The Effect of Tenure on Teacher Performance in Secondary Education

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Abstract

The merits of teacher tenure policies are currently being debated across the country, but little is known about their true effect on teacher performance. Critics argue that tenure, originally designed to provide job protection, may have adverse effects on teacher quality if job security removes incentives to perform at higher levels. Using a nationally representative survey of high school students, I examine the effect of receiving tenure on student achievement. Because tenure laws vary across states, I am able to compare teachers with the same level of experience but who differ in tenure status. I find no significant relationship between a teacher's tenure status and classroom performance. The magnitude of the effect of tenure increases when I limit the analysis to more similar groups of teachers, though it remains statistically insignificant. I argue that further research is necessary to better understand the implications of tenure policies.

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Introduction

The passage of the No Child Left Behind Act in 2001 refocused America's attention on efforts to reform the US public education system. A variety of policies, ranging from introducing new accountability standards to promoting school choice and competition, are currently being examined by researchers and lawmakers alike in an effort to determine what changes can be made to public education in order to improve its quality. The importance of teacher quality is widely recognized as one of the most critical components of successful education and so policies that aim to improve teacher performance through the use of incentives are gaining momentum.

Despite many findings that improvement in quality is associated with significant increases in student achievement (Aaronson et al., 2007), research has yet to pinpoint which teacher characteristics are most indicative of quality. For example, measurable teacher characteristics (such as race, gender, education history, or years of teaching experience) only account for 3% of a teacher's influence on student achievement (Goldhaber, 2002) and a teacher's experience is not significantly related to student achievement following the first few years in the classroom (Rivkin, 2005). These findings suggest that hard to measure teacher characteristics, such as personal motivation, job satisfaction, or patience and personality are the chief determinants of performance. Policies most likely to have a large impact on improving teacher quality may therefore be those that target positive change in these characteristics. Policymakers have attempted to address these issues through the evaluation and implementation of programs that provide incentives for teachers to improve.

One such program is teacher tenure, which creates incentives for teachers by providing job security. Public school teachers in every state are awarded tenure after completing a probationary period, the length of which is determined by state law. Tenure policies consist of two primary components. The first part is an automatically renewing employment contract, which is granted after completion of the probationary period and may be terminated only for reasons specified by law. The second component is the right of due process for a tenured teacher in the event that his or her employment contract is terminated. This permits the teacher to appeal to a state board and argue his or her case against the school district attempting to fire the teacher, which may be difficult and very costly for the school district.

Teacher tenure policies may provide teachers with incentives to either improve or diminish their teaching quality. If tenure gives a teacher confidence in job security and a sense that he or she is free of political pressures within a school system, it may improve teacher motivation, satisfaction, and overall productivity. This can also encourage teachers to try new methods or take risks in the classroom without the fear of losing one's job if the methods fail. In addition, the desire to obtain tenure may motivate new teachers to work harder in order to earn the approval of a school board or administrator. However, one could argue that tenure policies may have an opposite effect by removing incentives for a teacher to perform well. Once a teacher secures tenure, the link between teacher performance and career or financial incentives is severed. Teachers know that it would be difficult and costly for the school board to fire them. They therefore have little financial incentive to perform well.

In 1934, when tenure laws were on the books in only a handful of states, Willard S. Elsbree said, "Tenure is a subject which many educators have discussed, but few have studied" (Elsbree, 1934). Today, nearly one hundred years since the first tenure policy was implemented in 1910 (Elsbree, 1934), every state has some tenure policy in place (see Figure 1). Yet while policymakers think tenure policies may affect teacher's productivity, there has still been very little research conducted on the subject. In Washington D.C., for example, School Chancellor Michelle Rhee has proposed a plan to offer current teachers a choice of giving up tenure in return for a chance at higher, performance-based wages or of keeping tenure and receiving lower raises. As the debate over teacher tenure continues, research examining its effect on student achievement will be essential to make effective policy decisions. The objective of this paper is therefore to begin the research process and examine the effect of tenure on teacher effectiveness.

Literature Review

Literature on Teacher Tenure

Few studies focus directly on the effect of teacher tenure on teacher performance. Aaronson et al. (2007) include and analyze tenure status in their regression model explaining the impact of teacher characteristics on student performance. Using data collected from Chicago Public High Schools, Aaronson et al. aim to identify teacher characteristics correlated with student gains in math and, more generally, further understand the relationship between teacher quality and student achievement. The authors find that "variables that determine compensation in Chicago – tenure, advanced degrees, and teaching certification" – only explain about one percent of the variation in estimates

of teacher quality. Tenure status, specifically, had no statistically significant correlation with teacher quality. However, the effect of tenure on teacher quality was estimated without fully addressing the complex relationship between the effects of tenure and teaching experience. Tenure status is closely related to teacher experience, and it is important to create a research design that disentangles tenure effects from returns to experience. In Aaronson et al., years of teaching experience was measured by "potential experience," which is the age of a teacher minus years of education minus five (the age at which an individual begins schooling). In other words, potential experience is simply a measure of the number of years an individual is in the workforce, assuming that he or she completes education and immediately enters the workforce without taking any time off. This method of determining years of experience will be incorrect to the extent that teachers take nontraditional career paths or hold multiple jobs in different districts.

Using data from the National Education Longitudinal Study of 1988, I created a variable of "potential experience" for all math teachers in the sample and compared it to the teachers' reported years of experience. Figure 2 is a scatter plot of my findings, and it indicates that potential experience and true experience are often not equal. If potential experience perfectly predicted total experience, one would expect to see a linear line of the function Y=X, or total experience = potential experience. But as depicted by the fitted values line, this is not the case. Furthermore, the regression of total experience on potential experience produces estimates contrary to the assumption that potential experience predicts total experience. These regression coefficients are reported in Table 1. The constant term shows that, on average, the potential experience measure will predict that a teacher with no years of experience actually has approximately 7.07 years

of experience. The coefficient on total experience, 0.93, means potential experience predicts an additional full year of teaching experience for a teacher with only 0.93 additional years of total teaching experience. Taken together, these results show that potential experience measures initially overestimate the true number of years of experience and then continue to predict higher levels of experience than a teacher truly has. Additionally, Table 2 depicts the result of a t-test for which the null hypothesis is that potential experience is equal to total experience. Not only can the null hypothesis be rejected, but also the average size of the difference between the two measures is just over six years. This magnitude of a difference indicates that potential experience is a highly unreliable predictor of a teacher's experience and, instead, it drastically overestimates the true value of a teacher's experience. Because experience is so correlated with tenure status and potential experience proves to be a poor predictor of total experience, the results of the Aaronson et al. study may not accurately estimate the effect of tenure on teacher performance. Furthermore, the measurement error for experience may bias the estimates of both tenure and experience toward zero because the error is not correlated with student test score gains. This impacts the variance of and adds noise to the estimates. A more precise estimate may result from using data on true, reported years of teaching experience instead.

In another study, Thomas A. Kersten (2006) discusses possible negative outcomes of tenure. Kersten surveyed a simple random sample of 291 Illinois school board presidents. Most strikingly, 51% of the respondents agreed that "eliminating teacher tenure would increase student achievement," suggesting that tenure may be a "primary barrier to student achievement." Additional responses show that an overwhelming

majority (91%) of respondents agreed that "tenure law inhibits the dismissal of below average teachers." These strong negative opinions generate a case for empirical research to appropriately determine whether these arguments have merit and should be factored into the policymaking process.

Teacher Incentives and Merit Pay

Policymakers have considered and implemented a variety of alternative policies in an effort to create incentives for teachers to improve performance. Merit pay programs, for example, attempt to more effectively link teacher performance and pay. Public school teacher compensation is generally based on a rigid pay scale determined by two teacher characteristics: the highest degree obtained and the number of years of teaching experience. Merit pay programs, in comparison, provide higher pay – either through raises or bonuses – to teachers with high levels of performance. Literature on the effectiveness of merit pay is inconclusive. Dee and Keys (2004) used data from Tennessee's Project STAR to evaluate the effects of Tennessee's highly comprehensive merit pay system, the Career Ladder Evaluation System. Their research found that teachers who placed onto the "career ladder" after meeting a set of requirements were associated with student math score gains of nearly 3 percent. Eberts et al. (2002) found that a merit pay program in Michigan was successful at meeting its primary goal of increasing course completion rates. However, the program did not have positive effects on other, secondary, desired outcomes. For example, the program had no effect on student GPA, reduced the daily attendance rate, and increased the percentage of students who failed. The authors suggest that merit pay is only successful at producing those

outcomes for which teachers are directly rewarded – student retention in this example. Further research on merit pay suggests that it is most effective when awarded selectively (Figlio and Kenny, 2007) and in school districts that have the least parental oversight (Figlio and Kenny, 2007) and that have a lower degree of union influence (Ballou, 2001). These findings suggest that when administrators are freer to use and target a school's resources to achieve specific results, incentives are more likely to be successful at improving teacher performance. Although merit pay differs from tenure policies in many ways, empirical research on the effect of merit pay as an incentive can provide a framework to better understand incentive forces that also relate to tenure.

Teacher Characteristics Related to Effectiveness

The extensive literature on teacher effectiveness identifies many factors that are associated with student achievement. These correlations help explain the link between teacher quality and student performance. By taking them into account throughout my analysis, I can more effectively isolate and estimate the effect of tenure on teacher performance.

Experience. Most researchers acknowledge that the effect of an additional year of teaching experience on student achievement levels off after the first few years of teaching (Rockoff, 2004; Rivkin et al., 2005) and some argue that this effect eventually recedes (Aaronson et al., 2007). Wayne and Youngs (2003) assert that a review of literature shows generally positive effects of experience on teacher quality. Nonetheless they note that these findings are "difficult to interpret" due to factors not accounted for in most models such as changes in motivation, personal life situation (children, divorce, etc.), and

labor market changes over time, as well as the recognition that teachers who stay in the profession and have many years of experience may be very different from teachers that leave after only a few years.

In addition, there is no research that explains why the effect of experience flattens out when it does. A ceiling effect whereby teachers will ultimately reach some maximum level of effectiveness after gaining experience and confidence in the classroom should be expected, but it is unclear why this tends to happen at the same time that most states grant tenure (two to four years). This leads to an important question of whether this connection is merely coincidence or if there is a more complex relationship at play in which tenure status prompts the estimated effects of experience to taper off prematurely.

Certification Status. Goldhaber and Brewer (2000) used data from NELS:88 to determine the effects of different teacher certification levels on student achievement. They find that the type (standard, emergency, probationary, or private) of certification that a teacher holds is related to student outcomes. Additionally, the students of teachers certified "out of field" do less well than the students of teachers certified in the subject matter being taught. The strongest finding is that students of teachers with standard certification in math do better than students with teachers that have either no certification or private school certification in math, but their findings are relatively weak. Although one might expect the effects of certification status to relate to those of tenure status, since it is often based on years of experience, this is not the case. Probationary certification lasts for the first few years in which a teacher holds his or her position, similar to the probationary status that a teacher has until obtaining tenure, but unlike obtaining standard certification, acquiring tenure provides teachers with benefits – mainly increased job

security – that may affect a teacher's quality and alter incentives to perform at high levels.

Race, Gender, and Ethnicity. Several studies have considered the effects of teachers' race, gender, and ethnicity (RGE) on student performance. Ehrenberg et al. (1995) used NELS:88 data and a regression modeled on the education production function to conclude that, while there are some relationships between these demographic traits and student productivity, they are relatively small. The study found that while teacher RGE by itself is not related to student achievement, combinations of a specific gender with a certain race or ethnicity may produce statistically significant correlations for a given subject. For example, black male science teachers are associated with academic gains for black male, black female, and white female students. In another study, Thomas Dee (2004) used data from the randomized Tennessee STAR experiment to conclude that when students and teachers are of the same race or ethnicity, an elementary school student's reading and math scores are significantly higher.

Education History. There are many factors related to a teacher's education history that have been shown to be related to teacher effectiveness. These include highest degree obtained, coursework and subject matter of degree(s), and rating of undergraduate institution. A review of research shows that most findings regarding degrees held and coursework taken are largely inconclusive except in relation to math. High school math teachers with an educational background in these fields produce significant gains in student achievement in math (Wayne and Youngs, 2003). Research also indicates that the ranking of the undergraduate institution attended does have some relationship with student achievement gains (Wayne and Youngs, 2003), although it is possible that this

effect is overestimated because individuals that get into higher ranked schools are also likely to have other characteristics such as high levels of natural intelligence, more motivation, and better organization skills, all of which may also correlate with positive teacher effects on student achievement.

Test Scores. A teacher's test scores, whether on college entrance exams, tests of verbal skills, or teacher licensure examinations, can provide some measure of a teacher's natural aptitude and intelligence level. Wayne and Youngs (2003) conducted a review of studies examining test scores and found that they are related to higher student achievement in studies in which college ratings have not been taken into account. Because both test scores and undergraduate institution ranking, as mentioned above, are related to an individual's innate intelligence and ability to work and to learn, these variables may prove to be effective mechanisms to control for teacher ability in a regression to measure teacher effectiveness.

Measuring Teacher Effectiveness

Models to Measure Teacher Effectiveness. Teacher effectiveness is most commonly evaluated using a multivariate regression based on an education production function of the following form:

$$Y = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + ... + \alpha_m X_m + \varepsilon$$

in which Y is some indicator of student achievement. The X's represent all educational inputs (usually student, school and classroom, and teacher characteristics) that affect student achievement. Most regressions based on the education production functions that address teacher effectiveness use as the dependent variable some measure of student

performance. This measure is often the gain in a student's test scores from an initial or base period to the period in which all other relevant data (including characteristics of the teacher in question) are observed. Independent variables in these functions tend to include vectors of control variables at the student level, at the school and classroom levels, and at the teacher level. This model fits the needs of research on teacher tenure because it creates a structure in which all relevant educational inputs can be held constant in order to determine the correlation between a specific input – tenure status – and the output – teacher performance – as measured by student achievement.

Methodology

I will use multiple regression analysis to determine the effect of teacher tenure status on teacher effectiveness. A naïve way to consider the relationship in question is through the following model:

$$Y_{it} = \beta_0 + \beta_1 tenure_{it} + \varepsilon_{it} \quad (1)$$

in which Y measures student i's test score gain in the subject taught by teacher t as a function of the tenure status of teacher t. By measuring only tenure status and student test score gains, this equation neglects to control for confounding variables, such as years of teaching experience, that may be related to both tenure status and test score gains. Therefore, the estimated coefficient for tenure status, β_1, will be a biased estimate of the effect of teacher tenure on teacher performance because the error term, ε, is likely correlated with tenure. In order to eliminate this bias, the regression must control for variables that are related to tenure status that contribute to student test score gains. The resulting model is a form of the education production function:

$$Y_{it} = \beta_0 + \beta_1 tenure_{it} + \beta_2 T_{it} + \beta_3 X_{it} + \beta_4 S_{it} + \varepsilon_{it} \quad (2)$$

Y still measures student i's test score gain in the subject taught by teacher t, but a measure of tenure is no longer the only independent variable. It is now supplemented by the vectors T, X, and S, which consist of variables that control for teacher, student, and school and classroom characteristics, respectively. This more comprehensive model takes into account confounding factors that may lead to a spurious correlation between teacher effectiveness and tenure status that would emerge from equation (1).

Control Variables

I will control for several teacher characteristics that may also explain some of the variation in student test scores. Variables included in the vector of teacher characteristics are age, gender, race and ethnicity, education history (degree(s) obtained, major field of study), and years of teaching experience.

Rothstein (2008) found that teacher assignments are "not strictly exogenous, even conditional on a fixed individual effect" and argues that a regression measuring teacher performance must take into account the non-random element of classroom assignments. Teachers of honors classes or teachers that are known to give students harder assignments, for example, may attract higher performing students to their class. In order to control for this non-random factor of classroom assignment, student characteristics must be controlled for in my regression model. The student-level controls I use include gender, race and ethnicity, age, family income level, and parents' education levels. In accordance with similar research I also include variables for family size (Hanushek, 1971; Goldhaber and Brewer, 2000; Ehrenberg et al., 1995), special education or

disability status (Aaronson et al., 2007; McCaffrey et al., 2004; Jacob, 2007; Ehrenberg et al., 1995), English proficiency status (Ehrenberg et al., 1995), and initial academic ability as measured by the base year (eighth grade) subject test score (Aaronson et al., 2007; Goldhaber and Brewer, 2000; Ehrenberg et al., 1995). Additionally, I will include measures of student absenteeism from and attentiveness in class since the test scores of students that frequently miss class or do not pay attention are likely not an accurate reflection of their teachers' quality.

School and classroom controls used in this and similar research include school size, percentage of minority students enrolled (Goldhaber and Brewer, 2000; Ehrenberg et al., 1995), and percentage of students receiving free or reduced-price lunch, all of which correlate with student performance. Many models also aim to measure classroom effects by considering factors such as class size (Goldhaber and Brewer, 2000) in order to better evaluate how a teacher divides his or her attention among students in a classroom. I control for class size as well as additional information such as the total amount of class time per week in my data analysis. There may also be incentive effects on teachers that correlate with improvement in teaching quality and also tenure states, which vary by school-specific policies and reward systems. I account for one such factor – the frequency of classroom observation by a school administrator – in my analysis.

Finally, I will use a set of dummy variables to control for the state in which a teacher is employed. Each state may have specific laws regarding teachers such as certification procedures or incentive-based policies. These dummies will take into account the fixed effects of differences across states.

Measuring the Effect of Tenure

To answer the question of whether tenure status leads to a decrease in teacher performance, I will consider results from various permutations of equation (2). I will test the statistical significance of β_1, the coefficient of the variable for tenure status, to determine whether any correlation exists between teacher effectiveness and tenure status. In addition, to ensure that any change in teacher effectiveness, as measured by student score gains, is not solely because experience effects level off, I will compare teacher effectiveness for each year of teaching across states that have different tenure policies by measuring experience relative to when a teacher obtains tenure. I will test, for example, whether teachers that obtained tenure after two years of teaching perform better or worse in the third year of teaching than teachers that will obtain tenure after four years. This will separate the effects of experience from the effects of tenure. If I find differences in teacher performance based on tenure laws, the results may suggest that it is tenure, and not experience, which causes teacher effects on student test scores to level off.

Data

This paper uses restricted data from the National Education Longitudinal Study of 1988 (NELS:88), a nationally representative survey of approximately 25,000 eighth graders from 1,052 high schools in all fifty states in 1988. The restricted data contains a subset of 14,915 students who were surveyed and tested again in 1990 and 1992, and then surveyed two more times in 1994 and 2000. This research will use data collected in the base year (eighth grade) and in the first follow-up year (tenth grade). Data collected in each of these years includes responses from surveys administered to the students, their

parents, their school's administrators, and to two of their teachers, as well as their test scores from two subject areas (out of mathematics, science, reading/English, and social studies/history). Because this data links students to information on characteristics of their teachers and schools, the specific effects of teachers on students can be studied.

The subject tests, developed by the Educational Testing Survey and administered to students between February and June of eighth, tenth, and twelfth grades, allow for estimates of student achievement gains from eighth to tenth grade. NELS:88 uses Item Response Theory (IRT) to translate scores on exams given in different grades and for different subjects to a common scale. Ehrenberg et al. (1995) measure student test score gains as the difference between the tenth grade IRT-adjusted estimated number of correct responses and the rescaled eighth grade IRT estimated number of correct responses in order to determine the effect tenth grade teacher characteristics. Because this research also uses eighth grade scores as a base measure for student gains and focuses on the effects of certain characteristics of tenth grade teachers, I will use the IRT estimated number correct to measure student test score gains.

Because the NELS:88 surveys do not ask teachers whether they have tenure, I will infer tenure status by considering years of teaching experience as well as the state in which a teacher is employed. Each state has its own tenure law, ranging from one to one to five years of probationary status before becoming eligible for tenure. Figure 1 shows the state tenure law for each state in 1990 and illustrates the variation in tenure policies across states. I will match years of experience to the number of years required by a state to obtain tenure to create a measure of tenure status. This will also permit me to compare

teachers with the same number of years of experience but with different tenure status in order to further examine the effects of tenure.

My analysis of the effect of teacher tenure on student performance is restricted to a sample of students enrolled in eighth grade in 1988 and tenth grade, at a public school, in 1990. For a student to be used in the analysis, I must have data on that student's test scores in eighth and tenth grades in a subject for which I have data on that student's tenth grade teacher. Also, only teachers for whom there is data on the number of years employed at the current school and on the state in which a teacher is employed, such that state laws can be used to infer their tenure status, are retained in the sample. Many states do shorten or offer individual school boards the option of shortening probationary periods for teachers who obtained tenure from a different school district in the state, but these policies vary significantly and the shortened probationary periods are often applied to teachers on a case-by-case basis. Due to insufficient information on teacher employment history, I am unable to identify those teachers that receive tenure after fewer years of employment in a school. Applying the aforementioned restrictions results in an analysis sample of 14,817 students and 6,325 teachers.

In addition, research on the effect of teacher characteristics on student performance usually separates the sample by class subject and finds different results accordingly. For example, Rockoff (2004) concludes that the effect of a teacher's experience on student achievement varies by subject. Other research on teacher race, gender, and ethnicity (Ehrenberg et al.) and teacher certification (Goldhaber and Brewer) separate the sample according to school subject as well. Therefore, in accordance with previous literature on teacher effects, this analysis will also evaluate the effects of teacher

tenure on student test score gains by subject. Once the sample is divided into the four subjects – English, history, math, and science – there are fewer teachers in each group. Basic tabulations (see Appendix Table 1) of the number of teachers for each subject show that when years of experience relative to obtaining tenure are very low or very high, there are very few teachers at each level of experience, creating an outlier problem. Because the precision of estimates in the analysis so strongly relies on appropriately measuring and controlling for teacher experience, a teacher that shares his or her number of years of experience with fewer than thirty other teachers of the same subject in the sample will be dropped from the analysis. In order to then ensure that each of the four subject groups are analyzed uniformly, I determined a range of experience relative to tenure for which there are at least thirty teachers at each level of experience in each subject group and retained in my sample only those teachers with experience levels within this range. As a result, teachers in my sample have between negative three and twenty-one years of teaching experience relative to earning tenure. The final sample has 12,799 observations of which 4,322 link student English test score gains to tenth grade English teachers, 2,025 do the same for history, 3,427 for math, and 3,005 for science.

Results

Summary Statistics

Tables 3 and 4 describe the characteristics of the teachers and students, respectively, in the remaining sample. Each table compares the distribution of characteristics for teachers with and without tenure. The data in Table 3 identifies differences between teachers that do and do not have tenure. As one should expect,

tenured teachers are older and more experienced than non-tenured teachers. The magnitude of the difference of the variables in this sample, however, is important to note. Tenured teachers are approximately 7.66 years older, have about 10.6 additional years of total teaching experience, and have taught at their current school for just over 11.5 more years. On average, non-tenured teachers have taught at their current school for only about one and a half years, and may even still be adjusting to the school whereas the average tenured teacher has been there for over thirteen years and may be more comfortable with the school environment. If there are unobserved characteristics such as these associated with being older or have more experience, omitting these variables from the analysis may bias the estimates produced by regression. Since the size of the difference in age and years of experience between the two groups is so large, this bias could potentially be quite large. In addition, non-tenured teachers in the sample are, on average, just over two years away from earning tenure while tenured teachers have, on average, had tenure for approximately 9.67 years. As with age, if there are unmeasured differences between teachers who have recently earned tenure and those who have had it for a longer period of time, the characteristics of tenured teachers in the sample may not be very similar to those of non-tenured teachers, even after controlling for those traits for which I do have data. Beyond differences in age and experience, non- tenured teachers in this sample are more likely to be Hispanic or black, are less likely to have majored in the subject they teach (though more likely to have minored in it), and teach a given class for more total minutes each week. Finally, non-tenured teachers are more likely to have their teaching observed, and observed regularly, by school administration, which could explain why teachers without tenure might perform better than those with it.

The data from Table 4 suggests that tenured teachers are significantly more likely to have students with higher levels of socioeconomic status (income level and parents' education levels), higher eighth grade test scores, and students who are white. These characteristics are often associated with higher-performing students and schools. The simple difference in sample means also indicates that students of tenured teachers see larger test score gains between eighth and tenth grade. Teachers without tenure, on the other hand, appear to be associated with students that are limited English proficient (LEP) and students that are Hispanic or black, all of which are traits of students and schools that are on the lower end of the achievement distribution.

Regression Analysis

Column (1) of Table 5 shows the most naïve estimate of the effect of tenure, which is a simple regression of tenure status on student gain scores, controlling for subject. The coefficient on tenure, 0.159, means that, on average, students with tenured teachers get an additional 0.159 questions right, from eighth to tenth grade, than students without tenured teachers. Table 3 shows that there is a significant correlation between tenure and experience, so careful separation of the two variables is necessary in order to more precisely estimate the true effect of tenure on teacher performance. By neglecting to control for the effect of experience, this initial estimate of the coefficient on tenure very likely suffers from significant omitted variable bias.

Adding variables for experience level to the model may alleviate this bias and more accurately measure the effect of tenure. Much literature in the field of education recognizes that the relationship between experience and student performance is likely to

have a non-linear relationship. For this reason many researchers, such as Aaronson et al. (2007) and Rockoff (2004), include quadratic or cubic functions of experience in their models. I will follow suit in my analysis and include experience, experience-squared, and experience-cubed. In this paper, I measure a teacher's experience at his or her current school relative to when the teacher earns tenure. Measuring experience relative to tenure provides additional insight into the effect of experience by directly comparing teachers with the same level of experience but different a tenure status due to the tenure law for the state in which a teacher is employed. I can then narrow in on the change in teacher performance that occurs just after earning tenure. A value of negative one for this experience variable indicates that the teacher will have tenure beginning the following year, a value of zero indicates that a teacher is in his or her first year of tenure, a value of one indicates that the teacher is in his or her second year with tenure, and so forth. I can now estimate tenure again and take the effect of experience into account by regressing tenure status, experience, experience-squared, and experience-cubed on student test score gains, while controlling for subject. This results again in an estimate of the effect of tenure that is not significant. The coefficient on tenure, as seen in column (2) of Table 5, is approximately 0.0776, which means that, after controlling for experience and subject, students whose teachers have tenure answer approximately 0.0776 questions correctly in tenth grade than students whose teachers do not have tenure. In addition, the three measures of teacher experience relative to earning tenure (linear, quadratic, and cubic terms) are not significantly associated with improvements in student test scores.

While the last estimate should bring us closer to the true effect of tenure on student performance, there may still be other important variables omitted from the

analysis. The summary statistics from Table 4 show that tenured teachers are significantly more likely to have students with higher eighth grade test scores, suggesting that student assignment to teachers may not be random and instead that factors such as student aptitude may be taken into account when assigning students to teachers and classes. These students may be more likely to improve their scores or, instead, perhaps they have already scored at such a high level that there is simply little room to improve compared to a student with a lower eighth grade score. By controlling for students' base year test scores, the relationship between student aptitude and assignment to a tenured or non-tenured teacher as well as the potential ceiling effect of test scores can be assessed in order to more precisely estimate the effect of tenure. Indeed, a regression of tenure status, experience variables, and eighth grade scores on gain scores, holding subject constant, results in a new estimate of the effect of tenure. This new coefficient shown in column (3) of Table 5 is 0.077, which is approximately the same value as the previous regression. As before, it is not significant. Although an improvement of one point of an eighth grade score is significantly associated with a decrease in gain scores by approximately 0.03 points, the unchanged estimate of the tenure effect indicates that a student's base year score is not confounded with tenure and gain scores. However, it may still be an important measure to control for because it can be related to other student characteristics that are associated with gain scores or having a teacher with tenure.

Although these three regressions allowed me to begin to narrow in on the true effect of tenure, I know from the statistics in Tables 3 and 4 that the tenured and non-tenured teachers still differ in many ways, and I must use regression analysis in order to control for student, school, and teacher characteristics that may be associated with

whether a teacher has tenure or that may affect student test scores. For example, Table 4 shows that students of higher socioeconomic status are more likely to have a tenured teacher. If students with these characteristics are also more likely to earn higher test scores, then socioeconomic status must be controlled for in my analysis. Similarly, as noted previously in this paper, characteristics such as gender, race, or ethnicity can be related to test scores. Controlling for characteristic differences of students and teachers according to tenure status and for potential confounding factors as well as subject, I again estimate the effect of tenure on student gain scores. The results are shown in column (4) of Table 5. The estimate of the coefficient on tenure reveals that holding all other variables constant, a student with a tenured teacher has a 0.12 greater test score gain than a student without a tenured teacher, with a standard error of approximately 0.26. With a t-statistic of 0.48 ($p=0.631$), this estimate is not significant despite its increase in magnitude from the estimate in column (3), and I cannot reject the null hypothesis that there is no effect of tenure on student test score gains. The positive sign of the coefficient suggests an overall positive effect of tenure on student achievement. However, the magnitude of this effect is relatively small – approximately 2.1% of a standard deviation of the sample distribution of student gain scores (5.816). Even if this were the true effect of tenure, its size is negligible, and, with a 95% confidence interval of the estimate that ranges from -0.38 to 0.63, does not provide convincing evidence that tenure has an effect, in any direction, on student performance.

Results By Subject

The effect of teacher characteristics on student performance may vary according to subject. In addition, the subject tests administered as part of NELS:88 vary in the total number of questions, so the meaning of a test score will also vary according to the subject. For these two reasons, dummy variables for each of the four school subjects are not sufficient for this analysis. Instead, I ran a separate regression for each subject. Estimates of the coefficients from each of these regressions appear in Table 6.

As seen in Table 6, each estimate has a magnitude lower than 0.3 and none are significantly significant. The coefficients on tenure for history and math teachers are positive but for science and English teachers are negative. The effects of teacher characteristics on student performance tend to be more alike for math and science than for other subjects, as is the case with variables such as experience (Rockoff, 2004) or educational history (Wayne and Youngs, 2003). Here, however, I do not find the effect of tenure to even be in the same direction for math and science. While tenure experience may, in reality, have opposite effects on teacher performance in these two subjects, given the small size of these effects and the relatively large standard errors, it is more likely that the findings provide further evidence that there is no effect of tenure.

Results Using Eighth Grade Teacher Characteristics

The change in a student's test scores from eighth to tenth grade is a function of the impact of both the tenth grade teacher and the ninth grade teacher. Furthermore, because students in the sample were tested in eighth grade between February and June, an eighth grade teacher may have continued to improve a student's achievement in the

remaining months of school after the testing date. Although the NELS:88 data does not include information on the characteristics of ninth grade teachers, it does have sufficient information on eighth grade teachers such that I can include measures of eighth grade teacher tenure status and experience in my model. Adding these variables should make the estimates of teacher effects more precise by better identifying how much of a student's test score change can be attributed to the tenth grade teacher versus the eighth grade teacher. Not all student data is matched to teachers of the same subjects for both eighth and tenth grade, so the number of observations in the sample of student test scores in subjects with teacher data dropped from 12,779 to 10,546 with the inclusion of eighth grade teacher characteristics.

Table 7 shows estimates from a regression model that includes variables for eighth grade teacher tenure status and experience. Column (1) displays the results from a regression with subject dummy variables and the following four columns display the results of subject-specific regressions. There are no general patterns of change in the magnitude and direction of the estimates of the effect of tenure and experience from those presented in Table 5, column (4) or Table 6 to those in Table 7. However, including eighth grade teacher characteristics does result in estimates that suggest a significant negative effect of tenure for eighth grade history teachers and a significant positive effect of tenure for tenth grade English teachers. These differences are interesting because they are a change in both magnitude and direction from estimates of the effect of tenure status for tenth grade teachers in the same subject, but because there seems to be no pattern of changes for all estimates after adding the eighth grade teacher characteristics, the new

estimates do not provide convincing evidence in support of tenure having a significant effect on teacher performance.

Results for "New" Teachers

Considering the many differences between teachers with and without tenure (Table 3), it is quite feasible that there are several other unobserved factors that are associated with tenure status and that, if omitted, may bias estimates of the effect of tenure. The most striking difference in a measured teacher characteristic is that of experience. On average, teachers with tenure have been teaching at their current schools for over eleven years longer than their non-tenured counterparts. If there are confounding variables associated with teacher experience and performance, their omission may bias my results, especially because the difference in experience is so large. Furthermore, there are no teachers in my sample with greater than six years of experience but have not earned tenure, meaning that there is no variation in tenure status at higher levels of experience. To address the concerns that even after controlling for teaching experience there may still be unobserved confounding variables associated with experience, I re-estimated the effects of tenure dropping teachers with greater than ten, and then five, years of experience after earning tenure status. Arguably, this creates groups that are more similar to one another and may thus narrow in on the effect of being granted tenure on changes in performance in the short-run. As seen in Table 8, estimates of the coefficient on tenure display a pattern as the sample of teacher changes from those with fewer than twenty-two years of experience relative to tenure, to those with ten or fewer, and finally to those with five or fewer. For the entire sample as well as each of the four

subjects, the coefficient becomes more negative as the sample of teachers with tenure becomes smaller. The pattern is certainly noteworthy and it is tempting to draw some kind of conclusion from it. However, none of the coefficients become significant, and the size of each estimate is still small compared to the standard deviation of the sample distribution of gain scores. Also, each of the coefficients from all regressions using smaller groups of teachers according to experience level fall within the 95% confidence interval for the estimate of the tenure effect resulting from the complete sample. These findings appear to suggest that by limiting the analysis to teachers with lower levels of experience, the groups of tenured and non-tenured teachers become more similar to each other. The changes in the estimates of the effect of tenure may be explained by a reduction in bias that results from omitting variables associated with more experience or older teachers.

Discussion

Taken at face value, the results of this paper suggest that tenure status has no effect on teacher quality. To evaluate what this means about the effectiveness of tenure policies, it is important to recognize that there are different goals associated with tenure policies and that some schools, school districts, or states may be interested in only one of them. If, for example, the aim is to give teachers job security and fair treatment with regard to firing policies, then tenure may be effective at achieving it; my research does not address this. If the rationale behind tenure goes a step further and intends for job security to provide an incentive for high quality teaching, I do not see evidence that earning tenure improves teacher performance. If tenure policies appropriately filter out

the lower quality teachers in their first few years, meaning that they are fired before earning tenure, I would expect to see a positive effect of earning tenure since the group of teacher with tenure should consist of only good teachers. I did not find such an effect, which prompts the question of whether tenure truly provides job security to those teachers that have earned it as a result of high performance in the classroom. According to a Hoover Institution report, school districts in the US, on average, dismiss about one teacher per year for poor performance (Hess, 2003). If true, this statistic suggests that many lower quality teachers do not get cut from the system can eventually earn tenure, thus providing a possible explanation for my finding that tenure has no effect on teacher performance, since the mix of good and bad teachers by tenure status should be similar. However, this statistic may be misleading. Teachers are not necessarily "fired" for poor performance. School administrators may pressure a teacher to resign or retire, or the teacher's contract may simply not be renewed during his or her probationary period. Depending on how districts define "firing" and report the figures, the low rate of teacher firings may not tell us much about whether job security already exists de facto for teachers without tenure since dismissal is so rare, or if tenure is the only true way for a teacher to obtain job security. In the case that tenure does not provide meaningful incentives for teacher improvement, any change in performance as a result of earning tenure would be a function of some other variable correlated with tenure status.

That the effect of tenure on teacher performance changes when I limit the analysis to teachers with younger levels of experience draws attention to a general problem with trying to assess tenure policies. Tenure is based on years of experience, and teachers who do not earn tenure are usually not rehired to their current school and must seek

employment elsewhere. Full-time teachers with over five years of experience at their current school most likely have tenure. Those with ten or fifteen years almost certainly do. I am therefore unable to observe the teaching quality of teachers that have high levels of experience but no tenure and compare them to teachers that have the same level of experience and also tenure. Since there may be an effect of experience on performance, it is impossible to completely separate this effect from that of tenure for more experienced teachers and thus to estimate the true effect of tenure across the whole experience distribution.

Along these lines, an important focus in my research design was to untangle the effects of tenure and teacher experience on teacher quality. Aaronson et al. (2007) did consider tenure in their study on teacher performance and also found no effect, but used a flawed experience measure. My analysis uses true levels of experience at a teacher's current school, but was subject to limitations of the NELS:88 data. Although the data does report the precise number of years of experience that a teacher has in his or her current school, data on a teacher's total number of years of experience is missing for many teachers in the sample. Experience is too important a factor to impute the missing data, so the variable was not included in the analysis. However, of those teachers for whom I had data on both current school experience and total experience, the values of the two variables were only the same for about thirty-five percent of the teachers. This suggests that many teachers have prior experience, perhaps during which time the return in effectiveness for an additional year of experience has already leveled off. Still, the motivation to earn tenure at a new school may affect performance during the probationary period and the incentive to continue teaching at high levels may alter once

job security is obtained. While the estimated effect of experience on performance in my analysis may be diminished somewhat as a result of missing data, I suspect that the significance of the effect of tenure might not be altered if complete information on teacher experience were included in the regression model.

Another methodological concern is that a teacher's tenure status was inferred based on state laws and current school experience. Aaronson et al. (2007) used a similar method by comparing a teacher's potential experience to the Illinois tenure law and inferring tenure. While the method used in this research is in line with previous literature, there are always exceptions to the rule. For example, a teacher that switches to a new school in the same state or district may, depending on the state's law, have a shorter or even non-existent probationary period before earning tenure than that which a new teacher would have. A dataset that has specific information on a teacher's employment history would permit more accurate measures of tenure status and therefore more precise estimates of the effect of tenure on teacher performance.

There are several other variables that might be effective controls for this analysis but that were either not included in this analysis but would be useful for future research. For example, knowing the range of salaries for full-time teachers in a given school might be a useful variable. Not only do wage ranges provide information on incentives available to teachers, but also younger teachers with potential for larger raises in the future may perform at a higher level than teachers who expect smaller raises over time. Similarly, tenured teachers and those with greater experience at the school are likely to receive salaries near the high end of the range of wages and therefore not have much more room to increase wages, which could reduce the effect of the incentive to improve teaching

quality. Unfortunately, for too many schools in my sample (well over 20%) there was no data on salary range and imputing a value of the variable for so large a group of the sample would likely pose threats to the validity of my analysis.

Conclusions

This analysis suggests that teacher tenure does not have an effect on teacher performance, as measured by student test score gains. Even if we accept the point estimates, the magnitudes of the estimates are too small a percent of the standard deviation of the gain scores sample distribution for tenure to have a truly meaningful impact on student achievement.

With so much recent attention on how education policies can be used to improve teacher quality, it is important to research and understand the effects of policies, such as teacher tenure, that may affect teacher performance. Because these findings suggest that tenure does not impact teacher quality, the goals of a tenure program should be reevaluated. If tenure policies are meant simply to provide job security and protection for teachers, without affecting their performance, then it may be doing its job. However, if job security is meant to provide an incentive for teachers to improve by giving them the freedom to try more creative teaching styles or, this paper does not find evidence of such an effect.

There may be additional costs and benefits of tenure policies that are not identified in my analysis but that may help explain the impact of tenure on teachers, students, and schools. If the cost to school districts to fire a tenured teacher is too large, then tenure policies may prevent schools from firing poorly performing teachers. For

example, a school may decide that it is not worth the time or legal fees to argue for the dismissal of a tenured teacher in front of a state tenure board and would choose to retain poorly performing teachers, possibly giving them easier classes or students to teach in order to minimize the negative effects of their low quality teaching. On the other hand, school boards may grant tenure as a substitute for wage increases for teachers of higher quality or more experience. Seen in this light, tenure as an alternative to higher pay may make available more of a school's budget for school resources or programs. A cost-benefit analysis may reveal the magnitude of costs and benefits associated with tenure policies and thus allow for a more thorough evaluation of the impact of the policies.

With policymakers continuously examining how best to improve public education and teacher quality, research on teacher tenure is highly relevant. Tenure policies have long been implemented throughout the country, yet little is known about their impact on teacher performance. The results of this paper highlight the need for further research and consideration of a policy that has, for a century, has been a seldom-questioned status quo.

Data Appendix 1: Notes on State Tenure Policies

1. For each state, I first located the tenure policy in the current state statutes or code. I then conducted Lexis Nexis State Capital searches on the terms "Teacher AND tenure", "Teacher AND contract", and the state code number (to check for any legislation citing or amending it) for each year from 1991 to 2009 in order to determine if there had been any policy change regarding the number of years required to obtain tenure. I checked for news reports if I found a policy change and compared my findings to data on tenure laws from 1971 and 2007 as listed in reports by the National Education Association and the Education Commission of the States.
2. For several states, there was either no statewide or specified policy regarding tenure in 1990.
    a. Arkansas: Teachers receive tenure, and with it due process rights, after a three year probationary period. However, they are not granted an automatically renewing contract for an indefinite period of time. Instead contracts are limited to three-year time periods. I will determine that obtaining due process rights is the point at which tenure may change a teacher's perception of job stability and thus potentially alter a teacher's incentives. I will define the tenure law for Arkansas as three years.
    b. Mississippi, North Dakota, Vermont: None of these states had laws regarding tenure in 1990, but all provided tenure-like rights to teachers in their first year of teaching. I will therefore define the tenure law for each of these three states as one year.
    c. Wisconsin: In 1990, tenure protection existed for teachers who obtained tenure in cities with a population over 150,000 (after three years of consecutive service) and in counties with a population over 500,000 (after three years of consecutive service with a contract renewal for a fourth year). Contract renewal for all other teachers was based on collective bargaining procedures. Because it is near impossible to know which schools had which policy in 1990 and because the majority of my sample of Wisconsin observations comes from the more populated areas with specific tenure laws, I will define the tenure law for Wisconsin as three years.

Data Appendix 2: Notes on Variable Creation

For number-range categorical variables:

- If there were at least five categories, for each category, the average of the range (ex: 75 If the range is 50 to 100) were used as each unit's output for that variable
- For an un-bounded maximum-level category (example: income of $200,000 or more), I used the minimum boundary for the category (ex: $200,000).
- This method was used for family income, teacher age (by year of birth), minutes of class or lab time per week, school size, percent of students in a school receiving free or reduced price lunch, percent of students in a school that are not White.
    - All other variables used except for student test scores, teacher experience, and tenure status, are categorical dummy variables

For missing variables:

- If an observation was missing data for a categorical variable (such as race, gender, etc.), the observation was given a value of 0 for the variable and a value of 1 for a dummy variable indicating missing data (ex: male=0 and mis_male=1),
- For non-categorical variables, observations with missing data for a given variable received the mean value of the variable for all observations with reported data. Dummies indicating missing data for each of these variables were included in the regression model.

Measuring Tenure Status and Experience

- A variable indicating the length of the probationary period for each teacher's state of employment was generated. The values of this variable ranged from one to five.
- A variable was generated for a teacher's years of experience at the current school of employment relative to earning tenure by subtracting from the teacher's current school experience the length of the probationary period plus one year.
    - Ex: a teacher in his or her fourth year, in a state that grants tenure after three consecutive years of employment will have a value for this experience level equal to "0," indicating that the teacher is in his or her first year with tenure.
- A variable for tenure status was generated by assigning "1" to all teachers for whom their current school experience relative to tenure was greater than or equal to zero.

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Figure 1: Tenure Laws By State

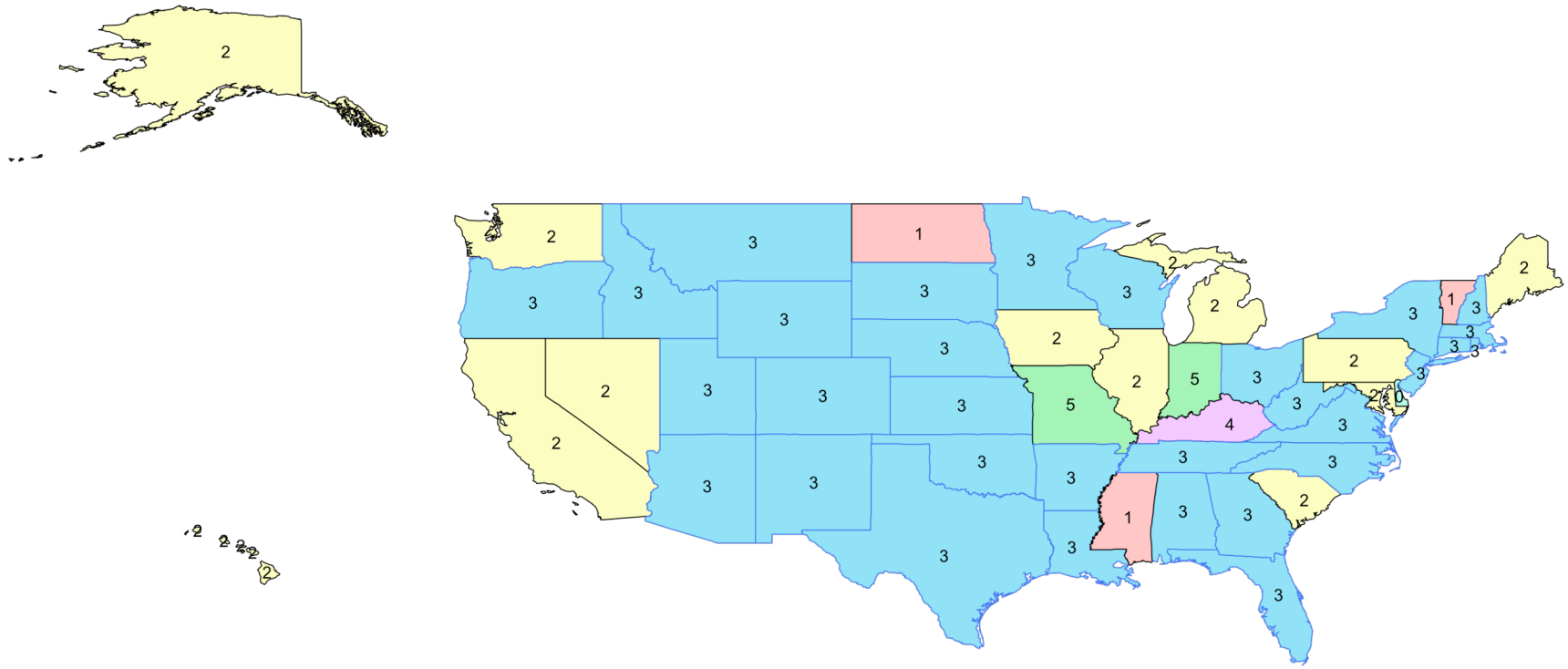

Figure 2: Scatterplot of Total Experience versus Potential Experience for Eighth Grade Math Teachers, with Fitted Values

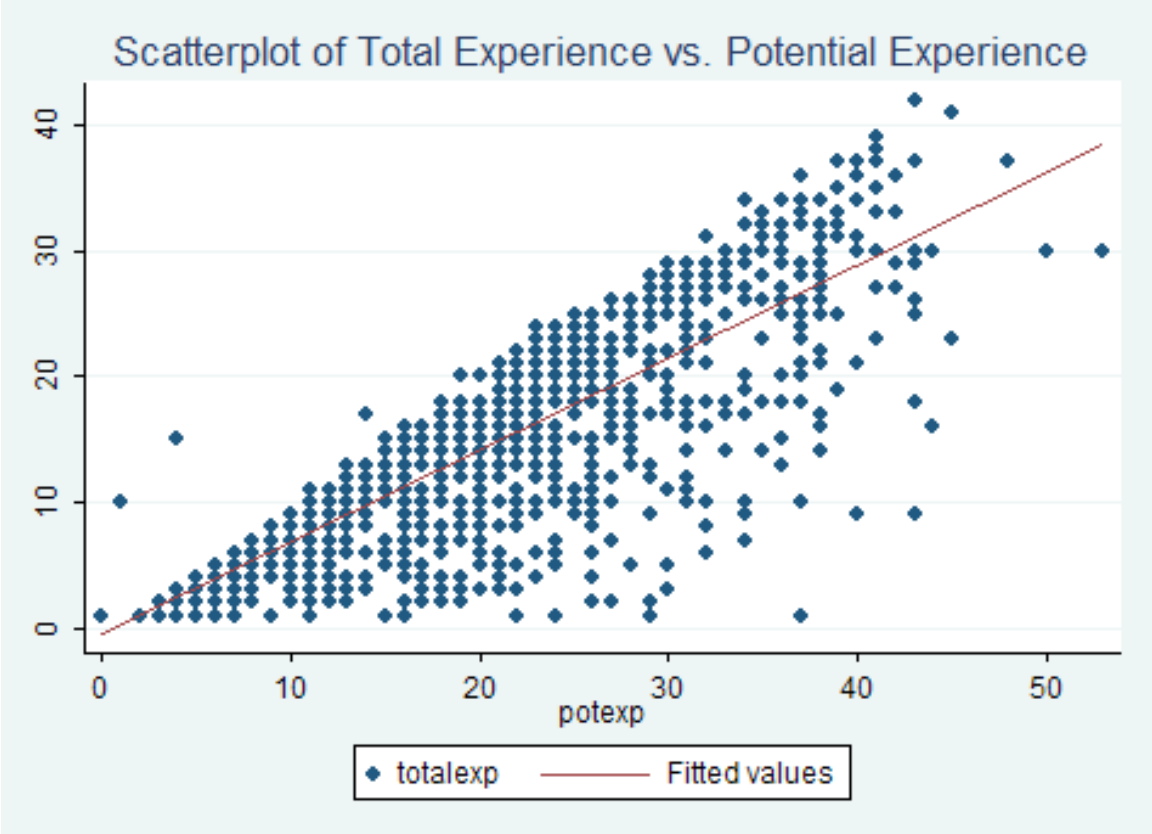

Table 1: Stata Output for Regression of Total Experience on Potential Experience for Eighth Grade Math Teachers

```
      Source |       SS       df       MS              Number of obs =    4955
-------------+------------------------------           F(  1,  4953) =10650.90
       Model |   310276.42     1   310276.42           Prob > F      =  0.0000
    Residual |  144288.187  4953  29.1314733           R-squared     =  0.6826
-------------+------------------------------           Adj R-squared =  0.6825
       Total |  454564.607  4954  91.7570867           Root MSE      =  5.3974

------------------------------------------------------------------------------
      potexp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    totalexp |   .9332549   .0090429   103.20   0.000     .9155269     .950983
       _cons |   7.074891   .1556784    45.45   0.000     6.769693     7.38009
------------------------------------------------------------------------------
```

Table 2: T-Test of the Difference Between Potential Experience and Total Experience for Eighth Grade Math Teachers

```
Paired t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
totalexp |    4955    14.98264    .1204687    8.480005    14.74647    15.21882
  potexp |    4955    21.05752    .1360812    9.578992    20.79074     21.3243
---------+--------------------------------------------------------------------
    diff |    4955   -6.074874    .0770887    5.426412   -6.226002   -5.923746
------------------------------------------------------------------------------
     mean(diff) = mean(totalexp - potexp)                          t = -78.8036
 Ho: mean(diff) = 0                           degrees of freedom =     4954

 Ha: mean(diff) < 0           Ha: mean(diff) != 0           Ha: mean(diff) > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

Table 3: Teacher Summary Statistics

Variable	Whole Sample	Tenure	No Tenure	Difference
Male***	0.4854 (0.0063) n=6300	0.5064 (0.0071)	0.4048 (0.0135)	0.0997 (0.1538)
Female***	0.515 (0.006) n=6300	0.4936 (0.0071)	0.5932 (0.0135)	-0.0997 (0.1538)
American Indian	0.0041 (0.0008) n=6287	0.0042 (0.0009)	0.0038 (0.0017)	0.0004 (0.0020)
Asian or Pacific Islander	0.0099 (0.001) n=6287	0.0107 (0.0015)	0.0068 (0.0023)	0.0039 (0.0031)
Hispanic***	0.0253 (0.0029) n=6287	0.0224 (0.0021)	0.0361 (0.0051)	-0.0138 (0.0048)
Black**	0.0121 (0.0014) n=6287	0.0105 (0.0014)	0.0182 (0.0037)	-0.0076 (0.0034)
White	0.9019 (0.0014) n=6287	0.9034 (0.0042)	0.8961 (0.0084)	0.0073 (0.0034)
Age***	42.6740 (0.1121) n=6154	44.3042 (0.1200)	36.6402 (0.2123)	7.6640 (0.2559)
Total Years of Teaching Experience***	15.7622 (0.1430) n=4718	18.1601 (0.1504)	7.4670 (0.2283)	10.6931 (0.3055)
Number of Years Teaching at Current School***	10.9570 (0.1038) n=6325	13.3899 (0.1079)	1.8720 (0.0252)	11.5179 (0.2089)
Years of Experience Relative to Earning Tenure***	7.1943 (0.1045) n=6325	9.6705 (0.1081)	-2.0524 (0.0247)	11.7229 (0.2093)
Years of Education	15.8570 (0.0211) n=6308	15.8436 (0.0247)	15.9070 (0.0388)	-0.0634 (0.0517)
Teaches Subject of College Major***	0.7201 (0.0062) n=5169	0.7295 (0.0070)	0.6852 (0.0140)	0.0443 (0.0153)
Teaches Subject of College Minor**	0.3442 (0.0075) n=3972	0.3362 (0.0084)	0.3750 (0.0170)	-0.0388 (0.0187)
Teaches Subject of Graduate Degree	0.4380 (0.0084) n=3475	0.4365 (0.0092)	0.4456 (0.0208)	0.0091 (0.0227)
Never Observed by Administrator Last Semester***	0.2860 (0.0062) n=5392	0.3311 (0.0072)	0.1152 (0.0095)	0.2159 (0.0148)
Observed by Administrator Once Last Semester***	0.03724 (0.0066) n=5392	0.3949 (0.0075)	0.2872 (0.0135)	0.1077 (0.0161)
Observed by Administrator 2 to 3 Times last Semester***	0.3203 (0.0064) n=5392	0.2589 (0.0067)	0.5523 (0.0148)	-0.02934 (0.0151)

Observed by Administrator at least Once per Month Last Semester***	0.0182 (0.0018) n=5392	0.0127 (0.0017)	0.0390 (0.0058)	-0.0263 (0.0045)
Observed by Administrator at Least Once per Week Last Semester**	0.0032 (0.0008) n=5392	0.0023 (0.0007)	0.0062 (0.0023)	-0.0039 (0.0019)
Minutes of Class per Week**	235.0819 (0.8591) n=6092	233.9939 (0.9803)	239.0949 (1.7711)	-5.1010 (2.0964)
Weekly Minutes of Lab Time per Week	20.9539 (0.5909) n=5945	21.3196 (0.6819)	19.6130 (1.1631)	1.7066 (1.4401)
Class Size	24.0018 (0.0922) n=6048	24.0446 (0.1037)	23.8418 (0.2015)	0.2029 (0.2259)

*significant at 10%;** significant at 5%;*** significant at 1%

Table 4: Student Summary Statistics

Variable	Whole Sample	Tenure	No Tenure	Difference
Male	0.477 (0.004) n=14741	0.475 (0.005)	0.483 (0.009)	-0.008 (0.010)
Female	0.524 (0.004) n=14741	0.525 (0.005)	0.517 (0.009)	0.008 (0.010)
American Indian***	0.042 (0.002) n=11760	0.039 (0.002)	0.053 (0.004)	-0.013 (0.004)
Asian or Pacific Islander***	0.067 (0.002) n=11760	0.073 (0.002)	0.045 (0.004)	0.028 (0.005)
Hispanic***	0.115 (0.003) n=11760	0.109 (0.003)	00.141 (0.006)	-0.032 (0.007)
Black***	0.098 (0.003) n=11760	0.0910 (0.003)	0.128 (0.006)	-0.037 (0.006)
White***	0.673 (0.004) n=11760	0.684 (0.004)	0.631 (0.009)	-0.053 (0.010)
Language Other than English Spoken at Home	0.446 (0.009) n=2945	0.449 (0.010)	0.433 (0.020)	0.016 (0.023)
Limited English Porficient (LEP)**	0.012 (0.001) n=14441	0.011 (0.001)	0.016 (0.002)	-0.006 (0.002)
Learning Disability	0.062 (0.002) n=14074	0.060 (0.002)	0.066 (0.005)	-0.005 (0.005)
Family Size	4.633 (0.012) n=14722	4.625 (0.013)	4.662 (0.027)	-0.036 (0.029)
Family Income***	36488.15 (243.075) n=13844	33949.000(519.876)	37135.950 (274.421)	3186.942 (603.435)
Father Years of Education***	13.458 (0.024) n=12521	13.549 (0.027)	13.094 (0.050)	0.455 (0.060)
Mother Years of Education***	13.168 (0.021) n=13091	13.220 (0.024)	12.963 (0.005)	0.257 (0.053)
8^{th} Grade Test Score***	28.002 (0.086) n=14817	28.261 (0.097)	26.984 (0.182)	1.277 (0.212)
Test Score Gain (8^{th} Grade to 10^{th} Grade)*	4.134 (0.048) n=14817	4.177 (0.054)	3.965 (0.105)	0.212 (0.119)

*significant at 10%;** significant at 5%;*** significant at 1%

Table 5: Regression Analysis

	(1)	(2)	(3)	(4)
Tenure	0.159	0.078	0.077	0.124
	(0.133)	(0.264)	(0.264)	(0.259)
Subject Dummies				
English	0.770	0.768	1.050	1.531
	(0.129)***	(0.129)***	(0.138)***	(0.169)***
History	-0.429	-0.430	-0.063	0.531
	(0.156)***	(0.156)***	(0.168)	(0.189)***
Math	4.853	4.853	5.467	6.718
	(0.136)***	(0.136)***	(0.172)***	(0.195)***
Teacher Characteristics				
Tenure Exp		0.022	0.028	-0.025
		(0.064)	(0.064)	(0.063)
Tenure Exp-squared		-0.002	-0.002	0.002
		(0.008)	(0.008)	(0.008)
Tenure Exp-cubed		0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)
Male				-0.361
				(0.105)***
Hispanic				-0.390
				(0.454)
Black				0.056
				(0.669)
Other non-White				-0.291
				(0.470)
Age				0.001
				(0.007)
Associates Degree				0.482
				(0.423)
Bachelors Degree				0.019
				(0.126)
Education Degree or Certification				0.015
				(0.212)
Masters Degree				0.314
				(0.139)**
Doctorate Degree				0.141
				(0.464)
Professional Degree				-1.641
				(0.664)**
Teach Subject of Major				0.564
				(0.134)***
Teach Subject of Minor				0.351
				(0.139)**
Teach Subject of Graduate Degree				0.008
				(0.124)
Observed Once				-0.081
				(0.120)
Observed 2 to 3 Times				-0.213
				(0.136)
Observed Monthly				-0.239
				(0.381)
Observed Weekly				-1.383
				(1.049)
Student Characteristics				
Eighth Grade Test Score			-0.034	-0.112
			(0.006)***	(0.006)***
Male				0.355

				(0.095)***
Asian or Pacific Islander				0.555
				(0.229)**
Hispanic				-0.627
				(0.207)***
Black				-1.210
				(0.184)***
American Indian				-0.531
				(0.245)**
Speak English at Home				-0.021
				(0.220)
Family Income				0.000
				(0.000) .
Family Size				0.005
				(0.035)
Father HS Diploma				0.525
				(0.163)***
Father Some College				0.932
				(0.185)***
Father at Least College Degree				1.014
				(0.195)***
Mother HS Diploma				0.326
				(0.159)**
Mother Some College				0.703
				(0.183)***
Mother at least College Degree				0.677
				(0.199)***
Absent from Class Most or				-1.290
All of the Time				(0.293)***
Absent Some of Time				-0.622
				(0.112)***
Attentive in Class Most or				1.686
All of the Time				(0.207)***
Attentive Some of Time				0.756
				(0.218)***
Limited English Proficient				-0.246
				(0.453)
Learning Disability				-2.443
				(0.206)***
<u>School and Class Characteristics</u>				
School Size				0.000
				(0.000)***
Percent of Students Receiving				-0.004
Free Lunch				(0.003)
Percent of Non-White Students				0.004
				(0.003)
Minnutes of Class Time per				0.000
Week				(0.001)
Minutes of Lab Time per				-0.002
Week				(0.001)
Class Size				0.012
				(0.006)**
Constant	2.534	2.573	3.180	3.294
	(0.151)***	(0.191)***	(0.217)***	(1.108)***
Observations	12779	12779	12779	12779
R-squared	0.128	0.128	0.130	0.195

Standard errors in parentheses;*significant at 10%;** significant at 5%;*** significant at 1%
Note: Regressions included dummy variables for the state in which a teacher is employed; also dummies for observations with missing data for each variable used in a regression.

Table 6: Regression Analysis by Subject

	English	History	Math	Science
Tenure	-0.006	0.294	0.250	-0.224
	(0.493)	(0.462)	(0.630)	(0.403)
Teacher Characteristics				
Tenure Exp	-0.080	-0.064	0.079	0.064
	(0.122)	(0.112)	(0.157)	(0.097)
Tenure Exp-squared	0.014	0.001	-0.010	-0.015
	(0.015)	(0.013)	(0.019)	(0.012)
Tenure Exp-cubed	-0.001	0.000	0.000	0.001
	(0.000)	(0.000)	(0.001)	(0.000)
Male	-0.270	-0.073	-0.537	-0.086
	(0.207)	(0.181)	(0.248)**	(0.162)
Hispanic	-0.595	-0.073	1.246	-1.484
	(0.881)	(1.706)	(1.017)	(0.599)**
Black	-0.169	0.261	-1.308	0.951
	(1.209)	(1.842)	(1.626)	(1.060)
Other non-White	-0.080	-0.471	-0.333	-1.029
	(1.075)	(0.945)	(0.974)	(0.666)
Age	0.007	0.022	-0.015	0.010
	(0.013)	(0.013)*	(0.018)	(0.011)
Associates Degree	0.731	1.307	0.207	-0.711
	(0.748)	(0.859)	(1.090)	(0.595)
Bachelors Degree	0.145	0.032	0.196	-0.057
	(0.240)	(0.213)	(0.313)	(0.200)
Education Degree or Certification	-0.073	0.328	-0.567	0.498
	(0.386)	(0.338)	(0.507)	(0.382)
Masters Degree	0.303	-0.182	0.681	0.276
	(0.259)	(0.224)	(0.354)*	(0.226)
Doctorate Degree	0.016	0.845	0.641	0.491
	(0.840)	(0.843)	(1.428)	(0.610)
Professional Degree	-1.093	0.118	-5.109	-1.279
	(1.373)	(0.817)	(2.355)**	(1.034)
Teach Subject of Major	0.728	0.696	0.990	0.193
	(0.319)**	(0.259)***	(0.373)***	(0.183)
Teach Subject of Minor	1.027	0.131	0.525	0.123
	(0.358)***	(0.228)	(0.418)	(0.172)
Teach Subject of Graduate Degree	-0.269	0.218	0.240	0.012
	(0.237)	(0.208)	(0.314)	(0.191)
Observed Once	0.061	-0.022	-0.194	0.034
	(0.228)	(0.220)	(0.281)	(0.194)
Observed 2 to 3 Times	-0.177	-0.294	0.095	-0.445
	(0.253)	(0.240)	(0.334)	(0.217)**
Observed Monthly	0.416	0.144	-0.373	-0.843
	(0.789)	(0.706)	(0.980)	(0.511)*
Observed Weekly	-0.575	-3.643	-4.990	1.465
	(2.840)	(2.083)*	(2.197)**	(1.327)
Student Characteristics				
Eighth Grade Test Score	-0.155	-0.266	-0.076	-0.257
	(0.012)***	(0.019)***	(0.011)***	(0.017)***
Male	0.066	0.440	0.093	1.024
	(0.178)	(0.156)***	(0.227)	(0.146)***
Asian or Pacific Islander	0.275	1.259	0.531	0.314
	(0.412)	(0.394)***	(0.527)	(0.354)
Hispanic	-1.073	-0.232	-0.447	-1.002
	(0.382)***	(0.350)	(0.490)	(0.318)***

Black	-0.914	-0.661	-1.899	-1.714
	(0.339)***	(0.3024)**	(0.462)***	(0.268)***
American Indian	-0.721	-0.160	-1.114	-0.403
	(0.463)	(0.379)	(0.6084)*	(0.365)
Speak English at Home	0.282	0.093	-0.239	0.220
	(0.398)	(0.386)	(0.527)	(0.336)
Family Income	0.000	0.000	0.000	0.000
	(0.000) .	(0.000) .	(0.000) .	(0.000)***
Family Size	-0.095	-0.007	0.109	-0.036
	(0.064)	(0.059)	(0.084)	(0.054)
Father HS Diploma	0.423	0.406	1.054	0.171
	(0.299)	(0.272)	(0.385)***	(0.249)
Father Some College	1.060	0.624	1.549	0.297
	(0.340)***	(0.307)**	(0.435)***	(0.282)
Father at Least College Degree	1.139	0.749	1.391	0.791
	(0.363)***	(0.321)**	(0.464)***	(0.296)***
Mother HS Diploma	0.247	0.428	0.363	0.593
	(0.291)	(0.269)	(0.382)	(0.2414)**
Mother Some College	0.539	0.928	0.921	0.865
	(0.336)	(0.300)***	(0.437)**	(0.278)***
Mother at least College Degree	0.572	1.051	1.040	0.540
	(0.370)	(0.323)***	(0.478)**	(0.300)*
Absent from Class Most or	-0.407	-0.574	-3.671	-0.783
All of the Time	(0.556)	(0.509)	(0.7368)***	(0.3992)**
Absent Some of Time	-0.415	-0.495	-1.038	-0.715
	(0.208)**	(0.188)***	(0.264)***	(0.173)***
Attentive in Class Most or	2.434	1.352	1.370	1.603
All of the Time	(0.387)***	(0.317)***	(0.527)***	(0.310)***
Attentive Some of Time	1.422	0.469	-0.021	1.092
	(0.405)***	(0.340)	(0.551)	(0.326)***
Limited English Proficient	-1.122	-1.677	0.718	0.252
	(0.816)	(0.832)**	(1.194)	(0.625)
Learning Disability	-2.664	-1.217	-4.278	-1.612
	(0.367)***	(0.342)***	(0.534)***	(0.318)***
<u>School and Class Characteristics</u>				
School Size	0.000	0.000	0.000	0.000
	(0.000)**	(0.000)	(0.000)	(0.000)*
Percent of Students Receiving	-0.002	-0.005	-0.001	-0.009
Free Lunch	(0.006)	(0.006)	(0.008)	(0.005)*
Percent of Non-White Students	0.003	0.003	0.005	0.000
	(0.005)	(0.004)	(0.006)	(0.004)
Minutes of Class Time per	-0.001	0.000	0.000	0.002
Week	(0.001)	(0.001)	(0.002)	(0.001)
Minutes of Lab Time per	0.000	0.002	-0.007	0.001
Week	(0.004)	(0.002)	(0.004)*	(0.002)
Class Size	0.023	0.007	0.048	0.003
	(0.016)	(0.013)	(0.018)***	(0.011)
Constant	1.035	6.130	10.488	4.802
	(2.435)	(3.540)*	(6.804)	(1.624)***
Observations	4322	2025	3427	3005
R-squared	0.097	0.197	0.122	0.177

Standard errors in parentheses;*significant at 10%;** significant at 5%;*** significant at 1%
Note: Regressions included dummy variables for the state in which a teacher is employed; also dummies for observations with missing data for each variable used in a regression.

Table 7: Regression Analysis with Eighth Grade Teacher Characteristics

	(1)	English	History	Math	Science
Subject Dummies					
English	-5.152				
	(0.155)***				
History	-6.172				
	(0.173)***				
Science	-6.583				
	(0.211)***				
8th Grade Teacher Characteristics					
Tenure	-0.078	0.126	-1.283	0.089	0.069
	(0.255)	(0.521)	(0.467)***	(0.622)	(0.389)
Tenure Exp	-0.024	-0.003	0.089	-0.003	-0.091
	(0.046)	(0.099)	(0.080)	(0.109)	(0.072)
Tenure Exp-squared	0.003	0.004	-0.006	0.005	0.002
	(0.004)	(0.010)	(0.008)	(0.010)	(0.007)
Tenure Exp-cubed	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
10th Grade Teacher Characteristics					
Tenure	0.435	1.378	0.454	0.147	-0.302
	(0.284)	(0.595)**	(0.495)	(0.680)	(0.442)
Tenure Exp	-0.044	-0.247	-0.077	0.112	0.071
	(0.069)	(0.146)*	(0.120)	(0.171)	(0.105)
Tenure Exp-squared	0.003	0.026	0.008	-0.012	-0.015
	(0.008)	(0.018)	(0.014)	(0.021)	(0.013)
Tenure Exp-cubed	0.000	-0.001	0.000	0.000	0.001
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
Male	-0.417	-0.432	0.003	-0.501	-0.053
	(0.114)***	(0.250)*	(0.194)	(0.269)*	(0.176)
Hispanic	-0.263	-0.317	-0.161	0.727	-1.537
	(0.505)	(0.969)	(1.694)	(1.097)	(0.726)**
Black	0.101	-0.204	0.584	-0.884	0.430
	(0.748)	(1.362)	(1.883)	(1.687)	(1.322)
Other non-White	-1.145	-0.354	-1.302	-1.609	-1.177
	(0.554)**	(1.293)	(1.013)	(1.253)	(0.758)
Age	-0.003	0.012	0.018	-0.026	0.012
	(0.008)	(0.016)	(0.014)	(0.019)	(0.012)
Associates Degree	0.569	1.211	1.811	0.312	-0.805
	(0.461)	(0.866)	(0.940)*	(1.161)	(0.651)
Bachelors Degree	0.054	0.300	0.118	0.061	-0.043
	(0.139)	(0.293)	(0.229)	(0.337)	(0.215)
Education Degree or Certification	-0.079	-0.417	0.294	-0.675	0.752
	(0.240)	(0.481)	(0.361)	(0.568)	(0.433)*
Masters Degree	0.335	0.214	-0.424	0.857	0.233
	(0.153)**	(0.309)	(0.241)*	(0.385)**	(0.244)
Doctorate Degree	0.017	-0.559	0.656	0.842	0.411
	(0.490)	(0.951)	(0.925)	(1.502)	(0.627)
Professional Degree	-1.714	-1.487	0.205	-5.327	-1.325
	(0.683)**	(1.535)	(0.834)	(2.526)**	(1.064)
Teach Subject of Major	0.440	0.578	0.355	0.781	0.189
	(0.145)***	(0.392)	(0.275)	(0.402)*	(0.197)
Teach Subject of Minor	0.370	1.100	0.080	0.635	0.064
	(0.149)**	(0.437)**	(0.242)	(0.452)	(0.184)
Teach Subject of Graduate Degree	0.009	-0.295	0.373	0.239	-0.053
	(0.136)	(0.286)	(0.226)*	(0.336)	(0.207)
Observed Once	-0.041	0.197	0.140	-0.103	0.014
	(0.132)	(0.278)	(0.238)	(0.309)	(0.211)
Observed 2 to 3	-0.220	-0.060	-0.166	0.011	-0.394

Times	(0.149)	(0.306)	(0.255)	(0.362)	(0.231)*
Observed Monthly	-0.087	1.951	-0.010	-0.885	-0.771
	(0.449)	(1.376)	(0.712)	(1.106)	(0.570)
Observed Weekly	-1.269	-0.042	-2.671	-4.864	1.706
	(1.064)	(2.865)	(2.435)	(2.204)**	(1.427)
Student Characteristics					
Eighth Grade Test Score	-0.109	-0.157	-0.270	-0.069	-0.266
	(0.007)***	(0.014)***	(0.020)***	(0.012)***	(0.018)***
Male	0.419	0.169	0.438	0.226	1.005
	(0.104)***	(0.212)	(0.164)***	(0.244)	(0.156)***
Asian or Pacific Islander	0.625	0.720	1.321	0.194	0.306
	(0.252)**	(0.503)	(0.423)***	(0.566)	(0.384)
Hispanic	-0.567	-0.741	-0.086	-0.501	-1.213
	(0.230)**	(0.465)	(0.380)	(0.534)	(0.349)***
Black	-1.242	-0.920	-0.687	-1.686	-1.838
	(0.200)***	(0.407)**	(0.319)**	(0.489)***	(0.286)***
American Indian	-0.499	-0.434	-0.118	-1.339	-0.519
	(0.267)*	(0.574)	(0.395)	(0.664)**	(0.378)
Speak English at Home	0.061	0.169	0.406	-0.088	0.290
	(0.244)	(0.486)	(0.424)	(0.572)	(0.361)
Family Income	0.000	0.000	0.000	0.000	0.000
	(0.00)**	(0.000)	(0.000)	(0.000)	(0.00)***
Family Size	0.012	-0.042	-0.013	0.049	-0.045
	(0.039)	(0.077)	(0.063)	(0.091)	(0.058)
Father HS Diploma	0.574	0.620	0.381	1.064	0.137
	(0.177)***	(0.353)*	(0.290)	(0.412)***	(0.265)
Father Some College	0.787	0.711	0.527	1.534	0.266
	(0.202)***	(0.408)*	(0.323)	(0.467)***	(0.303)
Father at Least College Degree	0.858	0.957	0.548	1.342	0.694
	(0.214)***	(0.435)**	(0.337)	(0.497)***	(0.319)**
Mother HS Diploma	0.251	0.006	0.494	0.225	0.658
	(0.173)	(0.347)	(0.283)*	(0.406)	(0.257)**
Mother Some College	0.592	0.454	1.055	0.537	0.808
	(0.200)***	(0.406)	(0.316)***	(0.469)	(0.297)***
Mother at least College Degree	0.613	0.603	1.138	0.718	0.557
	(0.216)***	(0.444)	(0.337)***	(0.507)	(0.321)*
Absent from Class r More/All of the Time	-1.325	-0.597	-0.413	-3.643	-0.748
	(0.328)***	(0.700)	(0.526)	(0.831)***	(0.429)*
Absent Some of Time	-0.636	-0.372	-0.452	-1.050	-0.748
	(0.123)***	(0.249)	(0.197)**	(0.286)***	(0.186)***
Attentive in Class Most/All of the Time	1.661	2.316	1.359	1.277	1.719
	(0.228)***	(0.462)***	(0.343)***	(0.570)**	(0.334)***
Attentive Some of Time	0.712	1.224	0.412	-0.145	1.238
	(0.239)***	(0.479)**	(0.366)	(0.594)	(0.351)***
Limited English Proficient	-0.448	-1.358	-1.975	0.824	0.338
	(0.542)	(0.980)	(0.934)**	(1.456)	(0.794)
Learning Disability	-2.472	-2.610	-1.261	-4.431	-1.899
	(0.228)***	(0.438)***	(0.358)***	(0.578)***	(0.345)***
School and Class Characteristics					
School Size	0.000	0.000	0.000	0.000	0.000
	(0.000)***	(0.000)**	(0.000)	(0.000)	(0.000)
Percent of Students Receive Free Lunch	-0.003	-0.005	-0.007	0.009	-0.009
	(0.004)	(0.007)	(0.007)	(0.009)	(0.006)
Percent of Non-White Students	0.005	0.004	0.005	0.005	0.000
	(0.003)*	(0.006)	(0.005)	(0.006)	(0.005)
Minutes of Class Time Per Week	0.000	-0.001	0.001	-0.001	0.001
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)

Minutes of Lab Time Per Week	-0.004 (0.002)**	-0.005 (0.005)	0.001 (0.004)	-0.009 (0.004)**	0.001 (0.002)
Class Size	0.009 (0.007)	0.008 (0.019)	0.015 (0.013)	0.047 (0.020)**	0.008 (0.012)
Constant	4.086 (9.436)	6.049 (5.923)	-0.459 (4.997)	-4.714 (7.103)	3.243 (4.223)
Observations	10546	3104	1800	2963	2679
R-squared	0.209	0.114	0.226	0.130	0.191

Standard errors in parentheses;*significant at 10%;** significant at 5%;*** significant at 1%
Note: Regressions included dummy variables for the state in which a teacher is employed; also dummies for observations with missing data for each variable used in a regression.

Table 8: Comparing the Effect of Tenure Among Different Groups

Regression Description	Number of Observations	Tenure Coefficient	Coefficient Standard Error	T-Statistic	P-Value	95% Confidence Interval
Full Regression, Subject Dummies						
Tenureexp≤22	n=12779	0.1244	0.2588	0.48	0.631	-0.3829 0.6316
Tenureexp≤10	n=8401	0.0096	0.3457	0.03	0.978	-0.6680 0.6871
Tenureexp≤5	n=6108	-0.0928	0.3608	-0.36	0.797	-0.8001 0.6146
English						
Tenureexp≤22	n=4322	-0.0056	0.4931	-0.01	0.991	-0.9724 0.9612
Tenureexp≤10	n=2867	-0.0633	0.6621	-0.1	0.924	-1.3615 1.2348
Tenureexp≤5	n=2063	-0.2948	0.7003	-0.42	0.674	-1.6683 1.0786
History						
Tenureexp≤22	n=2025	0.2941	0.4616	0.64	0.524	-0.6111 1.1994
Tenureexp≤10	n=1235	-0.1169	0.6353	-0.18	0.854	-1.3633 1.1296
Tenureexp≤5	n=887	-0.8235	0.6927	-1.19	0.235	-2.1832 0.5363
Math						
Tenureexp≤22	n=3427	0.2496	0.6300	0.4	0.692	-0.9858 1.4849
Tenureexp≤10	n=2364	-0.1153	0.8387	-0.14	0.891	-1.7600 1.5294
Tenureexp≤5	n=1757	0.1083	0.8930	0.12	0.903	-1.6432 1.8599
Science						
Tenureexp≤22	n=3005	-0.2237	0.4030	-0.56	0.579	-1.0139 0.5665
Tenureexp≤10	n=1935	-0.5495	0.5495	-0.98	0.326	-1.6467 0.5477189
Tenureexp≤5	n=1401	-0.3872	0.5832	-0.66	0.507	-1.5313 0.7570

Appendix Table 1: Distribution of the Sample of Tenth Grade Teachers by Subject and Years of Experience at Current School of Employment

Years of Experience Relative to Earning Tenure	Number of Observations				
	English	History	Math	Science	*Total*
-5	29	13	9	5	*56*
-4	39	9	42	17	*107*
-3	295	126	230	223	*874*
-2	294	164	283	247	*988*
-1	351	145	289	198	*983*
0	276	118	226	233	*853*
1	294	133	286	176	*889*
2	308	85	212	198	*803*
3	209	105	186	118	*618*
4	168	41	173	127	*509*
5	163	96	102	104	*465*
6	166	57	152	92	*467*
7	204	92	143	158	*597*
8	172	81	99	88	*440*
9	149	77	115	103	*444*
10	113	41	98	93	*345*
11	133	51	63	81	*328*
12	137	107	102	114	*460*
13	194	74	106	102	*476*
14	143	91	99	69	*402*
15	111	78	119	77	*385*
16	149	70	129	111	*459*
17	141	79	92	184	*496*
18	151	74	120	72	*417*
19	148	83	130	127	*488*
20	53	51	42	55	*201*
21	95	32	61	78	*266*
22	58	25	45	51	*179*
23	47	27	52	49	*175*
24	43	30	25	52	*150*
25	33	32	32	44	*141*
26	16	38	26	31	*111*
27	45	17	23	6	*91*
28	4	8	12	21	*45*
29	12	6	9	6	*33*
30+	22	15	34	5	*76*
Total	*4965*	*2371*	*3966*	*3515*	*14817*

Appendix Table 2: Distribution of the Sample of Tenth Grade Teachers by State Tenure Laws

Length of Probationary Period (year)	Number of States with Probationary Period Length	Number of Observations
1	3	275
2	12	4630
3	32	8890
4	1	239
5	2	783