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Restricting Seniority as a Factor in Public School District Layoffs: Analyzing the Impact of State Legislation on Graduation Rates

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Abstract

Following the Great Recession, employment in the local education sector fell by about 364,000. This paper seeks to capture any effect of states' teacher layoff legislation on public high school graduation rates. I analyze whether state legislation that prohibits or limits the use of seniority in layoff decisions has an impact on graduation rates. I find that, all else held constant, such legislation increases the yearly growth of district graduation rates by 0.2 percentage points on average. 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 such 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 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 increases of 0.16 to 0.23 percentage point increases in yearly gains.

E-mail address: christine.m.dabbs@gmail.com Declarations of interest: none.

1. Introduction

With two notable exceptions, the school-year average in the local government education sector has consistently added jobs since 1955, when the measure was first tracked. The first of such exceptions took place 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 between July 2008 and November 2012–more than double the 1980s loss and 4 percent of the workforce. As of May 2018, only 185,000 jobs have been added back since the 2012 low.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, many families were forced to relocate, thus contributing to substantially lower enrollment levels and further exacerbating funding problems. School districts across the United States saw the need 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 policies 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 layoff legislation on public 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.

I find that the enactment of such legislation on average increases the yearly growth of district graduation rates by about 0.2 percentage points, all else held constant. This finding is statistically significant at less than the 0.01 level. It is also economically significant, as the average yearly increase in the national graduation rate for public high school students from 2010-11 to 2015-

¹Using the U.S. Bureau of Labor Statistics data on local government education sector employment.

16 was about 1 percentage point. If the yearly growth of overall U.S. graduation rates were 0.2 percentage points higher, it would have resulted in an additional 115,808 graduates between 2011-12 and 2015-16. Also, the estimate of 0.2 is within range of what Bekkerman and Gilpin (2011) find from a \$1,000 investment in either improving teacher quality via offering higher wages (0.2 to 1.1 percentage point increase in the graduation rate).

The graduation rate increase due to restrictions on using seniority in layoff decisions would also generally 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 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 proceeds to discuss the recent background on teacher layoffs in Section 2. In Section 3, I present the conceptual framework for analyzing the impact of state policy on student outcomes. The data is described in Section 4. Following in Section 5 are results, and in Section 6 are robustness checks. Section 7 concludes and proposes other considerations particular to the analysis in this paper, as well as general concerns regarding using teacher effectiveness measures, as presented in current literature.

2. Background

Prior to 2009, the majority of state legislation 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. For states that did, the legislation usually specified that school districts must lay off in the order of reverse seniority (perhaps even irrespective of any other considerations such as high-demand certification areas,² or whether schools serving higher poverty populations would be more severely affected).

Then this issue gained national attention as state legislators were considering and passing laws aimed at reducing the effect of seniority. Some states merely specified factors to be considered before

 $^{^{2}}$ Districts required to layoff by seniority without considering high-demand certification areas would then need to 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 knowingly be laying off staff that would immediately need to be recalled.

seniority (such as performance or certification area); some required multiple factors to be considered simultaneously; and others prohibited the use of seniority at all. While all such legislation activity has aimed to weaken seniority protections, not all proposed bills have passed. In many states, it remains a debated, unresolved issue. Certainly, no broad consensus has been reached to address exactly how to determine staff subject to layoff.

There are two likely forces for this focus on layoff procedures: the push for retention of quality teachers and the Great Recession after which districts laid off substantial numbers of teachers. The focus on quality teachers, as measured by student performance or other metrics aside from seniority, was at least in part due to the priorities of the Obama administration. New federal grants were awarded to states on the basis of their efforts to define teacher performance in part on student outcomes and utilize the information for staffing decisions. This created an incentive for states to maintain or change legislation to match the grants' priorities. Simultaneously, states nationwide were dealing with constricted budgets following the recession, narrowing state funding flowing to districts. Other federal funding stimulus grants to school districts were often insufficient to fully compensate for the drop in state funding. For the first time it seemed to matter what the policy on layoffs was: states and districts were experiencing a need to layoff teachers, necessitating a formal stance on how to identify teachers affected.

The U.S. Bureau of Labor Statistics began tracking teacher employment in 2010. Between 2010 and 2017, 273,000 elementary, middle, and secondary teacher jobs were added (see Figure 1). However, secondary teaching positions alone dropped by 182,000. Combined with the overall local education sector layoffs and reduced employment levels continuing well beyond the recession years, there is evidence for national teacher layoffs occurring at significant levels even through 2017. In particular, layoffs are occurring even after state policy changes came into effect (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, "Employment of elementary and middle school teachers" and "Employment of secondary school teachers."

Supporters of prohibiting or limiting the use of seniority in layoff decisions argue that higherquality 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 in 2008 to 2010 from Goldhaber and Theobald (2010), who 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. This supports the claim by advocates of seniority protection that experience can contribute to higher-quality teachers. However, under simulation, if the layoff had been done by effectiveness measures, the mean quality of teacher laid off would have been 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 was significantly higher when effectiveness measures were used than when only seniority was 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. All else equal, it would be in the district's best interest to terminate a higher-cost contract even if they needed to rehire for that position, at which point they could hire a new, minimal-cost teacher. In addition, the impact of turnover would be lower since fewer positions would have to be closed in order to achieve the cost reduction. Advocates of seniority protections also argue that more experienced teachers are better, and perhaps any routine evaluation system should be sufficient to remove truly unsatisfactory employees. Yet findings from Goldhaber and Theobald (2010), as previously discussed, suggest otherwise.

3. Empirical Framework

3.1 Statistical Model

I analyze the effect of state policy on district graduation rates for the ten-year time period 2006-07 to 2015-16, controlling for related district attributes. The regression equation is as follows:

$$\Delta g_{dt} = \alpha + \gamma p_{st} + \beta \mathbf{X}_{dt} + \varepsilon_{dt} \tag{1}$$

where:

- Δg_{dt} is the change in graduation rate for district d from prior school year t-1 to year t
- α represents the fixed growth of the graduation rate from one school year to the next
- γ represents the fixed effect of policy on the graduation rate
- p_{st} indicates state *s* policy on the role of seniority in teacher layoffs, in effect for year *t*, where: $p_{st} = \begin{cases} 1 & \text{if use of seniority is restricted by state$ *s*in year*t* $} \\ 0 & \text{otherwise} \end{cases}$
- $\beta \mathbf{X}_{dt}$ is the control vector for attributes of district d in year t
- ε_{dt} is the effect of unobserved variables

Here, policy is defined as implemented if the influence of seniority on layoff order is prohibited or restricted, and not implemented otherwise.

The control vector contains the district-level measure of financial stability (surplus per 1,000 students), percentage of children ages 5-17 in poverty, percentage of students receiving special education services, percentage of students who are English language learners, membership, and graduation cohort size. Also included are urbanicity and geographic region indicator variables.

The parameter of interest is γ , the estimated effect of policy p_{st} . I hypothesize that the policy has a positive effect on the graduation rate and so expect a positive value for γ , the coefficient on policy. In the absence of seniority as the primary factor, subjective 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 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. 2. Graphical representation of the model.

Notes: The solid line illustrates a constant percentage point increase (α) in the graduation rate each year as a baseline for states that do not restrict using seniority in layoff decisions. The dotted line illustrates a steeper slope ($\alpha + \gamma$), assuming a γ -percentage point increase in the growth of the graduation rate in a state implementing restrictions on using seniority beginning with (for example) the 2011-12 school year.

3.2 Unbiasedness and Model Assumptions

In order to argue that the estimated effect of the policy is unbiased, I must control for any variables that correlate with the outcome (graduation rate) and the variable of interest (policy). There are some variables that impact both the graduation rate of districts within a state and whether the state enacted laws limiting the impact of seniority. The motivation for states to pass 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.

A district already financially-strained may also have a lower graduation rate. Therefore, it is necessary to consider a measure of general financial health within the control vector. I use the district surplus (total revenue less total expenditures) per 1,000 students as the indicator for financial health. However, as financial information is only available through 2013-14, all regressions including this variable cover a shorter eight-year period instead (see Table 4).

In addition, the district distributions of student poverty, special education needs, and English language learners (ELL) may significantly affect district resources. All may require additional district assistance beyond strictly academic services. As a proxy for student poverty, I use the U.S. Census Bureau's estimated percentage of children ages 5-17 in poverty within the boundaries of each district. I use student membership totals to convert special education and ELL variables to percentages of the district population.

Lastly, I consider district student membership totals and the size of their graduating cohort, as well as indicator variables for urbanicity and geographic region. These can help control for some unobserved fixed effects. The sensitivity of school district finances and graduation rates may vary by district size, population density and region. For example, a large urban district may have connections to more private funding sources. Graduation rates are observed to roughly vary by region, and I group states into one of four regions according to the U.S. Census Bureau's definition. I was unable to use the Census Bureau's more refined state grouping (division); it is too refined for this analysis since for some divisions it correlates perfectly with the policy variable.

One notable omission in the control vector is the political leaning or influence for each state.

Historically, more democratic politicians support unions, and unions 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 with more republican control. However, that does not appear to be the case with the observed policy implementation.

Some states that passed this legislation, such as Florida and Georgia, did have house and senate republican majorities and a republican governor. Florida's was passed without any democrat support. However, one of the early Georgia supporters was a democrat (who had even introduced a similar though unsuccessful house bill prior to the senate bill that was enacted). There are also cases of states under democrat control passing legislation restricting seniority use in teacher layoffs. Illinois and Colorado had democrat governors and majorities in both houses when they passed such legislation. Illinois passed their law with nearly unanimously. In New Jersey, a democrat introduced a bill in 2012 to remove its last-in-first-out law (among other changes), but amendments prior to its passage left LIFO intact. At the time, New Jersey had democrat control in legislature and a republican governor. Pennsylvania is another interesting case, whereby under republican control of both houses and the governorship 2011 to 2015, no legislation attempts were successful. Then the republican-controlled legislature finally approved a bill in 2016 to remove its LIFO law but the new governor, a democrat, vetoed it. Then the legislature repeated the process again in 2017, and the same governor allowed it to become a law via inaction.

These cases are not an exhaustive list of the activity and political composition of states over time, but illustrates that political control is not necessarily indicative of whether the state takes action to restrict seniority in teacher layoffs. Therefore, it is not included in the control vector. A future extension could explicitly analyze this factor, but for this paper I am assuming that it does not have a significant impact.

4. Data

4.1 Graduation Rates

The outcome variable is the graduation rate measured from 0 to 100, the number of graduates per 100 students who graduate. Graduation data is from the US Department of Education's National Center for Education Statistics (NCES). The graduation data for school years 2006-07 to 2009-10

are calculated differently than for years 2010-11 to 2015-16. During the first set of school years, the NCES did not regulate the methodology for calculating a graduation rate. Since 2010-11, NCES regulates this calculation but there still may be measurement differences despite using a uniform definition of cohort or degree type. Data reported in each set is insufficient to generate graduation rates that can be compared between the two sets. In order to address this problem, all analysis performed excludes the change in graduation rates 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 do 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 by each school district (GEDs, diplomas, or other options).

I hope to mitigate concerns with this data, as my analysis does not attempt to compare any absolute graduation rates with one another. 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.

4.2 Policy Indicator

The policy variable is generated from research on each state's legislative history.³ Policy takes on one of two values for each district and school year combination: state-mandated prohibited or restricted use of seniority in determining layoff orders (indicator equals 1), or otherwise (indicator equals 0). The parameter on the policy variable therefore measures the impact of state legislation that prohibits or restricts the consideration of seniority for school district layoffs.

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

³The 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.

may vary from 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) found 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 as a whole may or may not adopt strong seniority considerations when given the discretion.

Texas and Missouri are the only states observed to have the policy of limiting seniority for the entire time period covered in the data set. Texas in particular represents nearly ten percent of the observations in this compiled data set of public school districts. In the latter years of the data set, it also displays hardly any increase in graduation rates (see Fig. 3). Its average graduation rate is already over 90% by 2011-12, so additional yearly increases would be more difficult to achieve. Since including Texas would drive and bias the regression, I omit it in all analyses unless otherwise specified.

4.3 Control Variables

Figures for each district's total expenditure and total revenue, number of students receiving special education services, number of English language learners, urbanicity indicator, student membership, and graduating cohort size are all obtained from the U.S. National Center from Education Statistics (NCES). The percentage of children in poverty per school district boundary is from the U.S. Census Bureau's Small Area Income and Poverty Estimates. State groupings by region are aligned with the U.S. Census Bureau's definition.

4.4 Descriptive Statistics

Presented in Table 1 are descriptive statistics for graduation rates and the policy indicator variable, organized by state.

	Seniority not restricted (Policy==0)		Seni	Seniority restricted (Policy==1)			
		Graduat	ion Rate		Graduation Ra		
State	N	Mean	SD	N	Mean	SD	
Alabama	805	75.8	11.8				
Alaska	36	70.1	12.9				
Arizona	112	74.6	12.1	197	81.1	9.0	
Arkansas	450	79.8	9.9				
California	1000	88.0	9.9				
Colorado	107	73.7	14.0	22	75.1	12.8	
Connecticut	651	86.9	11.4				
Delaware	151	78.9	13.2				
DC							
Florida	60	66.2	82	45	72.3	96	
Georgia	567	66.8	10.0	292	81.1	9.0	
Hawaii	507	00.0	10.0	272	01.1	2.0	
Idaho	127	80.5	97	40	82.0	57	
Illinoic	550	85.6	10.4	620	87.1	7.6	
Indiana	201	79.6	10.4	405	80.7	6.5	
Inuiana	501	/0.0	10.5	495	09.7	0.5	
Iowa	242	89.3 04.6	0.1				
Kansas	342	84.6	9.1				
Kentucky	/55	82.5	9.3	1.5.4		6.0	
Louisiana	262	67.5	9.8	156	81.5	6.8	
Maine	76	81.2	6.8	60	84.7	6.7	
Maryland	136	87.4	6.6				
Massachusetts	1137	85.1	11.0				
Michigan	1415	81.3	12.9	905	80.4	14.2	
Minnesota	927	85.5	10.0				
Mississippi	718	67.9	11.7				
Missouri				1008	86.3	9.7	
Montana	54	85.1	3.9				
Nebraska	218	87.4	8.6				
Nevada	5	58.7	13.4	25	72.8	7.2	
New Hampshire							
New Jersey	1786	89.9	9.7				
New Mexico	140	71.2	9.4				
New York	2313	85.6	11.4				
North Carolina	887	78.2	8.6				
North Dakota	87	84.7	8.4				
Ohio	1704	84.9	11.1	876	89.8	8.0	
Oklahoma	381	80.5	9.2	131	83.8	7 2	
Oregon	192	76.1	9.4	151	05.0	7.2	
Pennsylvania	2648	87.9	9.0				
Rhode Island	2040	79.9	11.2	105	82.8	97	
South Carolina	304	74.8	11.2	105	02.0)./	
South Dakata	102	92 2	12.6				
Tonnoccoo	206	02.5 70.4	0.2	257	01.0	12	
Tennessee	390	/9.4	9.2	337	91.0	4.2	
Texas	127	70.1	0.4	120	04.4	7.1	
Utan	127	/9.1	9.4	128	84.4	/.1	
Vermont							
Virginia	590	77.4	9.3	222	84.9	5.8	
Washington	913	77.3	10.2	90	82.6	6.9	
West Virginia	364	81.7	6.9				
Wisconsin	316	94.0	6.1	203	94.0	3.9	
Wyoming	100	79.7	8.0				
	25478	79.9	9.9	5986	83.4	7.9	

Table 1: Descriptive statistics of graduation rates, by state and policy.

Notes: States with policies restricting the use of seniority in teacher layoffs a particular year are listed as "seniority restricted." School years included are 2006-07 through 2015-16. NCES does not provide graduation data under review or for very small districts. District-level graduating cohort sizes of less than 100 are omitted, as are districts where the standard deviation of graduation rate changes exceeds 30. Also, I excluded any districts that indicated charter schools were included, since not all are required to follow these state mandates on traditional public schools. Texas data is also omitted (see section 4.2 for explanation).

Table 2: Number of observations per year.							
School Year Comparison	No. of Observations						
	(Year Over Year)	(School Districts)					
2006-07 to 2007-08	0.41	4,538					
2007-08 to 2008-09	0.52	4,441					
2008-09 to 2009-10	1.22	4,372					
2009-10 to 2010-11	-	0					
2010-11 to 2011-12	1.14	2,605					
2011-12 to 2012-13	1.15	2,655					
2012-13 to 2013-14	0.90	2,604					
2013-14 to 2014-15	0.92	2,555					
2014-15 to 2015-16	0.62	2,470					
Total		26,240					

The number of observations per school year is shown in Table 2.

Notes: The significant decline in observations between 2009-10 and 2010-11 coincides with the change in graduation rate calculation methodology. The decline is likely due to increased privacy restrictions, whereby data for smaller schools is omitted from the latter sets.

Fig. 3(b) illustrates parallel trends prior to policy implementation. Fig. 3(a) shows that Texas, already with high rates in latter years, grows little and could easily bias the regression downward if included. Fig. 3(c) shows that, compared to states with no seniority restrictions, most groups of states implementing restrictions experienced gains in graduation rates. Since the graduation rate calculation changes between 2009-10 and 2010-11, trend lines in this time segment are omitted.



Fig. 3. Average graduation rate per group of states

Notes: Graduation rates are obtained from the U.S. National Center from Education Statistics. The formula for calculating graduation rates was adjust between 2009-10 and 2010-11, so comparisons in the changes in rates should not be made between those two years. Fig. 3(a) shows trendlines for the group with no statewide seniority restrictions on layoff decisions, along with the two states with state-mandated seniority restrictions during the entire time period under consideration. Fig. 3(b) shows trendlines for states enacting seniority restrictions in layoff decisions, only for the years prior to implementation. Fig. 3(c) shows trendlines for states enacting seniority restrictions in layoff decisions, beginning with the last year prior to implementation.

5. Results

First, I present results for 2006-07 to 2015-16, which do not account for district financial health. Information on district-level finances at the time of writing is only available through 2013-14; Table 4 presents results on the shorter 8-year timeframe to include the financial surplus per 1,000 students. To account for heteroskedasticity, I cluster standard errors by school district. District-level graduating cohort sizes of less than 100 are omitted, as are districts where the standard deviation of graduation rate changes exceeds 30.⁴ Observations from Texas are omitted from all models in this section.

Table 9: Coefficient Estimates	ior oradi		changeb,	2000 01 00	2010 10
	(1)	(2)	(3)	(4)	(5)
Policy	0.0905	0.236^{***}	0.234^{***}	0.173^{**}	0.165^{**}
	(0.0511)	(0.0605)	(0.0604)	(0.0635)	(0.0633)
				0.100*	
% Special Education				-2.102^{*}	-2.197^{*}
				(0.928)	(0.928)
07 FT I				1 779**	1 406*
70 ELL				1.110	1.400
				(0.579)	(0.594)
% Poverty				3.060***	3.174^{***}
J J J				(0.418)	(0.420)
				· · ·	, , , , , , , , , , , , , , , , , , ,
Constant	0.809^{***}	0.850^{***}	0.619^{**}	0.437	0.210
	(0.0294)	(0.187)	(0.223)	(0.227)	(0.262)
U.h	N.	V	V	V	V
Urbanicity Dummies	NO	res	res	res	res
Region Dummies	No	Yes	Yes	Yes	Yes
0					
Membership/Cohort Controls	No	No	Yes	No	Yes
N	26240	26240	26191	24578	24578

Table 3: Coefficient Estimates for Graduation Rate Changes, 2006-07 to 2015-16

Standard errors in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

Notes: Policy is a variable that indicates whether a state has legislation prohibiting or restricting the influence of seniority on teacher layoff order in effect in a given school year. I constructed this variable using legislation information from each state. Linear and quadratic terms are included for both student membership and graduating cohort size. Standard errors are clustered by district. District-level graduating cohort sizes of less than 100 are omitted, as are districts where the standard deviation of graduation rate changes exceeds 30. Texas is excluded (see section 6.2). The percentage of children in poverty per school district boundary is from the U.S. Census Bureau's Small Area Income and Poverty Estimates. State groupings by region are aligned with the U.S. Census Bureau's definition. All other figures are obtained from the U.S. National Center from Education Statistics.

Now, I include financial information, which then constricts the years under consideration to

 $^{^{4}}$ In districts with small cohorts, the graduation status of a single student can cause significant fluctuations in the overall graduation rate. Districts with standard deviations greater than 30 appeared to clearly contain an error.

2006-07 to 2013-14. Models (1)-(5) below correspond to those in Table 3 but are truncated to this 8-year window for comparison to model (6), which adds fiscal surplus per 1,000 students.

				0 /		
	(1)	(2)	(3)	(4)	(5)	(6)
Policy	0.128	0.299***	0.300***	0.237^{**}	0.228^{**}	0.225^{**}
	(0.0670)	(0.0772)	(0.0770)	(0.0828)	(0.0826)	(0.0827)
~~~						
% Special Education				-1.781	-1.862	-1.880
				(1.090)	(1.091)	(1.092)
07 ET I				1 690*	1 919	1 909
70 ELL				1.080	1.212	1.202
				(0.765)	(0.784)	(0.783)
% Poverty				2.488***	$2.675^{***}$	2.684***
,				(0.511)	(0.515)	(0.516)
				(0.0)	(0.010)	(0.010)
Surplus per 1,000 Students						0.0103
						(0.0238)
						. ,
Constant	$0.821^{***}$	$1.053^{***}$	$0.784^{**}$	$0.726^{*}$	0.450	0.452
	(0.0334)	(0.227)	(0.280)	(0.289)	(0.339)	(0.339)
Urbanicity Dummies	No	Yes	Yes	Yes	Yes	Yes
Domian Dumming	No	$\mathbf{V}_{\mathbf{c}\mathbf{c}}$	$\mathbf{V}_{\mathbf{c}\mathbf{c}}$	$\mathbf{V}_{\mathbf{c}\mathbf{c}}$	$\mathbf{V}_{\mathbf{c}\mathbf{c}}$	$\mathbf{V}_{27}$
Region Dummes	INO	res	res	res	res	res
Membership/Cohort Controls	No	No	Yes	No	Yes	Yes
N	21215	21215	21205	19679	19679	19676

Table 4: Coefficient Estimates for Graduation Rate Changes, 2006-07 to 2013-14

Standard errors in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

Notes: Policy is a variable that indicates whether a state has legislation prohibiting or restricting the influence of seniority on teacher layoff order in effect in a given school year. I constructed this variable using legislation information from each state. Linear and quadratic terms are included for both student membership and graduating cohort size. Standard errors are clustered by district. District-level graduating cohort sizes of less than 100 are omitted, as are districts where the standard deviation of graduation rate changes exceeds 30. Texas is excluded (see section 6.2). Surplus per 1,000 students is a fiscal measurement of district financial health, adjusted to real 2018 dollars using the Consumer Price Index from the U.S. Bureau of Labor Statistics. The percentage of children in poverty per school district boundary is from the U.S. Census Bureau's Small Area Income and Poverty Estimates. State groupings by region are aligned with the U.S. Census Bureau's definition. All other figures are obtained from the U.S. National Center from Education Statistics. 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 0.2 percentage points. After urbanicity and region indicators are included, this result is very consistent across covariate specification. It varies by no more than 0.075 percentage points within either the 8-year or the 10-year window. (Results range from 0.165 to 0.236 under the 10-year window, and results range from 0.225 to 0.3 under the shorter 8-year period—as long as urbanicity and region indicators are included.) Estimates of the policy indicator are statistically significant at less than the 0.01 level.

It is 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. If the yearly growth of overall U.S. graduation rates were 0.2 percentage points higher, it would have resulted in an additional 115,808 graduates between 2011-12 and 2015-16. Lastly, the estimate of 0.2 is within range of what Bekkerman and Gilpin (2011) find from a \$1,000 investment in either 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.

In Table 3, which includes two more recent years of data, the effect of policy is consistently lower than in Table 4. This is reasonable, as graduation rates cannot increase indefinitely; there is a maximum value. One would also expect that, at higher graduation rates, it becomes more difficult to keep the same pace of gains in the yearly increase of graduation rates. Therefore, the effect of prohibiting or restricting seniority as a factor in teacher layoffs would be expected to decline over longer periods of time when the graduation rate is approaching higher levels.

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 likely also have higher rates of poverty. It is possible that students with higher academic ability in areas with lower poverty have a greater selection of alternatives to public school districts (such as charter schools or private schools) 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.

## 6. Robustness Checks

#### 6.1 Linearity of the Impact of Policy

As a check for functional form, a plot of residuals on policy would not be informative since policy is a binary variable. However, the plot of residuals on fitted values in Fig. 4 and Fig. 5 do not show evidence against the linear form used for the policy variable; the range of residual values are relatively consistent over the fitted values.



Fig. 4. Residuals of on fitted values, using Model 5 of Table 3 (2006-07 to 2015-16).



Fig. 5. Residuals on fitted values, using Model 6 of Table 4 (2006-07 to 2013-14).

#### 6.2 Results Including Texas

As discussed under the Data section, Texas is omitted from all prior models. It is the only state that has the policy limiting seniority for the entire time period covered and represents nearly ten percent of the observations in this compiled data set of public school districts. The average graduation rate in Texas is over 90% by 2011-12, so additional yearly increases would be more difficult to achieve. The data does show that the yearly gains in Texas' average graduation rates are smaller in the latter years. Therefore, including Texas would drive and bias the effect of the policy variable downward. Below are two regressions that include Texas. Model (1) below uses the same control set and years as Table 3, model (5). Model (2) below uses the same control set and years as Table 4, model (6).

		0,0
	(1)	(2)
	2006-07 to $2015-16$	2006-07 to $2013-14$
Policy	0.0144	0.0531
	(0.0588)	(0.0741)
% Special Education	-1.440	-1.441
	(0.901)	(1.064)
$\% \ \mathrm{ELL}$	$0.968^{*}$	1.238
	(0.492)	(0.642)
% Poverty	3.696***	3.372***
	(0.385)	(0.471)
Surplus per 1,000 Students		0.0167
		(0.0216)
Constant	-0.0435	0.151
	(0.224)	(0.290)
Urbanicity Dummies	Yes	Yes
Region Dummies	Yes	Yes
Membership/Cohort Controls	Yes	Yes
Ν	26923	21563

Table 5:	Coefficient	Estimates	for	Graduation	Rate	Changes,	Including	Texas
						<b>()</b> ()	()	

Standard errors in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

Notes: Policy is a variable that indicates whether a state has legislation prohibiting or restricting the influence of seniority on teacher layoff order in effect in a given school year. I constructed this variable using legislation information from each state. Linear and quadratic terms are included for both student membership and graduating cohort size. Standard errors are clustered by district. District-level graduating cohort sizes of less than 100 are omitted, as are districts where the standard deviation of graduation rate changes exceeds 30. Surplus per 1,000 students is a fiscal measurement of district financial health, adjusted to real 2018 dollars using the Consumer Price Index from the U.S. Bureau of Labor Statistics. Figures for total expenditure and total revenue, the number of students receiving special education services, the number of English language learners, the urbanicity indicator, student membership, graduating cohort size, and graduation rates are are all obtained from the U.S. National Center from Education Statistics. The percentage of children in poverty per school district boundary is from the U.S. Census Bureau's Small Area Income and Poverty Estimates. State groupings by region are aligned with the U.S. Census Bureau's definition.

#### 6.3 Addressing the Standard Deviation of Changes in Graduation Rates

After calculating the yearly change in graduation rates per school district, I noticed a few that were larger than 90 percentage points. Especially where the district does not have a small cohort size, this is a highly suspect change. In such cases, there appears to be a data entry error. For example, a district reports over 90% graduation rate in all ten years except one, where it reports 0.9%. This clearly is an error and so I do not want to include such data in the regressions. In order to address this problem, I calculate the standard deviation in district graduation rate changes and exclude any districts that did not have a standard deviation less than 30. At this threshold, fluctuations in the graduation rate were not as extreme and appeared to be reasonable. This determination, however, does not have a large quantitative bearing on the regression results. Below in Table 6, model 3 is a repeat of Table 3, model 5. Then the other models below vary only in the standard deviation cutoff.

Table 6: Coefficient Estimates for Graduation Rate Changes, 2006-07 to 2015-16

	(1)	(2)	(3)	(4)
	Any SD	SD < 40	SD < 30	SD < 20
Policy	$0.204^{*}$	$0.173^{**}$	$0.165^{**}$	$0.162^{**}$
	(0.0808)	(0.0646)	(0.0633)	(0.0625)
N	24818	24675	24578	24475

Standard errors in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

Notes: Model 3 is a reproduction of model 5 from Table 3. Other models here only adjust the threshold for standard deviation in district graduation rate changes. See Table 3 for additional notes.

## 7. Conclusion

Many states, under various political party compositions, 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. After urbanicity and region indicators are included, this result is very consistent across covariate specification. When I utilize all ten years of data, I find that this policy on average increases the yearly growth of the graduation rate by 0.165 to 0.236 percentage points, all else held equal. Adding district-level fiscal surplus to the model (thereby restricting the dataset to the eight-year period through 2013-14 only), the average increase in the yearly growth of the graduation rate is higher (0.225 to 0.3). This is consistent with the presumption that, at higher graduation rates, additional increases are more difficult to achieve. Especially as graduation rates approach and exceed 90%, I would expect the annual increases to dampen over time.

These estimates overlap with the range of what Bekkerman and Gilpin (2011) find from a \$1,000 investment in either improving teacher quality via offering higher wages (0.2 to 1.1 percentage point increase in the graduation rate). These estimates 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 0.2 percentage points higher, it would have resulted in an additional 115,808 graduates between 2011-12 and 2015-16. All estimates of the policy indicator variable are also statistically significant at less than the 0.01 level.

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 responds differently to how a state or district determines layoff orders. 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.

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.

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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