Principal Turnover, Student Achievement and Teacher Retention

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Abstract

School principals are responsible for managing teachers, curricula and budgets. Despite the importance of principals, little is known about how principal turnover affects school quality. Using twelve years of administrative data from North Carolina public schools, I find that principal departures typically follow a downturn in school performance. The two years following a departure are marked by high teacher turnover and a dip in school performance, consistent with a small negative effect of principal turnover. Schools subsequently improve, returning to pre-turnover levels.

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1 Introduction

School principals play important and varied roles in the day to day operations of schools. As instructional leaders, principals select, monitor and support teachers, design curricula, and manage discipline. As administrative leaders, principals set budgets, manage the school facility, and develop relationships with the broader community. In addition to a broad range of responsibilities, principals have many constituents including students, parents, teachers, school boards and superintendents. (See, for example, Davis et al. (2005) and Richardson et al. (1993).) Improving principal quality has become a common focus of school reform efforts: A recent Department of Education report on turning around chronically low-performing schools recommends installing a new principal (Herman et al. (2008)) and over the last ten years many states, school districts and non-for-profits have introduced new initiatives to train and support principals.

Despite the attention currently paid to principals as levers for school improvement, much remains unknown about how school leadership affects student learning. In this paper I investigate the causes and consequences of principal turnover for academic achievement and teacher turnover by studying the changes that occur around the times that schools get new principals. In particular, I attempt to answer the following four questions: Do changes in student achievement cause principal turnover? What effect does principal turnover have an student achievement? What effect does principal turnover have on teacher retention? What is the relationship between teacher retention during a principal transition and subsequent student achievement?

Principal turnover is a common phenomenon nationwide. Using administrative data from Texas, Cullen and Mazzeo (2008) report that about 22% of principals switch jobs from one year to the next. Papa Jr. (2007) follows several cohorts of new principals hired in New York finds that after four years only 46% are still principals at the same school. Gates et al. (2006) follow a cohort of new principals find that after six years, only 37% of the Illinois cohort and 21% of the North Carolina cohort remained principals at the same school. In addition, it is known that more turnover takes place at low performing schools (Besley and Machin (2008) and Cullen and Mazzeo (2008)), schools located in high poverty communities, (Partlow and Ridenour (2008)), and schools with

more minority and limited English proficiency students (Gates et al. (2006) and Papa Jr. (2007)). Understanding the changes that accompany principal turnover is important not only because it is widespread, but also because any ill effects are disproportionately borne by disadvantaged students.

I study principal turnover using twelve years of administrative data from North Carolina public schools. Following the method of Jacobson et al. (1993), I measure student achievement at schools that will undergo a principal transition, are undergoing a principal transition, and have completed a principal transition. I take advantage of the panel aspect of the data to measure how schools perform relative to their usual performance before, during, and after a principal transition.

In line with the previous literature on the correlates of principal departure, I find that more turnover takes place at low performing schools. However, I find that this is not driven solely by permanent differences across schools. In fact, principal departures follow a downturn in school performance, a downturn which begins some four years before the new principal takes the helm. While it may be that principals who plan to quit work less in the years preceding departure, causing student achievement to suffer, it is also possible a drop in student achievement is a cause of principal turnover, either because principals quit in response to the unpleasantness of working at low performing schools, or because falling test scores make it more likely that a principal is fired.

The drop in school performance before the principal transition complicates inference on the causal effect of the transition. Since the typical school is doing badly relative to its usual performance before a new principal starts, it is entirely possible that the school would have experienced a recovery to its usual performance even in the absence of the principal transition.[1] Empirically, I find that test scores in the first two years of the new principal's tenure are low relative to both school performance under the old principal and to subsequent school performance under the new principal, which I argue is consistent with a small negative turnover effect. Performance then starts to rebound , returning to pre-transition levels by the end of the fourth year since the principal's departure.

Many of the ways that principals affect students are indirect. To change what students learn,

[1] This phenomenon, known as the Ashenfelter dip, was first described in Ashenfelter (1978) in the context of estimating the effects of job training programs on wages. De Paola and Scoppa (2008) note its importance in the context of assessing the effects of managerial turnover, albeit in soccer teams rather than schools.

principals need to change what goes on inside the classroom. One important channel through which principals affect students is selecting, monitoring and supporting teachers. Ingersoll (2001) argues that high teacher turnover can be both a sign of underlying problems in school performance and a cause of poor performance. In addition to examining student achievement, I also measure whether the population of teachers changes during principal turnovers. My findings suggest that principal turnover lowers teacher retention.

I start by estimating whether the teacher retention rate, the fraction of teachers at a school who return to teach at the same school in the following year, changes during a principal transition. Using the same strategy I adopt for student achievement, I compare teacher retention at schools that will undergo a principal transition, are undergoing a principal transition, and have completed a principal transition. I again take advantage of the panel aspect of the data to measure teacher retention at a school relative to the usual level of teacher retention at the same school, before, during, and after a principal transition.

Teacher retention drops during principal transitions. Teachers are less likely to return to the same school both when a principal is leaving and at the end of the first year of a new principal. I also measure the characteristics of teachers who leave during principal transitions. Teachers who leave during principal transitions are no different on any demographic measures I examine than teachers who leave the schools at other points of time.[2]

I find that while teacher retention is generally positively related to test score growth, this is not the case for transition schools. Two explanations for this finding are available in the literature. Brewer (1993) finds that the higher the fraction of teachers appointed by the current principal, the better a school performs. He argues that this is because teachers appointed by the current principal are more likely to share the principal's goals and vision for the school. The second explanation is that test score growth typically follows drops in test scores, and drops in test scores may precipitate the teacher turnover. I find evidence that suggests that Brewer (1993)'s explanation is more plausible and new principals may be more effective if they appoint more of the school's teachers.

[2]Would it be worth checking whether they are demographically similar to the departing principals? I think that I will check for "generation changes" - When an older principal leaves and a younger one takes over, is it the older teachers that account for the increased departures?

Previous work on how principals affect student achievement has primarily focused on the relationship between principal characteristics and student test score gains. Both traditional human capital variables such as the education and prior experience of the principal and variables designed to capture the leadership style of the principal have been studied. However, as in the analogous work on teacher characteristics (see, for example, Aaronson et al. (2007)), the evidence is mixed. Eberts and Stone (1988) find that test score gains are positively correlated with the principal's years of prior teaching experience and administrative experience, while Brewer (1993) finds no significant effect. *Add some citations here to the education literature on leadership style and principal effectiveness*. And, as Brewer (1993) points out, leadership style is likely endogenous since, for example, a student body with a high interest in academics may cause both high test score gains and a principal to emphasize academic achievement. *More literature review here.*

The remainder of the paper is organized as follows: In section 2, I present the model. Section 3 describes the data. Section 4 presents both the empirical specifications and the results. Section 5 concludes.

2 Empirical Framework

Consider the achievement test score, y, for a school s which is lead by principal j in year t. One way to consider the effect of principals on achievement test scores is to think about

$$y_{sjt} = \alpha_s + \beta_{sjt} + \epsilon_{sjt}$$

Here α_s represents the effect of time invariant characteristics of school s on achievement test scores, β_{sjt} represents the effect of principal j on school s in year t and ϵ_{sjt} is an error term that encompasses all of the other factors that affect achievement test scores. To estimate this relationship, it is necessary to put some restrictions on how principals affect student achievement test scores.

One restriction to consider is

$$\beta_{sjt} = \beta_j$$

This specification suggests that there are simply good (high β_j) and bad principals, and schools with good principals receive a uniform bump up in test scores for the duration of the principal's tenure.[3] I focus on a slightly more flexible form for principal effects, namely

$$\beta_{sjt} = \beta_{js} + T * \mathbb{1}\left(\text{principal } j \text{ is new to school } s \text{ in year } t\right)$$

Moving from β_j to β_{js} allows for the possibility that a principal who is highly effective at one school may be ineffective at another. In addition, I focus in this paper on the relationship between student achievement and principal turnover. I would like to allow for the possibility that principal turnover itself has an effect on student achievement. In this formulation, for a principal-school match with a given quality, the effect of the principal on student achievement test scores also depends on whether the principal has just arrived at the school. Note that the sign of T is hard to predict a priori: A new principal is less familiar with the students, teachers and school community and this loss of institutional knowledge may make T negative. On the other hand, a new principal may approach problems with fresh insight and teachers may work harder as they adapt to management policies of the new principal, suggesting a positive value for T.[4]

Parameters such as β_{js} and T are difficult to estimate. Principal changes are almost certainly correlated with ϵs because principal transitions occur for many different reasons. Whether a prin-

[3] If this formulation is correct, the method outlined in Rivkin et al. (2005) to provide a lower bound on the the variance of teacher quality within schools can be adapted to measure variance of principal quality. The intuition of Rivkin et al. (2005) is if the year-to-year variation in student test scores is larger between years when an input to student test scores has changed (in this case, if the school has a new principal,) this suggests that input is an important determinant of student test scores. More formally,

$$\begin{aligned} y_{sjt} &= \alpha_s + \beta_j + \epsilon_{sjt} \\ y_{sjt} - y_{sj't'} &= (\beta_j - \beta_{j'}) + (\epsilon_{sjt} - \epsilon_{sj't'}) \\ (y_{sjt} - y_{sj't'})^2 &= \beta_j^2 + \beta_{j'}^2 - 2\beta_j\beta_{j'} + e_{jj'stt'} \\ \text{where } e_{jj'stt'} &= \epsilon_{sjt}^2 + \epsilon_{sj't'}^2 - 2\epsilon_{sjt}\epsilon_{sj't'} + 2(\beta_j - \beta_{j'})(\epsilon_{sjt} - \epsilon_{sj't'}) \end{aligned}$$

If the variance of principal quality is the same across time, $E\left[\beta_{jt}^2\right] = E\left[\beta_{j't'}^2\right] = \sigma_\beta^2$. Denote $E\left[\beta_{jt}\beta_{j't'}\right]$ by $\sigma_{\beta_t\beta_{t'}}$. Then

$$E[(y_{sjt} - y_{sj't'})^2] = 2\left(\sigma_\beta^2 - \sigma_{\beta_t\beta_{t'}}\right) + E\left[e_{jj'stt'}\right]$$

If the principal does not change between t and t', $\sigma_\beta^2 = \sigma_{\beta_t\beta_{t'}}^2$ while if the principal does change between t and t', $\sigma_{\beta_t\beta_{t'}}^2 = 0$. As Rivkin et al. (2005) explain in the context of teacher changes, this assumption does not mean that schools hire randomly but that the expected product of the two deviations from mean principal quality in the school is zero. Empirically, if I regress squared changes of student test scores on an indicator for principal change and a constant, I do not find a statistically significant positive coefficient on principal change, suggesting that this model is wrong, the variance of quality in principals hired at the same school is small, or I do not have enough power to measure this variance in my data.

[4] A natural extension is to allow for the possibility that the sign of T varies with the performance of the school, since it seems possible that, for example, the loss of institutional knowledge is a bigger problem at schools that are performing well prior to the principal transition. This line of reasoning is suggested by the finding in Rowan and Denk (1984) that in schools with many students from low socioeconomic status families, transition effects are positive while in schools with few low SES students transition effects are negative. I explore this possibility empirically but find no compelling evidence that T varies in a systematic way with prior school performance.

cipal is new is almost certainly

Principals are fired, quit and retire.

Note that since particular cohorts of students moving through the school may be better or worse than usual and since the teaching staff is fairly stable from one year to the next, ϵ_{sjt} is likely to be serially correlated.

3 Data and Summary Statistics

To examine the relationship between principal turnover, student achievement and teacher retention I use administrative data on public schools in North Carolina distributed by the North Carolina Education Research Data Center (NCED), matched with data from the Common Core of Data (CCD).[5] The NCED data span twelve academic years, from the 1994-1995 school year through the 2005-2006 school year. During this period, the number of North Carolina public schools listed in the CCD rose from $1,968$ to $2,348$. As shown in Table 1, I restrict the sample to schools that were open (with students enrolled and teachers employed) for all twelve years.

To measure the timing of principal transitions as carefully as possible, I further restrict the sample to schools with reliable principal transition information. The data contain annual employment files (called Licensure-Salary Pay Snapshots) listing all teachers, counselors and principals. I match these files across years to measure the timing of principal transitions. For some schools, there is a year when no principal is listed. I exclude these schools from the sample. Similarly, there are schools that employ multiple principals in a single year. If a school had two principals, A and B, listed in a given year t, I exclude it unless only principal A was listed in year $t-1$ and only principal B in year $t+1$. This restriction eliminates, for example, schools with two principals for two years in a row and schools with two principals in the first or last years of the data. I exclude all schools with three or more principals employed in a single year. I am left with a sample of 979 schools.

A school experienced a principal transition between school years $t-1$ and t if the school

[5]North Carolina Education Research Data Center data is documented online at http://pubpol.duke.edu/centers/child/ep/nceddatacenter/. The Common Core of Data is available online at the National Center for Education Statistics' website, http://www.nces.ed.gov/.

had a new principal in t. Principal transitions are a common phenomenon. Figure 2 shows the distribution of job tenure for principals who started work at a North Carolina public school during the 1995-1996, 1996-1997 and 1997-1998 school years. More than half of these principals left their schools within four years. As summarized in Table 3, during the twelve school years analyzed here schools experienced 1.96 principal transitions on average. There was substantial variation across schools in the number of principal transitions; some schools had a single principal while others had seven principals.[6]

I measure school performance using student scores on annual state-wide exams. Currently, North Carolina public school students in 3rd through 8th grade take reading comprehension and math exams at the end of each school year, however only 3rd and 4th grade test scores are available for all 12 years of the sample period.[7] For this reason, I further restrict the sample to primary schools for my main analysis. To construct an annual school test score from student-level data, I exclude students who are missing test scores and then normalize math and reading scores separately by grade and subject to be mean zero and standard deviation one. I then compute the average 3rd grade and 4th grade reading and math scores of all the test takers at a given school, and average the four averages to produce a single school level score.[8] Middle school test scores, formed in the same way (but with 6th, 7th and 8th grade scores in place of 3rd and 4th grade scores) are available from the 1996-1997 school year through the 2004-2005 school year, three-quarters of the sample.

There are several potential problems with using these scores as a measure of academic achievement. One concern is not all students took the state exams, and the potential scores of excluded students might give a very different picture of academic achievement at the school. This does not appear to be a significant problem in North Carolina public schools. For example, Table 2 shows summary statistics for the 2000-2001 school year. While the average school enrollment (as reported in the CCD) is higher than the number of test takers, the difference is small; the average number of test takers is 96% of the average enrollment. A more serious concern is that test scores do a poor job of capturing important aspects of school quality such as whether students develop a

[6] In line with the results of Gates et al. (2006) and Cullen and Mazzeo (2008), primary schools experienced fewer principal transitions (1.89 on average) than middle schools (2.19) or high schools (2.05), with both differences statistically significant at the 10% level.

[7] More information about these exams is available online at http://www.dpi.state.nc.us/accountability/testing/eog/

[8] Taking the first principal component of the four scores yields similar results.

love of learning, or whether parents feel that children are safe at the school. Since NCED does not include information on these aspects of school quality, I am unable to measure how they relate to principal turnover with this data.

In addition to direct measures of academic achievement, I also examine the relationship between principal transitions and teacher retention. Teacher retention for year t is measured by the the percentage of teachers at the school in year t who return to the school to teach in year $t+1$. Average teacher retention is about 79% (averaged across all 979 schools and 12 years in the sample). This is a somewhat lower average retention rate than is typically reported (for example, Ingersoll (2001) reports that the national teacher retention rate was 87% in the 1990-1991 school year using data from the Schools and Staffing Survey). This difference could reflect higher than average turnover in North Carolina or difficulties matching teachers across years of data in the NCED.

4 Methodology and Results

4.1 Student Achievement

4.1.1 Elementary Schools

I start by measuring how, on average, a school performs during a principal transition relative to performance of the same school both before and after the transition. I follow the strategy adopted by Jacobson et al. (1993) in measuring earnings losses for displaced workers and estimate

$$y_{st} = \alpha_s + \gamma_t + \sum_{k \geq -m} D_{stk}\delta_k + \varepsilon_{st}$$

where s indexes schools and t indexes years. y_{st} is the school-year test score, α_s and γ_t are school and year fixed effects. $\{D_{stk}\}$ are dummy variables which turn on in year t at school s if the school changed principals k years ago (or, if k is negative, will change principals $-k$ years later). Year fixed effects are useful here because not all North Carolina public schools are included in the sample but test scores are normalized over all test takers, so the average score is likely to be

systematically different across years.[9] In the main specification, $\{D_{stk}\}$ begin at at $k = -4$, four years before the new principal assumes leadership of the school, and run through $k = 4$, with an additional dummy for five or more years since the new principal assumed leadership. Each coefficient δ_k measures how, on average, schools perform relative to their usual performance k years after a principal transition. Here usual performance is the omitted category of five or more years before the principal transition.

Note that some schools have multiple principal transitions during the sample period. One technique to deal with this is to restrict the sample to schools with just one principal transition. A second strategy, adopted here, is to include each transition separately. School-year observations are included in the regression just once if the school has zero or one principal transition, twice if the school has two principal transitions, etc. If, for example, a school gets a new principal in 1998 and in 2000, the year 2000 test score for that school will enter the regression twice, once with a two years post dummy turned on and once with a year of the transition dummy turned on. The point estimates are very similar with both techniques, but including all transitions yields significantly more precise estimates.[10]

The results are shown in Table 4 and plotted in Figure 3. Before a principal transition, on average test scores decline slightly. By the year before the new principal starts working at the school, scores average .014 lower than the baseline score at five or more years before the transition. To put this number in context, the average within-school standard deviation of the test score measure over the course of the twelve year sample period is .142, so this represents a drop of about 10% of the typical variation in scores. The school level test score is an average of student level test scores, so one way for this drop to occur is if every student at the school scored .014 lower on exam with mean zero and standard deviation one. Test scores continue to drop, on average, when the new principal starts working at the school, falling, on average to .021 below the school's baseline at the end of the new principal's first year, and .025 below the school's baseline at the end of the new principal's second year. (All three of these estimates for the δ_k are statistically significantly

[9] One idea that I haven't ever actually tested is looking at how the opening of an additional school in the same school district changes the odds of principal turnover.

[10] This strategy amounts to duplicating observations for schools with multiple principal transitions. In the main specification, the more principal transitions a school experiences the more weight it has in the estimation of the δ_k. I have also re-weighted the regression so each school has equal weight regardless of the number of transitions. The results do not change significantly.

different from zero at the 5% level.) Starting at the end of the third year of the new principal, the trend reverses and scores begin to rise. At the end of the fourth year since the new principal, scores are only .004 below baseline scores, and five or more years after the beginning of employment for the new principal, scores are actually higher on average than the baseline measure.

Column (1) of Table 4 shows the same results, though in a more parsimonious specification. During the four years before the new principal, scores are slightly below baseline and falling, though these estimates are not statistically significantly different from zero. During the first four years of the new principal, scores are significantly lower than usual (by 0.034 points relative to baseline scores) but rising, on average each year (by 0.006) suggesting about six years until a full return to baseline scores.

4.1.2 Middle Schools

End-of-grade tests are given to 3rd-8th grade students. However, test score data for middle school students is available for only three quarters of the sample. Despite this limitation, I use the same technique on the available years of middle school test scores (the 1996-1997 school year and the 2004-2005 school year). The results, shown in Figure 4, match the findings of the elementary school transitions.

As in the elementary school case, test scores fall on average in the years preceding the principal transition. The scores are lowest in the two years immediately following the departure of the principal, and scores then begin to rebound, returning to the pre-transition mean. The main difference between the elementary school and the middle school results is that the drop in scores preceding a transition only begins to occur two years before principal transition for middle schools.

The model suggests that to measure the effect of principal transition it is necessary to compare school performance immediately following a principal transition with performance after the transition. For both elementary and middle schools, I find that school performance is

4.2 Teacher Retention

Teacher hiring and retention policies are an important channel through which principals affect school life. (Citations go here.) A principal transition may be associated with decreased teacher retention both because the principal transition may be just one component of a larger shake-up of the school staff and as a direct effect of the transition itself. Teachers who are loyal to the old principal may quit when the old principal leaves, new principals may be more willing to fire poorly performing teachers, and policy changes put in place by the new principal may make the school a less desirable workplace for existing teachers.

To determine whether principal transitions are associated with decreased teacher retention, I estimate

$$r_{st} = \alpha_s + \gamma_t + \sum_{k \geq -m} D_{stk}\delta_k + \varepsilon_{st}$$

where r_{st} is the fraction of teachers who teach at school s in year t who still work at school s in year $t+1$. As before, α_s and γ_t are school and year fixed effects while $\{D_{stk}\}$ are dummy variables which turn on in year t at school s if the school changed principals k years ago (or, if k is negative, will change principals $-k$ years later). The estimated coefficients on the $\{D_{stk}\}$ are plotted in Figure 5. Unlike the case of test scores, on average there are no changes in teacher retention in the years preceding the principal transition. A higher than usual percentage of teachers leave the school at the same time that the old principal leaves and teacher retention remains low after the first year of the new principal.

It would be useful to know the causal effect of teacher retention during principal transitions on student outcomes in determining, for example, how much discretion new principals should be given in selecting teachers. A priori, the effect of teacher retention is ambiguous. High teacher retention might protect the school from instability or loss of institutional knowledge during a principal transition while low teacher retention might allow the new principal to eliminate poorly performing teachers or those who are unwilling to adapt to new policies. I present reduced form estimates of the relationship between the fraction of teachers who leave the school during the principal transi-

tion years and subsequent measures of school performance. I estimate

$$y_{s,t+4} - y_{s,t+1} = \beta_0 + \beta_1 * T_{s,t,t+1} + \beta_2 * \text{Retention}_{s,t,t+1} + \beta_3 * \text{Retention}_{s,t,t+1} * T_{s,t,t+1} + \varepsilon_{st}$$

where $y_{s,t+4} - y_{s,t+1}$ is the growth in test scores for school s between years $t+1$ and $t+4$, $T_{s,t,t+1}$ is an indicator for a principal transition at school s between t and $t+1$, and $\text{Retention}_{s,t,t+1}$ is the average of the fraction of teachers who return to school s after year t and the fraction of teachers who return to school s after year $t+1$. The results are shown in Table 6.

For schools without principal transitions, teacher retention is positively correlated with test score growth, but the relationship is reversed for schools that experience a principal transition. One possible explanation for this relationship is that poor school performance prior to the principal transition drives both lower teacher retention and high test score growth. I test this explanation by first restricting the regression to high performing schools (column (2)) and then by adding two measures of the prior performance of the school, the average test score at the school in the years preceding the transition and the trend in test scores, as control variables (column (3)). The coefficient on teacher turnover for principal transition schools remains negative in the high performing school sample, and while poor prior performance of the school is positively related to subsequent performance growth, the estimated coefficients are only mildly attenuated after the addition of these controls. While there may be important unobservable factors impacting both teacher retention and subsequent outcomes for transition schools, these robustness checks suggests that the negative relationship between teacher retention and subsequent student outcomes may not be driven solely by omitted variables.

Another explanation for the relationship can be found in (Citation goes here), who argue that school performance is higher the larger the fraction of teachers at the school appointed by the current principal. In column (4) I restrict the regression to schools without a principal transition between $t+1$ and $t+4$, the post period over which I measure school performance. Consistent with (citation goes here), the relationship between teacher turnover during a principal transition and subsequent school performance is even stronger for the subset of schools where the new principal remains at the school for several years.

I also measure differences in the teacher retention rate depending on whether the new principal was employed by the school in the previous year.[11]

5 Conclusion

[11] Johnson Jr. and Licata (1995) examine differences in teacher responses to new principals who are promoted from within the school and "outsiders" who are not. At the end of the first year of the new principal, they find no significant differences in the teachers' views on principal effectiveness. However, teachers report more confidence in insiders, and were more likely to subject outsiders to the "Rebecca Myth" (a reference to Daphne du Maurier's *Rebecca*) by comparing the principal to an idealized recollection of the old principal.

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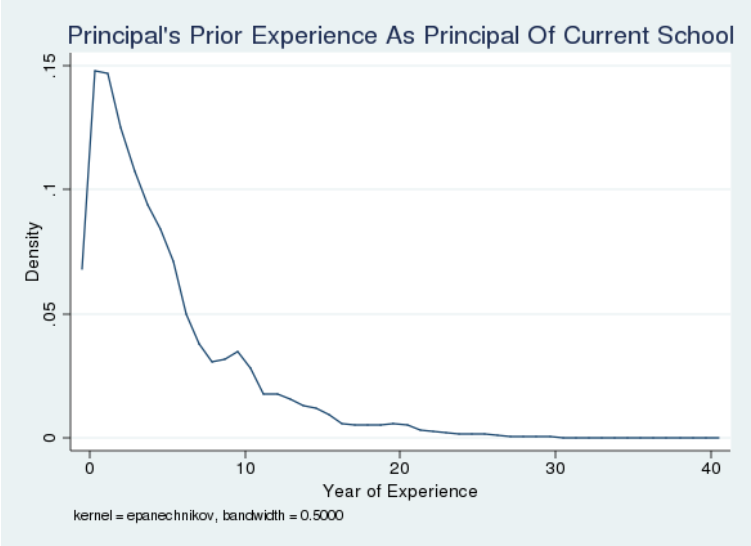
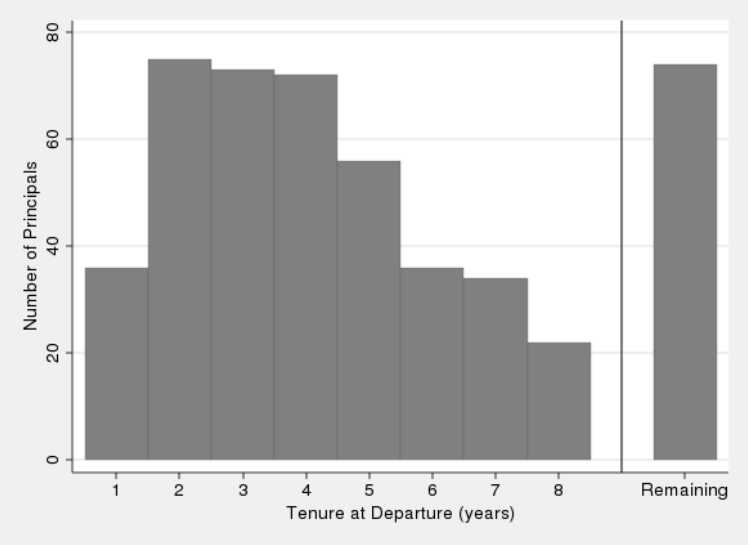
Figure 1: Distribution of Tenure As Principal of Current School



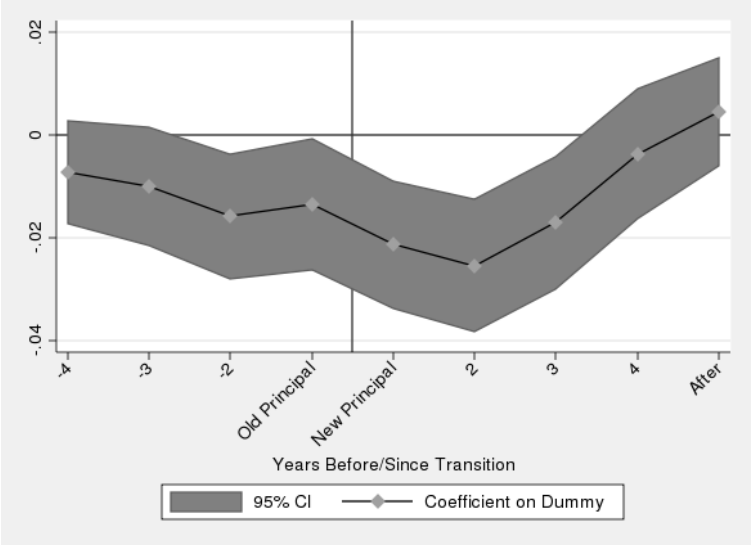
Notes: Data from the 1999-2000 Schools and Staffing Survey, administered by the National Center for Education Statistics. The principals of 8,524 public schools responded to the question "Prior to this school year, how many years were you employed as the principal of this school?" This is a kernel density plot of their responses.

Figure 2: Distribution of Principal Tenure



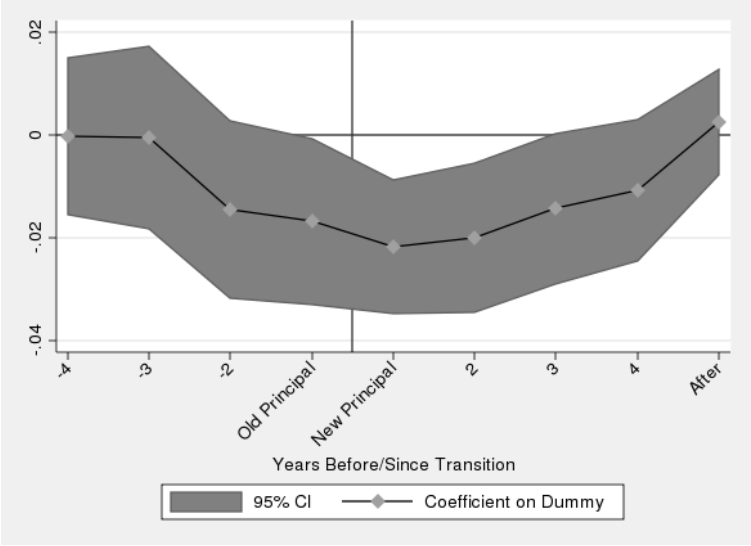
Notes: This is a histogram of principal tenure for principals who started working in North Carolina public schools during the 1995-1996, 1996-1997 and the 1997-1998 school years. All 979 schools with principal transition data are included. For schools where principal A works in years N-1 and N and principal B works in years N and N+1, principal A's final year is counted here as N-1, the last year in which principal A was the sole principal. The rightmost bar includes all principals who remained on the job for nine or more years.

Figure 3: Average of Elementary School Test Scores As the Principal Changes



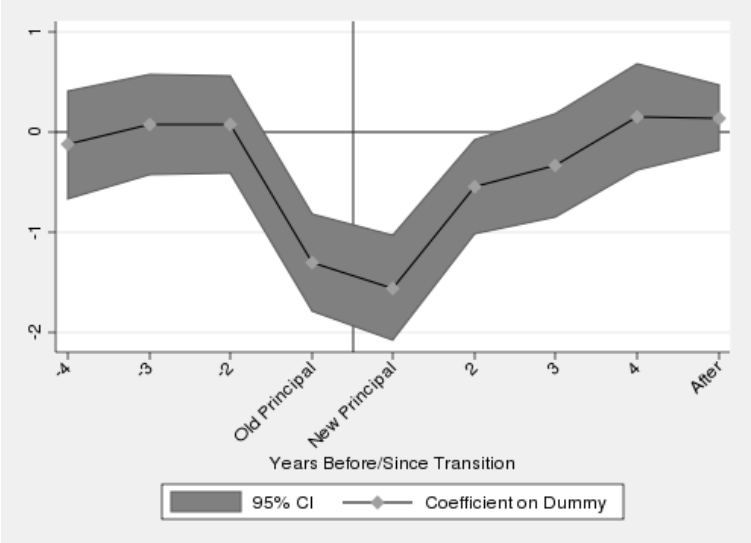
Notes: This is a plot of the coefficients from a regression of the average of average 3rd and 4rth grade math and reading scores on a set of indicator variables for years before or since a principal transition. Five or more years before the principal change is the omitted category. The regression includes school and year fixed effects. The 95% confidence interval is formed from standard errors clustered at the school level. The regression includes 554 primary schools and 12 years of test scores data (1994-1995 through 2005-2006). An observation is a school-year-transition: School-year observations are included in the regression just once if the school has zero or one principal transition, twice if the school has two principal transitions, etc. $N = 13,008 = 12$ years $* 1,084$ where the number of school-transitions, $1,084 = 211$ schools with zero or one transitions $+ 2 * 199$ schools with two transitions $+ 3 * 108$ schools with three transitions $+ 4 * 30$ schools with four transitions $+ 5 * 5$ schools with five transitions $+ 6 * 1$ school with six transitions . If, for example, a school gets a new principal in 1998 and in 2000, the year 2000 test score for that school will enter the regression twice, once with a two years post dummy turned on and once with a year of the transition dummy turned on.

Figure 4: Average of Middle School Test Scores As the Principal Changes



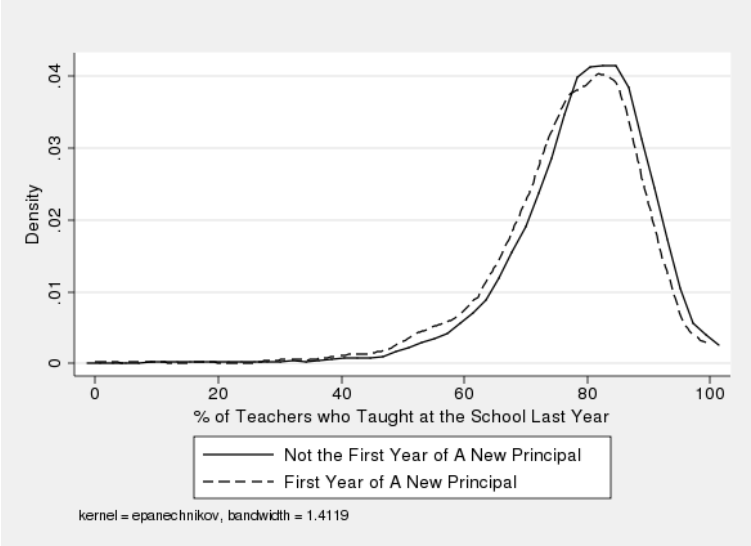
Notes: This is a plot of the coefficients from a regression of the average of average 6th, 7th and 8th grade math scores at a school in a given year on a set of indicator variables for years before or since a principal transition. Five or more years before the principal change is the omitted category. The regression includes school and year fixed effects. The 95% confidence interval formed from standard errors clustered at the school level. The regression includes 127 middle schools and 9 years of test scores data (1996-1997 through 2004-2005). An observation is a school-year-transition: School-year observations are included in the regression just once if the school has zero or one principal transition, twice if the school has two principal transitions, etc. $N = 2,529 = 9$ years $* 281$ where the number of school-transitions, $281 = 37$ schools with zero or one transitions $+ 2 *$ 46 schools with two transitions $+3*29$ schools with three transitions $+$ $4 * 11$ schools with four transitions $+ 5 *$ 3 schools with five transitions $+ 6 * 1$ school with six transitions . If, for example, a school gets a new principal in 1998 and in 2000, the year 2000 test score for that school will enter the regression twice, once with a two years post dummy turned on and once with a year of the transition dummy turned on.

Figure 5: Percentage of Teachers who Stay at the School After Each Year



Notes: This is a plot of the coefficients from a regression of the percentage of teachers in a given school who taught at the same school in the following school year on a set of indicator variables for years before or since a principal transition. Five or more years before the principal change is the omitted category. The regression include school and year fixed effects. The 95% confidence interval is formed using robust standard errors clustered at the school level. The regression includes 979 public schools and 11 years of data on the percentage of teachers who return the following year (1994-1995 through 2004-2005). An observation is a school-year-transition: School-year observations are included in the regression just once if the school has zero or one principal transition, twice if the school has two principal transitions, etc. $N = 23,820 = 12$ years $* 1,985$ where the number of school-transitions, $1,985 = 347$ schools with zero or one transitions $+ 2 * 354$ schools with two transitions $+ 3 * 199$ schools with three transitions $+ 4 * 64$ schools with four transitions $+ 5 * 13$ schools with five transitions $+ 6 * 2$ school with six transitions . If, for example, a school gets a new principal in 1998 and in 2000, the year 2000 percentage of teachers returning for that school will enter the regression twice, once with a two years post dummy turned on and once with a year of the transition dummy turned on. Restricting sample to elementary schools yields a similar figure.

Figure 6: Kernel Density Plot of Teacher Turnover (First Year)



Notes: These two plots show differences in the distribution of teacher retention between years when school-years with has a new principal and school-years without a new principal. An observation is the fraction of teachers at a given school in a given year who taught at the same school in the previous year. There are a total of 10,769 school-years in this graph, $10,767 = 11 \text{ years} * 979 \text{ schools} = 1,920$ school-years with a new principal $+ 8,849$ other school-years.

Table 1: Definition of Samples

	Number (1)	**% of Universe** (2)
North Carolina Public Schools in the 1994-1995 CCD	1,968	100.0%
and remain open through 2005-2006	1,779	90.4%
and principal transition data	979	49.7%
North Carolina Public Primary Schools in the 1994-1995 CCD	1,170	100.0%
and remain open through 2005-2006	1,070	91.5%
and principal transition data	623	53.2%
and test score data (1994-1995 through 2005-2006)	554	47.4%
North Carolina Public Middle Schools in the 1994-1995 CCD	413	100.0%
and remain open through 2005-2006	364	88.1%
and principal transition data	179	43.3%
and test score data (1996-1997 through 2004-2005)	127	30.8%

Notes: Common Core of Data (CCD) information comes from the National Center for Education Statistics' website, www.nces.ed.gov. North Carolina Education Research Data Center (NCED) data is documented online at http://pubpol.duke.edu/centers/child/ep/nceddatacenter/. A school is counted as open if it enrolls a positive number of students and employs a positive number of teachers (both in the CCD and in the NCED data) in each year. Schools are classified as primary, middle and high schools based on their designation in the 1994-1995 CCD. (The 61 remaining schools are classified as "Other".) Principal information and test scores are from the NCED. A school has principal transition data if the school either has a single principal each year or, if a school has two principals, A and B, listed in a given year, the school is included if the school has only principal A listed in year N-1 and only principal B in year N+1. This restriction eliminates, for example, schools with two principals in the first or last year of the data, and schools missing a principal at any point. Test scores for primary schools are state-wide end-of-grade exams for 3rd and 4th graders and test scores for middle schools are end-of-grade exams for 6th, 7th and 8th graders.

Table 2: Summary Statistics (2000-2001 School Year)

Primary Schools	Mean	SD	Min	Max	N
3rd Grade Enrollment (CCD)	83.33	35.69	11	281	554
3rd Grade Test Takers (NCED)	79.95	35.03	10	294	554
Average 3rd Grade Math Score (NCED)	-0.01	0.37	-1.10	1.06	554
Average of Average 3rd/4th Math/Reading Scores (NCED)	-0.01	0.33	-0.88	0.92	554
Number of Teachers (NCED)	30.63	9.87	6	61	554
Percentage of Teachers Returning to the School (NCED)	78.95	12.18	15.79	100.00	544

Middle Schools	Mean	SD	Min	Max	N
7th Grade Enrollment (CCD)					127
7th Grade Test Takers (NCED)	207.54	86.28	17	427	127
Average 7th Grade Reading Score (NCED)	-0.03	0.28	-1.24	0.63	127
Average of Average 6th/7th/8th Math/Reading Scores (NCED)	-0.03	0.29	-1.46	0.66	127
Number of Teachers (NCED)	43.94	13.71	10	76	127
Percentage of Teachers Returning to the School (NCED)	76.29	9.75	43.75	93.94	127

Notes: Means are unweighted averages across schools. School-year test scores (3rd and 4th grade Math and Reading for primary schools and 5th, 6th and 7th grade Math and Reading for middle schools) are formed by first standardizing individual scores (separately by subject and grade) across test takers to be mean zero and standard deviation one, and then averaging the standardized scores across students at a school to form the school subject-grade score.

Table 3: Average Number of Principal Transitions Across Samples

Sample	**Mean**	**SD**	**Min**	**Max**	**N**
All Schools	1.96	1.08	0	6	979
Primary School Sample	1.89	1.05	0	6	554
Middle School Sample	2.19	1.12	0	6	127

Notes: This table summarizes the number of times schools changed principals over the course of the 12 school years between 1994-1995 and 2005-2006 by school type.

Table 4: Test Score Changes Before and After Principal Transitions

	(1)	(2)
Intercept for the Four Years Before the New Principal	-0.006	
	(0.006)	
Trend in the Last Four Years of the Old Principal	-0.003	
	(0.002)	
Intercept for the first Four Years of the New Principal	-0.034***	
	(0.007)	
Trend in the First Four Years of the New Principal	0.006**	
	(0.002)	
Four Years Before New Principal		-0.007
		(0.005)
Three Years Before New Principal		-0.010
		(0.006)
Two Years Before New Principal		-0.016*
		(0.006)
The Year Before New Principal		-0.014*
		(0.007)
First Year of the New Principal		-0.021***
		(0.006)
Second Year of the New Principal		-0.025***
		(0.007)
Third Year of the New Principal		-0.017**
		(0.007)
Fourth Year of the New Principal		-0.004
		(0.006)
Five or More Years of the New Principal	0.002	0.005
	(0.004)	(0.005)
Adjusted R^2	0.774	0.774
N	13,008	13,008
School and Year Fixed Effects	Yes	Yes

Notes: Each column reports coefficients from a separate OLS regression. The dependent variable is the school-year test score. All regressions include school and year fixed effects. Standard errors clustered at the school level shown in parenthesis. The regressions include 554 primary schools and 12 years of test scores data (1994-1995 through 2005-2006). An observation is a school-year-transition: School-year observations are included in the regression just once if the school has zero or one principal transition, twice if the school has two principal transitions, etc. $N = 13,008 = 12$ years $* 1,084$ where the number of school-transitions, $1,084 = 211$ schools with zero or one transitions $+ 2 * 199$ schools with two transitions $+ 3 * 108$ schools with three transitions $+ 4 * 30$ schools with four transitions $+ 5 * 5$ schools with five transitions $+ 6 * 1$ school with six transitions . The omitted category is five or more years before the principal transition. A * indicates $p < 0.05$, ** indicates $p < 0.01$, and *** indicates $p < 0.001$.

Table 5: Test Score Trends After Principal Changes

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	$y_{s,t+3} - y_{s,t+1}$		$y_{s,t+4} - y_{s,t+1}$		$y_{s,t+5} - y_{s,t+1}$	
New Principal Between t and t+1	-0.005	-0.005	0.024	0.021	0.036*	0.032*
	(0.010)	(0.010)	(0.012)	(0.012)	(0.015)	(0.014)
Average of Scores in t-3, t-2, t-1 and t		-0.035*		-0.063**		-0.116***
		(0.017)		(0.024)		(0.030)
Pre-Trend (Score in t - Score in t-3)		-0.122***		-0.162***		-0.163***
		(0.026)		(0.031)		(0.036)
number of students		0.000		0.000		0.000
		(0.000)		(0.000)		(0.000)
% of teachers new to education		-0.000		-0.000		-0.001
Constant	-0.022***	-0.024	-0.030***	-0.026	-0.033***	-0.021
	(0.005)	(0.019)	(0.007)	(0.023)	(0.010)	(0.028)
Adjusted R^2	-0.000	0.020	0.002	0.036	0.004	0.052
N	1,771	1,771	1,472	1,472	1,178	1,178
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Each column reports coefficients from a separate OLS regression. The dependent variable is the school's test score trend in the post-period. Standard errors clustered at the school level are shown in parenthesis. All regressions are restricted to elementary schools with no transitions during the pre-trend period. The omitted year is t is 1998. Columns (1) and (2) report 3-year post trend, columns (3) and (4) report the 4-year post trend and columns (5) and (6) report the 5-year post trend. A * indicates $p < 0.05$, ** indicates $p < 0.01$, and *** indicates $p < 0.001$.

Table 6: Test Score Trends After Principal Changes By Level of Teacher Turnover

	(1)	(2)	(3)
New Principal Between t and t+1	0.228*	0.209*	0.306*
	(0.113)	(0.104)	(0.151)
Percentage of Teachers Returning to School	0.001	0.002	0.001
	(0.001)	(0.001)	(0.001)
Interaction: % Teachers Returning and New Principal	-0.003	-0.002	-0.004*
	(0.001)	(0.001)	(0.002)
Average of Scores in t-3, t-2, t-1 and t		-0.064**	-0.053
		(0.024)	(0.029)
Pre-Trend (Score in t - Score in t-3)		-0.165***	-0.202***
		(0.030)	(0.047)
Constant	-0.122	-0.156*	-0.125
	(0.074)	(0.069)	(0.086)
Adjusted R^2	0.004	0.041	0.051
N	1,472	1,472	747

Notes: Each column reports coefficients from a separate OLS regression. The dependent variable is the school's score in t+4 minus the school's score in t+1. Standard errors clustered at the school level are shown in parenthesis. All regressions are restricted to schools with no transitions during the pre-trend period. Column (1) reports results from the full sample without any control variables. In column (2) the regression is re-run with control variables, and in column (3), this regression is further restricted to schools with no transition during the post-trend period. Pre-trend years run from 1995-1998 to 1999-2002, while post-trend years run from 1999-2002 to 2003-2006. The inclusion of additional controls, including year dummies, the size of the school and the percentage of teachers at the school who were in their first year as educators do not significantly change any of the estimates. A * indicates $p < 0.05$, ** indicates $p < 0.01$, and *** indicates $p < 0.001$.

Table 7: Correlates of Teacher Departure

	(1)	(2)	(3)	(4)
New Teacher	0.151***	0.149***	0.134***	0.093***
	(0.003)	(0.004)	(0.004)	(0.011)
Female Teacher	-0.012***	-0.012***	-0.015***	-0.047***
	(0.002)	(0.002)	(0.003)	(0.010)
Black Teacher	0.029***	0.026***	-0.006*	-0.026***
	(0.002)	(0.003)	(0.003)	(0.007)
Another Ethnicity	0.036***	0.042***	0.043***	0.015
	(0.006)	(0.007)	(0.008)	(0.022)
Last Year of Old Principal	0.022***	0.023***	0.017***	0.061**
	(0.002)	(0.004)	(0.004)	(0.021)
First Year of New Principal	0.027***	0.024***	0.016***	0.026
	(0.002)	(0.004)	(0.004)	(0.021)
Female*Last Year of Old Principal		-0.004	-0.003	-0.039
		(0.005)	(0.005)	(0.021)
New Teacher*Last Year of Old Principal		0.017*	0.015	0.006
		(0.008)	(0.008)	(0.024)
Black*Last Year of Old Principal		0.005	0.003	-0.014
		(0.006)	(0.006)	(0.014)
Another Ethnicity*Last Year of Old Principal		-0.015	-0.012	-0.052
		(0.014)	(0.014)	(0.036)
Female*First Year of New Principal		0.004	0.005	0.009
		(0.005)	(0.005)	(0.022)
New Teacher*First Year of New Principal		-0.010	-0.011	-0.030
		(0.008)	(0.008)	(0.023)
Black*First Year of New Principal		0.008	0.004	-0.012
		(0.006)	(0.006)	(0.015)
Another Ethnicity*First Year of New Principal		-0.021	-0.022	-0.002
		(0.014)	(0.014)	(0.039)
Adjusted R^2	0.012	0.012	0.030	0.041
N	327,591	327,591	327,591	44,768
School and Year Fixed Effects	No	No	Yes	Yes

Notes: This table reports coefficients from OLS regressions. An observation is a teacher-year$_{ist}$ (where i indexes the teacher, t indexes the school year, at s indexes the school where teacher i worked in year t). The dependent variable is an indicator for whether teacher i left school s after year t. (It is 1 if teacher i departed school s for any reason, and 0 if teacher i worked at school s in year $t+1$.) A teacher-year$_{ist}$ is in the "Last Year of Old Principal" category if school s got a new principal in year $t+1$. A teacher-year$_{ist}$ is in the "First Year of New Principal" category if school s got a new principal in year t. Robust standard errors clustered at the school level are shown in parenthesis. In columns (1), (2), and (3), the regression is restricted to schools with principal transition data and to teachers who never work for more than one school in a given year. In column (4), the regression is further restricted to elementary school teachers with matching student test score data. This sample is described more fully in the notes to Table 8. A * indicates $p < 0.05$, ** indicates $p < 0.01$, and *** indicates $p < 0.001$.

Table 8: Correlates of Teacher Departure (3rd, 4th & 5th Grade Teachers)

	(1)	(2)	(3)
New Teacher	0.100***	0.105***	0.083***
	(0.009)	(0.011)	(0.011)
Female Teacher	-0.054***	-0.050***	-0.039***
	(0.009)	(0.010)	(0.010)
Black Teacher	-0.017**	-0.011	-0.032***
	(0.006)	(0.007)	(0.007)
Another Ethnicity	-0.033*	-0.028	0.012
	(0.016)	(0.019)	(0.022)
Fourth Grade Teacher	0.013**	0.013**	0.027***
	(0.004)	(0.004)	(0.005)
Fifth Grade Teacher	0.025***	0.025***	0.028***
	(0.005)	(0.005)	(0.005)
Average Pre Score at School	-0.077***	-0.070***	-0.080***
	(0.006)	(0.008)	(0.013)
Average Gain Score at School	-0.132***	-0.113***	-0.108***
	(0.012)	(0.014)	(0.016)
Pre Score of Teacher's Students, Relative to School Average	-0.051***	-0.049***	-0.051***
	(0.006)	(0.008)	(0.008)
Gain Score of Teacher's Students, Relative to School Average	-0.094***	-0.096***	-0.102***
	(0.012)	(0.014)	(0.014)
First Year of New Principal	0.030***	0.020	0.022
	(0.005)	(0.021)	(0.021)
Last Year of Old Principal	0.022***	0.060**	0.060**
	(0.005)	(0.021)	(0.021)
New Teacher*Last Year of Old Principal		0.000	-0.000
		(0.024)	(0.024)
New Teacher*First Year of New Principal		-0.032	-0.029
		(0.023)	(0.023)
Female*Last Year of Old Principal		-0.038	-0.039
		(0.022)	(0.021)
Female*First Year of New Principal		0.015	0.011
		(0.022)	(0.022)
Black*Last Year of Old Principal		-0.018	-0.017
		(0.014)	(0.014)
Black*First Year of New Principal		-0.015	-0.012
		(0.015)	(0.015)
Another Ethnicity*Last Year of Old Principal		-0.039	-0.051
		(0.036)	(0.036)
Another Ethnicity*First Year of New Principal		0.017	-0.001
		(0.039)	(0.040)
Pre Score, Relative to School Average*Last Year of Old Principal		-0.011	-0.007
		(0.017)	(0.017)
Pre Score, Relative to School Average*First Year of New Principal		-0.000	0.002
		(0.018)	(0.018)
Gain Score, Relative to School Average*Last Year of Old Principal		-0.035	-0.031
		(0.033)	(0.033)
Gain Score, Relative to School Average*First Year of New Principal		0.046	0.044
		(0.032)	(0.032)
Average Pre Score at School*Last Year of Old Principal		-0.023	-0.016
		(0.016)	(0.017)
Average Pre Score at School*First Year of New Principal		-0.016	-0.008
		(0.017)	(0.018)
Average Gain Score at School*Last Year of Old Principal		-0.079*	-0.054
		(0.032)	(0.032)
Average Gain Score at School*First Year of New Principal		-0.030	-0.007
		(0.031)	(0.031)
Adjusted R^2	0.018	0.018	0.047
N	44,768	44,768	44,768
School and Year Fixed Effects	No	No	Yes

Notes: As in Table 7, this table reports coefficients from OLS regressions, where the dependent variable is whether teacher i left school s after year t. The regressions are restricted to 3rd, 4th & 5th grade teacher-years$_{ist}$ in which the teacher can be matched with student test scores. The regressions are further restricted to teachers who match students in only a single grade. Pre-scores for 5th (4th) graders are 4th (3rd) grade test scores, while third graders take a pre-test. Both pre and post scores are normalized to be mean zero, SD one at the year-subject-grade level, and averaged across subjects (math and reading) to form a student-year-grade level score. Gain scores are the difference between post and pre-scores. Robust standard errors clustered at the school level are shown in parenthesis. A * indicates $p < 0.05$, ** indicates $p < 0.01$, and *** indicates $p < 0.001$.

Table 9: Summary Statistics, 1999-2000 Schools and Staffing Survey

	Mean	**SD**	**Min**	**Max**	**N**
Principal's Years of Experience at Current School	4.9	5.0	0	40	36,838
Teacher's Extra Hours Worked	12.2	8.2	0	60	36,838
Teacher's Total Years of Teaching Experience	13.8	10.0	0	57	36,838
Fraction of Teachers who are New	0.19	0.39			
Fraction Teachers Unionized	0.74	0.45			