The effect of school closings on teacher labor market outcomes and teacher effctiveness

Andrew J. Hill, Daniel B. Jones

[The effect of school closings on teacher labor market outcomes and teacher effectiveness. Education Finance and Policy p1-55 (2020)]2020Education Finance and Policy10.1162/edfp_a_00317

THE EFFECT OF SCHOOL CLOSINGS ON TEACHER LABOR MARKET OUTCOMES AND TEACHER EFFECTIVENESS

Andrew J. Hill
(corresponding author)
Department of Agricultural Economics and Economics
Montana State University
Bozeman, MT 59717
andrew.hill6@montana.edu

Daniel B. Jones
Graduate School of Public and International Affairs
University of Pittsburgh
Pittsburgh, PA 15213
daniel.jones@pitt.edu

Abstract

School closings displace thousands of teachers in the United States every year. This paper explores how elementary school teachers in North Carolina respond to this labor market shock. After documenting in our study that declining enrollment is a key driver of school closings, we find that whereas most displaced teachers move to new schools in the same district, a considerable number leave public education altogether. We find that the increase in the propensity to leave teaching is largest for experienced teachers. It is also marginally larger for the highest and lowest value-added teachers compared with teachers in the middle of the value-added distribution, and, strikingly, twice as large for black teachers than white teachers even from the same closing school. Moving schools after a school closing has no impact on teacher effectiveness as measured by value added. Although the primary goal of school closings is typically to move students out of declining or failing schools, school closings also affect the overall distributions of important teacher characteristics, such as experience, race, and effectiveness in raising test scores.

https://doi.org/10.1162/edfp_a_00317

1. INTRODUCTION

There have been widespread school closings in the United States in the past two decades. According to the National Center for Education Statistics, 1,737 schools closed in the 2013–14 academic year, displacing close to 300,000 students and about 17,000 teachers. This represents a large shift in a key educational input for the displaced students, as well as a sizeable labor market shock for the displaced teachers. Two factors tend to cause public school closings in the United States: declines in enrollment and failure to meet accountability standards. The declines in enrollment arise from both local demographic shifts (such as out-migration from areas with few economic opportunities) and increases in alternative schooling options (like private schools), while school accountability policies such as the No Child Left Behind Act (NCLB) required schools to be evaluated on a set of performance metrics and introduced the threat of school closure for schools with sufficiently poor performance.

School closings are controversial, and often pit local education authorities against students, parents, and teachers.[1] Although much of the public debate and media attention surrounding school closings has centered on the potential effects on displaced students, the potential impacts on displaced teachers have not passed by unnoticed. In 2015, for example, the Chicago Teachers Union filed a class action lawsuit against the Board of Education of the City of Chicago to contest school closings, arguing that they disproportionately resulted in the firing of black teachers.[2] In 2017, the Detroit Federation of Teachers came out against school closings in Michigan.[3] Although there is recent evidence that school closings benefit students displaced from low-performing schools (Brummet 2014), little is known about the effects on displaced teachers. Our paper aims to address this gap with an analysis of teacher administrative data from elementary schools in North Carolina over the period 2002 to 2013.

We find that almost all teacher displacement occurs when the school closes rather than in the years leading up to the closing. The most common response to school closings for teachers in our sample is moving to a new school in the same district, which occurs for the majority of teachers. In addition, they are about twice as likely to leave teaching as in other years, while there is no effect on their likelihood of moving to a new school in a new district.

There are important differences in these outcomes by teacher value added, experience, and race. The increase in the likelihood of leaving teaching is marginally higher for teachers whose value-added measures (VAMs) are in the top and bottom quartiles of the value-added distribution (in comparison to medium-VAM teachers). More strikingly, the impact on leaving teaching is concentrated among experienced teachers. Although part of this may be teachers retiring early, moderately experienced teachers who are not close to retirement are also more likely to leave teaching, potentially leading to costly losses in mentoring and institutional knowledge. Given the improved student outcomes associated with higher value added and more experienced teachers, these changes in the distribution of overall teacher effectiveness may have implications for student achievement. At the same time, given that salary schedules in North Carolina

1. See, for example, https://www.nytimes.com/2018/02/12/opinion/save-chicago-public-schools.html/.
2. See https://www.courthousenews.com/teachers-union-calls-school-closings-racist/.
3. See www.detroitnews.com/story/news/local/michigan/2017/01/23/detroit-schools/96971270/.

dictate that teachers with many years of experience be paid considerably more than the typical teacher, these early retirements may generate cost-savings for the state, which could be used to offset the potential negative effects on students.

We also find that black teachers displaced by a school closing are more likely to leave teaching and less likely to move to a new school in the same district than white teachers displaced from the same closing school. Furthermore, schools with more black teachers are more likely to close in the first place. This means that school closings exacerbate the underrepresentation of black teachers in the teacher labor market, which will have implications for the black–white achievement gap given the evidence that race congruence improves student outcomes (e.g., Dee 2005, among many others). Although we cannot disentangle the extent to which the heterogeneity by race in teacher labor market outcomes after school closings is driven by labor demand or labor supply, we do find the likelihood of leaving teaching for displaced black teachers increases with the share of white students in the district, while the impacts on displaced white teachers do not depend on the race composition of the district.

There is no evidence that school closings affect the productivity of displaced teachers as measured by value added, however, we do observe that teachers who move for any reason typically experience an increase in their effectiveness.

2. RELATED LITERATURE

The school closings literature up to this point has largely focused on students. In a study that draws on similar methods to our own, Brummet (2014) finds that school closings in Michigan did not have adverse effects on the achievement of displaced students and, when focusing on students from low-performing schools, observes evidence of test score gains. He also finds that the students displaced from low-performing schools generate small negative spillovers on the students at the incoming schools. In earlier work, Sacerdote (2012) documents temporary declines in student achievement from school closings due to Hurricane Katrina[4] (which become long-run gains in some cases), while Engberg et al. (2012) argue that students are negatively affected by school closings. Brummet (2014) suggests that these prior studies may be less externally valid in comparison to his statewide analysis as they rely on somewhat localized school closings caused by unique shocks. In a more recent study, Carlson and Lavertu (2016) take advantage of a performance threshold rule for charter schools and use a regression discontinuity approach to generate an alternative source of exogenous variation in school closure. They find that student achievement increases after students leave an underperforming closed school.

De la Torre and Gwynne (2009), Larsen (2020), and Kemple (2015) all examine school closures within particular cities (Chicago, Milwaukee, and New York, respectively); results are mixed.[5] School closures in Chicago had no negative effect on students after closure but did negatively impact students leading up to closure (De la Torre and Gwynne 2009). In Milwaukee, Larsen (2020) finds that high school closures have a

4. Hurricane Katrina was a devastating category 5 storm that hit New Orleans in August 2005.
5. Relatedly, Abdulkadiroğlu et al. (2016) study the impacts of public schools being taken over by charter schools in New Orleans and Boston. Students previously enrolled in the taken-over public schools are "grandfathered" into the newly formed charter schools. The achievements of these students increase relative to students at similar public schools that did not convert.

negative impact on students that dissipates over time. Finally, Kemple (2015) finds that closures of schools in New York City had a positive impact on affected students. Bross, Harris, and Liu (2016) synthesize findings from studies like these and others by noting that the impact of school closures depends on the quality of schools available to students after closures.

Lincove, Barrett, and Strunk (2017) look at what happens to teachers in New Orleans after Hurricane Katrina. This large and unique shock resulted in the firing of all teachers in the Orleans Parish School Board as the city transitioned to a more choice-based schooling system in the aftermath of the hurricane. Although half of the displaced teachers were subsequently employed within the public education sector in Louisiana, they found that these teachers went on to leave teaching at higher rates than other New Orleans teachers. The school closings we study are driven by very different factors, but we also find that the majority of teachers displaced by school closings stay in public education.

Turning to the teacher labor market more generally, there has been considerable research devoted to understanding why teachers become teachers and why teachers stay teachers (Ballou and Podgursky 1998; Boyd et al. 2008; Springer, Swain, and Rodriguez 2016). Hanushek, Kain, and Rivkin (2004) and Boyd et al. (2005) find that working conditions affect the probabilities with which teachers move to new schools or leave teaching. This is broadly consistent with a finding in our paper that teachers displaced from lower-performing closing schools are marginally more likely to leave teaching than those displaced from higher-performing closing schools (in which teachers likely experienced better working conditions).

3. EMPIRICAL METHODOLOGY

Teachers are forced to choose between moving to a new school or leaving teaching when their school closes. Although this is their decision, it is likely influenced to varying degrees by the actions and policies of their school districts. They may also respond to the threat of their school closing in the future. This means the composition of teachers in a school the year it closes may not provide a good counterfactual for what the teacher composition would have been if the school were not to close that year. We therefore estimate linear probability models that include either a single treatment indicator for the year of closing or, to allow for the possibility of anticipatory effects, a vector of treatment indicators for multiple years leading up to the school closing. Our aim in the second model is to include enough years before the school closes so that any potential effects on teacher labor market outcomes or teacher effectiveness related to the impending closing are captured.[6]

$$Y_{is,t+1} = \sum_{k}^{\circ} \delta_k Treat_{istk} + \alpha_s + \beta_t + \sum_{mt} \gamma_{mt} X_{m,2002} + \epsilon_{ist}. \quad (1)$$

Consider teacher i who taught at school s in period t. In our main specifications, we are interested in what happens to a teacher after the school he or she is teaching at

6. This has parallels with several papers in the general job displacement literature. Schwerdt (2011), for example, shows that separations up to two quarters before plant closure should be included in the treatment group in his analysis of the effects of job displacement.

closes. Our dependent variable is $Y_{is,t+1}$, the teacher's labor market outcome in year $t+1$. $Treat_{istk}$ is an indicator that is 1 if teacher i taught in school s in period t, and school s will close in $|k|$ years, which follows the notation of Brummet (2014). We set k to 0 in the first model (a single treatment indicator for the year of the school closing), with prior years as the omitted category. In the second model, we allow treatment effects from three years before a school closes, so k takes on values from 3, three years before the school closing, to 0, the year of the school closing. In the second model, years earlier than three years prior to closing are included as the omitted category. The decision to consider only three pretreatment years is somewhat arbitrary, but we will ultimately show that almost all of the effects occur in the year of the closing rather than in earlier years.

We partition teacher labor market behavior in year $t+1$ into four outcomes. A teacher either: (1) stays teaching at the same school, (2) leaves teaching, (3) moves to a new school in the same district, or (4) moves to a new school in a new district. We allow for one-year breaks from teaching, so if a teacher takes a break for a year and returns to teaching at the same school the subsequent year, this will be classified as staying at the same school. If she leaves for two years, this will be classified as leaving teaching. Our empirical analysis describes the effect of school closings on the probabilities of experiencing each of these labor market outcomes. We use school fixed effects and a vector of explanatory variables to control for confounding factors that may be correlated with both the likelihood of being "treated"—teaching at a school either the year it closes or in the three years leading up to its closing—and the respective outcome.[7]

School fixed effects α_s control for constant school-specific factors affecting both teachers' future labor market outcomes and the probability of school closings. For example, schools in rural areas may both struggle to retain teachers (in comparison to schools in populated areas) and be more prone to experiencing the declining enrollment that often precipitates school closings. Schools in less desirable locations or in poorer areas may also employ teachers with fewer outside options, and these teachers may have different underlying propensities to choose or experience the above labor market outcomes. For example, they may be more likely to quit teaching. These types of level differences across schools are captured by the school fixed effects.

In addition to the school fixed effects, year fixed effects β_t capture year-specific statewide factors that may affect teacher labor market outcomes and school closings, such as policy changes or economic shocks. For example, economic upturns may improve outside job opportunities for teachers, increasing the likelihood of teachers leaving education. In addition, parents may use the additional income obtained during economic upturns to enroll their children in private rather than public schools, resulting in the reduced public school enrollment that increases the probability of public school closings.

Finally, we include a vector of baseline school characteristics $X_{m,2002}$ interacted with year fixed effects. This term captures any differences across schools in their propensity to close that could be predicted by the school's underlying characteristics. We show

7. Note that the model is very similar to that of Brummet (2014). As in his study, we do not have a driver of school closings that is orthogonal to each school's context but rely on the vector of treatment leads to obtain a full description of effects along with the school fixed effects.

in table A.4 that results are very similar without this set of controls but include them in the main specification to capture as many differences as possible between treated and untreated schools. (All appendix tables are available in an online appendix that may be accessed on *Education Finance and Policy*'s Web site at https://doi.org/10.1162/edfp_a_00317.)

In sum, we estimate the treatment effect(s) δ_k of school closings using within-school variation in teacher labor market outcomes from the subset of schools that either close or share similar observable characteristics to schools that close.[8]

4. DATA AND DESCRIPTIVE STATISTICS

We use data on elementary school teachers in North Carolina. These data are from the North Carolina Education Research Data Center (NCERDC). Our sample period begins in 2002, the year NCLB was implemented, and runs to 2013. NCLB required schools to be evaluated on a set of performance metrics and introduced the threat of school closure for schools with sufficiently poor performance. We limit our attention to third through fifth grade mathematics and English Language Arts teachers because the students of these teachers are typically with the same teacher for the entire school day and therefore are more reliably matched to their actual classroom teachers in our data than students in higher grades. Additionally, students in these subjects take standardized end-of-grade tests that allow us to construct the teacher VAMs we use to assess teacher effectiveness.

A school is considered to have closed if the following two conditions are satisfied. First, the school is no longer present in the NCERDC database and, second, we find a news article or other online evidence confirming that the school has closed. We use the latter condition because there were a very small number of cases in which online searches revealed that schools no longer in the database still seemed to be operating. We further verified school closings by consulting the National Center for Education Statistics' Common Core of Data.

Some school closings may be school consolidations. School consolidations involve combining two or more schools, often with the goal of reducing costs through economies of scale, and may have their own unique effects on students and teachers (see, for example, Beuchert et al. 2018). Although we do not have formal school consolidation identifiers in our data, they appear to be a small fraction of the school closings we investigate; only 10 percent of school closings in our data involve at least two thirds of the displaced teachers going to the same school, which we consider a generous criterion for identifying school consolidations.[9]

We describe public elementary schools in North Carolina in table 1.[10] We partition the school-by-year level data into observations from (1) schools that remain open throughout the study period ("never treated schools"), (2) schools that were open in 2012

8. We report a variety of robustness and sensitivity results in the appendix. In online table A.4, we show the main results are robust to the exclusion of the baseline school characteristics interacted with year fixed effects, the exclusion of school fixed effects, the inclusion of teacher fixed effects, and the inclusion of more flexible district-by-year fixed effects that capture localized year-specific shocks.
9. Nonetheless, in online table A.4, we report the main results excluding these potentially consolidated schools from the treatment group, showing a similar pattern of effects to what we report in the main text of the paper.
10. Note that charter schools are included in the data. Only six elementary school teachers are displaced from closing charter schools during our entire study period, so the estimated effects on teacher labor market outcomes would not be affected if they were excluded from the analysis.

Table 1. Descriptive Statistics: Schools

	Never Treated Schools (all years) (1)	Never Treated Schools (snapshot, 2012) (2)	Ever Treated Schools (all years) (3)	Treated Schools (year of closing) (4)
Composition				
School enrollment	513 (202)	521 (199)	265 (135)	243 (142)
Share of students: white	0.54 (0.28)	0.51 (0.28)	0.37 (0.33)	0.37 (0.33)
Share of students: black	0.30 (0.25)	0.26 (0.23)	0.54 (0.34)	0.53 (0.37)
Share of students: economically disadvantaged	0.54 (0.24)	0.60 (0.22)	0.73 (0.24)	0.76 (0.18)
Number of full-time teachers	35 (12)	34 (12)	21 (10)	20 (9)
Student-teacher ratio	14.83 (3.38)	15.32 (2.17)	12.96 (3.85)	12.08 (3.69)
Urban	0.25 (0.43)	0.25 (0.43)	0.30 (0.46)	0.29 (0.46)
Rural	0.46 (0.50)	0.49 (0.50)	0.43 (0.50)	0.45 (0.50)
Performance				
Share of students at grade level	0.77 (0.13)	0.76 (0.11)	0.72 (0.14)	0.66 (0.16)
AYP not met: yearly indicator	0.39 (0.49)	0.51 (0.50)	0.37 (0.48)	0.46 (0.50)
AYP not met: number of sequential years	0.66 (1.19)	1.29 (1.58)	0.69 (1.14)	1.00 (1.47)
AYP: indicator for students eligible for school choice	0.16 (0.37)	0.42 (0.49)	0.17 (0.38)	0.23 (0.42)
Number of unique schools	1,556	1,290	66	66
Number of school-year observations	15,802	1,290	377	66

AYP = Adequate Yearly Progress.

(the penultimate year in our sample period) and remained open the following year (a snapshot of "never treated schools"), (3) schools that close ("ever treated schools"), and (4) schools in their final year before closing ("treated schools"). The first set of variables describes the composition of these schools, and the second set of variables describes their performance. Columns 1 and 3 provide a comparison reflecting all school-years, while columns 2 and 4 provide a comparison that involves no double counting of schools. There are 66 elementary schools that close during our study period.[11]

Schools that close have lower student enrollment, smaller shares of white students, larger shares of black students, larger shares of economically disadvantaged students,[12] fewer teachers, and lower student–teacher ratios than schools that remain open. This is consistent with some of the differences in characteristics observed by Brummet (2014)

11. North Carolina was a growing state during our study period—the growth of the school-aged population (individuals under age 18 years) was 16.2 percent between 2000 and 2010—and there were 302 elementary school openings offsetting the 66 school closings. School openings were often not in the same districts as school closings, and were also not similarly timed, pointing to population growth being uneven across the state.
12. Economically disadvantaged students are defined as students eligible for free or reduced-price lunch.

Table 2. Descriptive Statistics: Teachers

	Never Treated Teachers (all years) (1)	Never Treated Teachers (snapshot, 2012) (2)	Ever Treated Teachers (all years) (3)	Treated Teachers (year of closing) (4)
Teacher characteristics				
Value-added measures				
High (top quartile)	0.25	0.25	0.24	0.25
Medium	0.48	0.48	0.51	0.43
Low (bottom quartile)	0.28	0.28	0.25	0.31
Experience				
Very high (25 years or more)	0.13	0.08	0.16	0.14
High (10 to 24 years)	0.36	0.40	0.38	0.31
Medium (5 to 9 years)	0.23	0.26	0.20	0.18
Low (4 years or less)	0.28	0.25	0.25	0.37
Race				
Black	0.12	0.11	0.27	0.28
Teacher labor market outcomes the following year				
Same school	0.77	0.79	0.69	0
Leaves teaching	0.14	0.08	0.08	0.23
New school in same district	0.06	0.06	0.18	0.73
New school in new district	0.04	0.07	0.04	0.04
Number of unique teachers	50,402	13,327	423	423
Number of teacher-year observations	155,874	13,327	2,004	423

between schools that close and those that remain open in Michigan. In sum, school closings disproportionately affect minority and low-income students.

The second panel of table 1 reveals, on average, schools that close perform worse than schools that do not. This is evident both from the share of students at grade level and several Adequate Yearly Progress (AYP) measures that form part of the NCLB school assessments. The first AYP measure is a binary indicator for whether the school made adequate progress that year as defined by federal regulations. The second is a count variable that describes the number of sequential years the school has not made adequate progress, which is one of the determinants of the third AYP measure: an indicator for whether students at the school are eligible to choose another school because of consistently poor performance by their current school, one of the harshest sanctions imposed by NCLB before school closure.

Taken as a whole, table 1 reveals persistent differences between the schools in the treatment and control groups. This emphasizes the importance of including school fixed effects in the regression analysis to account for level differences between schools.

We now turn from describing schools to teachers, the focus of this paper. Partitioning observations into the same four categories as table 1, table 2 describes the teacher-by-year level data used in the main regression analysis. The treatment group includes 468 unique third through fifth grade teachers who teach at one of sixty-six elementary schools that close during our study period.

Our primary measure of teacher effectiveness is teacher value added, noting that it does not capture all dimensions of teacher quality. Time-constant teacher VAMs are

constructed in a standard way by aggregating teacher-specific residuals from a regression of student test scores on lagged student test scores, and an additional vector of individual and peer controls. Our procedure for doing so is fully described in Hill and Jones (2020). We categorize teachers as "high VAM" if they are in the top quartile of teachers, "low VAM" if they are in the bottom quartile, and "medium VAM" otherwise. Medium-VAM teachers constitute a large group, and given inherent noisiness in the estimation of VAMs, it is expected that this group includes more miscategorized teachers. Teachers are also categorized into four categories by their years of experience. Note that shares do not sum exactly to one in each column, given that the table describes teacher-by-year level data rather than teacher level data.

The top panel of table 2 reveals that there is no consistent pattern of differences in the distribution of teacher VAMs across never-treated and ever-treated schools. Comparing columns 2 and 4 (columns in which no teachers are double counted), we observe that closing schools have more teachers with either very high or low experience. From the bottom row of the top panel, we see that ever-treated schools have larger shares of black teachers than never-treated schools. School closings not only affect minority students disproportionately, they also affect minority teachers disproportionately. Note that black teachers still constitute a minority share of teachers in treated schools.

We describe the four teacher labor market outcomes in the bottom panel of table 2. A teacher is defined as staying at the same school if she is observed in the data at the same school the following year (or after a one-year break from teaching). Unsurprisingly, this is the most common outcome for never-treated teachers across columns 1 and 2; it occurs in about three-quarters of the teacher-by-year level observations, which is similar to the teacher retention rate in Texas documented by Hanushek and Rivkin (2010).

A teacher "leaves teaching" if she is no longer observed in the data in any future year. This is an upper bound of the true number of teachers who leave teaching, as it includes those who continue teaching but move to another state (or who return to teaching in a year beyond our sample period). It captures the loss of a worker from the perspective of the North Carolina public school system but would overstate the full costs of teacher losses caused by school closings. Teachers typically leave teaching in any given year with a probability of 8 to 14 percent.

Other teacher labor market outcomes the following year are less common. A teacher's mean propensity to move to a new school in the same district or to move to a new school in a new district is about 4 to 6 percent for never-treated teachers. As expected, moving to a new school in the same district is considerably more common after school closings (columns 3 and 4 of table 2). From column 4, we see that the year after a school's closing, teachers move to a new school with a probability of 0.73, about triple the rate at which they leave teaching, 0.23.

Table A.1 in the online appendix describes teacher labor market outcomes for ever-treated teachers in the years leading up to the school's closing. There is little evidence of effects in anticipation of the closing. Around 90 percent of subsequently treated teachers stay in the same school in all the years leading up to the school's closing.

Table A.2 in the online appendix describes heterogeneity by teacher value added, experience, and race in teacher labor market outcomes for both never-treated teachers and treated teachers. We observe limited heterogeneity among never-treated teachers, with the exception of some heterogeneity by teacher experience level. We observe more

Table 3. School Closings and School Composition

	School Enrollment (1)	Share of Students: White (2)	Share of Students: Black (3)	Share of Students: FRPL (4)	Number Full-time Teachers (5)	Student–Teacher Ratio (6)
			Panel A			
Year of school closing	−44.179***	−0.017*	0.030***	0.036*	−2.409***	−0.928*
	(7.851)	(0.009)	(0.010)	(0.020)	(0.719)	(0.541)
			Panel B			
Three years before school closing	−25.683***	−0.005	0.022***	0.018	−1.091	−0.532
	(7.192)	(0.008)	(0.008)	(0.035)	(0.842)	(0.483)
Two years before school closing	−29.079***	−0.017	0.034***	−0.025	−3.111***	−0.542
	(10.543)	(0.010)	(0.011)	(0.028)	(0.925)	(0.523)
One year before school closing	−51.331***	−0.021*	0.038***	0.051*	−3.286***	−0.770
	(9.474)	(0.012)	(0.012)	(0.029)	(0.845)	(0.603)
Year of school closing	−65.166***	−0.025*	0.048***	0.046*	−3.767***	−1.251*
	(11.185)	(0.013)	(0.014)	(0.027)	(0.879)	(0.673)
School-year observations	8,857	8,857	8,857	8,437	8,078	8,078

Notes: Robust standard errors clustered by school in parentheses. All models include year and school fixed effects, as well as baseline school characteristics interacted with year fixed effects.

***$p < 0.01$; *$p < 0.1$.

heterogeneity in labor market outcomes among treated teachers, especially in teacher value added and experience.

These descriptive statistics provide an overview of what happens to teachers after schools close. We now turn to the regression results, which are intended to provide a more causal analysis, given that we will be able to control for many of the other differences among teachers in the treatment and control groups.

5. RESULTS

The Causes of School Closings in North Carolina

Before turning to our main results, we begin by exploring the factors that led to school closings in North Carolina during our study period. The results from a probit model predicting school closings are reported in online appendix table A.3. Overall, we find that schools are more likely to close when they have lower levels of enrollment, higher shares of high-need and black students, and lower levels of school performance (although due to collinearity the coefficients on the school performance variables are not of the expected sign in the fully specified model). We unpack these findings in tables 3 and 4 by looking at within-school composition and performance changes.

Table 3 investigates how the student and teacher composition of a school changes in the years leading up to its closing. We report results from models taking the form of our main specification, but using school-by-year rather than teacher-by-year data and replacing the dependent variable, the teacher labor market outcome in year $t + 1$, with a time-varying school characteristic in year t. The inclusion of school fixed effects means we are describing how a given school changes in the years leading up to its closing. Throughout the analysis, we report results from a simple model that only estimates a single treatment effect for the year of the school closing (panel A), and a richer

Table 4. School Closings and School Performance

	Share of Students at Grade Level	AYP Not Met: Yearly Indicator	AYP Not Met: Number of Sequential Years	AYP: Indicator for Students Eligible for School Choice
	(1)	(2)	(3)	(4)
		Panel A		
Year of school closing	−0.020*	0.046	0.079	0.004
	(0.012)	(0.079)	(0.207)	(0.063)
		Panel B		
Three years before school closing	−0.019**	0.017	0.114	0.070
	(0.009)	(0.087)	(0.167)	(0.080)
Two years before school closing	−0.033***	0.049	−0.042	0.015
	(0.012)	(0.082)	(0.199)	(0.084)
One year before school closing	−0.034**	−0.080	0.016	0.088
	(0.015)	(0.067)	(0.223)	(0.072)
Year of school closing	−0.037**	0.038	0.091	0.038
	(0.018)	(0.084)	(0.260)	(0.070)
School-year observations	8,861	8,861	8,861	8,861

Notes: Robust standard errors clustered by school in parentheses. All models include year and school fixed effects, as well as baseline school characteristics interacted with year fixed effects. AYP = Adequate Yearly Progress.

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

model allowing multiple years of treatment in the years leading up to the school closing (panel B).

Column 1 shows that student enrollment steadily decreases in the years leading up to a school closing. From a small decline three years before closing, the final-year decline of 65 students corresponds to a considerable reduction relative to the average school sizes reported in table 1. The steady decline in enrollment is indicative of an underlying downward trend potentially driven by local demographics. If school closings were caused by school accountability policies, we may have observed flat enrollment being sharply affected by an information shock as the school fails to achieve a minimum performance threshold and the public is then informed about the future closing of the school.[13]

Columns 2 and 3 reveal a slight increase in the share of black students enrolled in a school before its closing. This tells us that, in comparison to white students, minority students are slower to leave (or slower to change their initial decision to enroll in) schools that will close. Minority students may be less mobile across schools for a variety of reasons, such as having fewer resources for transport or less access to information about the impending closing. Although not the focus of this paper, this means that any potential costs to students from staying longer in schools that will close are disproportionately borne by minority students. We observe a similar increase in the

13. One limitation of the data is that charter and private schools are not matched to the school districts in which they are located. This means we cannot readily explore the extent to which the declining enrollment observed in the years leading up to a school closing is related to local competition from charter or private schools. Although even with these data it would be difficult to attribute causation, given the location of new charter or private schools is not exogenous, and may be driven by actual or predicted changes in enrollment at local public schools. In online appendix table A.5, we show that the effect of school closings on teacher labor market outcomes is not affected by the extent of penetration by private schools into the local education market.

share of economically disadvantaged students (column 4). There is a small decline in the number of teachers (full-time equivalents) in the years leading up to school closings in column 5, but this is not sufficient to offset the declining student enrollment, and column 6 reports a reduction in the student-teacher ratio. Somewhat paradoxically, the learning environment for students as measured by student–teacher ratios is actually improving in the years leading up to a school closing.

In table 4 we report how school performance changes in the years leading up to a school closing. If school closings are driven by schools failing to meet the AYP standards established by NCLB policy, we would expect to see a school's performance declining in the years leading up to its closing. Results in table 4 show declines in the shares of students at grade level in the years leading up to school closings. However, these do not translate into any effects on the three AYP measures; we see no precisely estimated effects in columns 2 to 4.[14]

Taken as a whole, tables 3 and 4 indicate that declining enrollment plays a much larger part in school closings than school performance. The majority of school closings in North Carolina during our study period appear to be driven by demographic changes rather than accountability standards. This means the school closings we study are caused by the same factor as those in Michigan studied by Brummet (2014). Some caution should therefore be taken when extrapolating from our results to infer the effects of school closings brought about by factors other than declining enrollment.

The Effects of School Closings on Teacher Labor Market Outcomes

Our main results—the effects of school closings on teacher labor market outcomes the following year—are reported in table 5. We report effects on the four partitioned teacher labor market outcomes described in table 2. Changes in the propensities to experience each of these four outcomes necessarily sum to zero, but we include all of them for tractability. We will focus on the estimates in panel A; the estimates in panel B (with the vector of treatment indicators) confirm that most of the action occurs in the year of the closing rather than in the years leading up to the closing and generally paint a very similar picture to panel A. By definition, teachers cannot stay at the same school after it closes (column 1), explaining the large negative estimate. Most strikingly, column 3 tells us that school closings cause a 77 percentage point increase in the likelihood a teacher moves to a new school in the same district. Given that teachers usually move schools only 6 percent of the time in any given year (table 2), this is a large, but unsurprising, effect. Moving schools within a district is the least disruptive transition for displaced teachers as they likely do not need to move their homes and families.

Teachers are about 6 percentage points more likely to leave teaching after a school closing in comparison to teachers at the same school in earlier years (column 2). This is about a doubling of the baseline probability of leaving teaching, as reported in table 2. These teachers may be changing careers, moving out of the state to teach,

14. Another measure of school quality is North Carolina's ABC program. However, this program changed in marked ways midway through our analysis sample, making it difficult (and not recommended in North Carolina's Department of Public Instruction's documentation) to compare ABC school categorizations over time. A provisional analysis revealed no consistent pattern.

Table 5. School Closings and Teacher Labor Market Outcomes the Following Year

	Same School	Leaves Teaching	New School in Same District	New School in New District
	(1)	(2)	(3)	(4)
		Panel A		
Year of school closing	−0.772***	0.061**	0.719***	−0.013
	(0.020)	(0.024)	(0.034)	(0.014)
		Panel B		
Three years before school closing	0.016	0.058*	−0.056**	−0.018
	(0.041)	(0.030)	(0.022)	(0.015)
Two years before school closing	0.060*	0.005	−0.029	−0.037**
	(0.031)	(0.027)	(0.024)	(0.018)
One year before school closing	0.032	−0.005	−0.008	−0.019
	(0.050)	(0.023)	(0.032)	(0.018)
Year of school closing	−0.751***	0.068**	0.704***	−0.027
	(0.030)	(0.029)	(0.036)	(0.018)
Teacher-year observations	80,180	80,181	80,181	80,181

Notes: Robust standard errors clustered by school in parentheses. All models include year and school fixed effects, as well as baseline school characteristics interacted with year fixed effects.

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

becoming unemployed, or exiting the labor force. These are considerable changes and likely associated with substantial personal and professional costs.

Lastly, there is no effect on the probability of moving to a new school in a new district (column 4). Teaching in a new district may require residential relocation, and this may be prohibitively costly for spousal or family reasons; unfortunately, we do not have information on the marital status or family structure of teachers to probe this further. It is possible, for example, that unmarried teachers may be more likely to move districts.

The estimates in panel B tell us that most of the effects on subsequent labor market outcomes occur in the year of the school closing. Teachers only act when they are forced to make a change rather than in anticipation of the school's closing. Either a revealed preference argument is telling us that teachers prefer to stay teaching in the same school from year to year—even if this school is going to close—or teachers at closing schools face low demand and have few opportunities to move. As mentioned earlier, moving to a new school in the same district is likely the least disruptive and potentially least costly outcome that teachers may experience after their school closes. Although this is a common teacher labor market outcome the year after a school closes, many teachers experience one of the other potentially costlier outcomes.

Negative effects on teachers from school closings, however, do not necessarily translate into negative effects for society. For example, if the teachers who leave teaching due to school closings are disproportionately low-performing and are replaced by more effective teachers, this may generate gains for society. Indeed, the objective of the school closure sanction in the NCLB is precisely to reduce student exposure to poor educational inputs that may be otherwise difficult to change or terminate. On the other hand, several high-performing teachers may be displaced by closing schools, and if these more productive workers have better options outside of education than their less productive colleagues, they may be disproportionately likely to leave teaching.

To more accurately assess the benefits and costs to society of teacher displacement from school closings, we consider heterogeneity in the effects on labor market outcomes by teacher type. We focus on three dimensions of teacher type: (1) teacher quality as measured by value added; (2) teacher years of experience, a characteristic that has been associated with student success (see, e.g., Ost 2014); and (3) teacher race, which may directly affect race achievement gaps, as well as speak to the broader issue of representation in the teacher labor market. Teachers are categorized into bins for each of these characteristics. We estimate models taking the general form of equation 1, but using the year of closing treatment indicator and interacting it with the categorizations of teacher VAM (shown below), teacher years of experience, or teacher race, as well as indicators for the respective teacher characteristic:

$$\begin{aligned} Y_{is,t+1} = {} & \delta_H[Treat_{ist} \times HighVAM_i] + \delta_M[Treat_{ist} \times MediumVAM_i] \\ & + \delta_L[Treat_{ist} \times LowVAM_i] + \theta_H HighVAM_i + \theta_M MediumVAM_i + \alpha_s + \beta_t \\ & + \sum_{mt} \gamma_{mt} X_{m,2002} + \epsilon_{ist}. \end{aligned} \tag{2}$$

We report results in table 6.[15] From column 1 of panel A, the teachers who are most and least effective at improving the test scores of their students, high- and low-VAM teachers, experience larger increases in their likelihood of leaving teaching after school closings than their medium-VAM counterparts. This U-shaped pattern suggests that on this dimension the overall effects on society from school closings may be small; the cost of losing high-VAM teachers being offset by the benefit of losing low-VAM teachers. Medium-VAM teachers are much more likely to move to new schools in the same district in comparison to their high- and low-VAM counterparts. Note that a similar pattern of heterogeneity by teacher VAM was observed in the descriptive statistics in table 4, indicating that these differences would be less marked in relative terms.

In panel B, we see more striking heterogeneity by teacher experience. The increase in the propensity to leave teaching after school closings is concentrated among experienced teachers, even though experienced teachers typically have lower baseline probabilities of leaving teaching (Boyd et al. 2005). Very highly experienced teachers are also less likely to move to a new school in the district after school closings than their less experienced colleagues. Older teachers who have been at the same school for many years may find it especially costly to move to a new school and adapt to a new system, choosing instead to retire from teaching.

The loss of experienced teachers from the teacher labor force due to school closings is concerning. Beyond their impact on student test scores, experienced teachers may serve as mentors to their colleagues and provide additional value outside the classroom. At the same time, school closings' causing teachers to leave teaching or retire early may generate cost savings for the state. The state pays teachers in North Carolina according to salary schedules (although districts may provide supplemental pay). These schedules have a steep experience gradient, so the wage bill of the state is reduced when

15. There are some teachers for whom reliable value-added scores could not be computed, and others for whom experience and race were not available, so the samples in tables 5 and 6 are slightly different, as well as the samples across the panels of table 6.

Table 6. Heterogeneity by Teacher Characteristics in Effects of School Closings on Teachers

	Leaves Teaching	New School in Same District	New School in New District
	(1)	(2)	(3)
Panel A: Teacher VAM			
Year of closing			
X High VAM (top quartile)	0.118*	0.593***	−0.027
	(0.070)	(0.079)	(0.020)
X Medium VAM	0.056	0.695***	−0.032*
	(0.038)	(0.037)	(0.017)
X Low VAM (bottom quartile)	0.164**	0.559***	−0.032
	(0.074)	(0.070)	(0.021)
Post-estimation: p-value from test of joint coefficient equality	*0.09*	*0.02*	*0.96*
Panel B: Teacher Experience			
Year of closing			
X Very high experience (25 years or more)	0.112	0.668***	−0.024**
	(0.076)	(0.071)	(0.011)
X High experience (10 to 24 years)	0.082***	0.757***	−0.017
	(0.031)	(0.040)	(0.018)
X Medium experience (5 to 9 years)	0.052	0.696***	0.030
	(0.051)	(0.078)	(0.035)
X Low experience (4 years or less)	0.029	0.718***	−0.025
	(0.039)	(0.041)	(0.025)
Post-estimation: p-value from test of joint coefficient equality	*0.41*	*0.57*	*0.55*
Panel C: Teacher Race			
Year of closing			
X Black	0.129***	0.625***	−0.024
	(0.046)	(0.071)	(0.025)
X Not black	0.014	0.708***	−0.011
	(0.027)	(0.034)	(0.015)
Post-estimate: p-value from test of joint coefficient equality	*0.03*	*0.27*	*0.65*

Notes: Robust standard errors clustered by school in parentheses. All models include controls for the respective teacher characteristics, year and school fixed effects, as well as baseline school characteristics interacted with year fixed effects. The samples vary slightly across the panels; comparisons should therefore be made within categories rather than across them. VAM = value-added measures.

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

an experienced teacher retires and is replaced by a less experienced teacher. However, a back-of-the-envelope calculation suggests that such cost savings are not large, especially when dispersed across the state.[16]

16. A single school closing generates a maximum cost saving for the state of about $7,500 in teacher wages the year after the closing. Consider only the first year after a school closing. About half of teachers have more than ten years of experience (table 2), and the typical treated school has twenty full-time teachers (table 1), so, on average, a school closing displaces ten experienced teachers. About one in twenty experienced teachers leaves teaching or retires every year, so we would expect 0.5 retirements every year in a typical treated school (before treatment). The estimates in table 6 indicate that school closings approximately double the propensity to retire for experienced teachers. This means that a typical school closing induces an additional 0.5 retirements every year. The largest cost saving would be when a very highly experienced teacher retires. The salary schedule in the final year of our sample (2012) indicates a $15,000 salary difference between teachers with no experience and teachers with twenty-five years of experience. Assuming that retired teachers are replaced by teachers with no experience, which would generate an upper bound for the cost saving given the experience gradient in the salary schedule, a single school closing saves about $7,500 for the state the year after the closing, a relatively

As discussed in the Introduction, the Chicago Teachers Union is concerned that school closings disproportionately affect black teachers. Their argument is based on school closings being more frequent in high-minority neighborhoods, which we also document in table 2. We explore a related question in panel C of table 6. Do labor market outcomes in response to school closings differ by teacher race for teachers from the *same* closing school? Indeed, in column 1 we find that black teachers experience an increase in their propensity to leave teaching after school closings that is twice as large as it is for white teachers.[17] And, in column 2, we see that black teachers are less likely to move to a new school in the same district (although this difference is less statistically clear). Given the concerns around black teachers already being underrepresented in the teacher labor force, this is a troubling finding. On average, black students perform a little better with black teachers than white teachers, and there is evidence that these gains persist (Gershenson et al. 2018). Notably, this effect contrasts with the increase in black teacher representation in North Carolina over the same period that occurred at schools where black students were included as a subgroup in the NCLB accountability assessment (Shirrell 2018). Although this change in the composition of teachers is small, the reduction in the share of black teachers in response to school closings may widen race achievement gaps.

There are a variety of explanations for this finding. Displaced black teachers may be applying for teaching jobs at lower rates than their white counterparts. On the other hand, black teachers may be discriminated against and hired at lower rates than white teachers. We cannot answer this definitively, but in online appendix table A.6 we report that these race differences are particularly stark in districts with smaller shares of black students. In districts with black student shares below the 75th percentile (i.e., "whiter" districts), black teachers experience a much larger 26.5 percentage-point increase in their propensity to leave teaching in response to a school closing, while it remains around 10 percentage points for teachers who are not black. The gap is even wider in districts with student black shares below the median, but these districts have a very small number of treated black teachers. White teachers leave teaching at the same rate regardless of the race composition of the district, while black teachers leave teaching at higher rates in districts with more white students.

We explore teacher experience–teacher race heterogeneity in online appendix table A.7, showing that both black and white experienced teachers are more likely to leave teaching after school closings than their less experienced counterparts. Notably, the increase in the propensity to leave teaching is particularly large for black, very highly experienced teachers. Although close to retirement, highly experienced black teachers leaving teaching early could be particularly detrimental if same-race mentors are important in retaining minority teachers, who are already underrepresented.

In table 7, we probe more generally whether we can identify labor demand and labor supply channels. The large effect of school closings on leaving teaching may be driven by teachers not having many other schools to move to in the area; in other words, a labor demand factor. If so, we would expect a larger likelihood of leaving teaching and

small amount. Furthermore, any saving would be attenuated by the net cost of the additional pension payout that year.

17. In results not reported, we show that this difference is evident within all value-added and experience bins.

Table 7. Heterogeneity by School and District Characteristics in Effects of School Closings on Teachers

	Leaves Teaching	New School in Same District	New School in New District
	(1)	(2)	(3)
Panel A: District Size			
Year of closing			
X Large district	0.116***	0.752***	−0.066***
	(0.030)	(0.025)	(0.016)
X Medium district	0.081**	0.541***	−0.005
	(0.038)	(0.049)	(0.019)
X Small district	0.025	0.685***	−0.020
	(0.039)	(0.050)	(0.017)
Post-estimation: p-value from test of joint coefficient equality	*0.18*	*0.00*	*0.03*
Panel B: School Adequate Yearly Progress (AYP) Status			
Year of closing			
X AYP consistently met in years leading up to closing	0.052	0.635***	−0.026*
	(0.032)	(0.037)	(0.015)
X AYP not consistently met in years leading up to closing	0.102*	0.474***	0.032*
	(0.052)	(0.100)	(0.019)
Post-estimation: p-value from test of joint coefficient equality	*0.41*	*0.13*	*0.02*
Panel C: School Share of Students at Grade Level			
Year of closing			
X High share of students at grade level (top quartile)	0.178	0.610***	−0.111***
	(0.219)	(0.198)	(0.037)
X Medium share of students at grade level	0.073	0.590***	−0.007
	(0.048)	(0.045)	(0.023)
X Low share of students at grade level (bottom quartile)	0.052	0.607***	−0.015
	(0.032)	(0.058)	(0.016)
Post-estimation: p-value from test of joint coefficient equality	*0.81*	*0.97*	*0.04*

Notes: Robust standard errors clustered by school in parentheses. All models include controls for the respective school characteristics, year and school fixed effects, as well as baseline school characteristics interacted with year fixed effects. The samples vary slightly across the panels; comparisons should therefore be made within categories rather than across them.

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

a smaller likelihood of moving to a new school in smaller school districts with fewer alternative teaching options. We show in panel A of table 7 that the impacts on leaving teaching are actually larger in the largest districts, and therefore do not point toward this type of labor demand mechanism.

In panel B of table 7, we observe that teachers in closing schools that consistently fail to meet AYP in the years leading up to the closing (i.e., low-performing schools) are slightly more likely to leave teaching than teachers from other schools. Correspondingly, teachers from low-performing schools are also less likely to move to a new school in the same district. We interpret this as suggestive evidence of a labor supply channel; the large effect on leaving teaching may be driven by poor work environments in closing schools incentivizing teachers to quit at higher probabilities than they otherwise would have.[18] This interpretation is provided with the caveat that results in panel C exploring

18. A Worker Conditions Survey is given to teachers in North Carolina every second year from 2002. This instrument is available in the NCERDC data, but teachers cannot be matched to the main data. Results using data aggregated to schools (which can be matched) revealed no statistical differences in the working environment

heterogeneity by the share of students at grade level do not reveal the same pattern of effects, although confidence intervals are wide.

Panels B and C also speak to the generalizability of our findings. Earlier in the paper we showed that declining enrollment rather than failing to meet accountability standards drives many of the school closings in our study. To the extent that the effects of closing low-performing schools are similar to the effects of closing schools *because* of low performance, the comparable pattern of effects across high- and low-performing schools suggests that the reason for the school closing may not play a large role in determining the impacts on displaced teachers.

Finally, in order to probe the effects on society more generally, we eliminate within-district across-school spillovers by aggregating to the district level and estimating how the shares of teachers experiencing each labor market outcome respond to changes in the share of schools in the district that are closing. The estimates are reported in online appendix table A.4, panel G, and show the reduction in the probability of staying at the same school is completely offset by the increase in the probability of moving to a new school in the district. There is no longer a precisely estimated effect on leaving teaching after aggregation to the district level.

It is important to interpret these results in the context of North Carolina's teacher labor markets. North Carolina has relatively weak unions compared with the rest of the United States, so it is possible that the estimates on leaving teaching present an upper bound of the general effects of school closings in the United States if teachers displaced by school closings in other states are protected by collective bargaining agreements. Saying that, it is worth noting that in Illinois, where teacher unions are considered strong, school closings still result in layoffs for previously tenured teachers; strong unions do not automatically protect displaced teachers.[19]

The Effects of School Closing on Teacher Effectiveness

We now turn to exploring the extent to which school closings affect teacher productivity. Schools that close are typically experiencing declining enrollment, which, along with the threat of a future closing, may demotivate teachers. For such teachers, moving to a new school may be an exciting prospect, which could translate into achievement gains in the classroom. On the other hand, experiencing a school closing and finding a new job may be stressful and tiring, causing worse outcomes for students in the new school. Teacher productivity is also affected by the quality of their teacher peers (Jackson and Bruegmann 2009), and this may change considerably for displaced teachers moving to new schools.

For teachers who move to a new school in response to a school closing, the type of school to which the teacher moves may be an important factor in determining whether this will be a productivity-enhancing or diminishing experience. We explore in table 8 the quality of schools to which teachers move. Using the teacher-by-year level data, we run regressions in which the dependent variable is an indicator for the quality of the school at which the teacher will teach the subsequent year, and the explanatory

at treated and nontreated schools, although this component of our analysis is considerably underpowered, and is not reported.

19. See https://www.courthousenews.com/teachers-union-calls-school-closings-racist/.

Table 8. School Closings and the Quality of New Schools to Which Teachers Move

	Location of Next Year's School in Within-Year School Quality Distribution (measured by share of students achieving at grade level)			
	Top Quartile	Bottom Quartile	Top Quartile	Bottom Quartile
	(1)	(2)	(3)	(4)
Panel A: Within-State Quartiles				
Teacher will move to new school next year (a)	0.120***	−0.101***	0.124***	−0.125***
	(0.011)	(0.016)	(0.011)	(0.016)
Teacher will move to new school next year × Teacher treated by school closing (b)	−0.007	−0.095	−0.014	−0.115
	(0.054)	(0.073)	(0.058)	(0.093)
Post-estimation:				
Linear combination: (a) + (b)	0.113**	−0.196***	0.110*	−0.240***
	(0.053)	(0.073)	(0.057)	(0.092)
Panel B: Within-District Quartiles				
Teacher will move to new school next year (a)	0.087***	−0.077***	0.124***	−0.118***
	(0.015)	(0.016)	(0.013)	(0.018)
Teacher will move to new school next year × Teacher treated by school closing (b)	−0.121*	0.117	−0.063	0.092
	(0.062)	(0.136)	(0.053)	(0.107)
Post-estimation:				
Linear combination: (a) + (b)	−0.035	0.040	0.061	−0.026
	(0.063)	(0.137)	(0.052)	(0.106)
School fixed effects	N	N	Y	Y
Teacher-year observations	64,935	64,935	64,935	64,935

Notes: Robust standard errors clustered by school in parentheses. All models include year fixed effects, as well as baseline school characteristics interacted with year fixed effects.

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

variables are an indicator for whether the teacher moves to a new school the next year—the baseline effect of moving schools—and this indicator interacted with the year of closing treatment indicator, the additional effect caused by moving because of a school closing.[20] Teachers who will stay at the same school the next year are assigned the quality of their current school the next year. The specific school quality measures we use are binary indicators for being in the top quartile or bottom quartile of the statewide (panel A) or district-wide (panel B) distribution of the share of students achieving at grade level. The time-varying statewide school quality distribution will be relatively immune to individual school closings compared to the district-wide distribution; if a school closes in a given district, the year-to-year within-district ranking of the remaining schools may be affected, especially in smaller districts. Results are reported both with and without school fixed effects, although these have minimal impact.

First, we consider the effect on teachers who move schools for any reason, represented by the coefficient on "Teacher will move to a new school next year (a)." Teachers who move schools typically move to better schools. Depending on the specification, teachers are 8 to 12 percentage points more likely to be in schools in the top quartile of the school quality distribution (and similarly less likely to be in schools in the bottom

20. The dependent variable is missing for teachers who leave teaching, so the estimated effects are interpreted as effects conditional on staying in teaching.

Table 9. School Closings, Teacher Labor Market Outcomes, and Teacher Effectiveness

Dependent Variable: Time-varying teacher value-added measure	(1)	(2)	(3)	(4)
Teacher will move to new school next year (a)	0.013	0.014	0.013	0.013
	(0.016)	(0.016)	(0.016)	(0.016)
Teacher will move to next year and old school closes this year (b)		−0.040		−0.012
		(0.127)		(0.126)
Teacher has moved to new school (c)	0.062***	0.062***	0.080***	0.079***
(one for all years after move)	(0.015)	(0.015)	(0.015)	(0.015)
Teacher has moved to new school from school that is closing (d)		0.005		0.025
(one for all years after move)		(0.075)		(0.083)
Post-estimation				
Linear combination: (a) + (b)		−0.038		0.098
		(0.109)		(0.136)
Linear combination: (c) + (d)		0.083		0.180
		(0.076)		0.114
School fixed effects	N	N	Y	Y
Teacher-year observations	73,545	73,545	73,545	73,545

Notes: Robust standard errors clustered by school in parentheses. All models include year fixed effects, as well as baseline school characteristics interacted with year fixed effects.

***$p < 0.01$.

quartile). This is not surprising; when changing jobs by choice, employees typically move to better places of employment.

Second, we investigate the differential effect on school quality when teachers move to a new school because their current school is closing. This is captured by the coefficient on the interaction "Teacher will move to new school next year × Teacher treated by school closing (b)." Note that the sum of (a) and (b) reported in the bottom row of each panel reflects the overall effect of moving in response to a school closing. The estimates in panel A when considering the within-state distribution indicate that moving in response to a school closing has no additional effect on subsequent school quality in comparison to the baseline effect of moving schools. However, when we consider the within-district quality distribution in panel B, we see that teachers leaving closing schools are less likely to move to top quartile schools. This means that moving after a school closing works against the typical gain in school quality that teachers experience when they move for any reason. To the extent that teacher quality is affected by the quality of their school environment, this evidence suggests that we may expect positive shocks to teacher effectiveness when teachers move schools for any reason, but that this may be offset when they move in response to school closings.

Table 9 reports results from regressing time-varying teacher VAMs on indicators for moving to a new school and additional interactions that capture when this movement to a new school is prompted by a school closing. Note that these measures of value added are not the same as the fixed ones used for placing teachers into underlying effectiveness bins; time-varying VAMs are calculated in the standard way by aggregating teacher-year rather than teacher residuals from the same rich student test score model used before, and they are standard-normalized to be mean zero, standard deviation one. Columns 1 and 2 do not include school fixed effects, while columns 3 and 4 do.

The first two variables consider whether there are effects on value added the year before a teacher moves relative to other years we observe the teacher. For example, they

may be less motivated that year if they know they will be changing schools the subsequent year, which could cause a dip in value added. The first variable "Teacher will move to a new school next year (a)" captures this pretreatment effect, while the second variable captures any additional pretreatment effect if the school is closing. Across all four columns, the coefficients on the first two variables indicate that value added is not affected if a teacher will move the subsequent year; none of the estimates is precisely estimated or of considerable magnitude. This means that even if teachers lose motivation the year their school is closing, this is not translating into reduced effectiveness in the classroom.

The third and fourth variables consider the effects on value added after a teacher moves. The variable "Teacher has moved to a new school (c)" is an indicator that turns on and stays on after a teacher moves to a new school, and the fourth variable "Teacher has moved to new school from school that is closing (d)" captures any additional effects if this move was caused by a school closing.[21]

The estimates in columns 1 and 2 indicate that in comparison to all other teachers in the sample in a given year, teachers increase their value added by 0.06 standard deviation after moving to a new school. More pertinent to this study, the estimated coefficients on the fourth variable (d) reveal no differential effect on subsequent teacher effectiveness when moving after a school closing. Overall, the effectiveness of teachers in the classroom does not appear to be impacted by being displaced by a school closing, although these results are presented with the caveat that some of the standard errors are large, so we cannot reject the presence of moderate effects.

Finally, we also considered the impacts of school closings on the wages of displaced teachers. Given that teachers in North Carolina are paid according to state salary schedules (with districts allowed to supplement), we did not anticipate an effect, which is what we found. This may not be the case in other states with different salary structures. Naturally, the wage implications for teachers who leave teaching could be much more considerable.

6. CONCLUSION

School closings are disruptive for students, parents, teachers, and their communities. They are typically implemented as last resorts for dealing with declining or chronically poor-performing schools. The motivations for school closings may be financial—schools with declining enrollments becoming too expensive to run; or educational—forcing students to move from low-performing schools to better educational environments. Although much of the attention surrounding school closings in the United States is centered on students, school closings represent significant labor market shocks for affected teachers. This may have important consequences for the composition of the teacher labor force, a key educational input.

Using administrative data from North Carolina, we find that teachers displaced by school closings most commonly move to new schools in the same district, but also experience substantial increases in their probabilities of leaving teaching. The increase in

21. These are somewhat coarse measures given that they consider all years after a move as being treated. We also considered indicators that identify just the first few years after moving to a new school. Although these complicate the interpretation, results were similar.

the propensity to leave teaching is driven by experienced teachers, and marginally larger for teachers in the top and bottom quartiles of the value-added distribution. Overall, effects on the average quality of the teacher labor force are ambiguous: Experienced teachers who leave teaching may have been playing important roles as mentors and school leaders but some may have been close to retirement anyway; and the effects on high- and low-VAM teachers may balance out. More strikingly, we find that black teachers are twice as likely to leave teaching than white teachers displaced from the same closing school, exacerbating the underrepresentation of minority teachers. Finally, we find that the subset of displaced teachers who move to new schools experience no change in their effectiveness as measured by VAMs.

As Brummet (2014) finds for schools that close in Michigan, declining enrollment is the key driver of school closings in North Carolina during our study period. Declining enrollment in public schools may be driven by increasing competition in the education market from charter schools or other school choice initiatives (Toma, Zimmer, and Jones 2006). This links our study of school closings to the well-documented impacts of school choice (Bettinger 2005; Sass 2006; Bifulco and Ladd 2006; Jackson 2012). Second, declining enrollment may be driven by decreases in the local population of school-going children due to changing local economic conditions. In this context, we provide a case study of the potential labor market effects of areas or sectors in economic decline, contributing to the wider literature relating local economic conditions and local labor markets (Black, McKinnish, and Sanders 2005; Marchand 2012; Kroft, Lange, and Notowidigdo 2013).

Although school closings are often simply a reaction to a shrinking student population, they are also sometimes promoted as an instrument to improve student achievement by eliminating lower-performing inputs into the education production process. Teachers, of course, are one of the most important inputs in education, so we can speak to one aspect of the effectiveness of this policy instrument. Our results reveal that school closings do not have the clear impact on increasing average teacher quality that proponents of this approach may assume, as highly effective teachers leave at roughly the same rate as the least effective teachers. Likewise, the disproportionate loss of black teachers may have particularly negative effects for black students, as student–teacher race-match has been shown to generate positive effects for black students (e.g., Gershenson et al. 2018). Districts looking to the closure of underperforming schools as a means to improve student achievement may therefore find it necessary to make additional efforts to retain highly effective and underrepresented displaced teachers.

Finally, the black–white difference in the probabilities with which displaced teachers move to new schools or leave teaching is another example of race affecting labor market outcomes in the United States.[22] Unpacking this finding is beyond the scope of this paper, and there are many potential explanations, but it does raise the possibility of discrimination in teacher labor markets. Specifically, the result is reminiscent of a literature considering whether black workers are the "first fired and last hired" in response

22. There is a substantial literature exploring the role of race in U.S. labor markets. See Altonji and Blank (1999) for a review.

to business cycle fluctuations (Freeman et al. 1973). Recent empirical assessments of the "first fired, last hired" hypothesis provide mixed evidence on the degree to which black workers' employment is impacted by business cycle fluctuations, but clearly shows that black workers from throughout the economy transition more slowly from unemployment to employment than white workers, even after controlling for industry, occupation, and education level (Couch and Fairlie 2010). Insofar as school closings represent very localized economic downturns, our finding that black teachers are less likely to move to another school after a school closing can be interpreted as evidence consistent with the "last hired" hypothesis in the context of teaching.

ACKNOWLEDGMENTS

We thank Jared Ashworth, Marie Hull, and participants at the Association for Education Finance and Policy's Annual Conference and the Western Economic Association International's Annual Conference for helpful comments, as well as Zhongyu Cao for compiling the database of school closings in North Carolina. Andrew Hill received funding for this project from the Initiative for Regulation and Applied Economic Analysis.

REFERENCES

Abdulkadiroğlu, Atila, Joshua D. Angrist, Peter D. Hull, and Parag A. Pathak. 2016. Charters without lotteries: Testing takeovers in New Orleans and Boston. *American Economic Review* 106(7): 1878–1920. http://dx.doi.org/10.1257/aer.20150479

Altonji, Joseph G., and Rebecca M. Blank. 1999. Race and gender in the labor market. In *Handbook of labor economics 3*, edited by Orley Ashenfelter and David Card, pp. 3143–3259. Amsterdam: Elsevier Science B.V. http://dx.doi.org/10.1016/S1573-4463(99)30039-0

Ballou, Dale, and Michael Podgursky. 1998. Teacher recruitment and retention in public and private schools. *Journal of Policy Analysis and Management* 17(3): 393–417. http://dx.doi.org/10.1002/(SICI)1520-6688(199822)17:3%3c393::AID-PAM2%3e3.0.CO;2-B

Bettinger, Eric P. 2005. The effect of charter schools on charter students and public schools. *Economics of Education Review* 24(2): 133–147. http://dx.doi.org/10.1016/j.econedurev.2004.04.009

Beuchert, Louise, Maria Knoth Humlum, Helena Skyt Nielsen, and Nina Smith. 2018. The short-term effects of school consolidation on student achievement: Evidence of disruption? *Economics of Education Review* 65:31–47. http://dx.doi.org/10.1016/j.econedurev.2018.05.004

Bifulco, Robert, and Helen F. Ladd. 2006. The impacts of charter schools on student achievement: Evidence from North Carolina. *Education Finance and Policy* 1(1): 50–90. http://dx.doi.org/10.1162/edfp.2006.1.1.50

Black, Dan, Terra McKinnish, and Seth Sanders. 2005. The economic impact of the coal boom and bust. *Economic Journal* 115(503): 449–476. http://dx.doi.org/10.1111/j.1468-0297.2005.00996.x

Boyd, Donald, Hamilton Lankford, Susanna Loeb, and James Wyckoff. 2005. Explaining the short careers of high-achieving teachers in schools with low-performing students. *American Economic Review* 95(2): 166–171. http://dx.doi.org/10.1257/000282805774669628

Boyd, Donald, Hamilton Lankford, Susanna Loeb, and James Wyckoff. 2008. The impact of assessment and accountability on teacher recruitment and retention: Are there unintended consequences? *Public Finance Review* 36(1): 88–111. http://dx.doi.org/10.1177/1091142106293446

Bross, Whitney, Douglas N. Harris, and Lihan Liu. 2016. *The effects of performance-based school closure and charter takeover on student performance*. Available https://www.heartland.org/_template-assets/documents/publications/ERANO%20Closure%20Study.pdf. Accessed 24 March 2021.

Brummet, Quentin. 2014. The effect of school closings on student achievement. *Journal of Public Economics* 119:108–124. http://dx.doi.org/10.1016/j.jpubeco.2014.06.010

Carlson, Deven, and Stéphane Lavertu. 2016. Charter school closure and student achievement: Evidence from Ohio. *Journal of Urban Economics* 95:31–48. http://dx.doi.org/10.1016/j.jue.2016.07.001

Couch, Kenneth A., and Robert Fairlie. 2010. Last hired, first fired? Black-white unemployment and the business cycle. *Demography* 47(1): 227–247. http://dx.doi.org/10.1353/dem.0.0086, PubMed: 20355692

De la Torre, Marisa, and Julia Gwynne. 2009. When schools close: Effects on displaced students in Chicago public schools. Research Report. Chicago: Consortium on Chicago School Research at the University of Chicago.

Dee, Thomas S. 2005. A teacher like me: Does race, ethnicity, or gender matter? *American Economic Review* 95(2): 158–165. http://dx.doi.org/10.1257/000282805774670446

Engberg, John, Brian Gill, Gema Zamarro, and Ron Zimmer. 2012. Closing schools in a shrinking district: Do student outcomes depend on which schools are closed? *Journal of Urban Economics* 71(2): 189–203. http://dx.doi.org/10.1016/j.jue.2011.10.001

Freeman, Richard B., R. A. Gordon, Duran Bell, and Robert E. Hall. 1973. Changes in the labor market for black Americans, 1948–72. *Brookings Papers on Economic Activity* 1973(1): 67–131. http://dx.doi.org/10.2307/2534085

Gershenson, Seth, Cassandra Hart, Joshua Hyman, Constance Lindsay, and Nicholas W. Papageorge. 2018. The long-run impacts of same-race teachers. NBER Working Paper No. 25254.

Hanushek, Eric A., John F. Kain, and Steven G. Rivkin. 2004. Why public schools lose teachers. *Journal of Human Resources* 39(2): 326–354. http://dx.doi.org/10.2307/3559017

Hanushek, Eric A., and Steven G. Rivkin. 2010. The quality and distribution of teachers under the No Child Left Behind Act. *Journal of Economic Perspectives* 24(3): 133–150. http://dx.doi.org/10.1257/jep.24.3.133

Hill, Andrew J., and Daniel B. Jones. 2020. The impacts of performance pay on teacher effectiveness and retention: Does teacher gender matter? *Journal of Human Resources* 55(1): 349–385. http://dx.doi.org/10.3368/jhr.55.2.0216.7719R3

Jackson, C. Kirabo, and Elias Bruegmann. 2009. Teaching students and teaching each other: The importance of peer learning for teachers. *American Economic Journal: Applied Economics* 1(4): 85–108.

Jackson, C. Kirabo. 2012. School competition and teacher labor markets: Evidence from charter school entry in North Carolina. *Journal of Public Economics* 96(5–6): 431–448. http://dx.doi.org/10.1016/j.jpubeco.2011.12.006

Kemple, James J. 2015. High school closures in New York City: Impacts on students' academic outcomes, attendance, and mobility. Report. New York: Research Alliance for New York City Schools.

Kroft, Kory, Fabian Lange, and Matthew J. Notowidigdo. 2013. Duration dependence and labor market conditions: Evidence from a field experiment. *Quarterly Journal of Economics* 128(3): 1123–1167. http://dx.doi.org/10.1093/qje/qjt015

Larsen, Matthew F. 2020. Does closing schools close doors? The effect of high school closings on achievement and attainment. *Economics of Education Review* 76(June): 1–16.

Lincove, Jane Arnold, Nathan Barrett, and Katharine O. Strunk. 2017. Did the teachers dismissed after Hurricane Katrina return to public education? Policy brief. New Orleans, LA: Education Research Alliance for New Orleans.

Marchand, Joseph. 2012. Local labor market impacts of energy boom-bust-boom in Western Canada. *Journal of Urban Economics* 71(1): 165–174. http://dx.doi.org/10.1016/j.jue.2011.06.001

Ost, Ben. 2014. How do teachers improve? The relative importance of specific and general human capital. *American Economic Journal: Applied Economics* 6(2): 127–151.

Sacerdote, Bruce. 2012. When the saints go marching out: Long-term outcomes for student evacuees from Hurricanes Katrina and Rita. *American Economic Journal: Applied Economics* 4(1): 109–135.

Sass, Tim R. 2006. Charter schools and student achievement in Florida. *Education Finance and Policy* 1(1): 91–122. http://dx.doi.org/10.1162/edfp.2006.1.1.91

Schwerdt, Guido. 2011. Labor turnover before plant closure: "Leaving the sinking ship" vs. "Captain throwing ballast overboard". *Labour Economics* 18(1): 93–101. http://dx.doi.org/10.1016/j.labeco.2010.08.003

Shirrell, Matthew. 2018. The effects of subgroup-specific accountability on teacher turnover and attrition. *Education Finance and Policy* 13(3): 333–368. http://dx.doi.org/10.1162/edfp_a_00227

Springer, Matthew G., Walker A. Swain, and Luis A. Rodriguez. 2016. Effective teacher retention bonuses: Evidence from Tennessee. *Educational Evaluation and Policy Analysis* 38(2): 199–221.

Toma, Eugenia F., Ron Zimmer, and John T. Jones. 2006. Beyond achievement: Enrollment consequences of charter schools in Michigan. *Advances in Applied Microeconomics* 14(2): 241–255. http://dx.doi.org/10.1016/S0278-0984(06)14009-2