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Teacher Career Paths, Teacher Quality, and Persistence in the Classroom

Are Schools Keeping Their Best?

DAN GOLDHABER, BETHENY GROSS, AND DANIEL PLAYER

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Dan Goldhaber
University of Washington

Betheny Gross
University of Washington

Daniel Player
Mathematica Policy Research, Inc.

*Corresponding author: University of Washington, *Tel*: +1 206 685 2214, *Email:* dgoldhab@u.washington.edu.

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Abstract

Most studies that have fueled alarm over the attrition and mobility rates of teachers have relied on proxy indicators of teacher quality, even though these proxies correlate only weakly with student performance. This paper examines the attrition and mobility of early-career teachers of varying quality using value-added measures of teacher performance. Unlike previous studies, this paper focuses on the variation in these effects across the effectiveness distribution. On average, more effective teachers tend to stay in their initial schools and in teaching. But the lowest performing teachers, who are generally the most likely to transfer between schools, appear to "churn" within the system, and teacher mobility appears significantly affected by student demographics and achievement levels.

Teacher Career Paths, Teacher Quality, and Persistence in the Classroom

Introduction

The evidence that teacher quality is the key schooling factor influencing student outcomes (Aaronson, Barrow, and Sander 2007; Goldhaber, Brewer, and Anderson 1999; Rivkin, Hanushek, and Kain 2005; Rockoff 2004) raises significant concerns over teacher attrition and sorting in public schools. In particular, research generally shows that the most academically prepared teachers—measured by ACT scores, college selectivity, and degrees in technical subjects—are most likely to leave teaching, and the most qualified teachers—measured by such attributes as licensure status, the selectivity of the colleges from which they graduated, and their performance on standardized exams—are most likely to leave high-poverty and minority schools (Hanushek, Kain, and Rivkin 2004; Lankford, Loeb, and Wyckoff 2002).

When these patterns of sorting and attrition are coupled with evidence of a correlation between teachers' academic proficiency and student achievement (Clotfelter, Ladd, and Vigdor 2007; Ehrenberg and Brewer 1994, 1995; Ferguson 1991; Ferguson and Ladd 1996; Goldhaber 2007; Strauss and Sawyer 1986; Summers and Wolfe 1975), it is tempting to conclude that public schools are losing many of their most effective teachers and keeping too many of their least effective teachers. This conclusion, however, would be premature since a great deal of evidence suggests that easily observed and quantifiable teacher attributes (credentials, test scores, and so on) are only weakly correlated with student standardized assessment performance (Aaronson et al. 2007; Clotfelter et al. 2007; Goldhaber and Brewer 2001; Gordon, Kane, and Staiger 2006; Greenwald, Hedges, and Laine 1996). Moreover, recent studies that measure teacher quality based on test score gains made by a teacher's students have found that, on average, more effective teachers tend to stay in the classroom (Hanushek et al. 2005; Krieg 2006; West and Chingos 2008). Average trends, however, can mask important variation in behavior across teachers with different levels of effectiveness. Thus, it is worth examining differences in mobility behavior and asking: “Are public schools keeping their ‘best’ teachers, and what conditions predict who stays and who goes?”

We investigate these questions by studying the career paths of new elementary teachers who began teaching in North Carolina in 1996–2002. Our six-year panel allows us to explore the earlier career paths of teachers including transfers from one teaching position to another within and between school districts, and exits from the North Carolina public school workforce. And, because teachers can be matched to the students in their classrooms, we explore how career transitions relate to a more direct measure of worker quality: estimates of teachers’ value-added contributions toward student learning.

Our review of the literature finds only four papers that examine teacher mobility and its relationship with effectiveness (we use the terms “effectiveness,” “quality,” “productivity,” and “job performance” interchangeably); all four find, contrary to expectations, that more effective teachers were *less* likely to leave their schools, and most find that more effective teachers were less likely to leave the profession. Krieg (2006) (the only study currently published by a peer-reviewed journal) uses a single year of fourth-grade test scores merged with a panel of teacher observations from Washington State to investigate the decision to leave the profession. He finds that, on average, more effective female teachers (measured by value-added models) are less likely than less effective females to leave the profession the following year. The effect is negligible for males.

Hanushek and colleagues (2005) examine teacher exit and transfer behavior in a large urban district in Texas and find that teachers who change campuses within a district, change districts, or leave public education in Texas entirely are, on average, less effective than those teachers who stay at the same campus. Interestingly, evidence suggests that exiting teachers are of lower quality only in the year immediately preceding their departure. Similarly, Boyd and colleagues (2007) find in their analysis of teachers in New York City that more effective teachers tend to stay in the classroom.

West and Chingos (2008), in a descriptive analysis, reach a somewhat different conclusion than the authors described above. These authors find that the best performing teachers are more likely to stay in their initial schools than less effective teachers.[1] However, the Florida state school system appears to lose its highest performing teachers at approximately the same rate as their lowest performing teachers, with 40 percent of the highest performing teachers leaving the system within five years.

These studies suggest a modicum of good news to those concerned with teacher mobility and attrition: public schools are, on average, not "losing their best teachers." These studies, however, do not provide all the relevant detail we need to understand the relationship between teacher effectiveness and mobility. For example, only West and Chingos (2008) directly examine the propensity to leave schools at different points along the distribution of teacher effectiveness. This is important if we are concerned, for instance, with whether school systems are retaining their very best teachers and/or encouraging their least effective teachers to find an alternative occupation—a question of great policy interest (see Gordon et al. 2006 and Hanushek forthcoming). In addition, these studies do not fully conceptualize the factors that play a role in teacher attrition. While they each focus on the organizational factors (e.g., student population and school size), they do not directly consider important local labor market considerations such as the marketability of teachers and conditions in the local teacher and external labor markets. As

[1] These authors did find that more than 70 percent of the most effective teachers move at least once in the first five years of teaching.

we go on to describe in the next section, it is only through assessing all these issues that it is possible to fully understand the ramifications of teacher mobility for schools serving different types of students and the school system as a whole.

In the end we find, as others have, that the system's most effective teachers are, on average, more likely to stay in teaching, to stay in their current district, and even to stay in their current school than less effective teachers. But a deeper look at the issue shows that the factors predicting teachers' moves vary across the effectiveness distribution in ways that are not ideal for minimizing the loss of the system's best teachers, especially from schools serving the most challenged populations, or for minimizing the churn of its least effective teachers. Specifically, our findings reinforce concerns some have expressed about how often the lowest performing teachers are identified and removed from classrooms as opposed to just shuffled throughout the education system (a phenomenon commonly referred to as "the dance of the lemons").[2] They also reinforce concerns that many highly effective teachers leave disadvantaged schools and that those who have good opportunities outside the teacher labor market are enticed to leave the profession.[3]

In the next section we provide a conceptual discussion of teacher mobility and the relationship between teacher effectiveness and mobility.

Exploring Different Types of Teacher Mobility

We examine three types of teacher job moves: from school to school within a district, from school to school between districts, and out of the North Carolina public school system. From the

[2] For a more thorough discussion on the need to and challenges of removing the least effective teachers from the educational system by limiting tenure see Gordon et al. (2006) and Hanushek (forthcoming).

[3] Previous research by Hoxby and Leigh (2004) and Corcoran, Evans, and Schwab (2004) explore whether teachers are "pushed" by the narrowing of pay within teaching or "pulled" from the teaching profession by increased opportunities outside teaching. Unfortunately, the analysis in this paper cannot determine if the attrition from the field we observe is a result of teachers being pushed or pulled out of the field.

schools' vantage point, all three exits look the same: the teacher leaves the school. But there are at least two arguments for more carefully considering the type of move that teachers make. First, each type of move may be differentially motivated. Second, different types of moves have different consequences for the educational system.

In the simple model we describe below, a teacher is motivated both by compensation and nonpecuniary working conditions, but it is clear that different types of moves have very different implications for these factors. A teacher's within-district move may significantly change working conditions due to a change in the context of his or her teaching (e.g., school demographics that change from one school to the next). And, a significant amount of research shows that teacher career transitions are sensitive to working conditions (Ingersoll and Smith 2003), which to some extent can be proxied by the attributes of their students (Goldhaber et al. forthcoming; Guarino, Santibanez, and Daley 2006; Hanushek et al. 2004; Lankford et al. 2002).

A within-district move may influence a teacher's working conditions, but it will not result in an improved salary since virtually all teachers are paid according to districtwide salary schedules.[4] Cross-district moves, by contrast, may result in changes in both working conditions and salary. These moves may also entail transaction costs associated with learning a new curriculum and district culture and, in many cases, the cost of moving residences.[5] Teachers willing to bear the costs of moving to a new district are likely to either be seeking significant salary changes, be seeking working conditions changes that cannot be satisfied based on a within-district move, or are moving for an altogether different reason such as moving with a

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[4] In general, collectively bargained teacher contracts place all teachers in a district on a common salary schedule. In North Carolina, the teacher contract is bargained at the state level and applies to all teachers in the state. Even though the contract allows some districts to supplement the salary schedule to compensate for different costs of living across the state, North Carolina principals, as is typical across the country, do not have the flexibility to offer individual teachers wage bonuses.

[5] In North Carolina, school districts are relatively large countywide districts, which increases the chance that an across-district move will require that the teacher physically move residences.

spouse (Frank 1978). Given that moves within districts and across districts have different implications for the teacher, it stands to reason that the factors associated with these two types of moves differ as well. A similar case can be made when considering moves out of teaching. While working conditions would be predicted to be an important factor in within-teaching employment decisions, they may be completely irrelevant for the teacher who has concluded that "teaching isn't for me."[6]

More than just being driven by different factors, these different move types are likely to have very different impacts on the educational system. Exits from the system represent a loss to the teacher workforce (that may or may not affect its overall quality), whereas teacher moves within and across districts portend a possible redistribution of teacher quality within the system.[7] Moreover, different types of moves imply different costs associated with recruitment, hiring and selection, and acculturation of new staff, all of which can be substantial (Milanowski and Odden 2007).[8]

A Simple Model of Teacher Career Transitions

A simple model of utility maximization suggests that a teacher is more likely to remain in the current teaching job if the expected lifetime benefits of doing so exceed those of moving to

[6] We cannot directly observe whether those leaving the North Carolina public school system are leaving teaching, but this is likely for the majority of these teachers. The national Schools and Staffing Survey found that approximately 12 percent of teachers leaving schools for other schools actually cross state borders to continue teaching. However, because one of North Carolina's most dense districts lies along the state border, we do control for a border location in all our analysis. More detail on how we control for location is given in the data and methods sections.

[7] This redistribution can have serious consequences for equity if high-quality teachers favor certain kinds of students or schools and seeking out "better" assignments.

[8] The costly elements of hiring new staff include administrative costs of separating exiting staff and hiring new staff, personnel and activities to engage in advertising and recruitment, district and/or school staff time to screen prospective teachers, and, importantly, district and school resources to train new staff in the local curriculum, instructional practice, and district approaches. Some authors argue that losses in productivity should also be included in the overall cost of teacher replacement (Milanowski and Odden 2007). Depending on the specific district circumstances (e.g., level of centralization, local salaries) and elements of turnover included in the estimate, studies that estimate the cost of turnover derive costs ranging from $3,400 to tens of thousands of dollars (Milanowski and Odden 2007).

another job or profession. For simplicity, imagine a case where individual *i* chooses among various jobs, *j*, in order to maximize the present value of expected utility:[9]

$$\max_j \ pv[u^i(T_j)], \quad given\ j \in \{j\}_i \qquad (1)$$

Let T_j be the characteristics of job *j*. T_j is a function of both compensation, C_j, and other nonpecuniary job factors, N_j (these include, for instance, the demographics of students in school *j*).

$$T_j = f(C_j, N_j) \qquad (2)$$

The compensation available for alternative jobs depends on the marketability of the individual's qualities including his or her training, experience, and skills (X_i).

$$C_j = f(X_i) \qquad (3)$$

The marketability of certain skills will differ depending on the job being sought. A teacher's marketability may depend on some traditional teacher quality indicators such as certification, graduate degrees, and teaching experience (Ballou and Podgursky 1997), even though value-added models of student achievement suggest that some of these indicators poorly predict a teachers' effectiveness in the classroom (Aaronson et al. 2007; Clotfelter et al. 2007; Goldhaber and Brewer 2001; Gordon et al. 2006; Greenwald et al. 1996; Kane, Rockoff, and Staiger 2007). Typically, however, the labor market as a whole tends to reward measures of academic proficiency, such as the selectivity of the individual's undergraduate institution (Ballou 1996).

Individual *i* will opt to keep her current teaching job $(\hat{j})$ if the utility associated with this job exceeds that of the best alternative job less any costs of transferring jobs $u^i(r_j)$:

$$pv[u^i(T_{\hat{j}}, X_i)] \quad > \quad \max_{j \neq \hat{j}} \left[pv[u^i(T_j, X_i)] - u^i(r_j) \right] \qquad (4)$$

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[9] This simple model ignores the demand side of the market. For a more comprehensive analysis of how teacher and school-district preferences interact to produce a distribution of teachers across schools, see Boyd et al. (2005) or Ballou (1996).

Given this framework, we might imagine the likelihood of leaving a teaching job would vary along three dimensions: the relative compensation that teachers can command in an alternative job (*C*), which is a function of the individual's characteristics that determine marketability (*X*); the relative value of nonpecuniary rewards of teaching and non-teaching jobs (*N*); and the transaction costs associated with a job switch (*r*).

The model, not surprisingly, predicts that individuals would be more likely to leave their current position as compensation for the alternative job rises. This conclusion is consistent with empirical evidence showing that the relative financial rewards and job opportunities in and outside teaching influence teacher attrition rates and the length of time teachers stay in the profession.[10] In addition, this model predicts that individuals would be more likely to leave as the nonpecuniary factors associated with another job provide more benefits and when transactions costs are lower.

The model offers some predictions for the relationship between teacher effectiveness and mobility, but the specific predictions depend on the nature of the human capital that drives effectiveness—whether it is job-specific, industry-specific, or more general[11]—and whether this human capital is easily recognized by prospective employers.[12] Specifically, if human capital is primarily job-specific because, for instance, it depends heavily on the fit with colleagues or unique instructional methodologies used in a school, then the model would predict unambiguously that more effective teachers would be more likely to stay in their current schools. The assumption here is that teachers would reap nonpecuniary rewards (i.e., have a higher value

[10] See Baugh and Stone (1982); Brewer (1996); Dolton and van der Klaauw (1999); Greenberg and McCall (1974); Murnane (1981); Murnane and Olsen (1989); and Stinebrickner, Scafidi, and Sjoquist (2007). There is also some empirical evidence (Brewer 1996) that suggests NBPTS certification could affect the quit rates of non-NBPTS-certified teachers by providing potential avenues for teacher career advancement.

[11] See Becker (1962) for a discussion of specific versus general human capital.

[12] Effectiveness, as we measure it, only affects marketability if our *measure* of it is consistent with performance measures that can be observed by potential employers.

of *N* in the model above) from being more effective and may also be able to command higher compensation, but they would not be more marketable in other schools or outside teaching.[13]

The predictions are less clear if there are industry-specific or general components to human capital. In the case of industry-specific human capital, more effective teachers will enjoy the nonpecuniary rewards (*N*) in their current school, or in an alternate school, but their skills (*X*) would also make them more marketable in the *teacher* labor market. Here the model predicts that more-effective teachers will be less likely to exit teaching but it is unclear whether the satisfaction with the current job will be enough to offset satisfaction from alternative teaching jobs or potentially greater compensation in an alternative teaching job (note that teachers would have to switch school districts to increase their base salaries).

For the third case, in which a teacher's effectiveness reflects general human capital, the model offers even less guidance. In this case, a good teacher would be expected to be effective in alternative occupations, implying that she would also have greater out-of-teaching marketability. Here then the model offers no clear predictions about the transfer or exit of teachers given their effectiveness. A teacher's decision to transfer or exit will depend on which end of the scale (the rewards of teaching or teaching in the current school versus compensation from alternative jobs) carries more weight.

Analytic Approach

The data for this study are collected by North Carolina for administrative purposes and include detailed information on schools, teachers, and students. For example, the data include school-level information on the percentages of free and reduced-price lunch (FRL) recipients, the

[13] While districts typically pay all teachers by a standardized schedule, which makes all within-district compensation the same for a given experience and education level, teachers can still receive supplemental compensation for taking on additional responsibilities, such as overseeing extracurricular activities.

percentage of African American students in schools, and each school's average math performance.[14] At the teacher level, the data include information on race and ethnicity (indicator variables for African American, Hispanic, and all non-Hispanic, non–African American teachers); gender; measures of academic and professional credentials such as a teacher's degree attainment (master's or higher); the average SAT score at a teacher's undergraduate institution, a teacher's pre-service licensure exam score; and a variable indicating whether she has earned National Board of Professional Teaching Standards (NBPTS) certification. Finally, there is information on students including race and ethnicity, gender, free and reduced-price lunch status, and performance on the end-of-grade state assessments that are vertically aligned and designed to measure student growth.

Importantly, the data also include links between teachers and the students—information we use to estimate measures of teachers' effectiveness. We restrict the data to teachers and students in the elementary grade level (grades 4–6) because we are more confident at this level that the teacher-student links provide good matches of students to their *classroom* teachers.[15]

We also restrict our sample to teachers who entered the North Carolina public school system between the 1995–96 (hereafter 1996) and 2001–02 school years in order to avoid left censoring, which occurs when the start date for an observation is unknown.[16] Our focus on early- to mid-career teachers includes the period when attrition out of the occupation is highest. As is

[14] These variables have all been shown to be correlated with teacher attrition (Guarino et al. 2006; Hanushek and Rivkin 2004; Lankford et al. 2002).

[15] The North Carolina data link students to teachers by identifying the teacher who is proctoring the students' exam. To ensure that we have accurate links between students' assessments and the teacher primarily responsible for the instruction of these students, we limited our sample to elementary teachers who are listed as having taught a "self-contained class," meaning the teacher was the sole instructor of core academics for the students in her class. In so doing, we avoid attributing student assessments to teachers who only instructed the students in select classes.

[16] Our dataset includes observations from 1995 through 2003. The first year is dropped because we want to observe who has entered the system (i.e., those not present in 1995 but present in 1996). The last year is dropped because we need to record the mobility decision in the last year of our analytic sample (2002), which requires that we observe the teacher's school assignment in 2003 relative to 2002.

apparent in national trends (Ingersoll and Smith 2003), the most rapid loss of teachers in our sample also occurs in the early years (between year 1 and 4) with 25 percent of teachers exiting the North Carolina system within the first four years of teaching. Focusing on the early- to mid-career cohorts also eliminates the complication of modeling the retirement of teachers.

The longitudinal nature of these data allows us to identify the movement of teachers across schools and out of the North Carolina system, but an important limitation of the North Carolina data is that we do not know what happens to teachers who exit the system. In most cases, these are likely exits from teaching and education altogether; however, it is also possible that teachers are leaving the labor market entirely or leaving the North Carolina public system for a teaching job in private schools or in another state.[17] North Carolina shares borders with four other states, and one of its largest districts (Charlotte-Mecklenburg) is along a state border. So, to account for the possibility that mobility (especially exit from the system) may differ for teachers in districts on the state border, we include indicators for districts along the state border in all models.

The above schooling data are combined with local labor market information retrieved from the Bureau of Labor Statistics to capture local labor market conditions and geographic information on the concentration of schools from the Federal Common Core of Data. These include measures of county-level unemployment and average wage rates.[18] In addition, we add a measure of the concentration of schools: the number of schools within five miles of the current

[17] Evidence from the National Center for Education Statistics' *Teacher Follow-up Survey* suggests that most moves out of a state system are due to teachers leaving the profession (only 12 percent of teachers who left their state's public school system after the 2000–01 school year were still teaching in either a private school or a public school in another state).

[18] County unemployment and wage information is included to capture the local labor market conditions and assess the opportunity costs of teaching. Ondritch, Pas, and Yinger (2008) find that teachers in upstate New York are less likely to leave teaching when their salaries are higher relative to local non-teaching wages.

school, which may indicate the opportunity costs associated with teacher moves to other schools within a district.

Given that it is common to find systematic differences in labor market behavior for men and women (Keith and McWilliams 1997), we estimate transitions for men and women separately. For simplicity we report only estimates from women, who make up almost 85 percent of the elementary teachers in North Carolina.[19] In total, the 1996–02 sample of women included 30,564 person-year observations from 9,027 different teachers: 3,192 cases of transferring schools within the district (by 2,588 different individuals), 2,649 cases of transferring teaching positions to a new district (by 2,185 different individuals), and 2,442 cases of exiting the system. In total, 34 percent of female teachers in our sample never move schools, 38 percent transfer but never exit, and 28 percent exit. The number of different teaching positions ranges from one to five, with 66 percent of female teachers having made at least one move or exit from the classroom.

To give a sense of who is making each type of move each year in North Carolina, **table 1** reports sample statistics for four possible outcomes for (1) those who remain in their original schools as teachers, (2) those who move to another public school teaching position within their original school district, (3) those who move to another public school teaching position in a different district in North Carolina, and (4) those who leave the North Carolina public school system for the year 2002.

As can be easily seen, on average, the least effective teachers are those who exited the system, closely followed by the teachers who move districts; the most effective teachers tend to stay in their current job. A relatively high share of all teachers are located in districts that border South Carolina, and just over a quarter of all teachers who exited the system in this year left from

[19] Results from the sample of men are available upon request.

districts on this border; this demonstrates the importance of controlling for border districts in our more detailed analysis.

Interestingly, teachers who exited the North Carolina system in 2002 did not come from markedly more selective undergraduate colleges, nor were they more likely to have advanced degrees. They were, however, more likely to leave schools with a higher percentage of students receiving free or reduced-price lunches, higher percentages of African American students, and lower achievement in math.

Measuring Teacher Effectiveness

We measure a teacher's effectiveness based on value-added model (VAM) estimates of her contribution toward student achievement on standardized tests.[20] There is no universally accepted method for calculating a teacher's value-added contribution, and research shows that methodology and context can influence the measure (Ballou, Sanders, and Wright 2004; McCaffrey et al. 2004; Rothstein forthcoming; Rubin, Stuart, and Zanutto 2004; Tekwe et al. 2004). In recognition of this we employ two different VAM specifications and test whether our mobility models differ depending on the specification we employ.

The primary specification we use is:

$$y_{ijt} = \alpha + \Theta_i + \Phi_j + \varepsilon_{ijt} \quad (4)$$

In this model, student *i*'s achievement in class *j* in year *t* is a function of student *i* fixed effects, Θ_i, and teacher-specific fixed effects for each class j, Φ_j. From this equation, the predicted values of the teacher-specific effects (Φ_j) are used as measures of teacher

[20] This measure of teacher quality is controversial as these scores are measured with error (Gordon et al. 2006; McCaffrey et al. forthcoming), and are potentially compromised by complications from matching and lagged effects (Rothstein 2009).

effectiveness, which we standardized at the state level. In an alternative specification we replace student fixed effects with a measure of prior student achievement and student covariates.[21] The correlation between the two teacher effectiveness scores in our data is 0.509, and we generally find little qualitative difference in our models across these two teacher effectiveness measures; so, we only report the results from (4). (Results based on this alternative measures are available from the authors upon request.)

Modeling Teacher Transitions

We employ competing risk models to estimate the risk that individual teachers leave their current teaching position given their own characteristics and the characteristics of the school in which they teach.[22] Hazard models are conceptually appealing for studies of teacher movement and attrition. They measure the risk of changing schools or leaving teaching given the length of time the teacher has been with a school or in the school system, which we count in one-year increments. Accounting for time is important because we know that new teachers are substantially more vulnerable to moves and exits than more established teachers. These models also provide some flexibility with our data by allowing us to analyze the movement of teachers without necessarily viewing the entire career of all teachers. That is, we can describe career movement with censored data. Finally, the models allow the effects of the explanatory variables to differ depending on the type of move the teacher makes.

We build all our analyses from a basic, discrete time, hazard model (equation 5), which defines an individual's odds of leaving the position as a function of a baseline hazard function ($\lambda_0(t)$) and a series of covariates (X_{ik}) that would include measures of the teacher's quality,

[21] Specifically, we regress student achievement in year *t* on cubic *Y* of achievement in the previous year, a vector of observable student characteristics X_{ijt} and teacher fixed effects as specified in below:

$$y_{ijt} = \alpha + \beta Y_{ij_{t-1}t-1} + \delta X_{ijt} + \Phi_j + \varepsilon_{ijt}$$

[22] In some model specifications we include a measure of the average number of FRL students in the classroom.

teacher's background characteristics, labor market conditions, and school and classroom characteristics.[23] All models account for a teacher being located in a district along a state border and basic teacher demographics.

$$h_i(t) = \lambda_0(t) e^{\sum_{n=1}^{k} \beta_n X_{in}} \qquad (5)$$

We estimate these models with conditional maximum likelihood logit. We represent time as discrete because the school year provides the field with an annual hiring cycle during which most new hires, transfers, or exits occur.[24] Because a teacher's stay could result in one of three primary outcomes (transferring to a new school within the district, transferring to a new school outside the district, or leaving the North Carolina system),[25] we extend equation 5 to account for the *j* "competing risks" in equation 6:

$$\text{logit}\, h_{ij}(t) = \alpha_j(t) + \sum_{n=1}^{k} \beta_{nj} X_{inj} \quad \text{where } j = 1, 2, 3 \qquad (6)$$

We estimate these competing risk models with separate logit regressions[26] and report robust standard errors to account for clustering at the school level.[27] Since teachers can at times stay

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[23] For computation, equation 5 is often rewritten as the log hazard:

$$\ln h_i(t) = \alpha(t) + \sum_{n=1}^{k} \beta_n X_{in}, \text{ where } \alpha(t) = \ln \lambda_0(t)$$

[24] Since some teachers do transfer, exit, or begin their careers mid-year, we also estimated all the models using log-log models for continuous time. Results from these models qualitatively parallel the results provided in this paper's discussion. However, because we wanted to test our mobility models controlling for school fixed effects—something that cannot be done with the log-log models—we opted to present the results of the logit models.

[25] Moving to administration is a fourth possible outcome. However, we found that only 112 teachers in this yearly career sample actually moved to administration. With so few making this move, we found that the models of moves to administration could not converge. To focus the paper on the moves of greatest importance for our sample, we have opted not to report models that estimate the hazard of moving to administration. However, when we estimate the likelihood that a teacher leaves their school by *any move type*, we do include teachers who end a teaching spell with a move to administration.

[26] We estimate these models separately for each move type instead of using a multinomial logit, which estimates all move types simultaneously. Allison (1995) reports that doing so results in a slight loss of precision in the estimates, but separate estimates allow us to more easily present and describe results for different move types and potentially specify models for the different move types differently.

[27] We also estimated models with school fixed effects. We found very little difference in the results.

while other times move and/or exit, individual teachers can be identified as stayers, movers, or exiters at different points in their career.

Results

We begin by noting that teacher mobility, in and of itself, is not necessarily problematic. For example, if a teacher leaves a school to find a better fit in a different school, implying greater productivity, it may benefit the system overall. Likewise, the attrition of the weakest teachers from the profession may well be beneficial. Mobility and attrition becomes more problematic when, for instance, highly productive teachers leave the field or opt out of disadvantaged schools in large numbers or when ineffective teachers float around the system, moving from school to school. As we argued earlier, some of the most important questions about teacher mobility and attrition require that we examine how the factors associated with teacher mobility vary across the teacher effectiveness distribution.

Recall that we are focusing on three distinct types of moves: within-district moves, across-district moves, and exits from the North Carolina public education system. Understanding the complexity of these results, we structured the results discussion in the following manner. Each move type is described in a separate subsection below. Within each subsection, we briefly discuss the relationship between teacher effectiveness and teacher moves, then address three issues: (1) how labor market factors relate to teachers' moves, (2) how school contexts relate to teachers' moves, and (3) whether and how these effects differ across the effectiveness distribution.[28]

[28] Quintile ranks were determined from the complete sample of teachers in the state and not just the early career sample used in these analyses.

Teacher Effectiveness and Within-District Moves

We begin our analysis of teacher transfers by first focusing on a teacher's odds of moving between schools within a school district. The estimated coefficients from the competing hazard models for within-district moves are presented in **table 2**. The table includes four model specifications. The first specification (**column A**) includes a continuous measure of teacher effectiveness (estimated by equation 4) as well as individual teacher characteristics (including years of service), variables designed to account for labor market factors that influence a teacher's other job options and marketability; variables describing school context. This specification most closely parallels those typically estimated in the existing empirical literature. Since it is possible that a teacher's mobility will relate to aspects of his or her school that cannot be directly observed such as school working conditions (Ingersoll 2001), we estimate a second model **(column B)** that adds school fixed effects to the column A specification. This fixed-effects model controls for all constant observed and unobserved aspects of the school. In specification three **(column C**), we replace the continuous measure of teacher effectiveness with a vector of indicators identifying in which quintile of the effectiveness distribution teachers fall. This specification allows for a nonlinear relationship between teacher effectiveness and teacher moves. Finally, our fourth specification, presented in the lower panel of **table 2**, interacts these quintile rankings with the labor market and school context variables, allowing us to see variation across the effectiveness distribution.

On average we find that the odds of leaving a school for another school in the same district decline as teacher effectiveness increases; this finding is squarely in line with the four studies described earlier. Specifically (based on estimates provided in column A of table 2), the odds of transferring between schools within a district decline by 11 percent when estimated teacher effectiveness increases by a standard deviation.[29] While we do not show these results, we add the labor market and then school context variables to the model separately and test whether their joint addition adds explanatory power to the model. And although each set is statistically significant,[30] their addition has almost no impact on the teacher effectiveness coefficients.

In terms of the labor market variables, we would expect that credentials that signal quality to the *internal* teacher labor market are correlated with within-district moves, since these credentials might give teachers more bargaining power and job options.[31] Similarly, a high concentration of schools nearby for most teachers would signal a large number of job options with minimal transfer costs, so we would expect within-district transfers to increase with the concentration of schools. In general our findings are consistent with these hypotheses. For example, the odds of a within-district move significantly increase when a teacher is NBPTS-certified (56 percent) or holds an advanced degree (17 percent). Both results are consistent with previous research (Goldhaber and Hansen 2009; Hanushek et al. 2004). In addition, a high concentration of schools locally has a small but statistically significant and positive effect on the odds of a within-district move.[32]

The extent to which school conditions lead to the clustering of the most-effective teachers in the most advantaged schools is a critical issue in teacher mobility research. If the most effective teachers are more likely to leave the most challenging students and schools, teachers will be inequitably distributed across schools—something that a significant body of evidence

[29] The coefficients reported in the tables reflect the log odds of transferring. In the text, we have converted these log odds into the percent change in odds based on the following equation:

$$\%\text{ change in odds} = 100(e^{\beta} - 1)$$ where β is the estimated log odds coefficient.

[30] The chi-squared log likelihood test for adding the labor market variables was 718.1 for eight degrees of freedom while adding in the school context variables yielded a chi-square of 152.6 for six degrees of freedom. We cannot reject the addition of these variables.

[31] The empirical evidence on whether various teacher credentials are in fact signals is, however, weak. The teacher quality literature, for example, has not found a consistent association between teachers' degrees and effectiveness in the classroom (Goldhaber and Brewer 1997; Greenwald et al. 1996; Hanushek 1997).

[32] An additional school within five miles increases the odds of transferring within the district by 0.9 percent.

suggests is the case (Goldhaber et al. forthcoming; Guarino et al. 2006; Hanushek et al. 2004; Lankford et al. 2002). We find that North Carolina's elementary teachers do tend to leave schools that are larger and/or lower performing. The odds of transferring to another school in the district increases by just under 1 percent with each additional 10 students enrolled and increase by about 9 percent with a one standard deviation decline in the school's math score.

Interestingly, the percentages of FRL and African American students do not significantly predict within-district moves. While within-district moves do not systematically relate to the levels of FRL and African American students in a school, many teachers view their school's contexts as they relate to other schools around them. When we compare the relative disadvantage of schools within districts using the within-district standardized percentage of FRL (Z score FRL) and percentage of African American students (Z score African American), we find that teachers in schools with relatively high concentrations of African American students are more likely to transfer (5 percent with each additional standard deviation) to new schools in the district.[33] This result falls in line with previous analysis on teacher's mobility and the racial composition of schools (Hanushek et al. 2004; Jackson 2009).

We might expect that teacher mobility would relate to unobserved conditions in schools. To account for this, we include school fixed effects in the model (shown in column B).[34] The coefficient on teacher effectiveness and the coefficients on the labor market variables are virtually unchanged after adding the school fixed effect in column B.[35]

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[33] While it seems reasonable to expect that these school-level effects will be overshadowed by the teacher's own classroom conditions as principals reward better teachers with more advantaged classrooms (Player forthcoming; Rothstein forthcoming), we did not find this to be the case. Instead, in a separate analysis that uses a subset of observations with classroom-level student demographic information, we found that controlling for the concentration of FRL students in a teacher's individual classroom slightly improves the fit of the model but does not eliminate the school-level effects.

[34] Since the geographic location of districts on the state's border does not differ over time, these factors have been dropped from the school fixed effects models.

[35] While some coefficients on the school context differ from the model in column A, it is important to note that these

How do findings differ along the teacher effectiveness distribution?

As we discussed above, important variation may be lost in the models that assume that the relationship between teacher effectiveness and mobility is linear (as in columns A and B). We test this explore this variation first with a model specification that includes variables for the quintile of effectiveness for each teacher (the middle quintile is the reference category) in column C of table 2.[36]

The model with indicators for the quintile of teacher effectiveness shows that the odds of exiting are similar for teachers in the second through fourth quintiles of effectiveness. Only teachers at the extremes show statistically significant differences in the odds of transfer. The least effective teachers are more likely to transfer to new schools in the district than teachers in the middle of the effectiveness distribution; the most effective teachers are less likely to make within-district transfers relative to teachers in the middle of the effectiveness distribution.

We extend the analysis to see how the labor market and school contextual factors vary across teachers with different levels of effectiveness in the lower panel of table 2. This final specification includes interaction terms between quintile of effectiveness and the various labor market and school context variables.

Looking across the columns from the lowest quintile of effectiveness to the top quintile in the lower panel of table 2, there are some interesting differences in the factors that affect teacher within-district mobility but few consistent patterns. For instance, having an advanced degree corresponds with the within-district transfer of teachers in the second, third, and fourth quintiles but not teachers in the lowest or highest quintile. Also, we clearly see that both the most effective

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coefficients in column B are identified by within-school (over time) variation in these variables, which is limited.

[36] We also explore the issue of nonlinear effects by estimating models that include the squared and cubic of the teacher effectiveness measure. The cubic terms were not significant in any models while the squared term was significant in the models of exits. These results are not presented in this paper but available upon request.

and least effective teachers are more likely to transfer to other schools in the district when teaching in lower performing schools.

Teacher Effectiveness and Moves between School Districts

In this section, we turn our attention to a second form of teacher transfers: transfers across district lines. As explained above, issues such as the costs of moving and learning a new district's culture and curriculum make these transfers somewhat different propositions than transfers within district. In this section (and in the next), we use the same four specifications as we did in our analysis of transfers within districts.

The results (given in **table 3**) show, again, that more effective teachers are, on average, less likely to leave their school for a school in another district. For example, the odds of transferring across districts decline by 12 percent with an additional standard deviation of effectiveness. As with the models of moves within districts, this result remains unchanged as we add a school a fixed effect (**column B**).[37] In addition, the specification that explores a nonlinear relationship between effectiveness and teachers transfers out of district given in **column C** mirrors what we saw for transfers within districts. Teachers in the middle of the distribution are not statistically different from each other, while the least effective quintile of teachers shows greater odds of transferring districts and the most effective quintile of teachers shows lower odds of transferring districts.

Where the models of transfers within and across districts differ is in the effect of labor market and school context factors. For brevity, we focus our discussion on how these results differ from those seen in the model of transfers within districts. Whereas advanced degrees and

[37] As in the models of within-district transfers, we built up to the specification presented in column A by first jointly adding the labor market factors then the school context factors. In doing so, we found that these factors improved the overall fit of the model but changed the coefficient on the teacher effectiveness variable very little.

NBPTS certification mattered for within-district moves, college selectivity and local unemployment rates predict increases in transfers across district boundaries. We also find that teaching in an area with a high concentration of schools lowers the risk of transfers across districts, a result that confirms our hypothesis that a greater number of local options reduces the odds that a teacher seeks a position outside her current district.

Just as we were concerned with whether the best teachers leave disadvantaged schools for new schools within their district, we are also concerned with whether they leave disadvantaged schools for new districts. In addition to high enrollments and higher within-district FRL concentrations (two effects seen in the models of within district transfers), the overall concentration of both African American students and FRL students are associated with higher odds of transferring to new districts.[38] Unlike the within-district models, the school's math score does not significantly predict across-district transfers.

How do findings differ across the teacher effectiveness distribution?

The lower panel of table 3 provides estimates from a model that allowed the effects of labor market and school context factors to vary across effectiveness quintiles.[39] Again, we focus primarily on how these results differ from what was seen in the models of within-district transfers.

Focusing on the labor market factors, we observe that a teacher graduating from a more selective college corresponds with a greater odds of moving between districts for the lowest and second quintile of teachers. But, the specifications that allow exploration of whether the

[38] None of these effects are particularly large; increases in the odds of transferring are about 5 percent with a 10 percent increase in FRL or African American students and only 0.2 percent with a 10 student increase in enrollment. As was the case in the models of within-district transfers, accounting for the teacher's classroom context does not eliminate the effects of the school-level conditions on teachers' odds of transferring districts.

[39] As above, we were able to reject the assumption of a linear relationship between teacher effectiveness and mobility.

strongest teachers are more likely to pursue a district move from disadvantaged contexts show that no school context factors correspond with odds of district moves for the most effective teachers. A higher concentration of African American students corresponds with a greater odds of district moves by teachers in the fourth quintile, but this effect is very small and only significant at a 10 percent level of confidence.

Teacher Effectiveness and Exits from the North Carolina Public School System

Teachers leaving the North Carolina public education system reflect a net loss of public school teacher resources to the state. To the extent that North Carolina loses its best teachers, these exits may reflect a productivity loss for the system as well. Our third set of models uses the same specifications as above to explore the exit of teachers from the North Carolina public education system. These specifications, given in **table 4**, in the end show that, on average, the most effective teachers are the least likely to exit the system.

As seen in **table 4, column A,** the odds of exiting the system decline by 23 percent with each additional standard deviation of effectiveness. As before, this effect persists even after accounting for school fixed effects (see **table 4, column B**).

Looking at the relationship between school context factors and exits from the system, we again see that an assortment of factors including enrollment, the concentration of FRL students, and the within-district standardized concentration of African American students all correspond with increases in the odds of exiting the system. The one notable difference in our models of teacher exits from the system is that a high concentration of FRL students relative to the rest of the schools in the district corresponds with *lower* odds of exiting the system.

As our conceptual model suggests, there is good reason to think that the labor market factors predicting the exit of teachers will differ from those predicting the transfer of teachers.

However, before addressing this issue, it is worth noting again that we do not know the reason for an exit: it may be because a teacher is accepting another job in the same occupation in a different state, because a teacher is taking a job outside teaching, or because a teacher is leaving the labor market altogether. In the discussion that follows, we focus mainly on the likelihood that teachers are leaving the North Carolina system for a nonteaching job.

If the decision is to stay in teaching or leave for another occupation, the chance that a teacher will leave the system depends on whether the teacher displays qualities that are desired in the external labor market and the relative compensation and benefits of teaching and opportunities in the external labor market. Estimates from table 4 show that college selectivity and pre-service licensure exam scores are significant predictors of the likelihood of teachers leaving the North Carolina system. For example, the model suggests that teachers who graduated from colleges where the average entering freshman SAT score is 1,000 are 26 percent more likely to leave the North Carolina system than are teachers graduating from colleges where the average entering freshman SAT score is 900. Similarly, the odds of exiting the system increases by about 11 percent for each additional standard deviation in the pre-service licensure exam score.

The finding on college selectivity is not surprising since this is likely to be a commonly used screen for job applicants, but it is somewhat curious to find that licensure exam scores were significant since employers external to teaching would be unlikely to ask about these. There are, however, two potential explanations for the findings: teachers may be leaving North Carolina for an out-of-state teaching position; or pre-service licensure exam performance may be a good measure of, for instance, cognitive ability or other skills that are observed and valued by employers outside the education system.

The finding that the external market appears to more highly value measures of academic competence like college selectivity and test performance is consistent with research on distribution of individuals across occupations (Ballou 1996), which finds that graduates from more selective colleges receive smaller pay premiums in teaching than in other occupations.

How do findings differ along the teacher effectiveness distribution?

Just as we were concerned with the variation in teacher transfer behavior across the effectiveness distribution, we also argued that we might expect teachers' exit (from the North Carolina system) behavior to relate to their effectiveness levels. And, consistent with both within-district and across-district transfers, we find that the attrition patterns for teachers in the middle of the effectiveness distribution are similar while the top and bottom quintile teachers are more likely to exit than those in the middle (see **table 4, column C**). One factor that might be driving the findings, particularly at the bottom of the effectiveness distribution, is school district administrators encouraging ineffective teachers to leave teaching. We cannot directly test this hypothesis, but we can see whether the results differ for teachers who are tenured (and therefore far more likely, given the job protections that come with tenure, to be leaving on their own accord). Tenure in North Carolina is achieved after four years of continuous service, so to test this possibility, we estimate models (available upon request) restricted to a subsample of teachers that have five or more years of service. The findings with this subsample differ little for the key coefficients of interest, suggesting that our findings are unlikely to be driven by teacher pre-tenure exits.

Turning to the interactions between effectiveness and the labor market and school context variables (shown in the lower panel of table 4), we see that the effect of college selectivity does not vary much across the effectiveness distribution. The pre-service licensure exam score, by contrast, varies in both magnitude and statistical significance across the effectiveness distribution but lacks an intuitive or consistent pattern. The least effective teachers appear slightly more sensitive to school context than more effective teachers. For example, the percentage of FRL students predicts greater attrition from the system across for all but the fourth quintile of teachers, but only the least effective teachers appear sensitive to a school's math performance.

Policy Implications and Conclusions

At the beginning of this paper, we argued that, when focusing on teacher attrition, it is important to consider both the type of exit and whether the influence of individual teacher, school, and labor market conditions for teachers vary across the effectiveness distribution. Consistent with the broad story from prior research, we find that more effective teachers are less likely to leave their schools and/or the public school system. But we argue that the complex results we report in the prior section also offer some more nuanced lessons.

To help explore these policy issues, **table 5** summarizes the key results by displaying the predicted probably of moves and exits across the effectiveness quintiles for teachers under several scenarios. The first row displays the predicted probably of moves and exits across all teachers displaying average characteristics in each quintile. The next two rows illustrate the role of school context factors in teachers' mobility by comparing the probability of moves and exits from schools with advantaged and disadvantaged contexts. Advantaged schools are those in the lowest quartile for enrollment, percent FRL, and minority (both overall and within districts), and the highest quartile for math scores. Disadvantaged schools are on the flip side of all these factors. Finally, last two rows illustrates the role of teachers' external marketability by comparing the predicted probably of moves and exits between teachers with varying individual characteristics. We characterize high marketability by teachers who graduate from colleges in the top quartile for college selectivity and have top-quartile pre-service licensure exam scores. Low marketability is defined as teachers falling in the lowest quartile for college selectivity and pre-service exam scores.

There are arguably three key findings. First, there is a considerable amount of churn of ineffective teachers in the system; a finding consistent with the colloquial phrase "the dance of the lemons." Looking at the simulation based on our empirical models of mobility provided in the first row of table 5, the least effective teachers have the highest predicted probability of both moving schools within districts and moving to new schools across districts.

Despite being relatively ineffective, these teachers found jobs in other schools.[40] If policymakers are interested in minimizing the churn of the least effective teachers, they might devote efforts to incorporate measures of teacher's effectiveness as part of the portfolio of information when making tenure decisions (Gordon et al. 2006; Hanushek forthcoming) and/or consider ways to provide more thorough information on teacher effectiveness to hiring officials.[41]

The churn of the least effective teachers, however, is not the only concern. The second and third rows of table 5 show that teachers, across the effectiveness distribution, are far more likely to leave schools serving disadvantaged and underperforming student populations than more advantaged and higher-achieving populations. Even though, as our model of teacher mobility suggested, challenging school contexts do not seem to drive the most talented teachers out of the field, many of these teachers do seem to seek out better school contexts. The

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[40] Hanushek et al. (2005) also raised concern about the quality of hiring decisions when they found that advantaged schools in a Texas district, despite having fewer minority students and offering higher salaries, did not seem to exploit this advantage to hire more effective teachers.
[41] See Strauss et al. (2000) for a discussion of the principal hiring practice and possible improvements.

probability that a teacher in the highest quintile moves to a new school in the district from a disadvantaged school is 0.13 versus 0.08 for teachers in advantaged schools; the probably that this teacher moves to a new school outside the district from advantaged and disadvantaged schools is 0.10 and 0.06. These findings are not new. The flight of new teachers from arguably more difficult school settings has been well documented (e.g., Lankford et al. 2002). But these results reinforce those findings and show that they hold even for the most effective teachers. Clearly the results suggest a need to address this issue, perhaps as some have suggested through targeted incentives to keep effective teachers in challenging schools (Kirby, Berends, and Naftel 1999; Clotfelter et al. 2006).

Finally, a significant amount of research suggests that college graduates with high standardized test scores are less likely to become teachers (Goldhaber and Liu 2003; Hanushek and Pace 1995; Henke et al. 1996; Hoxby and Leigh 2004; LakDawalla 2001) and are more likely to leave teaching (Murnane and Olsen 1990). These findings have fueled the concern that the rewards of teaching are not enough to attract and keep the most talented graduates. While our theory predicts that relatively weak teachers, finding only minimal nonpecuniary rewards from teaching, will readily leave teaching if their background is attractive to outside employers, our theory offers no clear prediction for teachers who are both strong teachers and attractive to outside employers. Do teachers who are both effective and marketable stay, enjoying the rewards of their success in teaching, or do they leave, seeking better professional opportunities or compensation? Our analysis allowed us to explore this open question.

Assuming that those leaving the North Carolina system are in fact leaving teaching, our analyses (illustrated by the findings reported in rows 4 and 5 of **table 5**), confirms the findings that more academically talented individuals (based on the selectivity of their college and their performance on licensure tests) are more likely to leave the teaching profession while they do not appear systematically more likely to move from one school to another (within or between districts). Moreover, this is true across the teacher effectiveness distribution.

In sum, if the goal is to minimize the churn of the least effective teachers to maximize the number of highly effective teachers staying in the system and staying in schools that need them the most, these results suggest that some of the hard debates about teacher pay and incentives, tenure, evaluation, as well as working conditions are worthwhile. In moving forward, the policy community will be well served by research that focuses specifically on the relationship between teacher incentives, teacher effectiveness, and retention.

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Table 1: Descriptive statistics for teacher effectiveness, labor market, and school context factors	No move	Transfer within districts	Transfer across districts	Exit the system
Teacher characteristics				
Teacher effectiveness measure	5.89	-5.55	-18.08	-18.22
(Standard error)	(1.10)	(1.05)	(0.96)	(1.00)
Percent African American teachers	14.43	18.31	18.71	18.75
Percent other non-white ethnicity teacher	1.59	1.85	1.25	1.10
Labor market factors				
Average district salary supplement/$100	25.86	29.62	24.18	28.45
	(14.53)	(15.27)	(13.91)	(15.25)
Average county wage/$100	350.02	370.98	340.34	365.54
	(77.03)	(86.81)	(76.09)	(84.32)
Number of schools within 5 mile radius	13.92	17.45	12.14	16.63
	(12.84)	(15.02)	(11.63)	(13.63)
Percent county unemployment	4.79	4.71	4.93	4.82
	(1.049)	(0.92)	(1.10)	(1.01)
Average SAT at teacher's undergraduate college/100 points	8.89	8.95	8.82	9.00
	(1.06)	(1.10)	(1.06)	(1.12)
Teacher's preservice exam score	10.22	9.94	4.53	8.19
	(0.65)	(0.66)	(0.61)	(0.68)
Percent with Master's or higher degree	12.88	17.69	9.15	11.76
Percent holding NBPTS certification	1.99	2.78	0.85	0.76
Percent Bordering SC	19.98	29.77	18.03	26.16
Percent Bordering TN	1.50	1.71	1.29	0.37
Percent Bordering VA	5.27	3.88	4.72	6.12
Percent Bordering GA	0.45	0.47	0.00	0.37
School context factors				
Schoolwide percent of students on FRL	47.62	48.35	50.08	51.11
	(22.50)	(22.80)	(22.59)	(22.78)
Schoolwide percent of African American students	34.15	38.39	37.47	41.22
	(24.33)	(25.51)	(25.59)	(24.32)
Enrollment/10 students	63.18	65.12	62.76	63.84
	(24.68)	(30.65)	(27.96)	(25.30)
Standardized schoolwide math score	0.007	0.032	0.038	0.029
	(0.18)	(0.26)	(0.19)	(0.187)
Z score FRL (within districts)	0.17	0.17	0.19	0.28
	(0.91)	(0.90)	(0.92)	(0.93)
Z score African American (within districts)	0.01	0.16	0.13	0.22
	(0.96)	(0.97)	(0.97)	(0.96)
Total N	19763	2665.0000	2263	2071

Table 2, Panel I: Log odds estimates from models of teachers within district moves

Parameter	Panel I					
	Model A		Model B		Model C	
Teacher effectiveness	-0.117	**	-0.132	**		
(Standard error)	(0.022)		(0.024)			
Lowest quintile					0.150	**
					(0.060)	
Quintile 2					0.051	
					(0.062)	
Quintile 3 (reference category)						
Quintile 4					-0.082	
					(0.063)	
Highest quintile					-0.164	**
					(0.069)	
Teacher demographic background						
African American	-0.084		-0.137	*	-0.080	
	(0.068)		(0.077)		(0.068)	
Other non-white	0.107		0.096		0.110	
	(0.156)		(0.183)		(0.156)	
Labor market factors						
Average district salary supplement /$100	0.000		-0.001		0.000	
	(0.003)		(0.004)		(0.003)	
Average county wage/$100	0.000				0.000	
	(0.001)				(0.001)	
Number of schools within 5 mi radius	0.007	**			0.007	**
	(0.002)				(0.002)	
Percent unemployment in county	-0.010				-0.011	
	(0.030)				(0.030)	
Average SAT at undergraduate college/100	-0.008		-0.004		-0.007	
	(0.023)		(0.023)		(0.023)	
Preservice exam score	-0.042		-0.039		-0.041	
	(0.032)		(0.032)		(0.032)	
Master's or higher degree	0.154	**	0.166	**	0.156	**
	(0.056)		(0.056)		(0.057)	
NBPTS certified	0.443	**	0.417	**	0.425	**
	(0.210)		(0.211)		(0.336)	
School context factors						
Percent FRL	0.003		0.010	**	0.003	
	(0.003)		(0.004)		(0.003)	
Percent African American	-0.001		0.032	**	-0.001	
	(0.002)		(0.011)		(0.002)	
Enrollment/10 students	0.007	**	0.029	**	0.007	**
	(0.001)		(0.006)		(0.001)	
Schoolwide math score	-0.430	**	-0.201		-0.432	**
	(0.149)		(0.404)		(0.149)	
Z score FRL	-0.016		-0.072		-0.018	
	(0.056)		(0.095)		(0.056)	
Z score African American	0.136	**	-0.169		0.135	**
	(0.046)		(0.142)		(0.046)	
Includes school fixed effects	No		Yes		No	
Model Log Likelihood	-8007.54		-7956.48		-8009.88	

Table 2, Panel II: Log odds estimates from models of teachers within district moves

Parameter	LOWEST Quintile		2ND Quintile		3RD Quintile		4TH Quintile		5TH Quintile
	Panel II: Effects of Labor Market and School Context Factors by Effectiveness Quintile								
Teacher effectiveness	-0.254	**	0.500		0.112		0.015		-0.090
	(0.0780)		(0.474)		(0.558)		(0.325)		(0.049)
Labor market factors									
Average district salary supplement /$100	-0.002		-0.006		0.004		-0.004		0.008
	(0.005)		(0.005)		(0.005)		(0.006)		(0.007)
Average county wage/$100	0.000		0.000		0.000		0.001		0.001
	(0.001)		(0.001)		(0.001)		(0.001)		(0.001)
Number of schools within 5 mi radius	0.013	**	0.011	**	0.008	*	0.003		-0.001
	(0.005)		(0.004)		(0.005)		(0.006)		(0.005)
Percent unemployment in county	-0.044		-0.059		0.048		-0.011		0.033
	(0.049)		(0.053)		(0.055)		(0.052)		(0.055)
Average SAT at undergraduate college/100	-0.009		0.027		-0.003		-0.016		-0.049
	(0.035)		(0.039)		(0.040)		(0.040)		(0.039)
Preservice exam score	-0.008		0.047		-0.108		-0.142	*	-0.069
	(0.059)		(0.068)		(0.079)		(0.075)		(0.072)
Master's or higher degree	0.011		0.220	*	0.323	**	0.278	**	-0.137
	(0.119)		(0.131)		(0.125)		(0.128)		(0.152)
NBPTS certified	0.104		0.598		0.525		0.163		0.526
	(0.518)		(0.497)		(0.408)		(0.441)		(0.390)
School context factors									
Percent FRL	0.002		0.009	*	0.000		0.008	*	-0.004
	(0.004)		(0.005)		(0.005)		(0.005)		(0.005)
Percent African American	0.003		-0.003		-0.005		-0.004		0.001
	(0.004)		(0.004)		(0.004)		(0.004)		(0.004)
Enrollment/10 students	0.006	**	0.008	**	0.006	**	0.007	**	0.012
	(0.002)		(0.002)		(0.002)		(0.002)		(0.002)
Schoolwide math score	-0.437	*	-0.462	*	-0.194		-0.353		-0.693
	(0.259)		(0.282)		(0.282)		(0.287)		(0.256)
Z score FRL	0.080		-0.042		0.150		-0.346	**	0.032
	(0.096)		(0.110)		(0.111)		(0.113)		(0.114)
Z score African American	0.003		0.191	**	0.079		0.365	**	0.090
	(0.081)		(0.085)		(0.081)		(0.089)		(0.098)
Model Log Likelihood -7960.67									

Note: All models also controlled for years of teaching experience.
Note: All models except those with school fixed effects control for the district's location on the state's border.
Note: Standard errors are in parentheses
Note: *indicates significance level of p≤0.05, ** indicates significance level of p≤0.01

Table 3, Panel I: Log odds estimates from models of teachers' across district moves

Parameter	Panel I					
	Model A		Model B		Model C	
Teacher effectiveness	-0.1284	**	-0.1384	**		
(Standard error)	(0.022)		(0.024)			
Lowest quintile					0.2232	**
					(0.065)	
Quintile 2					0.1111	*
					(0.066)	
Quintile 3 (refernece category)						
Quintile 4					0.0266	
					(0.072)	
Highest quintile					-0.1657	**
					(0.071)	
Teacher demographic background						
African American	-0.033		-0.0055		-0.0274	
	(0.076)		(0.088)		(0.076)	
Other non-white	-0.1011		-0.1532		-0.0968	
	(0.198)		(0.2488)		(0.198)	
Labor market factors						
Average district salary supplement /$100	-0.0022		0.0017		-0.0024	
	(0.003)		(0.004)		(0.003)	
Average county wage/$100	-0.0007				-0.0006	
	(0.001)				(0.0007)	
Number of schools within 5 mi radius	-0.0098	**			-0.0098	**
	(0.003)				(0.0028)	
Percent unemployment in county	0.0466	**			0.0459	*
	(0.028)				(0.028)	
Average SAT at undergraduate college/100	0.079	**	0.080	**	0.080	**
	(0.023)		(0.023)		(0.023)	
Preservice exam score	(0.033)		(0.034)		(0.032)	
	(0.033)		(0.033)		(0.033)	
Master's or higher degree	(0.010)		(0.002)		(0.008)	
	(0.069)		(0.069)		(0.069)	
NBPTS certified	(0.186)		(0.208)		(0.207)	
	(0.390)		(0.390)		(0.358)	
School context factors						
Percent FRL	0.005	*	0.007		0.004	*
	(0.003)		(0.004)		(0.003)	
Percent African American	0.005	**	0.009		0.005	**
	(0.002)		(0.011)		(0.002)	
Enrollment/10 students	0.003	**	0.009	**	0.003	**
	(0.001)		(0.003)		(0.001)	
Schoolwide math score	-0.038		0.081		-0.036	
	(0.151)		(0.339)		(0.150)	
Z score FRL	-0.082		-0.085		-0.085	
	(0.057)		(0.095)		(0.057)	
Z score African American	0.083	*	-0.141		0.082	*
	(0.044)		(0.134)		(0.044)	
Includes school fixed effects	No		Yes		No	
Model Log Likelihood	-7082.14		-7076.17		-7082.17	

Table 3, Panel II: Log odds estimates from models of teachers' across district moves

	Panel II: Effects of Labor Market and School Context Factors by Effectiveness Quintile								
Parameter	LOWEST Quintile		2ND Quintile		3RD Quintile		4TH Quintile		5TH Quintile
Teacher effectiveness	-0.1926	**	0.1935		0.4636		0.208		-0.077
	(0.090)		(0.521)		(0.618)		(0.331)		-0.051
Labor market factors									
Average district salary supplement /$100	0.0025		-0.009		0.007		-0.006		-0.009
	(0.006)		(0.006)		;(0.006)		(0.006)		(0.006)
Average county wage/$100	0.0004		-0.0006		-0.004	**	0.001		-0.001
	(0.001)		(0.001)		(0.001)		(0.001)		(0.001)
Number of schools within 5 mi radius	-0.0119	**	-0.0087		-0.005		-0.020	**	-0.001
	(0.005)		(0.006)		(0.006)		(0.007)		(0.006)
Percent unemployment in county	0.0366		0.0053		0.047		0.073		0.071
	(0.047)		(0.052)		(0.054)		(0.058)		(0.055)
Average SAT at undergraduate college/100	0.0658	*	0.1085	**	0.162	**	0.039		0.022
	(0.038)		(0.041)		(0.043)		(0.043)		(0.047)
Preservice exam score	-0.0229		-0.1003		-0.079		-0.017		0.036
	(0.059)		(0.073)		(0.086)		(0.081)		(0.082)
Master's or higher degree	-0.0803		-0.1956		0.038		0.120		0.065
	(0.138)		(0.177)		(0.165)		(0.151)		(0.158)
School context factors									
Percent FRL	0.0063		0.0038		0.005		-0.002		0.007
	(0.005)		(0.006)		(0.005)		(0.006)		(0.005)
Percent African American	0.0013		0.0074	*	0.009	**	0.008	*	0.002
	(0.003)		(0.004)		(0.004)		(0.005)		(0.004)
Enrollment/10 students	-0.0001		0.0049	**	0.001		0.002		0.008
	(0.002)		(0.002)		(0.003)		(0.002)		(0.003)
Schoolwide math score	0.3451		-0.0685		-0.406		-0.132		0.071
	(0.318)		(0.292)		(0.312)		(0.327)		(0.337)
Z score FRL	-0.1248		0.1016		-0.145		-0.108		-0.120
	(0.097)		(0.111)		(0.118)		(0.123)		(0.117)
Z score African American	0.2025	**	0.0324		-0.028		0.113		0.044
	(0.077)		(0.087)		(0.096)		(0.091)		(0.101)
Model Log Likelihood -7050.5									

Note: All models also controlled for years of teaching experience.

Note: All models except those with school fixed effects control for the district's location on the state's border.

Note: Standard errors are in parentheses

Note: *indicates significance level of p≤0.05, ** indicates significance level of p≤0.01

Table 4, Panel I: Log odds estimates from models of teachers exits from the North Carolina Public Education System

	Panel I					
Parameter	Model A		Model B		Model C	
Teacher effectiveness	-0.257	**	-0.280			
(Standard error)	(0.029)		(0.032)	**		
Lowest quintile					0.538	**
					(0.069)	
Quintile 2					0.014	
					(0.076)	
Quintile 3 (refernece category)						
Quintile 4					-0.104	
					(0.077)	
Highest quintile					-0.169	**
					(0.080)	
Teacher demographic background						
African American	-0.078		-0.069		-0.067	
	(0.077)		(0.087)		(0.079)	
Other non-white	-0.297		-0.322		-0.260	
	(0.228)		(0.275)		(0.224)	
Labor market factors						
Average district salary supplement /$100	0.017	**	0.039	**	0.017	**
	(0.003)		(0.006)		(0.003)	
Average county wage/$100	-0.001				-0.001	
	(0.001)				(0.001)	
Number of schools within 5 mi radius	0.002				0.001	
	(0.003)				(0.003)	
Percent unemployment in county	0.008				0.004	
	(0.031)				(0.031)	
Average SAT at undergraduate college/100	0.233	**	0.234	**	0.234	**
	(0.025)		(0.025)		(0.025)	
Preservice exam score	0.103	**	0.102	**	0.113	**
	(0.038)		(0.039)		(0.038)	
Master's or higher degree	-0.045		-0.022		-0.048	
	(0.070)		(0.070)		(0.071)	
NBPTS certified	-0.562		-0.608		-0.602	
	(0.450)		(0.450)		(0.352)	
School context factors						
Percent FRL	0.012	**	0.016	**	0.011	**
	(0.003)		(0.004)		(0.003)	
Percent African American	0.000		0.007		0.000	
	(0.002)		(0.011)		(0.002)	
Enrollment/10 students	0.003	**	0.010	**	0.003	**
	(0.001)		(0.004)		(0.001)	
Schoolwide math score	-0.071		-0.155		-0.062	
	(0.145)		(0.390)		(0.144)	
Z score FRL	-0.150	**	-0.127		-0.149	**
	(0.056)		(0.098)		(0.056)	
Z score African American	0.073	*	-0.003		0.071	
	(0.045)		(0.150)		(0.046)	
Includes school fixed effects	No		Yes		No	
Model Log Likelihood	-6312.76		-6285.69		-6294.1	

Table 4, Panel II: Log odds estimates from models of teachers exits from the North Carolina Public Education System

	Panel II: Effects of Labor Market and School Context Factors by Effectiveness Quintile									
Parameter	LOWEST Quintile		2ND Quintile		3RD Quintile		4TH Quintile		5TH Quintile	
Teacher effectiveness	-0.465	**	-0.676		0.496		0.256		-0.093	
	(0.077)		(0.616)		(0.708)		(0.397)		(0.060)	
Labor market factors										
Average district salary supplement /$100	0.020	**	0.017	**	0.020	**	0.012	*	0.022	**
	(0.006)		(0.007)		(0.007)		(0.007)		(0.008)	
Average county wage/$100	0.000		-0.002		-0.001		0.000		-0.003	**
	(0.001)		(0.001)		(0.001)		(0.001)		(0.002)	
Number of schools within 5 mi radius	-0.004		0.008		-0.002		0.000		0.007	
	(0.004)		(0.006)		(0.006)		(0.006)		(0.005)	
Percent unemployment in county	0.016		-0.011		-0.049		0.057		0.013	
	(0.046)		(0.071)		(0.065)		(0.059)		(0.061)	
Average SAT at undergraduate college/100	0.241	**	0.183	**	0.265	**	0.197	**	0.282	**
	(0.036)		(0.049)		(0.047)		(0.047)		(0.047)	
Preservice exam score	0.066		0.147		0.114		0.059		0.242	**
	(0.057)		(0.091)		(0.095)		(0.100)		(0.090)	
Master's or higher degree	0.015		-0.007		0.006		0.108		-0.630	**
	(0.123)		(0.161)		(0.166)		(0.166)		(0.212)	
School context factors										
Percent FRL	0.009	**	0.019	**	0.016	*	0.008		0.011	**
	(0.004)		(0.006)		(0.006)		(0.006)		(0.0054)	
Percent African American	-0.002		0.001		0.003		-0.001		0.002	
	(0.003)		(0.004)		(0.005)		(0.005)		(0.005)	
Enrollment/10 students	0.002		0.004		0.002		0.002		0.005	*
	(0.002)		(0.003)		(0.003)		(0.003)		(0.003)	
Schoolwide math score	-0.651	**	-0.015		0.551		0.113		0.102	
	(0.283)		(0.324)		(0.363)		(0.325)		(0.303)	
Z score FRL	0.020		-0.294	**	-0.216		-0.162		-0.308	**
	(0.092)		(0.137)		(0.147)		(0.127)		(0.126)	
Z score African American	0.104		0.051		0.085		0.161		-0.003	
	(0.078)		(0.099)		(0.108)		(0.111)		(0.111)	
Model Log Likelihood -6241.7										

Note: All models also controlled for years of teaching experience.

Note: All models except those with school fixed effects control for the district's location on the state's border.

Note: Standard errors are in parentheses

Note: *indicates significance level of p≤0.05, ** indicates significance level of p≤0.01

Table 5: Probability of moves by Quintile

	Move schools within district					Move schools across districts					Exit NC system				
	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5
P(move)	0.113	0.095	0.095	0.090	0.102	0.110	0.087	0.080	0.081	0.079	0.141	0.101	0.089	0.076	0.092
P(move) advantaged	0.088	0.065	0.081	0.071	0.079	0.092	0.060	0.069	0.068	0.062	0.111	0.080	0.065	0.065	0.084
P(move) dis-advantaged school	0.140	0.130	0.111	0.110	0.126	0.126	0.119	0.095	0.093	0.097	0.176	0.122	0.101	0.086	0.098
P(move) high marketability	0.112	0.096	0.095	0.089	0.099	0.112	0.088	0.083	0.082	0.081	0.159	0.115	0.104	0.084	0.113
P(move) low marketability	0.113	0.093	0.095	0.090	0.104	0.108	0.086	0.077	0.080	0.077	0.126	0.089	0.077	0.068	0.075

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