reliance on state revenue is associated with a differential impact of about a 1.7 percentage points additional decrease in per-pupil spending. As a result, strong union states dismissed more full-time equivalent teachers, which raised average class size dramatically. Analyses using data from the ACS and CPS-MORG provide further evidence that the average age of teachers in strong union states increased more, suggesting that relatively more senior teachers were able to maintain employment in strong union states. Although districts in strong union states made larger cuts to educational spending, the results on academic outcomes indicate that they left no additional ill-effects to students' academic performance. This finding supports the anecdotal evidence that school districts under union pressure may not spend their resources in an efficient manner during the time periods when they are financially sound. Moreover, the results on employment and wages suggest that unions' behavior of protecting senior teachers' employment and compensation continued to some extent during the economic downturn. One potentially effective way to reduce costs without harming student achievement is to layoff ineffective teachers and/or to encourage senior teachers, who are the highest paid on the pay scale, to retire early. Consistent with the "last in, first out" layoff rules, the results presented in this study demonstrate that strong union states continued protecting employment and salaries of senior teachers. Given the cost-saving measures did not leave any additional ill-effect on student achievement, the possibility remains that districts

were able to successfully weed out ineffective teachers in order to minimize the impact of rising class sizes.

While the financial situation changed rather quickly and unexpectedly during the Great Recession, the possibility remains that actions taken by state governors and local school board officials might have influenced teachers' collective bargaining power. These mechanisms are not sources of bias, but rather, are some of the ways through which government restrictions might have led to the results presented in this study. Such policy actions in response to unions influences would be of interest in its own right, and I stress that the results presented in this paper are net of any of these endogenous adjustments. It is also important to note that the findings presented in this study should be interpreted as purely short-run and may not have similar effects in the long run. For example, temporary benefit reductions during a time period of financial struggle may not foster teachers' decision to leave the profession, avoiding the loss of high-quality teachers. However, the effects of permanent decrease in teacher compensation might motivate high-quality teachers to look for alternative options, which could adversely impact student achievement. These concerns notwithstanding, the implication of the results in this paper are clear: teacher unions' objectives may lead to the misallocation of valuable school resources.

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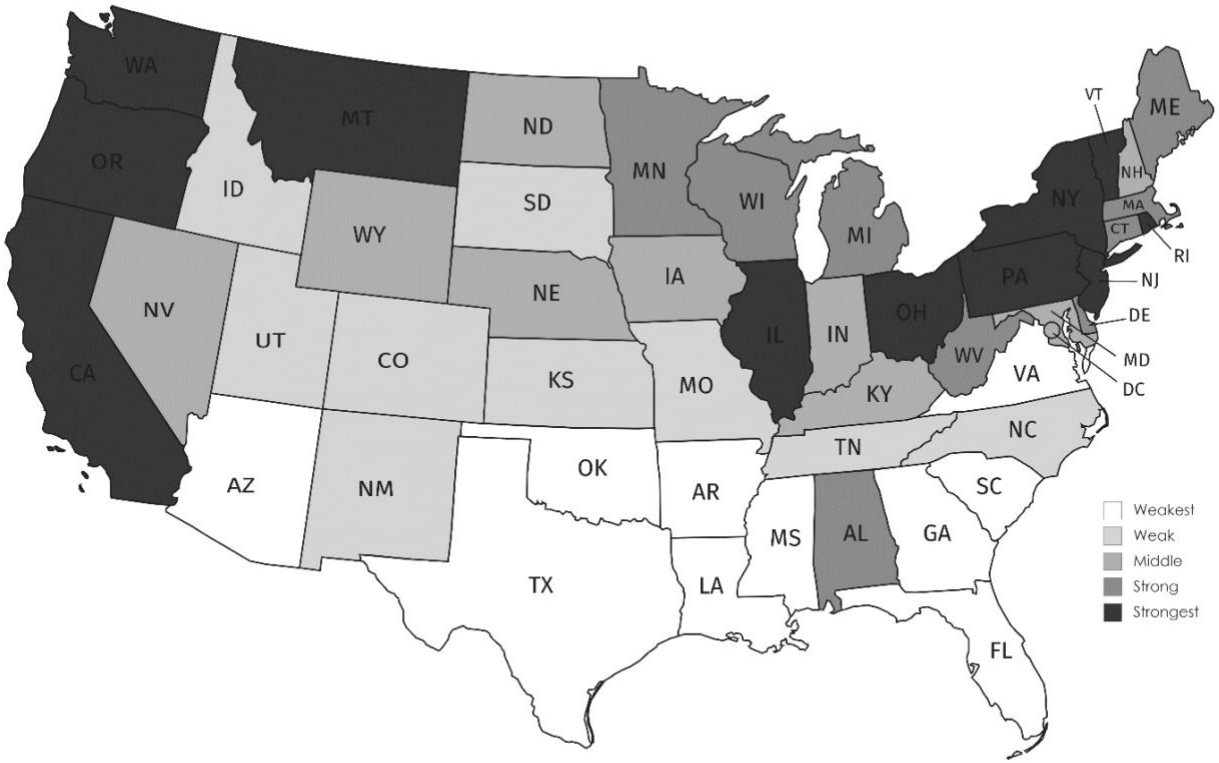
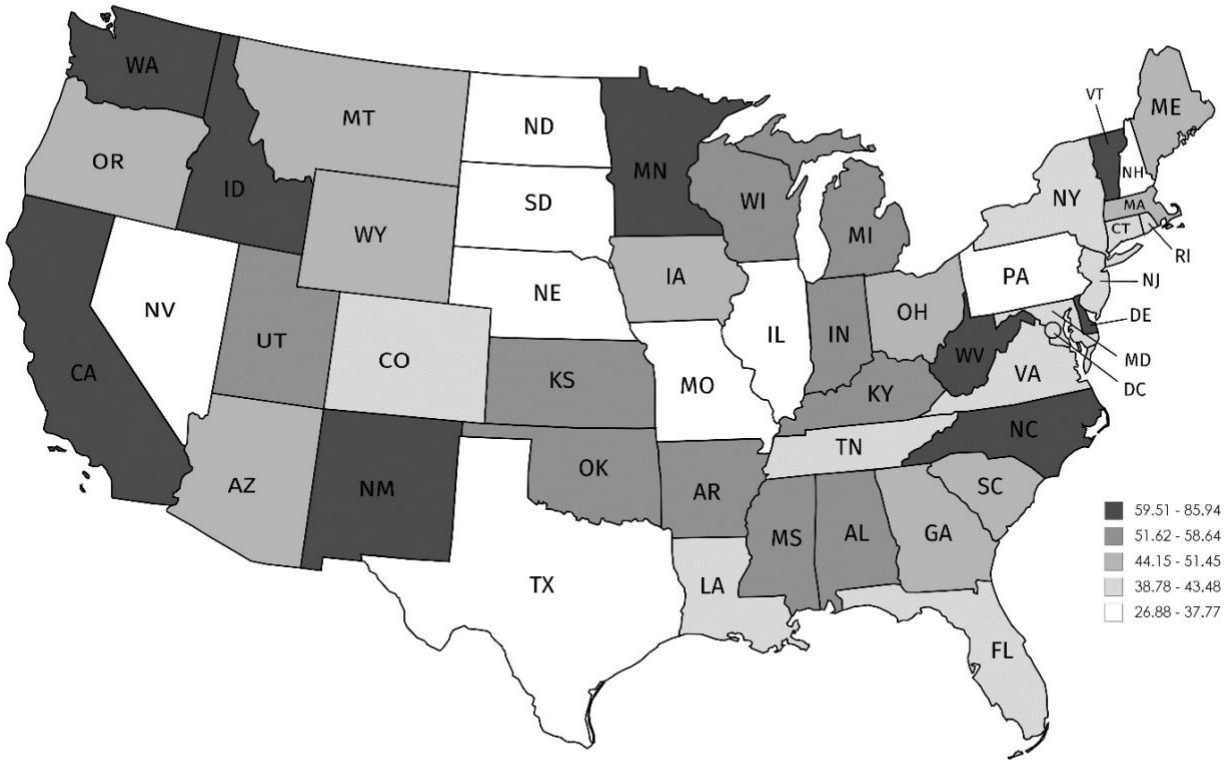
Figure 1: State Union Power Measure



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.

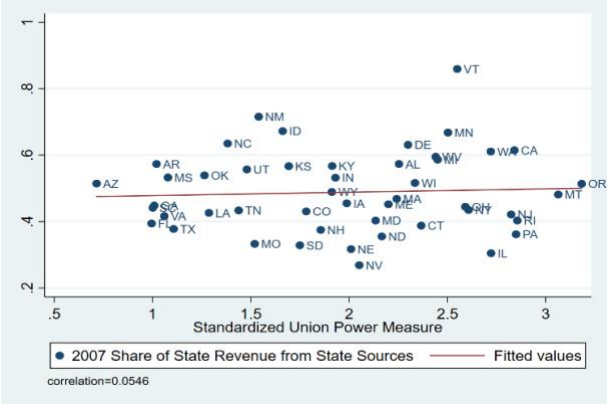
Figure 2: 2007 Fraction of State Revenue from State Sources



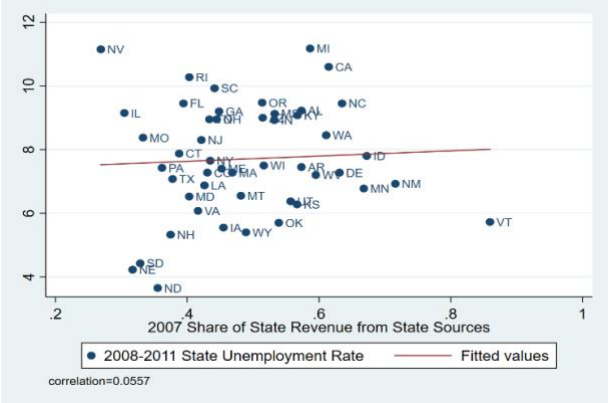
Notes: Map shows states by 2007 fraction of state total revenue from state sources, calculated following Jackson, Wigger, and Xiong (2018)

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

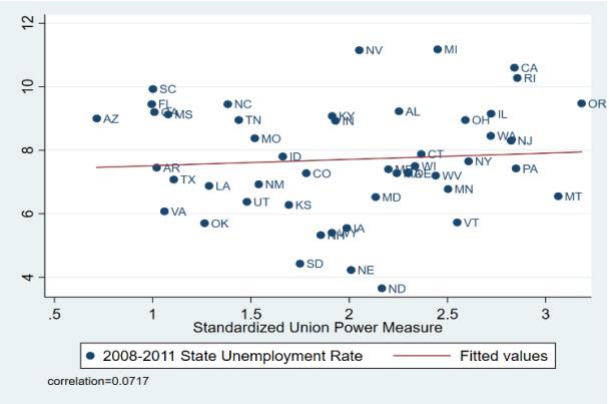
(A) 2007 Share of State Revenue, by Union Power Measure



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



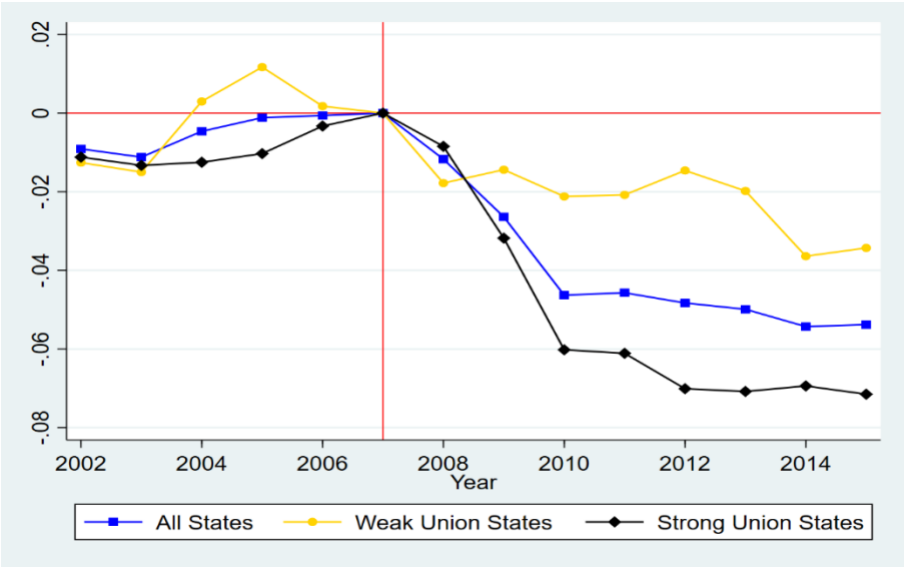
(C) 2008-2011 State Unemployment Rate, by Union Power Measure



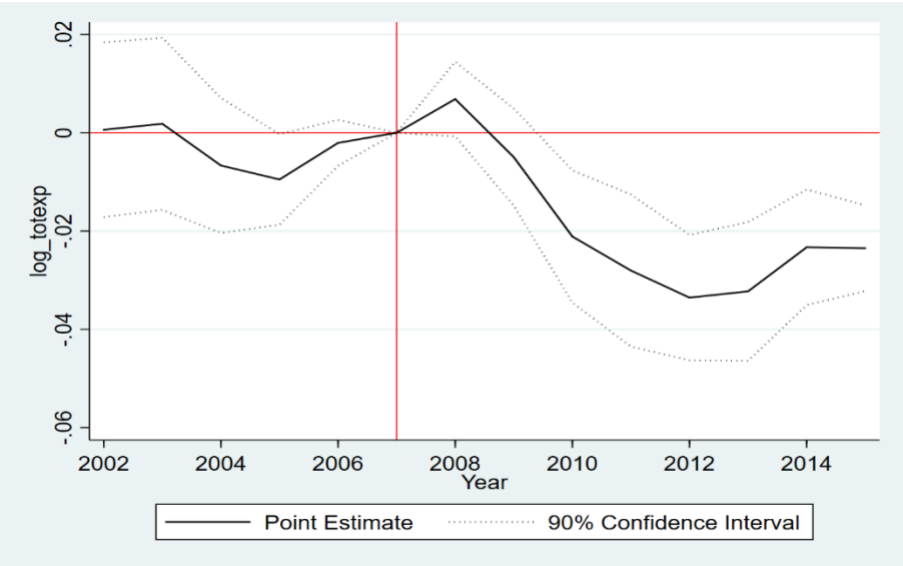
Notes: Panel A plots 2007 share of state revenue that came from state sources by the continuous union power measure. Panel B plots the state average unemployment between 2008 and 2011 by 2007 share of state revenue that came from state sources. Panel C plots the state average unemployment between 2008 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

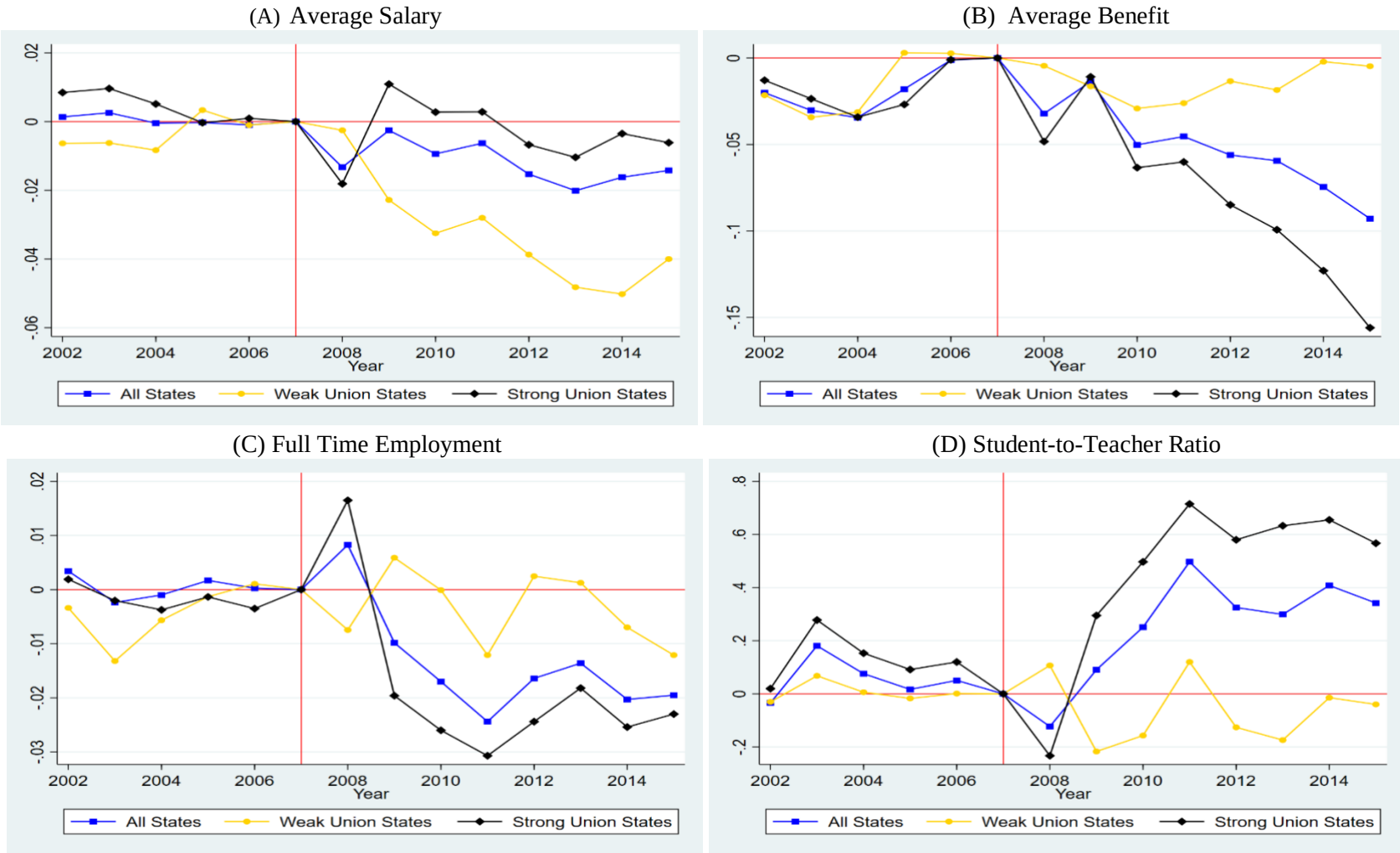


(B) DDD Event Study (Strong Union States – Weak Union States)



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 depics 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, and year fixed effects. The 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: Each panel shows point estimate, γ_t, for each calendar year from Equation (3) together (blue) and separately for strong (black) and weak (yellow) union states. 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. The regressions are weighted by enrollment, and standard errors are clustered at the state level.

Table 1 - Summary Statistics

	Full Sample		Strong Union States		Weak Union States	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Per-Pupil Spending (District)						
Total Expenditure	12,082	5,692	13,133	5,901	10,692	5,081
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	
Educational Outcome						
NAEP 4th Grade Math (State)	239.5	5.9	240.3	5.7	238.6	6.0
NAEP 8th Grade Math (State)	281.7	7.6	283.2	7.6	280.0	7.2
NAEP 4th Grade Reading (State)	220.5	6.3	222.0	5.9	218.8	6.3
NAEP 8th Grade Reading (State)	264.2	5.9	265.7	5.8	262.6	5.5
Observations	336		161		175	
Other State Level Variables						
Share 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	

Notes: 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 statistics 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

	Log (Total Exp.)		Log (Avg. Inst. Salary)		Log (Avg. Inst. Benefit)		Log (FTE)		Class Size	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
SSRev * GR	-0.0328***	-0.0340***	-0.0160***	-0.0178***	-0.0308***	-0.0300***	-0.0112***	-0.00941***	0.153***	0.145**
	(0.00464)	(0.00472)	(0.00330)	(0.00349)	(0.00867)	(0.00896)	(0.00344)	(0.00356)	(0.0586)	(0.0588)
Union * GR	0.00421	0.00488	0.0127***	0.0153***	0.0419***	0.0416***	-0.0165***	-0.0180***	0.0147	0.0282
	(0.00452)	(0.00472)	(0.00343)	(0.00362)	(0.00858)	(0.00899)	(0.00381)	(0.00406)	(0.0665)	(0.0720)
SSRev * Union * GR	-0.0161***	-0.0168***	0.0102***	0.00803**	-0.0419***	-0.0405***	-0.0103**	-0.00979**	0.274***	0.246***
	(0.00533)	(0.00541)	(0.00385)	(0.00390)	(0.0100)	(0.0102)	(0.00425)	(0.00417)	(0.0753)	(0.0710)
Observations	167,715	167,715	167,715	167,715	167,715	167,715	167,715	167,715	167,692	167,692
District Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

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 total district population, school age population, child poverty rate, district-level Bartik Instruments, district fixed effects and year fixed effects. Expanded controls include fraction female students, fraction Asian students, fraction Hispanic students, fraction black students, fraction SPED students, fraction LEP students. All specifications are weighted by district enrollment. 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

	4th Grade Math		8th Grade Math		4th Grade Reading		8th Grade Reading	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SSRev * GR	-0.0940**	-0.0890**	-0.0845**	-0.0828**	-0.166***	-0.161***	-0.108***	-0.120***
	(0.0435)	(0.0443)	(0.0340)	(0.0342)	(0.0475)	(0.0514)	(0.0413)	(0.0430)
Union * GR		0.0445		0.0259		0.00108		0.0986**
		(0.0392)		(0.0353)		(0.0390)		(0.0386)
SSRev * Union * GR		-0.0669		-0.0310		-0.0328		-0.00930
		(0.0472)		(0.0422)		(0.0512)		(0.0489)
Observations	336	336	336	336	336	336	336	336
State Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: All test score analyses are at the state 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 columns include the controls listed in the Table 2 notes aggregated to the state level, state fixed effects, and year fixed effects. Robust standard errors in parentheses and clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Teachers' Average Salary, Wage, and Unemployment

	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
State Controls	Yes	Yes	Yes	Yes

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 (2002-2015). All columns 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

Table 5: Using Alternate Union Power Measure

	Log (Total Exp.)	Log (Avg. Sal.)	Log (Avg. Ben.)	Log (FTE)	Class Size	4th Gr. Math	8th Gr. Math	4th Gr. Reading	8th Gr. Reading
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A									
Collective Bargaining Required vs. Collective Bargaining Not Required (0, 1)									
CB * GR * SSRev	-0.0544***	-0.0108	-0.0651***	-0.0174**	0.280**	-0.141	0.0186	-0.201	-0.100
	(0.0102)	(0.00790)	(0.0205)	(0.00842)	(0.122)	(0.107)	(0.0825)	(0.146)	(0.137)
Panel B									
Collective Bargaining Required, Right-to-Work, and Right-to-Strike (0, 1, 2, 3, 4)									
Union * GR * SSRev	-0.0340***	-0.0174***	-0.0313***	-0.0105***	0.173***	-0.0277	-0.0355	-0.0573	-0.0442
	(0.00481)	(0.00373)	(0.00955)	(0.00388)	(0.0662)	(0.0270)	(0.0376)	(0.0552)	(0.0508)
Observations	167,715	167,715	167,692	167,715	167,692	336	336	336	336
District Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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. All specifications are weighted by district enrollment. Robust standard errors in parentheses and clustered at the district and state-year level. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Controlling for Heterogeneity by State-Level Union Power Correlates

	Log (Total Exp.)	Log (Avg. Sal.)	Log (Avg. Ben.)	Log (FTE)	Class Size	4th Gr. Math	8th Gr. Math	4th Gr. Reading	8th Gr. Reading
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A. 2000 Median Income									
SSRev * Union * GR	-0.0240***	0.00854*	-0.0475***	-0.0209***	0.314***	-0.0200	-0.0337	0.00183	-0.0181
	(0.00699)	(0.00507)	(0.0122)	(0.00544)	(0.0961)	(0.0495)	(0.0574)	(0.0764)	(0.0791)
B. 2004 Democratic Vote Share									
SSRev * Union * GR	-0.0189***	0.00375	-0.0497***	-0.00799*	0.266***	-0.0519	-0.0518	0.00302	0.0315
	(0.00568)	(0.00404)	(0.0109)	(0.00447)	(0.0750)	(0.0588)	(0.0606)	(0.0732)	(0.0677)
C. 2000 Unemployment Rate									
SSRev * Union * GR	-0.0184***	0.00594	-0.0411***	-0.00853**	0.228***	-0.0548	-0.0706	-0.0249	-0.0335
	(0.00538)	(0.00402)	(0.0102)	(0.00434)	(0.0734)	(0.0489)	(0.0488)	(0.0519)	(0.0533)
D. All Three Variables									
SSRev * Union * GR	-0.0261***	0.00245	-0.0585***	-0.0167***	0.284***	-0.0356	-0.0389	0.0121	0.00841
	(0.00702)	(0.00532)	(0.0133)	(0.00588)	(0.0984)	(0.0604)	(0.0636)	(0.0981)	(0.0882)
Observations	167,715	167,715	167,715	167,715	167,692	336	336	336	336
District Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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 controls for 2000 median income, 2004 state share voting for the Democratic presidential candidate and 2000 unemployment rate. All specifications are weighted by district enrollment. Robust standard errors in parentheses and clustered at the district and state-year level. *** p<0.01, ** p<0.05, * p<0.1

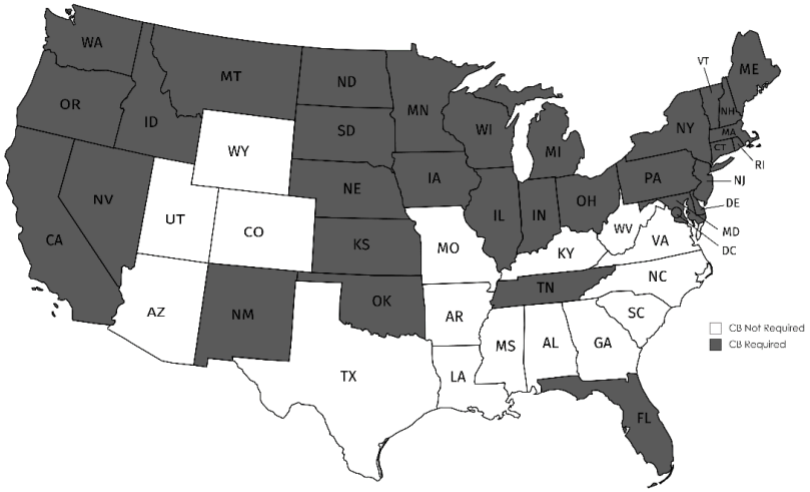
Table 7 - Effect of Union Power on Potentially Correlated Variables

	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

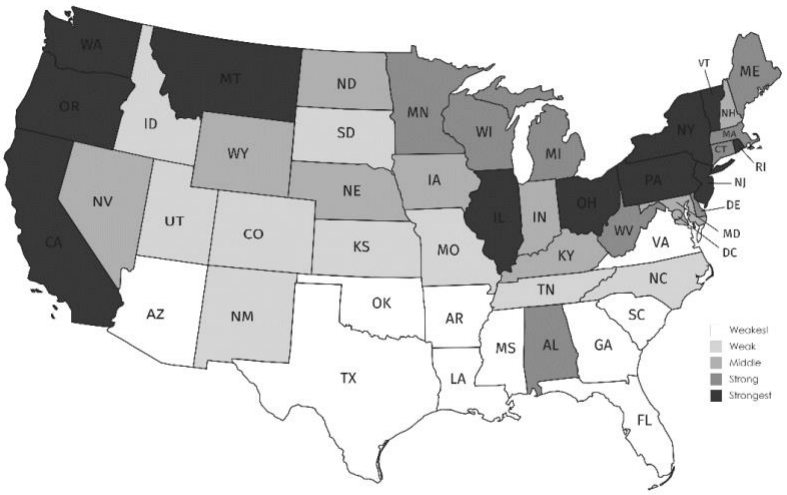
Notes: Each column presents results from a separate regression where the dependent variable is listed in the column headers. All specifications include the controls listed in the Table 2 notes aggregated to the state level, state fixed effects and year fixed effects. Robust standard errors in parentheses 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

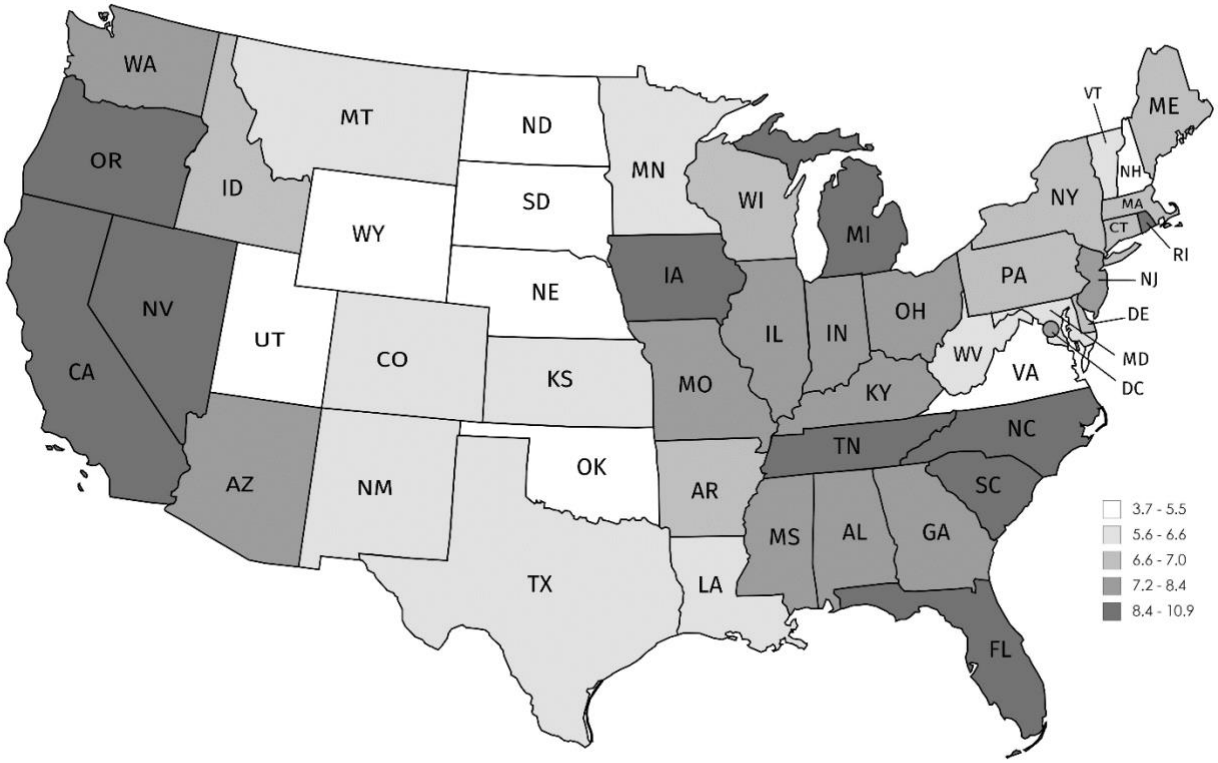


(b) CB, Right-to-Work, and Right-to-Strike



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 and Figure (b) shows state by the five-value index incorporating CB law right-to-work status, and right-to-strike status.

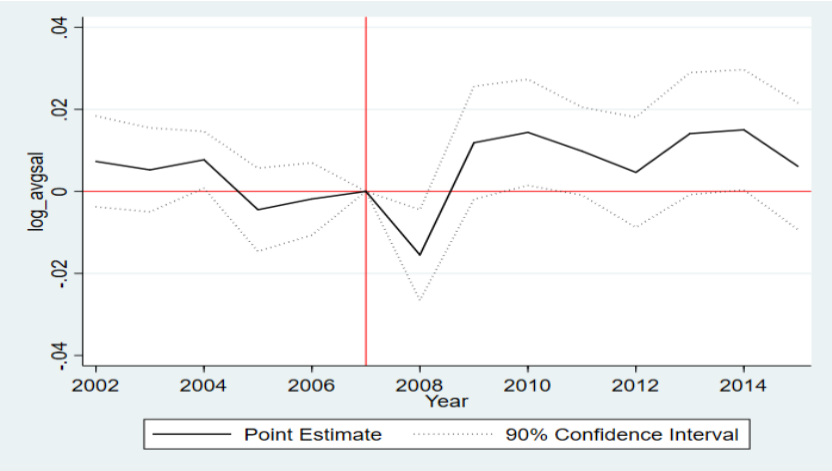
Appendix Figure 2: 2008-2011 Average State Unemployment Rate



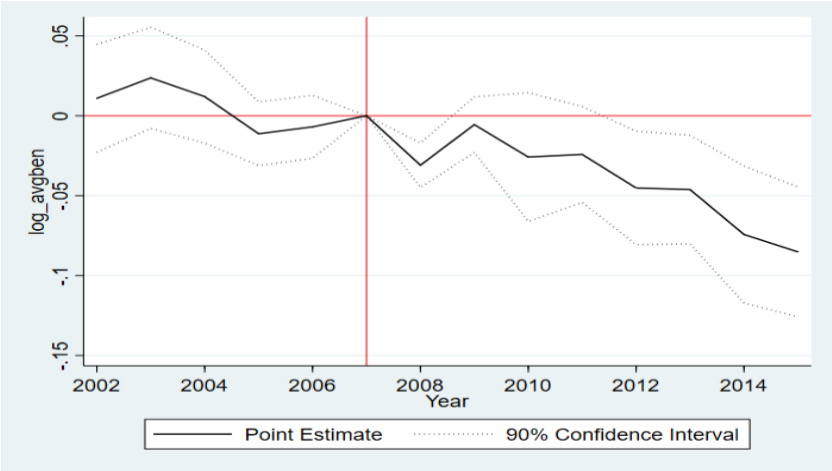
Notes: Map shows states by 2008-2011 average state unemployment rate. Data obtained from the Bureau of Labor Statistics (BLS) - Local Area Unemployment Statistics (LAUS) website: https://www.bls.gov/lau/data.htm

Appendix - Figure 3: DDD Event Study – Teachers' Average Compensation, Employment, and Class

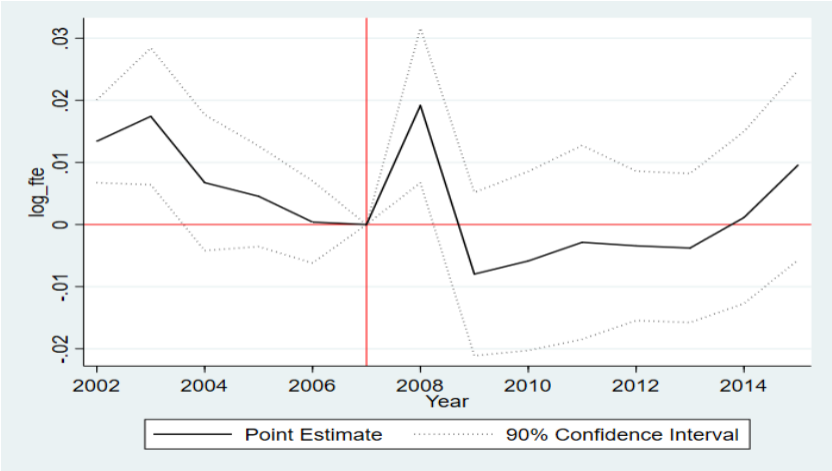
(A) Average Salary



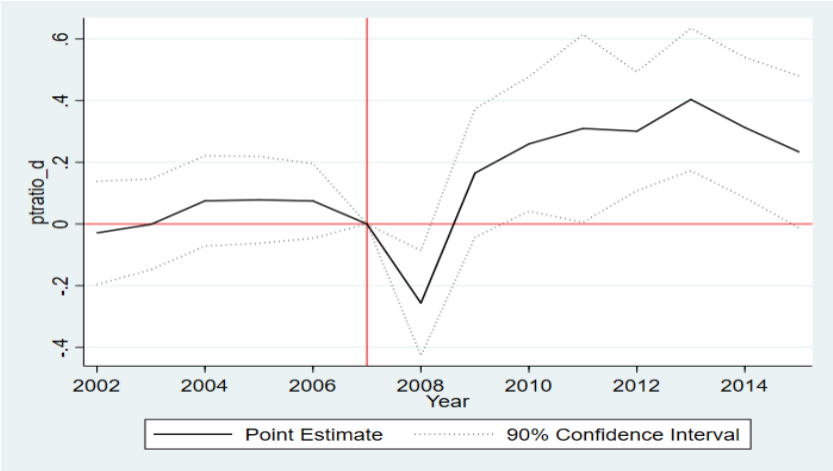
(B) Average Benefit



(C) Full Time Employment



(D) Student-to-Teacher Ratio



Notes: All figues plot estimated triple-diff coefficient, β_t, for each year from Equation (4) 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. The regressions are weighted by enrollment, and standard errors are clustered at the state level.

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 (upto 2011)	4
Wyoming	48.91	1.91		0

Notes: Continuous union power index built following Brunner, Hyman, and Ju (2018). Information on state CB status obtained from NBER Public Sector Collective Bargaining Law Data Set, developed by Freeman and Valletta (1988) and updated by Kim Reuben. Information on RTS and RTW status obtained from the National Conference of State Legislature.

Appendix - Table 2: Other Finance Outcomes

	Log (Capital Ex.)		Log (Current Exp.)		Log (Inst. Exp.)		Log (Inst. Salary Exp.)		Log (Inst. Benefit Exp.)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
SSRev * GR	-0.0298	-0.0322	-0.0233***	-0.0241***	-0.0246***	-0.0251***	-0.0249***	-0.0261***	-0.0398***	-0.0383***
	(0.0201)	(0.0210)	(0.00414)	(0.00415)	(0.00443)	(0.00442)	(0.00365)	(0.00372)	(0.00995)	(0.0101)
Union * GR	-0.0773***	-0.0757***	0.0187***	0.0195***	0.0234***	0.0239***	0.0145***	0.0160***	0.0437***	0.0423***
	(0.0227)	(0.0237)	(0.00398)	(0.00408)	(0.00433)	(0.00442)	(0.00342)	(0.00348)	(0.00929)	(0.00959)
SSRev * Union * GR	0.000976	0.000190	-0.0167***	-0.0167***	-0.0153***	-0.0150***	-0.00486	-0.00555	-0.0570***	-0.0540***
	(0.0245)	(0.0252)	(0.00475)	(0.00467)	(0.00511)	(0.00501)	(0.00399)	(0.00398)	(0.0113)	(0.0114)
Observations	167,715	167,715	167,715	167,715	167,715	167,715	167,715	167,715	167,715	167,715
Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

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 total district population, school age population, child poverty rate, district-level Bartik Instruments, district fixed effects and year fixed effects. Expanded controls include fraction female students, fraction Asian students, fraction Hispanic students, fraction black students, fraction SPED students, fraction LEP students. All specifications are weighted by district enrollment. Robust standard errors in parentheses and clustered at the district and state-year level. *** p<0.01, ** p<0.05, * p<0.1