



# Teacher Layoffs: An Empirical Illustration of Seniority vs. Measures of Effectiveness

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School districts are confronting difficult choices in the aftermath of the financial crisis. In prior recessions, districts often muddled through by imposing a combination of tax increases and expenditure cuts that avoided involuntary personnel reductions. Today, the financial imbalance in many school districts is so large that there is no alternative to teacher layoffs. In nearly all school districts, layoffs are currently determined by some version of teacher seniority. Yet, alternative approaches to personnel reductions may substantially reduce the harm to students from staff reductions relative to layoffs based on seniority.

First, because salaries of novice teachers are often much lower than those of veteran teachers, seniority-based layoffs lead to more teachers being laid off to meet any given budget deficit, with the associated implications for class size. Second, because teachers vary substantially in their effectiveness, staff-reduction policies that do not consider effectiveness will likely allow some ineffective teachers to continue teaching while some more effective teachers lose their jobs. Third, because many districts have redesigned human resource policies to place greater emphasis on the recruitment and retention of effective teachers, they may have hired disproportionately more effective

teachers over the last several years than in prior years. In such cases, seniority-based layoffs will be even more detrimental for quality. Finally, if, as in many districts, novice teachers are concentrated in schools serving low-achieving students and students in poverty, then a seniority-based layoff approach will disproportionately affect the students in those schools. As a result, many school district leaders and other policymakers are raising important questions about whether other criteria, such as measures of teacher effectiveness, should inform layoffs.<sup>1</sup>

This policy brief, a quick look at some aspects of the debate, illustrates the differences in New York City public schools that would result when layoffs are determined by seniority in comparison to a measure of teacher effectiveness. Due to data limitations and an interest in simplicity, our analysis employs the value added of teachers using the 4th and 5th grade math and ELA achievement of their students. Unsurprisingly, we find that layoffs determined by a measure of teacher effectiveness result in a more effective workforce than would be the case with seniority-based layoffs. However, we were surprised by facets of the empirical results.

First, assuming readily available measures of teacher effectiveness actually measure true teacher effectiveness, an assumption to which we return below, the differences between seniority and effectiveness-based layoffs are larger and more persistent than we anticipated. Second, even though seniority-based layoffs imply laying off more teachers, the differential effect on class size is very small in our simulations, though it would be larger for larger budget reductions. Third, there is a somewhat greater school-level concentration of layoffs in a seniority-based system, though with a few notable exceptions, both methods result in fairly dispersed layoffs, with the vast majority of schools having no more than one layoff in grades four and five combined.

*So where does this leave us?* As a result of the limited applicability of teacher value-added measures to the full population of teachers as well as concerns about potential mismeasurement of effectiveness associated with using value-added measures even when available, neither seniority nor measures of value added to student achievement should be the sole criterion determining layoffs. However, ignoring effectiveness measures completely, as seniority-based systems do, is also problematic. Instead, the use of multiple measures of effectiveness for layoff decisions holds promise for softening the detrimental effect of layoffs.

### **SENIORITY VS. EFFECTIVENESS: THE CONCEPTUAL ISSUES**

There is substantial evidence that, on average, teachers become more effective over the first few years of their careers (Rivkin et al. 2005; Boyd et al. 2008b; Goldhaber and Hansen 2010). Since in many urban school districts newly hired teachers represent roughly five percent of the workforce, a seniority-based layoff that targets less than 10 percent of teachers would eliminate teachers with two or fewer years of experience, typically those teachers who are least effective on average.

However, while teachers typically improve over their first two years, there are some very effective new teachers and some quite ineffective teachers with far greater experience.<sup>2</sup> Seniority-based layoffs result in promising, inexperienced teachers losing their positions, while their ineffective, but more senior, peers continue to teach. As a result, seniority-based layoffs to meet budget shortfalls are more detrimental to students than would be a system that laid off the least effective teachers first. However, schools and districts are not able to judge teacher effectiveness perfectly and so the important question is whether they can judge teacher effectiveness well enough to improve upon seniority-based layoffs.

Several approaches exist to measure teacher effectiveness, including statistical estimates of teacher value added to student achievement, validated observation protocols that are administered by principals or trained evaluators, and less formal observational procedures. Little is known about how these measures overlap or complement each other, but recent work suggests that structured observational protocols correlate with value-added measures (Kane et al. 2010; Grossman et al. 2010).

Additionally, studies find that when asked to evaluate the effectiveness of individual teachers to improve student achievement, principals typically identify as their least effective teachers many of the same teachers identified as least effective by value-added analysis (Jacob and Lefgren 2008; Harris and Sass 2008). These recent studies provide some evidence of overlap among the different approaches to measuring teacher effectiveness.

The value-added approach to measuring teacher effectiveness is gaining popularity. However, in most districts principal ratings of teachers are still the only formal measure of teacher effectiveness (see Kane et al. [2010] for a description of the Cincinnati school district, which is an exception to this pattern). Value-added measures have the obvious appeal of linking

teachers to the improvement of their students on state-sanctioned exams. In addition, value-added measures are generally not as costly to collect as observational measures, especially if a system of standardized testing is already in place. Furthermore, observational protocols require agreement on what good teaching looks like—agreement which is often difficult to come by. There are, however, a number of well-documented problems with employing value-added measures to evaluate individual teachers in high-stakes decisions such as layoffs. The following are among the more troublesome issues:<sup>3</sup>

- value-added measures can be estimated for just those teachers in tested grades and subjects, typically math and reading in grades 4 through 8;
- while tested outcomes are important, most would agree that effective teachers do more than just improve outcomes as measured on standardized achievement tests;
- value-added estimates are unstable when based on relatively small numbers of students, thus requiring several classes of students to reduce measurement error;
- empirically isolating the effect of individual teachers from other school inputs and other attributes, many of which are difficult to measure, is very tricky in the context of comparisons of teacher effectiveness across diverse school environments, as is the case in many school districts.

Measures of value added either compare teachers within the same school—and thus, are not able to tell whether, on average, teachers in one school are more effective than teachers in another school—or they compare teachers across schools and thus may attribute to the teacher some of the differences in student achievement gains due to school-wide effects. A potential solution to this issue of separating the school effect from the teacher effect is the use of validated observational protocols, such as CLASS or

the Danielson rubric. These protocols measure teacher practices directly and thus are less likely to attribute influences outside of the classroom to the teacher. However, the properties of principal or observational protocols are not well developed in the context of high-stakes outcomes such as layoffs.

Choosing the criteria for layoffs is not easy. Using either seniority or currently available measures of effectiveness as the primary determinants presents a variety of potential conceptual issues. Seniority suffers from the obvious pitfalls of basing retention on a variable that is only loosely connected to student outcomes. On the other hand, current research is very thin on the properties of any of the effectiveness measures for application in the high-stakes, politically charged layoff environment. Moreover, value-added measures suffer from the practical and conceptual limitations described above while the other measures of effectiveness have either not been validated or require considerable investment to implement.

Nonetheless, many school districts will need to lay off teachers this year. In the remainder of this brief we employ data from New York City to simulate the differential effects of layoffs determined by seniority and by value-added measures of teacher effectiveness as a means of providing empirical guidance to the following questions:

- Who would be laid off under each approach?
- How does the effect of layoffs on student achievement compare across approaches?
- How does each approach affect class size?
- Are some students disproportionately affected by either approach?

## NEW YORK CITY LAYOFFS: AN EMPIRICAL ILLUSTRATION

As an illustration of the differences between layoffs determined by seniority and those determined by value added, we examine the implications of needing to meet a budget shortfall equivalent to five percent of total teacher salaries. We chose five percent as this is consistent with discussions in many school districts regarding the magnitude of potential layoffs.<sup>4</sup> In New York City layoffs are determined by inverse seniority in a teacher's license area, e.g., childhood education or secondary math.<sup>5</sup> The law provides no guidance on how layoffs should be determined across license areas.

Because of the current limitations in the availability of value-added measures and the within-license area requirement of the seniority rules, we apply the budget shortfall to 4th and 5th grade teachers, nearly all of whom have a license in childhood education and for whom value added in math and ELA can be estimated. We further structure our analysis by assuming that layoffs applied to teachers as of the summer of 2009, since the data to calculate teacher value added for the 2009–10 teaching workforce is not yet available.

Our primary analysis employs measures of teacher value added and seniority provided by the New York City Department of Education. Unless otherwise noted, all estimates are for teachers who taught during the 2008–09 school year. A teacher's value-added effectiveness estimate is based on up to four years of data depending on the teacher's longevity within New York City public schools teaching in 4th and 5th grade with student achievement scores in math and ELA.<sup>6</sup>

Also, we separately estimate several different models of teacher value added to explore the robustness of the results across different model specifications. The results of these analyses are nearly the same and are noted more specifically below. Our methods for estimating teacher value added are consistent with what is typically found in the literature. We estimate models that include student, classroom

and school variables in addition to teacher fixed effects. We also estimate models with and without controls for teacher experience.

Either approach can be appropriate depending on the policy goal. Excluding experience controls ignores the well-documented finding that, on average, teachers improve over the first four or five years of their careers and less effective novice teachers in 2009 will likely become more effective teachers within just a few years. Controlling for experience adjusts for this difference in effectiveness on average, but does not identify the teachers that are currently most effective.

We examine outcomes both ways to assess how much of a difference adjusting for experience makes in practice. The estimates presented below also have been adjusted for the instability associated with measurement error, for example when a teacher's value-added estimate is based on relatively few students, by employing an Empirical Bayes shrinkage adjustment. Appendix A outlines our empirical approach in more detail.

The first goal of the analyses is to determine which teachers would be laid off. In order to do this, we assume that the budget shortfall that needs to be addressed by layoffs in the 4th and 5th grade is equivalent to a five percent reduction in total salaries paid to 4th and 5th grade teachers. We then identify which teachers would be laid off to meet this salary reduction under a seniority-based system and which teachers would be laid off to meet this salary reduction under a system that based layoffs on teacher effectiveness as measured by each of the value-added measures available—NYC's own measure and the ones that we construct.

Students take exams in both math and English language arts; and, thus, we have measures of teachers' value added in both of these subject areas. For the analyses, we average each teacher's value added based on her students' math and ELA achievement. We describe the number of teachers laid off overall, the number of teachers from each

school laid off, and the average effectiveness of the teachers laid off under each approach.

Only part of the teacher effectiveness that value-added approaches measure is persistent from one year to the next. To address this imperfect persistence, we re-estimate value added for the 2006–2007 school year, model layoffs as if they happened after that year and then estimate value added only using the 2007–08 and the 2008–09 data to see how effective the laid-off teachers would have been in the two following years under each approach for determining layoffs. We present the results of these analyses below.

### Who Is Laid Off?

Because seniority-based layoffs target teachers whose salaries are typically among the lowest, more layoffs are required to meet any given budget deficit. We find that:

- Layoffs that produce a five percent reduction in salaries for NYC 4th and 5th grade teachers in 2009 implies terminating about 7 percent of teachers when seniority is the criterion and about 5 percent of teachers when their value-added effectiveness determines terminations. Said slightly differently, in our simulation, a layoff system based on value-added results in about 25 percent fewer layoffs than one based on seniority.
- Few of the teachers identified to be laid off are the same under the two approaches. In our simulation, approximately 13 percent of the teachers who are identified to be laid off under a seniority-based system also would be laid off if value added were the criterion. When we employ value-added estimates that control for experience, the comparable statistic is 5 percent.

### What Is the Effect on Class Size?

Most schools are simulated to lose relatively few teachers, while some schools would lose more

teachers than others. Under a seniority-based layoff system, 73 percent of schools lose fewer than 10 percent of their fourth and fifth grade teachers. However, 12 percent of schools lose more than 20 percent of teachers under the seniority-based system. Value-added layoffs are somewhat less concentrated. Seventy-two percent of schools have no layoffs while fewer than 8 percent of schools lose more than 20 percent of their teachers. Layoffs, regardless of which system is employed, would cause important staffing issues in some schools, which would likely be addressed by reallocations across schools.

Reducing the teaching workforce implies an increase in class size, other things equal. However, because our simulation only reduces the teaching workforce by between 5 and 7 percent, class sizes, on average, increase by less than two students and the average difference between the two methods of laying off teachers is about half a student per class. Nonetheless, as describe above, a small portion of schools would lose a meaningful portion of their teachers and, without reallocations across schools, would result in noticeable increases in class size. For example, schools which lost 20 percent of their teachers would experience average class size increases of about 5.5 students per class. It is very likely that teachers would be reallocated across schools to moderate these effects.

### How Do Layoffs Affect Achievement?

Figure 1 shows the average math and ELA value-added distribution of all 4th and 5th grade teachers and that for teachers laid off under each system. While a system of seniority-based layoffs does terminate some low-value-added teachers (the portion of the left tail of the distribution to the left of the vertical dashed line), most of the teachers who would be laid off by seniority have substantially higher value added than even the highest value-added teacher terminated under the value-added criterion.

The distribution of teachers laid off under a seniority-based system is very similar to the overall distribution of teacher value added. To the extent that value-added measures reflect actual effectiveness in the classroom, the value-added approach identifies the least effective teachers.

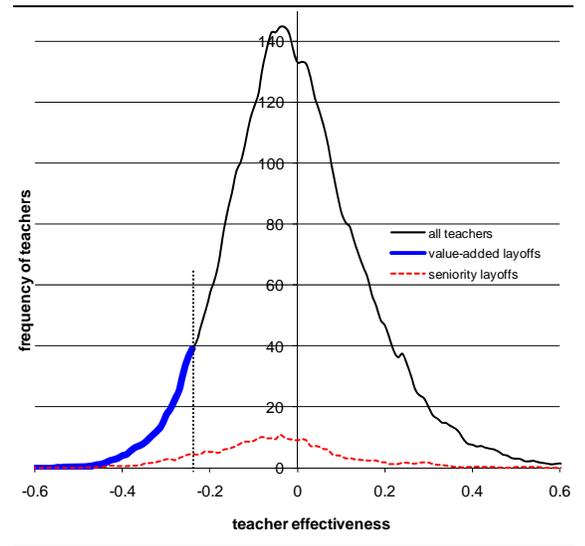
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*The typical teacher who is laid off under a value-added system is 26 percent of a standard deviation in student achievement less effective than the typical teacher laid off under the seniority-based policy.<sup>7</sup> This is a large effect, corresponding to more than twice the difference between a first and fifth-year teacher and equivalent to the difference between having teacher who is 1.3 standard deviations below the effectiveness of the average teacher.*

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We estimate that teachers laid off under the seniority system are much less experienced and have somewhat lower value added than those who remain. Under such as system, those laid off, on average, are seven years less experienced and have approximately 5 percent of a standard deviation in student achievement lower value added on average than their peers who remain. As expected, the differences under a layoff system determined by value added are more striking. Using a value-added system, those laid off and their peers who remain differ in experience by about half a year. However, the average value added of those laid off is 31 percent of a standard deviation of student achievement lower than that for teachers who remain.

**Figure 1. Frequencies of Teacher Layoffs by Teacher Value-Added to Math and English Language Arts Achievement**



We can also compare the resulting layoffs to an observational measure of teacher effectiveness. Each year New York City principals rate a small percentage of teachers as “unsatisfactory.”<sup>8</sup> Of the teachers in our simulation, 2.5 percent received a “U” rating between 2006 and 2009. Principal unsatisfactory ratings are much more closely aligned with value-added layoffs than seniority-based layoffs, although not nearly perfectly so. Of teachers who received a “U” over the past four years, 16 percent would have been laid off under the value-added criterion, while none would have been laid off using the seniority criterion.

Teachers in our simulation identified as unsatisfactory by their principals had an average value added of 9 percent of a standard deviation of student achievement lower than their peers who did not receive an unsatisfactory rating. Value-added estimates of effectiveness and the principal ratings have some overlap but address different dimensions of performance.

Because the proportion of all teachers who are terminated under either system is relatively small, depending on one's perspective, the difference between the two systems may or may not be viewed as consequential. Clearly, for the students who would have been taught by the teachers laid off under each system, the layoff rule is of great consequence. However, since only a relatively small percentage of teachers are laid off, the difference does not have a large effect on the average achievement of students in the district.

Under the two scenarios, the average value added effectiveness of the 4th and 5th grade workforce is estimated to differ by less than two percent of a standard deviation of student achievement or about one-tenth of a standard deviation in teacher value added. The size of this effect is about equivalent to 12 percent of the difference in value added between the average first year teacher and the average fifth year teacher. While small on average, this effect has some overall impact, and, if lower value-added teachers also reduce the effectiveness of other teachers in their school, the difference between the seniority-based and the value-added system may be bigger.

### **The Effect on Future Achievement.**

Employing value-added measures or other measures of effectiveness in determining layoffs assumes that these measures are good predictors of future effectiveness. However, there are reasons why this might not be the case. For example, there is research that documents that student achievement test scores reflect substantial measurement error (Boyd et al. 2008a) and that estimates of teacher value added vary substantially over time (McCaffrey et al. 2009; Goldhaber and Hansen 2010). In addition, despite controlling for experience, some novice teachers will improve more quickly or more slowly than the average. Each of these would suggest that value-added estimates employed in layoff decisions made in one year may mischaracterize teachers' value added in future years.

To explore the effects of layoffs on student achievement in subsequent years, we simulate how layoffs would have been made in summer of 2007 had the district used data for 2005–06 and 2006–07.<sup>9</sup> We then follow these teachers for two additional years and compare their effectiveness estimates based on the first two years with separate estimates solely based on the second two years in order to assess whether there are persistent differences in effectiveness between outcomes when layoffs are based on seniority rather than value added.

This simulation indicates that in 2007 the teachers laid off under a value-added system are, on average, less effective than those laid off under a seniority-based system by 36 percent of a standard deviation of student achievement, which is about 1.9 standard deviations of teacher value added, results which are somewhat greater than our estimates for the 2009 layoff. We follow both groups over the next two years and assess their effectiveness in 2009 using data for just 2008 and 2009. The difference is now 12 percent of a standard deviation of student achievement—equivalent to the difference between a first and fifth-year teacher, and also equal to having a teacher who is about 0.7 standard deviations less effective than the average teacher. Although there is an important decline in the difference between seniority and value-added estimates when we project the effect to future student achievement, meaningful differences remain. The method by which teachers are laid off has important implications for future achievement.

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*In the simulation, in 2007 teachers laid off under a value-added system were, on average, less effective than those laid off under a seniority-based system by 36 percent of a standard deviation of student achievement. In 2009 the difference in effectiveness was 12 percent of a standard deviation of student achievement—equivalent to the difference between a first and fifth-year teacher.*

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The comparisons of future achievement presented above represent conservative estimates of the difference between seniority and value-added based layoffs. When we employ estimates of teacher value added that controlled for experience, the difference in future achievement between seniority and value-added based layoffs is 19 percent of a standard deviation in student achievement (compared to the 12 percent shown above), which is 1.0 standard deviations in teacher value added (compared to 0.7) and now equivalent to about 1.5 times the difference between a first and fifth-year teacher.

In addition, if instead of using combined math and ELA value-added estimates, our layoff decisions had been made solely based on math achievement, the difference in value added between seniority-based and value-added based estimates is 21 percent of a standard deviation in student achievement, which is 1.0 standard deviation of teacher value added. Finally, if the pre- and post-layoff estimates were each based on more than two years of data, the reduction in estimation error would likely lead to a higher correlation between those estimates. In turn, the difference between seniority-based and value-added based layoffs on future achievement would likely be larger.

### Are Some Students Disproportionately Affected?

Teachers often sort systematically into schools based on student characteristics. For example, schools with a higher proportion of black students or students in poverty may have teachers with weaker credentials or less experience (Jackson 2010; Lankford et al. 2002). As a result, the different criteria for layoffs may differentially affect groups of students. However, our simulation shows little difference in the average characteristics of students taught by teachers laid off under a seniority-based system compared to a value-added approach.

For example, teachers laid off based on seniority came from schools where about 80 percent of the students were free- or reduced-price-lunch eligible. The comparable figure for teachers identified for layoff under a value-added criterion taught in schools where 79 percent of the students, on average, were free- or reduced-price eligible. Similarly, the teachers who would be laid off under a seniority-based rule taught in schools where, on average, 4 percent of the students achieve at level 1 on the 4th grade math exam, while 4.5 percent of the students performed at level 1 for teachers identified to be laid off by a value-added criterion.

### SUMMARY

In the face of unavoidable layoffs, policymakers must juggle a variety of issues in choosing the best criteria for laying off teachers. The standard approach in most school districts relies on measures of seniority. Our simulations show substantial differences in the teachers laid off under a seniority-based system and those who would be laid off if the system instead relied on teacher value-added measures. Results for other districts or even for other grades or license areas in New York City may differ from those presented here, so this analysis needs to be expanded.

Value added is currently only feasible for the portion of teachers who teach in tested grades and subjects, often math and ELA in grades 4 through 8, thus limiting their applicability. In addition, as described above, we know little about the extent to which value-added measures employing standardized achievement tests capture other important dimensions of teaching. While these issues should be considered in the application of value added, we should not lose sight of the main point.

Given the large differences found in our layoff simulation, developing fair and rigorous measures of teacher effectiveness are likely to pay important dividends. Measures that include a variety of approaches of assessing teacher effectiveness offer

promise and should be carefully evaluated to better understand their strengths, weaknesses, and complementarities.

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## NOTES

1. For a summary of reactions by policymakers to seniority based layoffs see Stephen Sawchuck, "Congress Urged to Tie Aid in Jobs Bill to Elimination of Seniority-Based Firing" (*Education Week*, May 19, 2010, <http://www.edweek.org/ew/articles/2010/05/19/32layoff-side.h29.html>).
2. For example, using North Carolina data, Goldhaber and Hansen (2010) estimate that on average teachers in their fifth year of teaching have math effect sizes that are about 0.07 larger than they had as first-year teachers. However, with a standard deviation of 0.11, there is substantial overlap between the effectiveness of first and fifth-year teachers.
3. For a more detailed description of issues associated with value added see Hanushek and Rivkin (2010).
4. For example, recently New York City was considering laying off 4400 teachers, which is about 5.6 percent of teachers (*New York Times*, June 1, 2010, <http://www.nytimes.com/2010/06/02/nyregion/02layoffs.html?scp=20&sq=teacher%20layoffs&st=cse>). However, earlier in the year some districts were projecting layoffs of ten percent or more of their teachers (*New York Times*, April 20, 2010, <http://www.nytimes.com/2010/04/21/education/21teachers.html?scp=7&sq=teacher%20layoffs&st=cse>).
5. Article 52, section 2588 of New York State Education Law defines how layoffs are to be made in New York City.
6. For teachers with fewer than four years of available data, estimates are based on available data.
7. These differences are very similar to those we obtain when experience controls are included in the estimates of teacher fixed effects.
8. The details of the system are set out in "Teaching for the 21st Century: Teacher Performance Review." [http://www.uft.org/chapter/teacher/teaching\\_for\\_th/](http://www.uft.org/chapter/teacher/teaching_for_th/).
9. Because we do not have a seniority measure in 2007, we simulate teacher layoffs in 2007 by laying off all first-year teachers, 8.4 percent of all teachers. This resulted in a salary savings of 6.2 percent. We then laid off the least effective teachers until we realized the same salary savings. In this case 6.8 percent of teachers would be laid off with the most effective laid off teacher having a value added of -0.28.

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## APPENDIX A

### TEACHER VALUE-ADDED ESTIMATION

#### Data

The data we employ on teachers in grades four and five and their students in grades three, four and five for school years 2005-06 through 2008-09 come from the New York City Department of Education. The student data consists of a demographic data file and an exam data file for each year from 2004-05 through 2008-09. The demographic files include measures of gender, ethnicity, language spoken at home, free-lunch status, special-education status, number of absences, and number of suspensions for each student who was active in grades three through eight that year. The exam files include, among other things, the year in which an exam was given, the grade level of the exam, and each student's scaled score on the exam.

Using these data, we construct a student-level database where exam scores are normalized for each subject, grade and year to have a zero mean and unit standard deviation, to accommodate any year-to-year or grade-to-grade anomalies in the exam scores. For our purpose, we consider a student to have value-added information in cases in which he/she has a score in a given subject (ELA or math) for a particular year and a score for the same subject in the immediately preceding year for the immediately preceding grade. We do not include cases in which a student took a test for the same grade two years in a row, or where a student skipped a grade.

Data on teachers comes from the New York City Department of Education (NYCDOE). We employ NYCDOE information to match teachers to their classrooms and students. For this analysis, we employ information regarding teachers' seniority and experience provided by NYCDOE, and teacher salaries from the New York State Department of Education.

Classroom data for students comes largely from aggregating student-level data to the classroom level. In addition we include class size and employ school-level information regarding enrollment, student socio-demographics and pupil teacher ratios drawn from the Common Core of Data.

#### Estimation

Our primary analysis—the simulation of layoffs in 2009—employs measures of teacher value added provided to us by NYCDOE. The 2007 simulation employs our own value-added estimates. Using student data for the 2005-2006 and 2006-2007 school years, the effects of student, classroom and school variables on student achievement are estimated after sweeping out teacher fixed effects. In turn, the teacher fixed effects were estimated by calculating the mean student-level residuals (by teacher) from the first-stage regression. The standard errors for the estimated teacher effects are proxied using the standard deviations of the mean residuals, an approach that ignores the fact that those residuals are based on estimated parameters. We follow the same procedure for our estimates for 2006–09, with the exception of employing four years of data.

Having to employ estimates of the actual value teachers add to student achievement, rather than their true value added, implies that it is important to take into account the corresponding measurement error. We follow the standard approach of adjusting the value-added estimates employing empirical-bayes shrinkage to account for the estimation error. A conditional-bayes estimator is employed which results in the variance of these estimates equaling our best estimate of the variance in the actual value added of teachers (Carlin and Louis 1996). Statistics reported in the brief are for these conditional-bayes estimates.

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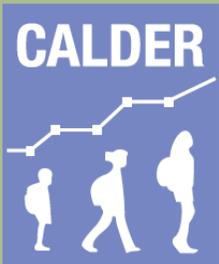
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## National Center for Analysis of Longitudinal Data in Education Research

N THIS ISSUE

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## National Center for Analysis of Longitudinal Data in Education Research



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