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Abstract

Following the Great Recession, employment in the U.S. local education sector fell by about 364,000. I analyze whether state legislation that prohibits or limits the use of seniority in layoff decisions has an impact on public high school graduation rates. I find that over a ten-year time span, all else held constant, such legislation on average increases the yearly growth of district graduation rates by about 0.3 percentage points. This is economically significant, as the average yearly increase in the national graduation rate from 2010-11 to 2015-16 was 1 percentage point. When states prohibit or limit using seniority to determine a layoff order, districts must utilize other considerations such as teacher quality. In states with this legislation, teachers remaining following layoffs are likely more effective as opposed to ones in states that used seniority to determine the layoff order.

Keywords: Efficiency; Human capital; Layoffs; Seniority; Rate of return; State legislation

JEL Classifications: H75; I28

Highlights:

- Following the Great Recession, school districts faced massive teacher layoffs.
- Many states passed legislation restricting the use of seniority in teacher layoffs.
- Such legislation may lead to a higher yearly gain in high school graduation rates.
- Results show an approximate 0.3 percentage point increase in yearly gains.

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Declarations of interest: none.

1. Introduction

In 1955, the U.S. Bureau of Labor Statistics began tracking the school-year average employment in the local government education sector. Since then, the sector has consistently added jobs—with two notable exceptions. During and following the 1980s recession, the sector lost approximately 140,000 jobs (about 2 percent of the workforce) between February 1981 and October 1983. Employment levels recovered within a year. Then, during and following the Great Recession, the sector lost 364,000 jobs (about 4 percent of the workforce) between July 2008 and November 2012. In December 2018, six years after the 2012 low, only 218,000 jobs had been added back.[1]

The Great Recession caused a significant and lasting effect on state budgets, constricting the flow of state funding to public school districts. In regions particularly impacted by the recession, families were forced to relocate, thus contributing to lower enrollment levels and further exacerbating funding problems. School districts across the United States now needed to lay off substantial numbers of personnel, including teachers, in order to address financial and enrollment problems. However, perhaps in part due to the relatively short history of teacher layoffs, many states and school districts were ill prepared to determine which teachers would be subject to termination.

The focus of this paper is how a policy regarding teacher layoff order affects students. Different policies affect the quality distribution of teachers, and higher-quality teachers contribute to improved student outcomes (Goldhaber and Theobald, 2010; Chetty et al., 2014). As several states since 2009 have enacted legislation prohibiting or restricting the use of seniority in teacher layoff decisions, I seek to capture the effect of this layoff legislation on high school graduation rates. My hypothesis is that legislation prohibiting or restricting the use of seniority as a predominant factor in determining the layoff order of teaching positions has a positive impact on graduation rates.

Using data spanning school years 2006-07 through 2015-16, I find that the enactment of such legislation increases the yearly growth of district graduation rates by about 0.3 percentage points on average, all else held constant. This is economically significant, as the average yearly increase in the national graduation rate for public high school students from 2010-11 to 2015-16 was about 1 percentage point. If the yearly growth of overall U.S. graduation rates were 0.3 percentage points higher in the five years between 2011-12 and 2015-16, it would have resulted in nearly 174,000

[1]Source: U.S. Bureau of Labor Statistics data on local government education sector employment.

additional graduates. Also, the estimate of 0.3 is within range of what Bekkerman and Gilpin (2011) find from a $1,000 per-teacher investment in improving teacher quality via offering higher wages (0.2 to 1.1 percentage point increase in the graduation rate).[2]

A higher year-to-year growth rate due to restrictions on using seniority in layoff decisions can also increase the social welfare, as high school graduates have better access to jobs with higher wages and postsecondary education. These results suggest that, absent using seniority to determine a layoff order, considerations such as teacher quality may play a larger role. The teachers remaining following layoffs not based solely on seniority may be more effective and therefore their schools would experience higher graduation rates, as opposed to schools that used seniority to determine the layoff order.

This paper provides a background on recent activity concerning teacher layoff policies in Section 2. The data is described in Section 3. In Section 4, I present a model for analyzing the impact of state policy on graduation rates. Following in Section 5 are results, and in Section 6 are robustness checks. Section 7 concludes and notes general concerns regarding using teacher effectiveness measures as presented in current literature.

2. Background

Prior to 2009, the majority of states did not mandate the manner in which school districts could determine personnel subject to dismissal in the event of a layoff, permitting districts to decide. Of states that did, most maintained laws requiring school districts to lay off teachers in the order of reverse seniority (perhaps even irrespective of considerations such as high-demand certification areas,[3] or whether schools serving higher poverty populations would be more severely affected).

Then, with the Great Recession, these policies gained national attention as school districts across the country faced mass layoffs of teachers. States were dealing with constricted budgets, narrowing state funding flowing to districts. Contrary to the status quo, state legislatures began considering and passing laws aimed at reducing the weight of seniority on layoff decisions. Some laws specified factors to be considered before seniority (such as performance or certification area),

[2] The range of these results are for sample schools within different graduation rate quantiles, up to the 60th quartile. The authors also provide results for the 80th quartile, though that estimate is not statistically significant.

[3] Districts required to layoff by seniority without considering high-demand certification areas would need to immediately recall such teachers to fill these areas. This inefficient process would require the number of staff subject to layoff to be unnecessarily larger, as the district would be laying off staff that it knew would be recalled.

some required multiple factors to be considered simultaneously, and others prohibited the use of seniority at all. While all such legislation activity aimed to weaken seniority protections, not all proposed bills have passed. In several states, it remains a debated, unresolved issue. No broad consensus has been reached to address exactly how to determine staff subject to layoff.

In addition to the pressures caused by the Great Recession, there was a nationwide push for the retention of quality teachers. Both are likely forces for this attention on layoff procedures. The focus on quality teachers, as measured by student performance or other metrics aside from seniority, was at least in part influenced by the priorities of the Obama administration. New federal grants were awarded to states on the basis of their efforts to consider student outcomes for teacher evaluations (and, consequently, staffing decisions). This created an incentive for states to maintain or change legislation to match the grants' priorities.

The U.S. Bureau of Labor Statistics data on the local education sector includes teaching positions as well as non-instructional positions such as central office and maintenance staff. Data tracking specific to teacher employment began in 2010. Between 2010 and 2018, 449,000 elementary, middle, and secondary teacher jobs were added (see Figure 1). However, secondary teaching positions alone dropped by 159,000. Combined with the overall local education sector layoffs and reduced employment levels continuing well beyond the recession years, there is evidence for teacher layoffs occurring at significant levels even through 2017. In particular, layoffs are occurring even after state policy changes came into effect (which for the time period analyzed in this paper was as early as 2009-10 and as late as 2015-16).

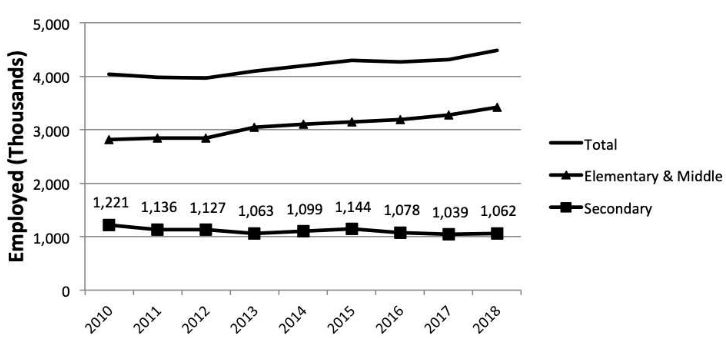

Fig. 1. Teacher employment.

Source: United States Bureau of Labor Statistics, Labor Force Statistics from the Current Population Survey.

Supporters of prohibiting or limiting the use of seniority in layoff decisions argue that higher-quality teachers should not be laid off before lower-quality teachers just because they have fewer years of service to the district. The main assumption here, as Chetty et al. (2014) find, is that higher-quality teachers have higher average impacts on students' test scores and future labor market outcomes. A second important assumption is that the quality distribution of teachers remaining is in fact different under two alternate policies favoring or limiting seniority as the deciding factor. This assumption is supported by research on Washington state school district layoffs during 2008 to 2010 from Goldhaber and Theobald (2010). They find little overlap in the teachers remaining using a simulation of layoff by value-added measures (VAM), a measurement of teachers' contributions to their students' performance, versus by seniority. Using student achievement to quantify teacher quality, they find that the mean quality of teacher actually laid off (by seniority) was 5-6% of a standard deviation lower than that of all teachers. While this does suggest experience contributes to higher-quality teachers, Goldhaber and Theobald (2010) add that when they simulated the layoff by effectiveness measures, the mean quality of teacher laid off was then 24-26% of a standard deviation lower than that of all teachers.

Therefore, the distribution of teacher quality, as defined by effectiveness or ability to positively impact student outcomes, is expected to be different under the two layoff policies. In addition, teacher quality of those remaining may be significantly higher when effectiveness measures are used than when only seniority is used. My results suggest that the distribution of quality teachers is not just immediately or temporarily altered by such policies, but also that restricting seniority consideration persistently and positively affects student graduation rates.

One argument against limiting seniority protections involves school districts' financial concerns. School districts implement layoffs as part of a response to declining enrollment and/or major financial problems. Therefore, it is natural for teachers and advocates to fight for protections against a district simply laying off its most expensive (and likely most senior) personnel. In addition, the impact of turnover would be lower since fewer positions would have to be closed in order to achieve a cost reduction. Advocates of seniority protections also argue that a routine evaluation system should be sufficient to remove truly unsatisfactory employees. Yet findings from Goldhaber and Theobald (2010), as previously discussed, suggest otherwise.

3. Data

3.1 Graduation Rates

Graduation rates, between 0 and 100, are a measure of the number of graduates per 100 high school students. In this paper, the outcome variable is the change in the graduation rate from the prior year. This data is obtained from the US Department of Education's National Center for Education Statistics (NCES) for the school years 2006-07 through 2015-16. However, the data for school years 2006-07 to 2009-10 are calculated differently than for years 2010-11 to 2015-16. During the first set, the NCES did not regulate the methodology for calculating the graduation rate. Since 2010-11, NCES regulates this calculation (such as using a uniform definition of cohort or degree type) but there still may be measurement differences. Data reported in each set is insufficient for generating graduation rates that can be compared between the two sets. In order to address this problem, all analysis performed excludes the change in graduation rate between the two years in which the formula was also changed (2009-10 to 2010-11).

As suggested by Heckman and LaFontaine (2010) and Murnane (2013), these particular sets of graduation data can each be unreliable for analysis. They argue that the calculation of graduation rates does not ensure uniform treatment of problems with student accounting and variation in degree types. It is difficult to assign a definition of the cohort basis, without introducing potential for error, to compare to the number of graduates. (For example, NCES makes adjustments to account for eighth-grade dropouts or net student migration immediately prior to ninth grade, but would still be imperfect.) Also, it is difficult to account for varying degree types offered (GEDs, diplomas, or other options). I hope to mitigate concerns with this data, as my analysis does not attempt to compare absolute graduation rates between school districts. I only utilize the difference in a district's graduation rate from one year to the next. As long as district reporting is internally consistent, concerns Heckman and LaFontaine (2010) and Murnane (2013) raised should not affect these results.

Shown in Table 1 is the initial number of observations (regular school districts), the numbers meeting specified criteria for exclusion, and the resulting number of observations that is utilized in analysis.[4,5] Also displayed is the mean change in graduation rate for the resulting data. First excluded are district-level cohort sizes of less than or equal to 100. Cohort size is the number of graduates a district would expect to have with a 100% graduation rate. These are already omitted from later years due to increased privacy restrictions, and in any case the status of a single student can cause significant fluctuations in the overall graduate rate. The second group excluded is districts with standard deviations (of the change in graduation rate) greater than or equal to 30 percentage points; these appeared to clearly contain an error. For example, one district reports over 90% graduation rate in all ten years except one, in which it reports 0.9%. The last exclusion is of districts that in any year indicate charter schools were part of reported data, since not all charter schools are required to follow state mandates on traditional public schools. These exclusions do not substantially impact results, however.[6]

Table 1: Number of observations (public school districts) per year.

School Year	Initial	Exclusion			Resulting	Mean Change
Comparison	No. of Obs.	Small Cohort	Large Std. Dev.	Has Charters	No. of Obs.	in Grad Rate
2006-07 to 2007-08	9504	4020	364	738	4822	0.39
2007-08 to 2008-09	9177	3970	214	567	4726	0.60
2008-09 to 2009-10	9222	4034	309	573	4656	1.34
2009-10 to 2010-11	0	0	0	0	0	-
2010-11 to 2011-12	3272	0	26	503	2745	1.17
2011-12 to 2012-13	3223	0	18	497	2709	0.80
2012-13 to 2013-14	3262	0	20	496	2747	0.73
2013-14 to 2014-15	3232	0	20	502	2711	0.85
2014-15 to 2015-16	3225	0	26	500	2701	0.58
	44117	12024	997	4376	27817	0.80

Notes: Data for 2009-10 to 2010-11 is excluded due to the NCES change in graduation rate calculation methodology. The significant decline in school district observations before and after 2010-11 is likely due to increased privacy restrictions, with data for smaller schools omitted from the latter sets. I also exclude when: district-level cohort sizes are less than or equal to 100, standard deviations (of the change in graduation rate) are greater than or equal to 30 percentage points, and/or charter schools are as part of the district in any year.

[4] Already excluded in initial observations is the change in graduation rate between the two years in which the formula was also changed, as well as Alabama and New York City school district data. Alabama data has been declared misstated. New York City school district data is reported only at a finer geographic level while other sources for their control variable data are not. Within this time period, one to three years of data for some states is omitted by NCES. NCES documentation states this is due to granting waivers for submission or when states missed the deadline for publication. In some years, NCES does not provide exact graduation rates in the 99 to 100 range for even large populations. So for 262 observations, I assign the rate to the low end of 99 (though it hardly makes a difference if the high end of 100 is used instead).

[5] The NCES definition of regular schools is "a public elementary/secondary school providing instruction and education services that does not focus primarily on special education, career/technical education, or alternative education, or on any of the particular themes associated with magnet/special program-emphasis schools."

[6] See Table 6 in Section 6.1.

3.2 Policy Indicator

The data on the policy this paper seeks to evaluate, the policy of prohibiting or restricting the use of seniority in determining layoff orders, is generated from my research on each state's legislative history.[7] I construct the policy as a time-variant binary variable for each district and school year combination: state-mandated prohibited or restricted use of seniority in determining layoff orders in a given year (indicator equals 1), or otherwise (indicator equals 0).

Where state legislation has specified the role of seniority, it does not vary across its districts. Where no explicit policy is in place (or the state explicitly permits district flexibility), practices may vary district to district. When school districts are permitted discretion, they may vary in the degree to which they consider seniority. In analyzing a North Carolina district implementing a large layoff, Kraft (2015) finds that, while no VAM model was explicitly used, there was significant emphasis on teacher attributes (such as principal evaluations) in the determination of layoff order. However, districts in general may or may not adopt strong seniority considerations when given the discretion.

Over the ten years analyzed, 28 states and the District of Columbia never implement a state policy significantly restricting the use of seniority in teacher layoff decisions. Two states have such a policy in force during the entire ten-year period (via legislation enacted prior to the time window analyzed). The remaining 20 states did not have this policy in effect as of 2006-07 but enacted legislation at some point over the ten-year period (effective as early as the 2008-09 school year and as late as the 2015-16 school year). Due to data exclusions as described in section 3.1, no observations remain for Alabama, D.C., Hawaii, and Vermont (which never implemented such policy), as well as New Hampshire (which did). Presented in Table 2 are descriptive statistics for the change in graduation rates, without and with policy implementation for each state as applicable.

[7] The National Center on Teacher Quality (NCTQ) also produces a State Policy Yearbook Database every two years beginning with 2011, which was very helpful in guiding my research.

Table 2: Descriptive statistics of change in graduation rates, by state and policy.

	Seniority Not Restricted (policy=0)			Seniority Restricted (policy=1)		
		Change in Graduation Rate			Change in Graduation Rate	
State	N	Mean	SD	N	Mean	SD
Alabama						
Alaska	28	2.5	10.8			
Arizona	76	1.0	9.8	195	0.6	4.3
Arkansas	367	-0.5	6.9			
California	769	1.2	4.7			
Colorado	83	0.2	7.1	21	2.2	5.6
Connecticut	532	0.7	4.0			
Delaware	129	1.3	4.9			
D.C.						
Florida	45	0.1	5.2	44	2.4	5.8
Georgia	441	2.4	5.8	278	2.6	5.4
Hawaii						
Idaho	95	1.0	7.2	26	0.2	3.6
Illinois	409	0.0	6.4	620	0.6	3.7
Indiana	670	0.8	6.4	482	0.7	3.3
Iowa	416	0.4	5.7			
Kansas	280	1.1	5.5			
Kentucky	551	0.7	5.3			
Louisiana	204	0.6	6.1	155	1.8	4.0
Maine	38	1.1	4.7	57	0.9	4.0
Maryland	120	0.7	3.0			
Massachusetts	959	0.4	4.2			
Michigan	1066	-0.5	7.1	869	0.9	4.0
Minnesota	769	0.6	5.1			
Mississippi	589	0.6	6.6			
Missouri				842	1.0	5.3
Montana	50	0.7	4.1			
Nebraska	185	0.4	5.2			
Nevada				25	0.7	5.5
New Hampshire						
New Jersey	1537	0.8	4.5			
New Mexico	116	1.4	5.8			
New York	1962	1.1	4.7			
North Carolina	766	2.0	4.2			
North Dakota	71	1.9	5.1			
Ohio	1281	0.5	6.4	829	0.4	3.2
Oklahoma	289	0.1	7.6	91	-0.7	4.1
Oregon	157	0.9	7.1			
Pennsylvania	2201	0.2	5.1			
Rhode Island	50	-2.1	6.5	102	1.4	3.8
South Carolina	218	1.7	4.1			
South Dakota	79	-0.4	6.7			
Tennessee	297	2.4	6.3	348	0.8	3.3
Texas				2352	1.2	5.1
Utah	95	0.0	6.0	124	1.6	3.4
Vermont						
Virginia	477	1.5	5.1	217	1.0	3.2
Washington	763	1.0	6.2	85	1.3	3.4
West Virginia	315	1.1	4.2			
Wisconsin	237	0.6	5.3	195	0.3	2.6
Wyoming	78	0.6	6.1			
	19860	0.7	5.4	7957	1.0	4.3

Notes: States with policies restricting the use of seniority in teacher layoffs a particular year are listed as "seniority restricted." Data spans school years 2006-07 through 2015-16. See section 3.1 for detail on data exclusions.

With a naïve look at the data on graduation rates and policy implementation, Figure 2 below is consistent with my hypothesis that state policy restricting seniority as a factor in layoff decisions positively impacts public high school graduation rates. On the vertical axis is the *time-averaged* yearly change in graduation rates. For states that have no policy change (in other words, states that always or never implement this policy during the time period), I calculate one time-averaged value. For the group of states implementing policy during the time period, I separately average data prior to (left-hand plot point) and after (right-hand plot point) implementation.

The figure shows that, among states implementing policy between 2006-07 and 2015-16, the time-average before implementation is below all others but after implementation is higher than states that never implement policy. There are few states in the always-implemented group, but their time-average rate is also the highest.

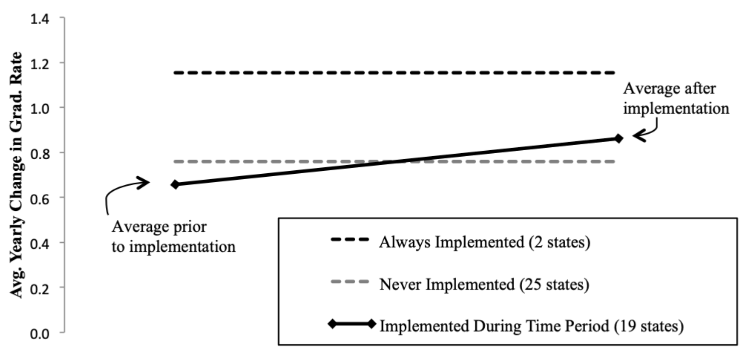

Fig. 2. Average yearly change in graduation rate per group of states.

Notes: The time period spans school years 2006-07 through 2015-16. The change in graduation rate is calculated as the difference between a district's rate and its prior-year rate. For the states that experienced no policy change regarding the restriction of seniority as a factor in teacher layoffs, rates are averaged over time and per group of states. For the states that experienced policy implementation during this time period, rates prior to implementation and post-implementation are separately averaged. Due to data exclusions as noted in section 3.1, no observations remained for 4 states as well as D.C.

3.3 Control Variables

I utilize panel data on several district-level control variables. Some factors describe the makeup of the student population: the percentage of children aged 5-17 in poverty within district boundaries (as a proxy for student poverty), the percentage of students requiring special education services, and the percentage of students who are English language learners (ELL). I also include figures on the cohort size, total district membership, and an indicator of the district's urbanicity level.[8] A final district-level variable is the fiscal surplus per 1,000 students, adjusted to real 2018 dollars, as a measure of financial health. The percentage of children in poverty per school district boundary is from the U.S. Census Bureau's Small Area Income and Poverty Estimates. All others are obtained from the U.S. National Center for Education Statistics (NCES).

Additionally, I use indicator variables that describe political party power at the state level. For each of governorship, state senate, and state house, I constructed panel data that indicates which party is in power for each state-year combination. Possible values assigned for party control are: Democrat, Republican, Tie (for state senates and/or houses) and Independent (for governorships), as applicable. This data is derived from the National Conference of State Legislatures.[9] I assign political party power forward in time. For example, if the partisanship of the state governor changes with the 2008 election, I align it with 2009-10 school-year data.[10]

An important note about the district-level dynamic factors is that they vary little over time (see Table 3). The following hardly vary: student population percentages (poverty, special education, ELL) and fiscal surplus per 1,000 students. Cohort size, district size, and urbanicity indicators vary somewhat more. Urbanicity levels (not displayed below) for 75% of districts have a max-min range of 1 or fewer steps on a 12-step scale, but at the 95th percentile, have a range of up to 6 steps.

Table 3: Standard deviations of district-level data.

Variable	N	75th Percentile	95th Percentile
% Poverty	27621	3 pct. pts.	5 pct. pts.
% Special Education	27692	1 pct. pt.	2 pct. pts.
% ELL	27681	1 pct. pt.	3 pct. pts.
Surplus per 1,000 students	27715	\$2	\$4
Cohort Size	27714	12%	20%
District Size	27715	6%	12%

Notes: Data spans school years 2006-07 through 2015-16, excluding data as noted in section 3.1. Cohort Size and District Size standard deviations are divided by time-averaged values.

[8]NCES indicators of urbanicity are assigned on a non-linear 12-step scale, based upon local population levels and/or distance from a larger urban area.

[9]I cross-referenced this with other sources such as Ballotpedia, and where I found discrepancies I investigated further (referring to national and/or local news sites, for example) to confirm the accurate assignment. Nebraska state legislature is officially nonpartisan, but the legislators individually maintain an affiliation with a major party. Nebraska also has a unicameral system, so whichever party is in power in the legislature, I assign it as in power for both the "senate" and "house" for my model.

[10]In this example, the transition affects the 2009 legislative session. Legislation concerning public school districts would then tend to be effective the 2009-10 school year.

These district-level descriptive statistics have notable implications for district-level fixed effects models. If these variables are treated as constant over time, a district-level fixed effects model will implicitly control for them. But treating variables with low within-variation as dynamic and including them (the student population percentages and fiscal surplus in particular) in district-level fixed-effects models is likely to lead to results with low precision.

4. Empirical Framework

4.1 Statistical Model

The goal is to analyze the effect of state policy on school district graduation rates for the ten-year time period 2006-07 to 2015-16, controlling for related district and state attributes. I set up a model with the change in graduation rates as the dependent variable, and so estimated parameters describe the rate of change in graduation rates. The model, to be estimated with fixed effects, is as follows:

$$\Delta g_{dt} = \alpha_d + \gamma policy_{st} + \boldsymbol{\beta} \boldsymbol{X}_{dt} + \varepsilon_{dt} \tag{1}$$

The dependent variable Δg_{dt} is the change in the graduation rate for district d from the prior school year. Allowing for district-level fixed effects, a_d represents the fixed baseline year-over-year increase per district. The variable $policy_{st}$ indicates the state policy on teacher layoffs over time, valued at 1 if the seniority consideration in teacher layoff decisions is restricted by state s in year t, and 0 otherwise. The effect of this policy is then measured by γ. Finally, $\boldsymbol{X}_{dt}$ is the control vector for attributes of district d in year t and $\boldsymbol{\beta}$ is the coefficient vector.[11]

The parameter of interest is γ, the effect of implementing a state policy prohibiting or restricting the use of seniority in layoff decisions. My hypothesis is that the policy has a positive effect on the graduation rate and so predict that estimated γ will be a positive value. In the absence of seniority as the primary factor, alternative factors such as the quality of the teacher are used. As Chetty et al. (2014) and Goldhaber and Theobald (2010) suggest that considering teacher quality would lead to a higher-quality distribution of teachers and therefore improved student outcomes, I expect

[11] The control vector is denoted at the district level but some factors (such as political party power) will only vary by state.

that the effect of the policy on teacher quality distribution is long-lasting and significant enough to have a persistent effect on the graduation rate.

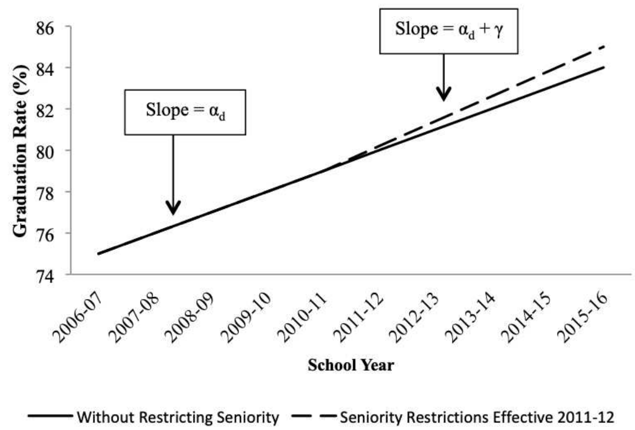

Fig. 3. A graphical interpretation of model parameters.

Notes: Consider a district in a state that implements a policy restricting the use of seniority in teacher layoff decisions beginning with the 2011-12 school year. The solid line represents its pre-policy trend (shown for simplicity as a constant yearly increase; control variables add flexibility). It has a year-over-year percentage point increase of α_d in the graduation rate. The dotted line then illustrates a steeper slope ($\alpha_d + \gamma$) for a yearly additional γ-percentage point attributed to policy implementation.

Above, Figure 3 illustrates the interpretation of model parameters for a district in a state that implements a policy restricting the use of seniority effective 2011-12. On this graph of graduation rates over time, the slope is the yearly change in graduation rates (the dependent variable in my model). The solid line with initial slope α_d describes the trend in absence of this policy through 2010-11, and afterward represents the assumed counterfactual of policy implementation. The dotted line with a steeper slope (for $\gamma > 0$) represents a change in the slope of graduation rate increases after policy implementation in 2011-12.

4.2 Identification and Model Assumptions

For identification of the estimated effect of the policy in question, the main concern is omitted variable bias. So it is important to control for any variables that correlate with the outcome (yearly change in graduation rate) and the variable of interest (policy). There are some factors that impact both the graduation rate of districts within a state and whether the state enacted laws limiting the weight on seniority. Generally, the political party with power at the state level will play a role in education policy and public school funding. More specifically, the motivation for states to pass this type of legislation was derived from two events impacting all states: the Great Recession, and the Obama administration initiatives concerned with teacher quality. Both events affected the funding available to school districts, but likely affected them differently based upon the prior financial health of the district and its state. These policies potentially have greater impacts on districts that are already struggling.

Therefore, I consider district-level and state-level factors that can disproportionately and substantially constrain a district's budget as well as the growth in its graduation rate. Such factors included are: the percentage of students requiring special education services, the percentage of students who are English language learners (ELL), and the percentage of children aged 5-17 in poverty within district boundaries (as a proxy for student poverty). I include the district surplus (total revenue less total expenditures) per 1,000 students as a measure of the district's general financial health, as well as district membership totals, cohort size, and indicator variables for urbanicity. The sensitivity of school district finances and graduation rates could vary by district size and population density. A large urban district, for example, may more easily connect with outside sources of supplemental financial and/or student support.

By estimating the regression equation with district-level fixed effects, any district-level time-invariant factors related to policy implementation and the yearly change in graduation rate are controlled for. The district-level variables I identified as important to consider actually vary little over time (as discussed in section 3.3). It may be more appropriate, then, to treat them as static variables already controlled for under district-level fixed effects models—including them only when considering a model with only state-level fixed effects, for example. In any case, I provide for comparison regression results with at least three variants for district-level fixed effects models: treating these variables as static (excluded), treating some as static (excluding those with lowest variance over time), and treating all as dynamic (none excluded).

Finally, I include the political leaning or influence for each state. These variables indicate the party in power for each of the governorship, state senate, and state house. State government can play a large role in their school districts. Where political ideology differs with regard to public education, the party in power in state government may impact graduation rates differently. While I note the Great Recession and the teacher quality initiatives as motivators for states to alter their policy on teacher layoffs, actual policy change requires action by the state legislators. Historically, more Democratic politicians support teacher unions, which tend to oppose restrictions on seniority protections. Therefore, one would expect a policy reducing the consideration of seniority in layoff decisions to be proposed and passed in states under Republican control. While there are in fact notable instances to the contrary, this was generally the case.

A limitation of my analysis is that I do not directly account for actual layoffs in the model. I rely heavily on the fact that layoffs were pervasive and substantial. However, perhaps not every district laid off teachers. Certainly, some districts had proportionally larger and/or more rounds of layoffs than others. This omission can lead to bias in the estimated effect of state policy. If some states had more districts severely impacted, maybe they were more likely to consider and implement changes to their layoff policies. It is also reasonable that these districts saw slower growth in graduation rates. Supposing then a positive correlation between the number of layoffs and the variable of interest (policy), as well as a negative coefficient on layoffs if included in the model, my estimated effect of state policy may actually be biased downward. Investigating this further could be a line of future research.

5. Results

Presented in the following subsections are results assuming district-level and state-level fixed effects, respectively. (Each regression table begins with the same naïve OLS regression, however.) As with all models in this paper, I cluster standard errors by school district to account for heteroskedasticity.

5.1 District-Level Fixed Effects

Below in Table 4, all but the first model are estimated with district-level fixed effects. I find that implementation of a state policy prohibiting or restricting the use of seniority as a factor in teacher layoff decisions increases, on average, the yearly growth of the graduation rate by about 0.3 percentage points. Results are relatively consistent across model specification. The estimated effect of policy ranges from 0.250 to 0.375 percentage points. Estimates of the policy indicator are statistically significant at less than the 0.05 level. These estimates are also economically significant, as the average yearly increase in the national graduation rate for public high school students from 2010-11 to 2015-16 was about 1 percentage point.

Table 4: Coefficient estimates for graduation rate changes, with district-level fixed effects.

	(1) OLS	(2) District FE	(3) District FE	(4) District FE	(5) District FE
Policy	0.253***	0.250**	0.375***	0.282*	0.271*
	(0.0480)	(0.0944)	(0.111)	(0.114)	(0.117)
Surplus per 1,000 Students					-0.0191
					(0.0254)
% Special Education					-5.353
					(2.749)
% ELL					1.771
					(3.897)
% Poverty					3.349
					(1.727)
Political Party Dummies	No	No	Yes	Yes	Yes
Urbanicity Dummies	No	No	No	Yes	Yes
Membership/Cohort Controls	No	No	No	Yes	Yes
N	27817	27817	27817	27768	26235

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Data spans school years 2006-07 through 2015-16, excluding data as noted in section 3.1. The first model is estimated by regular OLS. All others include district-level fixed effects. Policy is a variable indicating whether a state has legislation prohibiting or restricting the influence of seniority on teacher layoff order in effect in a given school year. Linear and quadratic terms are included for district membership and cohort size. Standard errors are clustered by district.

If the yearly growth of overall U.S. graduation rates were 0.3 percentage points higher in the five years between 2011-12 and 2015-16, it would have resulted in nearly 174,000 additional graduates. The estimate of 0.3 is within range of what Bekkerman and Gilpin (2011) find from a \$1,000 per-teacher investment in improving teacher quality via offering higher wages (0.2 to 1.1 percentage point increase in the graduation rate). These results suggest that, absent using seniority to determine a layoff order, considerations such as teacher quality may play a larger role. The teachers remaining following layoffs not based on seniority may be more effective and therefore their schools would experience higher graduation rates, as opposed to schools that used seniority to determine the layoff order. Another possible consideration is how individual school staffing is affected. If some schools in a district already have high teacher turnover, then much of their staff will have little seniority. So if districts can prevent disproportionate layoffs at schools that already have high turnover, it may have a positive effect on graduation rates overall.

When the district-level controls are added, the precision of the estimated effect of policy is reduced. This is expected, as the within-variation of these factors is low. It is possible that these variables should be treated as static. Under model 3, all are treated as static and the estimated effect of policy is 0.375 percentage points with a 95% confidence interval of 0.159 to 0.592. Model 4 is a compromise that allows membership/cohort controls as well as urbanicity to be dynamic. In this case, the estimated effect of policy is 0.282 with a 95% confidence interval of 0.059 to 0.505. Conducting an F-test on model 5, the null hypothesis that the four variables with least variability over time (surplus; special education, ELL, and poverty percentages) are jointly insignificant cannot be rejected at the 5% level.

A final comment on the above results is that the measure of district financial health (surplus per 1,000 students) appears to be insignificant and has little effect on the estimated effect of state policy. It is possible that this metric for describing financial health is not sophisticated enough for the model to identify any relationship between other variables. Public school funding streams are indeed complex; grants can be earmarked for specific expenditures and so the flexibility for spending on teacher salaries can differ between two districts with identical fiscal surpluses. Investigating whether more complex definitions of fiscal health leads to different findings would be an avenue of future research on this topic.

5.2 State-Level Fixed Effects

Allowing only state-level fixed effects, I find estimated effects of policy similar to those found under models with district-level fixed effects. Coefficient estimates on the policy variable range from 0.253 to 0.405 percentage points; all are statistically significant at less than the 0.001 level. Using state-level fixed effects is a stronger restriction: district-level variables specifically included in the model provide the only dimension in which trendlines of districts in a given state can vary from one another. However, the fact that the estimated effect of policy is fairly similar whether district-level variables are included or excluded suggests that they make little difference. When omitted, any possible bias appears to be minimal; the state-level factors that more strongly correlate with the policy variable are more important.

Table 5: Coefficient estimates for graduation rate changes, with state-level fixed effects.

	(1) OLS	(2) State FE	(3) State FE	(4) State FE	(5) State FE
Policy	0.253***	0.277***	0.388***	0.405***	0.382***
	(0.0480)	(0.0814)	(0.0965)	(0.0970)	(0.0986)
Surplus per 1,000 Students					0.000628
					(0.0196)
% Special Education					-1.690
					(1.022)
% ELL					1.385*
					(0.540)
% Poverty					3.343***
					(0.413)
State Dummies	No	Yes	Yes	Yes	Yes
Political Party Dummies	No	No	Yes	Yes	Yes
Urbanicity Dummies	No	No	No	Yes	Yes
Membership/Cohort Controls	No	No	No	Yes	Yes
N	27817	27817	27817	27768	26235

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Data spans school years 2006-07 through 2015-16, excluding data as noted in section 3.1. The first model is estimated by regular OLS. All others, with state dummy variables, are effectively estimated with state-level fixed effects. Policy is a variable indicating whether a state has legislation prohibiting or restricting the influence of seniority on teacher layoff order in effect in a given school year. Linear and quadratic terms are included for both student membership and cohort size. Standard errors are clustered by district.

In model 5 above, two variables (the percentage of students who are English language learners and the percentage of children aged 5-17 in poverty within district boundaries) are now individually statistically significant.[12] Forcing these variables to be static via regressing policy on time-averaged district-level variables produces only a marginal difference to results.[13] This supports treating district-level variables as static.

[12] The only statistically significant estimates that do not have the signs I expected are the percentage of children in poverty within the school district boundaries and the percentage of English language learners at the district. Districts with more English language learners may also have higher rates of poverty. Students with higher academic ability in areas with lower poverty may have a greater selection of alternatives to public school districts and select out of public education. This would contribute to lower graduation rates for public school districts where the poverty level is low. Students in high-poverty areas may have no alternate options, whether or not they are more able. The model would then find a positive relationship between the poverty rate and public school graduation rate.

[13] The estimated effect of the policy variable is 0.390 percentage points when utilizing time-averaged district-level variables versus 0.382 percentage points when allowed to be dynamic (see model 5 in Table 5). Both estimates are statistically significant at less than the 0.001 level.

One last note on regression results in Table 5 is that, unlike with models estimated with district-level fixed effects, I cannot reject the null hypothesis that the errors are autocorrelated. Autocorrelation of the errors does not lead to bias of the coefficient estimates, but does invalidate the test statistics including reported standard errors. Generally, the concern is that standard errors would be larger and invalidate the statistical significance. Not only would the standard errors need to be much larger in this case (as reported standard errors are substantially small), but also it is possible that an autocorrelation correction would lead to even smaller standard errors since the correlation between residuals over time is negative. Future work could more directly investigate the possible impact of autocorrelation with state-level fixed effects models.

6. Robustness Checks

6.1 Addressing Data Exclusions

In section 3.1, I discussed excluding from analysis any data on school districts with certain characteristics. Now, I want to look at how results may have been affected by the decision to exclude, in particular, the following: district-level cohort sizes of less than or equal to 100, standard deviations (of the change in graduation rate) greater than or equal to 30 percentage points, and/or charter schools as part of the district in any year. While I provide reasons it is important to have these exclusions, results are not fully dependent upon them. In Table 6 below, results without such exclusions show the estimated effects of state policy are consistently higher but not substantially so. The models are identical to those in Table 4 (which utilizes district-level fixed effects in all but the first model).

Table 6: Coefficient estimates for graduation rate changes, without data exclusions.

	(1) OLS	(2) District FE	(3) District FE	(4) District FE	(5) District FE
Policy	0.337***	0.267*	0.449**	0.360*	0.353*
	(0.0627)	(0.121)	(0.139)	(0.145)	(0.150)
Surplus per 1,000 Students					-0.0234
					(0.0308)
% Special Education					-0.676
					(5.668)
% ELL					3.062
					(5.587)
% Poverty					9.822***
					(2.420)
Political Party Dummies	No	No	Yes	Yes	Yes
Urbanicity Dummies	No	No	No	Yes	Yes
Membership/Cohort Controls	No	No	No	Yes	Yes
N	44117	44117	44109	44060	40766

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Data spans school years 2006-07 through 2015-16; see section 3.1 for initial exclusions. The first model is estimated by regular OLS. All others include district-level fixed effects. Policy is a variable indicating whether a state has legislation prohibiting or restricting the influence of seniority on teacher layoff order in effect in a given school year. Linear and quadratic terms are included for both student membership and cohort size. Standard errors are clustered by district.

6.2 Adding Weights

District-level observations of graduation rates are ultimately averages over individual student graduation outcomes (a binary variable denoting if graduated). It is probable, then, that the variance of errors is correlated with cohort size. With smaller cohort sizes, a single student's outcome has a higher impact on the district's graduation rate. Therefore, I might expect higher variance in the error with smaller cohort sizes. Consider then, this form of heteroskedasticity:

$$Var(\varepsilon_{dt}|cohort_{dt}) = \frac{\sigma^2}{cohort_{dt}} \tag{2}$$

In addition to continuing to cluster standard errors by district, in Table 7 below I now add cohort size as weights. Estimates of the effect of policy are a little higher and still (marginally) statistically significant. The district-level fixed effects regressions use a time-averaged cohort size for the weight ($\overline{cohort_d}$). It is not unreasonable to use a time-averaged weight: across school years considered, cohort size varies by less than 20%, 95% of the time. The regression with only state-level dummies is not averaged (though results are similar with the time-averaged weight).

Table 7: Coefficient estimates for graduation rate changes, with weights=cohort size.

	(1) District FE	(2) District FE	(3) State FE
Policy	0.453*	0.322*	0.456*
	(0.185)	(0.160)	(0.186)
Surplus per 1,000 Students		-0.0604	-0.0311
		(0.0341)	(0.0265)
% Special Education		-0.852	-2.162*
		(3.539)	(1.004)
% ELL		-0.766	0.797
		(3.728)	(0.538)
% Poverty		2.425	4.035***
		(2.442)	(0.474)
State Dummies	No	No	Yes
Political Party Dummies	Yes	Yes	Yes
Urbanicity Dummies	No	Yes	Yes
Membership/Cohort Controls	No	Yes	Yes
N	27817	26235	26235

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Data spans school years 2006-07 through 2015-16, excluding data as noted in section 3.1. The first two models allow for district-level fixed effects and are weighted by the time-averaged cohort size. The third model allows only state-level fixed effects and is weighted by cohort size (not averaged over time). Policy is a variable indicating whether a state has legislation prohibiting or restricting the influence of seniority on teacher layoff order in effect in a given school year. Linear and quadratic terms are included for both student membership and cohort size. Standard errors are clustered by district.

Note that models 1 and 3 in Table 7 display near-identical results for the policy variable. Again, the district-level fixed-effects model omitting the district-level factors that lightly vary over time is consistent with the full model using state-level fixed effects. This suggests that the district-level variables included with the state-level fixed effects model may substantially describe the time-invariant factors at the district level. (In fact, replicating the third model using time-averaged values of these variables leads to similar results: that this policy adds an estimated 0.446 percentage points to yearly graduation rate increases, significant at less than the 0.01 level.) However, even when assuming these variables as dynamic under the district-level fixed effects model, the estimated effect of policy is still marginally significant.

7. Conclusion

Many states have since 2009 passed legislation prohibiting or restricting teacher seniority as a factor in public school layoffs. Overall, results in this paper show a positive, persistent effect of this policy on graduation rates. It considers data for school years 2006-07 through 2015-16, and accounts for such state legislation changes during this time period. This result is consistent across model specification. I find that this policy on average increases the yearly growth of the graduation rate by about 0.3 percentage points, all else held equal.

These estimates overlap with the range of what Bekkerman and Gilpin (2011) find from a $1,000 per-teacher investment in improving teacher quality via offering higher wages (a 0.2 to 1.1 percentage point increase in the graduation rate). The estimates I find are economically significant, as the average yearly increase in the national graduation rate for public high school students from 2010-11 to 2015-16 was about 1 percentage point. If the yearly growth of overall U.S. graduation rates were 0.3 percentage points higher in the five years between 2011-12 and 2015-16, it would have resulted in nearly 174,000 additional graduates. Estimates of the policy indicator variable, under each model specification analyzed, are also statistically significant at less than the 0.05 level, and less than 0.001 under many specifications. These results suggest that, absent using seniority to determine a layoff order, considerations such as teacher quality may play a larger role. The teachers remaining following layoffs not based on seniority may be more effective and therefore their schools would experience higher graduation rates, as opposed to schools that used seniority to determine the layoff order.

However, as Boyd et al. (2011) notes, the exact makeup of factors considered is important: the distribution of importance placed on factors such as principal evaluations, teacher quality (VAM) and teacher credentials may still impact the layoff order or result in unintended consequences for student outcomes. For example, the labor market for teachers may respond differently to how a state or district determines layoff orders. A compelling analysis in Rothstein (2015) reinforces the concern for how the act of implementing something like VAM for hiring or retention can have significant consequences on the labor market. It is optimistic that the benefits to students and society can outweigh the costs (such as offering higher pay since the job is now more risky), but suspects that other research has overstated the net gains. Furthermore, greater importance placed on value-added measures could result in more teachers "teaching to the test" and not necessarily improving student outcomes beyond test scores. Hanushek and Rivkin (2012) note that how to optimally quantify the characteristics that exhibit changes in a teacher's effectiveness is unknown, so I would expect a large degree of subjectivity and possible incentive distortion.

Districts continue to experience mass layoffs and debate what the optimal policy is. It has not only been a contentious topic among legislatures; the issue has been brought to and continues in state courts as well. The initial analysis in this paper suggests that the effects may be significant enough to warrant this debate.

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Appendix

Table 8: School year in which policy restricting seniority is first in effect.

School Year	States with Policy Restricting Seniority in Teacher Layoff Decisions (First Year in Effect)
2006-07	Texas, Missouri (see note)
2007-08	
2008-09	
2009-10	Arizona, Rhode Island
2010-11	
2011-12	Florida, Idaho, Illinois, Indiana, Michigan, Nevada, New Hampshire, Ohio, Tennessee, Utah, Wisconsin
2012-13	Colorado, Georgia, Louisiana, Maine, Oklahoma
2013-14	Virginia
2014-15	
2015-16	Washington

Notes: Texas and Missouri both had such policy prior to 2006-07.

References

Bekkerman, A. and Gilpin, G. (2011). Cost-effective hiring in U.S. high schools: Estimating optimal teacher quantity and quality decisions. Working paper 2011-007. *Center for Applied Economics and Policy Research*.

Boyd, D., Lankford, H., Loeb, S., and Wyckoff, J. (2011). Teacher layoffs: An empirical illustration of seniority versus measures of effectiveness. *Education Finance and Policy*, 6(3):439–54.

Chetty, R., Friedman, J. N., and Rockoff, J. E. (2014). Measuring the impacts of teachers II: Teacher value-added and student outcomes in adulthood. *American Economic Review*, 104(9):2633–79.

Goldhaber, D. and Theobald, R. (2010). Assessing the determinants and implications of teacher layoffs. Working paper 55. *National Center for Analysis of Longitudinal Data in Education Research*.

Hanushek, E. A. and Rivkin, S. G. (2012). The distribution of teacher quality and implications for policy. *Annual Review of Economics*, 4(1):131–57.

Heckman, J. J. and LaFontaine, P. A. (2010). The American high school graduation rate: Trends and levels. *Review of Economics and Statistics*, 92(2):244–62.

Kraft, M. A. (2015). Teacher layoffs, teacher quality, and student achievement: Evidence from a discretionary layoff policy. *Education Finance and Policy*, 10(4):467–507.

Murnane, R. J. (2013). US high school graduation rates: Patterns and explanations. *Journal of Economic Literature*, 51(2):370–422.

Rothstein, J. (2015). Teacher quality policy when supply matters. *American Economic Review*, 105(1):100–30.