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by

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Abstract

Using matched student-teacher panel data from the state of Florida, we study the determinants of teacher job change and the impact of such mobility on the distribution of teacher quality. We find that the quality of teachers who exit teaching is bimodal with peer teacher characteristics playing an important role. Teachers who rank above their faculty colleagues are more mobile. Additionally, as the share of peer teachers with more experience, advanced degrees or professional certification increase, the likelihood of moving within district decreases. We also find evidence of assortative matching among teachers.

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I. Introduction

Given the central role of teacher quality in determining student achievement,[1] there is growing concern over the impact of teacher job change on both the overall level of teacher quality and the distribution of teacher quality across schools. In particular, do the best teachers leave teaching and does teacher mobility within the profession exacerbate differences in educational quality across schools? The answers to these questions have important implications for designing policies to promote student achievement and reduce achievement gaps across students from different racial, ethnic and economic backgrounds.

The effects of teacher labor market decisions on teacher quality and student achievement are ambiguous, a priori. If high quality teachers possess transferable skills which are valued in other occupations, attrition will tend to erode average teacher quality. However, attrition may have a positive effect on the average quality of teachers if relatively less-effective teachers receive little job satisfaction, voluntarily leave the profession and are replaced by more able teachers. Likewise, the effect of teacher movement between schools on the distribution of teacher quality across schools is not clear ex-ante. Inter-school mobility of teachers could exacerbate the divergence in education quality across schools if schools serving disadvantaged populations lose their best teachers to schools serving more advantaged students. However, it is also possible that switching of schools by teachers has no effect on the distribution of teacher quality across schools and simply enhances the utility of the teachers that move.

A number of previous studies have explored the relationship between various observable teacher qualifications, including college entrance exam scores, performance on teacher certification exams and possession of advanced degrees on teacher attrition (Boyd, et al. (2005), Feng (2009), Feng (2011), Imazeki (2005), Podgursky, et al. (2004)). However, studies of student achievement find little correlation between these credentials and the impact of teachers on student test scores, particularly in elementary and middle school (Betts, et al. (2003), Clotfelter, Ladd and Vigdor (2007), Clotfelter, Ladd and Vigdor (2010), Hanushek et al. (2005), Harris and Sass (2011), Kane, Rockoff and Staiger (2008)).

[1] See recent work by Aaronson, Barrow and Sander (2007), Hanushek, et al. (2005), Kane, Rockoff and Staiger (2008), Rockoff (2004) and Rivkin, Hanushek and Kain (2005) which demonstrate that teacher quality is the most important schooling input in the determination of student achievement.

Previous research has highlighted the disparity in qualifications of teachers in schools serving primarily disadvantaged and minority students versus teachers in schools with more advantaged student bodies (Clotfelter, Ladd and Vigdor (2005), Goldhaber, Choi and Cramer (2007), Lankford, et al. (2002)). There is also circumstantial evidence that within-profession teacher mobility is contributing to these differences in teacher credentials. Teachers in schools serving primarily disadvantaged students are more likely to transfer to a new school district (Hanushek, et al. (2004), Imazeki (2005), Ingersoll (2001)) and teachers in urban inner-city schools are more likely to migrate away from their schools than teachers in other areas (Ingersoll (2001), Lankford, et al. (2002)). Similarly, teachers, particularly white teachers, tend to move away from schools with high percentages of minority students ((Boyd et al. (2005), Feng (2009), Feng (2010), Feng (2011), Hanushek et al. (2004), Imazeki (2005), Scafidi, Sjoquist and Stinebrickner (2007)).

Given the generally weak relationship between observable teacher characteristics and student achievement, three recent studies have attempted to directly investigate the relationship between teacher job choice and a teacher's contribution to student achievement or teacher "value-added." Kreig (2006) analyzes the relationship between teacher attrition and teacher value-added in Washington State while Boyd, et al. (2007) and Goldhaber, Gross and Player (2007) analyze both attrition and inter-school mobility in New York City and in North Carolina respectively. These papers generally conclude high quality teachers are less likely to transfer and leave.

In this paper we consider the impact of teacher quality, measured by teacher value-added, on both teacher movement into other occupations and mobility across schools in Florida. We derive multiple value-added measures of teacher quality and investigate how each is related to individual teacher choices of exit from teaching and movement across schools. Building on recent work which highlights the importance of teacher peer effects (Jackson and Bruegmann (2009), Jackson (2010)), we also explore how the average quality of faculty colleagues and the productivity of a teacher relative to her peer teachers affect teacher job choice. Further, we consider the faculty and student characteristics of schools teachers move to and the implications for the distribution of teacher quality across schools.

II. Institutional Background

Public schools in Florida are organized into 67 countywide school districts, ranging in size from Miami-Dade, with 350,000 students to Jefferson County with just over 1,000 students in pre-K through 12 (Florida Department of Education (2011)). While new teachers tend to obtain their first job near where they went to school, initial placements are spread throughout the state, with many working far from the location of their preparation program (Mihaly et al. (2012)). New teachers exhibit a high degree of mobility with 60 percent of teachers leaving their initial school placement within four years and only one-fourth of new teachers remaining in their initial school placement after 6 years (Feng (2009)). Perhaps due to the relatively large geographic size of districts in Florida, inter-district transfers make up a relatively small proportion of teacher transfers; only about 1 in 10 new teachers leave their first placement to teach in a different district in the first four years of their career. In contrast, about 30 percent transfer to another school in the same district within four years and about one-third leave the public school system altogether.

Among the 67 countywide school districts in Florida, all but one have collective bargaining agreements that govern personnel matters, including transfer rights. District collective bargaining agreements vary in the restrictiveness of the contract with respect to voluntary transfers, involuntary transfers and reduction-in-force provisions. They also differ in the seniority provisions regarding each type of job action. Voluntary transfer provisions in collective bargaining agreements establish the criteria for selecting among candidates for open positions. In some districts transfer positions do not mention seniority, in others it is one among many criteria and in still others seniority takes priority over all other criteria (Feng, Cohen-Vogel and Osborne-Lampkin (2009)). Frequently current teachers have preference over new hires. The preference may be as weak as simply giving advance notification of open positions or as strong as requiring district employees be placed into open positions before any new teacher is hired.[2]

[2] In future work we plan to include district fixed effects to account for the differences in collective bargaining provisions across districts in Florida.

III. Methods

A. Measuring Teacher Quality

In order to gauge teacher quality we construct twelve value-added measures of teacher productivity (six each for math and reading). All of the measures are derived from the following student achievement model:

$$A_{it} = \lambda A_{it-1} + \boldsymbol{\beta}_1 \mathbf{X}_{it} + \boldsymbol{\beta}_2 \mathbf{P}_{-ijmt} + \boldsymbol{\beta}_3 \mathbf{S}_{mt} + \gamma_i + \delta_{kt} + \nu_{it} \tag{1}$$

A_{it} is the achievement level of student i in year t, where achievement is measured by the student's scale score on the FCAT-NRT (Stanford Achievement Test), normalized by grade and year. The vector $\mathbf{X}_{it}$ represents time varying student/family inputs, which include student mobility within and between school years. Classroom peer characteristics are represented by the vector $\mathbf{P}_{-ijmt}$ where the subscript –i denotes students other than individual i in classroom j in school m. These peer characteristics include class size, the fraction of classroom peers who are female, fraction of classroom peers who are black, average age (in months) of classroom peers, and the fraction of classroom peers who changed schools. The school-level input vector, $\mathbf{S}_{mt}$, includes the administrative experience of the principal, the principal's administrative experience squared, whether the teacher is new to the school and whether the school is in its first year of operation. Time-invariant student/family characteristics are represented by γ_i. Unobserved teacher characteristics are captured by a year-specific teacher effect, δ_{kt}. ν_{it} is a mean zero random error. The teacher effect, which we use to measure teacher quality, represents a teacher's contribution to student achievement, net of prior educational inputs and contemporaneous student, peer and school influences. Given the student test scores are normalized, the teacher effects are calibrated in standard deviation units.

The six teacher quality measures for each subject vary according to the assumed persistence of educational inputs (λ), the method for capturing time-invariant student heterogeneity (γ_i) and whether or not teacher effects are measured separately by year or assumed to be constant across all years (i.e. $\delta_{kt} = \delta_k$ for all t). The first measure of teacher quality, which we denote Q1, assumes complete persistence (λ =1), uses observable student characteristics[3] to control for time-constant student heterogeneity, and allows for separate teacher effects by year. The second teacher quality measure, Q2, is the same as Q1 except the persistence of educational inputs is no longer constrained to equal one. Teacher quality measure Q3 is the same as Q1, but employs student fixed effects, rather than observable student covariates to capture both observed and unobserved time-invariant student heterogeneity. Measures Q4, Q5 and Q6 correspond to Q1, Q2 and Q3, except that the teacher effect is assumed to be constant across all years, rather than varying by year. While time-invariant measures Q4-Q6 will mask any changes in true teacher performance, they are less subject to variation due to measurement error in individual student tests scores. As such, they are likely to provide a less "noisy" signal of teacher quality (McCaffrey, et al. (2009)).

The teacher effect estimates are re-centered to have a mean value of zero in each school level (elementary, middle, high) for measures Q4, Q5 and Q6 and within each school level in each year for measures Q1, Q2 and Q3. Since there are no school fixed effects in the achievement model, the estimates represent the teacher's effect on student achievement relative to the average teacher in the state at the same school level.

B. Estimating the Determinants of Teacher Job Choice

We model a teacher's decision about job quits or job change as an individual utility maximizing problem over a number of job choices.[4] A teacher will select among a group of jobs based on her individual preferences and the characteristics of the job, including both pecuniary aspects and non-pecuniary components. A teacher will compare the available options and select the job that yields the highest present value of expected utility.

The decision facing a teacher during each time period t is represented by:

$$\mathrm{Max}[\mathrm{PV}(\mathrm{U_s}, \mathrm{U_w}, \mathrm{U_B}, \mathrm{U_L}) \text{ where } \mathrm{U} = \mathrm{f}(\mathbf{D}_{\mathrm{kmrt}}, \mathrm{Q}_{\mathrm{kmrt}}, \mathrm{R}_{\mathrm{kmrt}}, \mathbf{F}_{-\mathrm{kmrt}}) \qquad (2)$$

Where the subscript kmrt indicates teacher k in school m and district r at time t. The first term, $\mathbf{D}_{kmrt}$, represents a vector of control variables that have been shown in the literature to be

[3] These include gender, race/ethnicity, free/reduced-price lunch eligibility, gifted program participation, limited English program participation, and a set of indicators for types of student disabilities.

[4] This is the traditional approach that has been employed in the analysis of teacher labor markets. However, a recent paper by Boyd, et al. (forthcoming) employs an alternative approach based on a two-sided matching model. We intend to explore this two-sided approach in future work.

important in influencing a teacher's mobility decision. These include teacher demographics and professional credentials as well as classroom, school, and district characteristics. A teacher's race, gender and age are included to account for teacher preferences. Interactions between age and gender are included to account for women's reproductive decisions.[5] A teacher's experience and education level, professional certification status, and subject specific certification are all included to reflect human capital investment. A set of subject-area indicators allows for differences in teaching difficulty and outside opportunities. Teacher's salaries are included to account for the monetary rewards from teaching.[6] The effects of non-monetary working conditions are captured by a variety of classroom, school, and district characteristics such as class size, average student math scores, disciplinary incidents, student racial/ethnic composition, and percent of students receiving free or reduced-price lunch (a proxy for family income). As is standard in discrete time hazard models, the natural log of time (the number of years a teacher has been teaching at their current school) is also included as an explanatory variable.

$\mathbf{Q}_{kmrt}$ is an indicator of teacher quality or effectiveness, captured by one of the teacher quality measures, Q1-Q6, described above. The value-added teacher quality measures capture a variety of unobserved teacher characteristics that impact teacher productivity and hence labor market decisions, including innate ability, non-cognitive skills and pre-service (undergraduate) training. The quality parameter may also proxy intrinsic psychological rewards from teaching.

Campus peer faculty characteristics are represented by $\mathbf{F}_{-kmrt}$, where the subscript –k denotes teachers other than teacher k in school m. These teacher peer characteristics include value-added peer teacher quality measures and peer teacher credentials, such as teaching experience, advanced degree attainment, National Board certification, and professional (non-temporary) state certification. We also include measures of the percent of peers with certification in specific subject areas to allow for different types of peer human capital to have unequal impacts on the mobility of individual teachers. In addition to the absolute level of peer teacher quality, we include R_{kmrt}, which is an indicator of the quality ranking of a specific teacher within their school. This allows us to test whether relative performance influences a teacher's mobility choices.

[5]Commuting time to school is possibly an important aspect of teachers' employment choice. Unfortunately, the available data do not provide such information.

[6]In particular, we employ annual base teaching salary, excluding bonuses, as our measure of teacher compensation.

A teacher maximizes his utility by selecting the option that provides the highest utility out of four possibilities: stay at the present school (S), move to a different school within the school district (W), move between districts to a new school in a different school district (B), and leave teaching (L). It is thus assumed that all moves are the results of utility-maximizing choices. While this assumption may not be correct in cases of involuntary separation due to poor performance or workforce reduction, such cases are relatively rare. According to teacher exit interviews conducted by the Florida Department of Education, 85 to 90 percent of teachers exit voluntarily. Including involuntary separations in the estimation would tend to bias against finding significant results since involuntary separations are primarily unrelated to pay and working conditions.

For teachers, most moves and exits occur at the end of the school year. In addition, information on schools and districts is typically only available at yearly intervals. Given this discreteness in the data, we employ a discrete multinomial logit hazard model with both time-varying and time-invariant coefficients. The discrete-time hazard function models the probability that any of the four events—staying, moving within the district, moving between districts, or leaving—happens to teacher k during period t+1, which is conditional on the event not occurring until that time. The discrete-time hazard function can be interpreted as the probability of transition at discrete time t+1 given survival up to time t+1:

$$h_{kmr,t+1} = \Pr\left[T_{kmr,t+1} = t+1 \middle| T_{kmr,t+1} > t+1, D_{kmrt}, Q_{kmrt}, R_{kmrt}, F_{-kmrt}\right] \quad (3)$$

Assuming independence of irrelevant alternatives and error terms that are independently and identically extreme value distributed, a multinomial logit hazard model specifies the probability of choosing each alternative as a function of teacher, school, and district characteristics. The cumulative probability of leaving a particular school is a summation of the transition probability of exiting teaching, the probability of moving within a district and the probability of moving across districts:

$$\text{Logit}\left(h_{kmr,t+1}(W)\right) = \alpha_W + \beta_{W1} * D_{kmrt} + \beta_{W2} * Q_{kmrt} + \beta_{W3} * R_{kmrt} + \beta_{W4} * F_{-kmrt} \quad (4A)$$

$$\text{Logit}\left(h_{kmr,t+1}(B)\right) = \alpha_B + \beta_{B1} * D_{kmrt} + \beta_{B2} * Q_{kmrt} + \beta_{B3} * R_{kmrt} + \beta_{B4} * F_{-kmrt} \quad (4B)$$

$$\text{Logit}\left(h_{kmr,t+1}(L)\right) = \alpha_L + \beta_{L1} * D_{kmrt} + \beta_{L2} * Q_{kmrt} + \beta_{L3} * R_{kmrt} + \beta_{L4} * F_{-kmrt} \quad (4C)$$

Estimates are reported as exponentiated coefficients or odds ratios. An odds ratio greater than one indicates that a one-unit increase in the predictor is associated with an increased probability of moving or leaving compared with the default of staying at the initial school. Likewise, an odds ratio of less than one implies a one-unit increase in the explanatory variable is associated with a decreased probability of leaving or moving.

The coefficients of primary interest are β_2, β_3 and β_4. The values of β_{w2}, β_{B2} and β_{L2} will depend in part on the degree to which human capital traits that are associated with productivity in teaching are transferable across schools and occupations. For example, Harris and Sass (2010) find that teacher value-added in math is positively correlated with a teacher's intelligence and subject knowledge (as rated by their principal). Likewise, the enthusiasm and motivation of reading teachers is positively associated with their value-added. If such cognitive and non-cognitive traits also have value in occupations other than teaching, then β_{L2} will have a value greater than one, indicating that high quality teachers are more likely to exit public school teaching than are teachers of average quality. If, however, the traits of highly effective teachers are not transferable across occupations, the value of β_{L2} may be indistinguishable from zero. Presumably productive traits of teachers would be more likely to be transferable across schools within the public education sector, making the values of β_{w2} and β_{B2} greater than β_{L2}. However, if the skills that make a teacher productive are not easily observable by persons outside of the teacher's current school the odds ratios β_{w2} and β_{B2} may still be close to one, indicating teaching quality has little or no effect on mobility between public schools.

In addition to absolute teacher quality, the productivity of a teacher relative to her current colleagues may influence teacher job choice, though the direction of the effect is unclear. Podgursky, et al. (2004) find that the probability of female teachers exiting the teaching profession increases the greater the difference between their own ACT college entrance-exam score and the average of the ACT scores of other teachers at their school. This may reflect positive assortative matching whereby teachers seek out positions in which their productivity matches the productivity of their colleagues.[7] In addition, relative peer quality could affect teacher mobility choice if positive spillover effects exist whereby more capable peers stimulate

[7]Note that our teacher quality measures are not conditional on experience, so an inexperienced teacher could have experienced colleagues who are unconditionally more productive than the new teacher, but who would be less productive conditional on experience.

productivity via informal learning channels (Jackson and Bruegmann (2009), Sass, et al. (2010)). Alternatively, if one's self perception is a function of the productivity of their colleagues, relatively less productive teachers might opt to move to schools where they would be surrounded by less able colleagues. In this case the odds ratio of β_{w4} would be less than one, i.e., teachers with higher quality peers are more likely to switch schools. Relative rank within a school may also be used as a signal of absolute productivity by potential employers at other schools (e.g. Mrs. Smith was teacher of the year at school X, therefore she must be good). This would yield an odds ratio greater than one.

IV. Data

We utilize data from the Florida Education Data Warehouse (FL-EDW), an integrated longitudinal database that covers all public school students and teachers in the state of Florida.[8] Like statewide administrative databases in North Carolina and Texas, the FL-EDW contains a rich set of information on both individual students and their teachers which is linked through time. Since students may have more than one instructor in a given subject at a point in time (e.g. a regular education teacher and a special education reading teacher in elementary school or two math classes taught by different instructors in high school), we limit the analysis to students with a single "solely responsible" teacher in a subject and year.

Statewide data, as opposed to data from an individual school district, are particularly useful for studying teacher labor markets since we can follow teachers who move from one district to another within Florida. We cannot, however, track teachers who move to another state. Fortunately, because Florida is a peninsula surrounded on three sides by water, interstate emigration of teachers from Florida is relatively infrequent. Using the nationally representative School and Staffing Survey, Feng (2010) concludes that misclassifications of the three types of movers (i.e., inter-state movers, movers to private school within same state, and movers to private schools in other states) are not a major concern in geographically large states like Florida.

The available data cover school years 1995/1996 through 2004/2005. However, testing of math and reading achievement in consecutive grades did not begin until the 1999/2000 school year and only includes grades 3-10. Construction of our teacher quality measures is based on

[8] Detailed descriptions of the Florida data are provided in Sass (2006) and Harris and Sass (2011).

current and prior-year student achievement, thereby limiting our sample to the school years 2000/2001 through 2004/2005 for math and reading teachers in grades 4-10. Teacher mobility status for year t is based on job information in year t+1. Therefore, our analysis of teacher quality and mobility is limited to the school years 2000/01 through 2003/04.

V. Results

A. Descriptive Evidence

Table 1 shows the correlation among teacher quality indicators for both math and reading.[9] Within-subject correlation is fairly strong for both math and reading. For example, the correlation between teacher-by-year estimates assuming complete persistence and those with partial persistence (Q1 and Q2) is 0.80 for both math and reading. However, when student fixed effects are used in place of observed student characteristics to control for time-invariant student heterogeneity (Q3 versus Q2) the correlations are lower (0.57 in math and 0.51 in reading). When we compare teacher-by-year estimates (Q1, Q2 and Q3) with the corresponding all-year teacher effects the correlations are relatively strong, ranging from 0.63 to 0.71 in math and 0.61 to 0.74 in reading. Thus while there is no consensus on the specification of value-added models, the selection of a particular value-added model should not radically alter our estimates of the effect of teacher quality on teacher labor market decisions.

Since there is subject specialization by teachers in middle and high school, the cross-subject correlations almost universally represent elementary school teachers who teach all subjects in a self-contained classroom. Interestingly, these teacher effect correlations are more modest than the cross-model correlations within subject, ranging from 0.20 to 0.49. This suggests that teaching ability can vary across subject matter and that the estimated impacts of teacher quality on teacher mobility could differ between math and reading.

Table 2 provides means and standard errors of the 12 teacher-quality-by-subject measures for each of the teacher mobility categories: stayers, intra-district movers, inter-district movers and leavers. Across subject and quality measures, the average quality of teachers who stay at the initial school is statistically higher than that of other teachers. While the average quality of inter-

[9] For a more detailed analysis of alternative value-added models and the degree to which they produce similar estimates of teacher value-added, see Harris, Sass and Semykina (2010).

district movers is generally lower than that of intra-district movers and leavers, the differences are small. The differences in average quality between intra-district movers and leavers are also small and show no readily discernible pattern.

B. Multivariate Estimates of Absolute Teacher Quality and Teacher Mobility

Table 3 presents a series of estimates of the multinomial logit hazard model, which controls for factors besides teacher quality that may affect teacher job choice. Each row of the table represents estimates from a separate regression that employs a particular teacher quality measure. All statistically significant odds ratios are less than one, indicating that in general, the likelihood a teacher stays in the current school assignment increases with teacher quality.

For the models based on separate teacher-by-year quality estimates (Q1-Q3), the results indicate there is a consistent negative relationship between teacher quality and the probability of exit from the teaching profession (holding other factors constant). In five of six equations the odds ratio on the quality indicator is statistically significant and less than one. In models which assume teacher quality is constant over time (Q4-Q6), the estimated odds ratios are also always less than one, though are statistically significant in only three of six cases. Whether time-invariant or time-varying teacher quality measures are used the estimated effects are quantitatively substantial. For example, the model where the computation of teacher quality is based on complete persistence of inputs, student fixed effects, and time-invariant teacher quality in math (Q6-math) yields an odds ratio on teacher quality of 0.837. This indicates that a teacher who boosts student achievement by one standard deviation more than the average teacher would have a 16.3 percent (1 - 0.837) lower probability of exit. Overall the effect of a one-standard – deviation-unit increase in teacher quality on the likelihood of exit ranges from 3.0 to 20.7 percent.

Compared to leavers, results for the relationship between teacher quality and intra-district moves are less robust. The odds ratios are always less than one, indicating a negative relationship between teacher quality and the likelihood of making a within-district move. However, the relationship is only statistically significant in half the cases (two out of four in math and four out of six in reading).

Consistent with expectations, the quality/mobility relationship is weakest for inter-district moves. Given Florida has county-wide school districts, taking a job in a different district typically involves changing residential locations. Most likely residential change is affected by external factors like spousal job change or the desire to move closer to other family members. We find that a significant relationship between inter-district moves and teacher quality in only two of six math specifications and in none of the six reading specifications.

The estimates presented in Table 3 are based on models that assume a monotonic relationship between teacher quality and teacher job choice. However, as discussed above, there are reasons for expecting otherwise. For example, assortative matching could lead both relatively high and low-quality teachers to change schools. Further, both higher and lower-quality teachers may be more likely to leave teaching than the average quality teacher, but for different reasons. High quality teachers may be more likely to exit because they have particularly good outside opportunities whereas low quality teachers exit because they recognize they are not particularly effective teachers or do not enjoy teaching.

To account for the different departure trends for teachers of different quality, we divide teachers into four quality quartiles and estimate the relationship between a teacher's quality quartile and the odds of staying, moving and exiting. Estimates of the multinomial hazard are presented in Table 4 (quartile 1 is the reference category). With the time-invariant teacher quality measures, a clear bimodal pattern emerges for the relationship between teacher quality and exit. For all three measures and both subjects, teachers in the middle two quartiles have much lower exit probabilities than do teachers in the bottom and top quartiles. The odds ratios for the second and third quartiles are around 0.7 to 0.8 and statistically significant, indicating that teachers in the middle 50 percent of the quality distribution are 20 to 30 percentage points less likely to leave teaching than are teachers in the lowest quartile of the quality distribution. Odds ratios for the highest quartile teachers are typically in the range of 0.9-1.0, indicating that they are only slightly less likely to exit than are bottom-quartile teachers and are much more likely to leave teaching than teachers in the middle of the quality distribution. In contrast, the pattern of results is less clear for the single-year quality estimates (Q1-Q3). The odds ratios are generally close to one and do not differ much between quartiles.

The bimodal relationship between teacher quality and exit does not carry over to decisions to switch schools. Consistent with the results in Table 3, we find that in seven of twelve cases top quartile teachers are less likely to change schools within a district than are their colleagues in the bottom quartile. There is no consistent pattern for inter-district moves.

C. Estimates of Peer Teacher Quality and Teacher Mobility

Table 5 displays estimates from five separate multinomial logit hazard models. All employ the teacher quality estimate derived from the math achievement model with complete persistence, student fixed effects and time-invariant teacher quality (Q6-math). Results from the other eleven teacher quality indicators are not presented to conserve space, but are available by request. We discuss below any qualitative differences in results between the models using the Q6-math quality metric and models using the other eleven quality measures.

Models 1 and 2 consider peer quality in absolute terms. In model 1 peer teacher quality effects are linear in means whereas model 2 allows for non-linear peer teacher effects. Using either the continuous peer teacher quality or peer quality quartiles, we do not find any consistent patterns of peer teacher quality on either inter-school mobility or exit from teaching.

Using model 3 we investigate whether one's quality standing within a school influences the decision to move or leave. Rank is in reverse order where the worst teacher is ranked as 1, next worst teacher 2, and so on. Controlling for the total number of faculty at a school, we find a statistically significant positive relationship between a teacher's quality ranking within their current school and the likelihood of moving. Specifically, better ranked teachers are more likely to move to other schools within a school district and exit public schools.[10]

In model 4 we examine whether observable teacher peer characteristics influence individual teachers' mobility decisions. We find that having more experienced peers and higher percentages of colleagues with a masters degree or professional (non-temporary) certification translates into a lower likelihood of transferring within district. This result is robust across all twelve measures of teacher quality. This suggests that peer teachers with better qualifications may be more likely to provide positive spillovers or otherwise enhance the work environment. Having more professionally certified colleagues is also associated with a lower smaller likelihood of exiting the teaching profession. Curiously, increases in the shares of colleagues who hold masters degrees or are National Board certified are associated with a greater likelihood of exiting public school system.

[10] While the odds ratio for teacher quality in the exit equation is not statistically significant using the Q6-math measure. However, for all six reading teacher quality measures as well as math teacher quality measures Q4 and Q5 the odds ratio is statistically significant.

Our final model of teacher job choice combines all variables of interest into a single specification. The likelihood of an intra-district move decreases uniformly with teacher quality. The relationship between teacher quality and exit continues to be bimodal; both top-quartile and bottom-quartile teachers are less likely to exit public school that are teachers in the middle two quality quartiles. Holding constant own-teacher quality, having more bottom quartile colleagues is associated with a lower likelihood of intra-district mobility. However, holding constant own and peer teacher quality, the higher the relative rank of a teacher the more likely she is to move between schools in a district. Having more professional certified colleagues with both advanced degree and job-specific teaching experience translates into a lower likelihood of intra-district transfer. Additionally, having more colleagues with professional certification in high school math is also associated with lower intra-district turnover. In contrast, more peers with advanced degrees and national board certification are associated with higher exit rates.

D. Mobility and the Distribution of Teacher Quality

To understand the implications of teacher mobility on the distribution of teacher quality across schools we first compare the mean characteristics of the origin and destination schools for teachers who switch schools. The averages and t-statistics for the differences in means are presented in Table 6. Consistent with prior research, teachers tend to move to schools where students have higher achievement, a smaller fraction of students are black and a smaller proportion from low-income families. In contrast, we do not find a consistent pattern in the relationship between average teacher quality at the sending and receiving schools. The results vary depending on the measure of teacher quality we employ and in general the differences are quite small. For intra-district movers, they generally move to schools with higher student test scores, as reflected by a better school grade.[11] However, the comparison of school averages can be deceptive if the teachers fleeing low-quality schools are better than the average of the colleagues they leave behind.

In Table 7 we compare the quality of a teacher making a move and the quality of faculty at the receiving school. Since we examine the average faculty quality prior to the move, we are avoiding any confounding caused by incoming teachers changing the average quality of teachers

[11] In Florida, schools are assigned letter grades based on student performance on standardized exams. See Florida Department of Education (2010) and Feng, Figlio and Sass (2010).

on campus. The restricted student fixed effects based teacher-by-year value-added in math (Q6-math) is used as the metric of teacher quality and the distribution of teacher quality is broken up into four quartiles. Looking down the diagonal, it is apparent that the pluralities of movers into each of the four receiving-school quality categories are of comparable quality to the average quality of faculty at the receiving school. Looking across rows it is also evident that the fraction of movers goes down with the difference in the quality of the moving teacher and the average quality of teachers at the receiving school. Schools whose average teacher quality is in the top quartile draw many more top-quartile teachers (32.38 percent) than to schools where average teacher quality is in the bottom quartile (23.17 percent). Similarly, bottom-quartile schools are disproportionally attracting bottom-quartile teachers (28.52 percent) compared to top quartile schools (24.37 percent).

VI. Summary and Conclusions

It has been well established that teacher quality is an important determinant of student achievement and that the observable credentials of teachers in schools teaching disadvantaged students are substantially below those of faculty in schools serving more advantaged students. It is also well known that teacher mobility and attrition are significant, particularly among relatively new teachers. However, there is currently a lack of evidence directly linking teacher mobility and the distribution of teacher quality across schools.

In this paper we provide new evidence on the impact of teacher quality on teacher job change and on the distribution of teacher quality across schools. We find that the most effective teachers are more likely to stay put rather than move to another school in the same district. In the case of exit, we uncover a bimodal quality distribution. The most effective teachers are more likely to exit than middling quality teachers, but teachers at the low end of the quality distribution are also more likely to leave. Additionally, we find the fit between teacher own quality and peer faculty quality is important. Holding own quality constant, teachers whose peers are more effective tend to move around to find a better fit. In particular, school quality rank plays a significant role in intra-district mobility. We also find evidence of human capital spillovers. Peers with job-specific teaching experience, professional certification, and advanced degree will help school stem the trend of intra-district mobility. These peers may provide school specific job skills and knowledge to their colleagues, resulting in lower turnover.

Further, teachers generally move to better schools with higher achieving students and with smaller shares of poor and minority students. Teachers who move tend to go to a school where the average teacher quality is like their own. The fraction of top quartile movers hired by schools whose faculty is in the top quartile of the quality distribution is much higher than that of schools whose faculty is in the bottom quartile of the quality distribution. The net result is that the “rich get richer” and the movement of teachers across schools tends to exacerbate differences in teacher quality.

Given the strong link between teacher quality and student performance, our results suggest that teacher mobility tends to increase the achievement gaps between white and minority students and between poor and more affluent students. This suggests that mechanisms that reduce the natural flow of teachers to schools with superior faculties could help reduce student achievement gaps. In particular, salary differentials for teachers willing to re-locate to schools serving disadvantaged students might be a worthwhile policy. However, for differential salary schemes to alter the distribution of teacher quality, any monetary inducements must be tied to teacher quality.

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Table 1. Correlations of Teacher Quality Indicators in Math and Reading

	Q1-Math	Q2-Math	Q3-Math	Q4-Math	Q5-Math	Q6-Math	Q1-Reading	Q2-Reading	Q3-Reading	Q4-Reading	Q5-Reading	Q6-Reading
Q1-Math	1.00											
Q2-Math	0.80	1.00										
Q3-Math	0.72	0.57	1.00									
Q4-Math	0.71	0.59	0.51	1.00								
Q5-Math	0.57	0.74	0.42	0.80	1.00							
Q6-Math	0.57	0.47	0.63	0.81	0.65	1.00						
Q1-Reading	0.27	0.21	0.18	0.22	0.19	0.18	1.00					
Q2-Reading	0.23	0.43	0.16	0.20	0.37	0.17	0.80	1.00				
Q3-Reading	0.16	0.11	0.20	0.13	0.12	0.15	0.66	0.51	1.00			
Q4-Reading	0.24	0.21	0.17	0.33	0.28	0.27	0.69	0.56	0.46	1.00		
Q5-Reading	0.20	0.35	0.16	0.27	0.49	0.25	0.54	0.74	0.35	0.78	1.00	
Q6-Reading	0.17	0.13	0.18	0.24	0.20	0.28	0.53	0.41	0.61	0.77	0.58	1.00

Table 2. Average Teacher Quality in Math and Reading for Stayers, Intra-, Inter-district Movers, and Leavers

	Stay	T-test (stay vs. move or exit)	Intra-district move	Inter-district move	Exit FL public schools	Total
Q1-Math	0.0075 (0.279)	6.88	-0.0095 (0.280)	-0.0236 (0.314)	-0.0063 (0.279)	0.005 (0.280)
Q2-Math	0.0008 (0.287)	7.44	-0.0066 (0.286)	-0.0279 (0.310)	-0.0098 (0.287)	-0.0007 (0.288)
Q3-Math	0.0086 (0.484)	5.90	-0.0233 (0.450)	-0.023 (0.457)	-0.0117 (0.474)	0.0047 (0.481)
Q4-Math	0.0187 (0.206)	5.11	0.0086 (0.226)	-0.0091 (0.262)	0.0146 (0.245)	0.0173 (0.211)
Q5-Math	0.0254 (0.212)	11.51	0.0091 (0.229)	-0.0113 (0.251)	0.013 (0.243)	0.023 (0.216)
Q6-Math	0.0219 (0.302)	7.75	-0.0066 (0.328)	-0.0132 (0.342)	0.0051 (0.346)	0.0185 (0.307)
Q1-Reading	0.0051 (0.256)	6.90	-0.0197 (0.263)	-0.0229 (0.286)	-0.0067 (0.250)	0.0023 (0.256)
Q2-Reading	-0.0024 (0.259)	8.62	-0.0269 (0.267)	-0.0332 (0.282)	-0.0158 (0.254)	-0.0053 (0.259)
Q3-Reading	0.0077 (0.516)	4.26	-0.0257 (0.486)	-0.0164 (0.508)	-0.006 (0.478)	0.0042 (0.512)
Q4-Reading	0.0113 (0.182)	4.84	-0.0038 (0.210)	-0.0121 (0.237)	0.0073 (0.211)	0.0097 (0.187)
Q5-Reading	0.0175 (0.195)	10.77	-0.0071 (0.222)	-0.0168 (0.240)	0.0036 (0.220)	0.0145 (0.199)
Q6-Reading	0.0147 (0.297)	6.68	-0.0147 (0.337)	-0.0128 (0.352)	-0.0025 (0.332)	0.0113 (0.303)

Note: Standard errors are in parentheses.

Table 3 Multinomial Logit Hazard Estimates of the Relationship Between Teacher Quality in Math and Reading and the Odds of Teacher Mobility

	Math			Reading		
	Intra-district move	Inter-district move	Exit FL public schools	Intra-district move	Inter-district move	Exit FL public schools
Q1	0.916 (0.06)	0.881 (0.11)	0.841** (0.06)	0.801*** (0.05)	1.040 (0.16)	0.819*** (0.06)
Q2	0.991 (0.07)	0.744** (0.10)	0.851** (0.06)	0.887 (0.07)	0.927 (0.15)	0.863** (0.06)
Q3	0.896*** (0.04)	0.951 (0.07)	0.931* (0.04)	0.929** (0.03)	1.118 (0.09)	0.970 (0.04)
Q4	0.865 (0.08)	0.795 (0.14)	0.885 (0.09)	0.813** (0.08)	1.029 (0.22)	0.793** (0.09)
Q5	0.998 (0.10)	0.720* (0.14)	0.862 (0.10)	0.989 (0.10)	1.034 (0.24)	0.833 (0.10)
Q6	0.807*** (0.05)	0.941 (0.12)	0.837** (0.06)	0.863** (0.05)	0.973 (0.12)	0.851** (0.06)

Note: Each row under the appropriate subject heading represents a separate regression. Reported numbers are the odds ratios. Robust standard errors for the underlying coefficients clustered at the school level are in parentheses. Explanatory variables included teacher's age, age squared, female, female and age interaction term, teacher's race, teacher's education level, professional certification, reading certification, middle school math certification, high school math certification, indicator variables for special education teachers, middle school education teachers, high school teachers, English teacher, math or science teachers, self-contained class teachers, social studies teachers, indicator variable for regular and full time teachers, teacher's experience and experience squared term, dummy variables indicating the cohort year, and teacher's own salaries, and classroom, school, and district characteristics such as class size, average math score on the FCAT, disciplinary incidents, percent of minority students (Black, Hispanic), percent of students on free or reduced lunch program, indicator variables for the school grade in 1999 and log(years of teaching). ***p<0.01 **p<0.05 *p<0.10

Table 4 Multinomial Logit Hazard Estimates of the Relationship Between Different Quartiles of Teacher Quality in Math and the Odds of Teacher Mobility

		Intra-district move	Inter-district move	Exit FL public schools				Intra-district move	Inter-district move	Exit FL public schools
Q1-Math	2nd quartile	1.032	1.079	0.956		Q4-Math	2nd quartile	0.926	0.981	0.705***
		(0.05)	(0.10)	(0.05)				(0.05)	(0.09)	(0.04)
	3rd quartile	1.002	1.049	0.918*			3rd quartile	0.931	0.991	0.751***
		(0.05)	(0.10)	(0.05)				(0.05)	(0.10)	(0.04)
	4th quartile	0.920	0.842*	0.854***			4th quartile	0.960	0.857	0.965
		(0.05)	(0.09)	(0.04)				(0.05)	(0.09)	(0.05)
Q2-Math	2nd quartile	0.957	0.936	0.944		Q5-Math	2nd quartile	0.955	0.914	0.799***
		(0.05)	(0.09)	(0.05)				(0.05)	(0.09)	(0.04)
	3rd quartile	1.049	0.896	0.943			3rd quartile	1.012	0.918	0.851***
		(0.06)	(0.09)	(0.05)				(0.06)	(0.09)	(0.05)
	4th quartile	0.982	0.784**	0.896*			4th quartile	1.097	0.821	0.982
		(0.06)	(0.09)	(0.05)				(0.07)	(0.10)	(0.06)
Q3-Math	2nd quartile	0.994	1.055	0.911*		Q6-Math	2nd quartile	0.888**	0.968	0.685***
		(0.05)	(0.11)	(0.05)				(0.05)	(0.10)	(0.03)
	3rd quartile	0.997	1.115	0.958			3rd quartile	0.877**	0.957	0.740***
		(0.05)	(0.11)	(0.05)				(0.05)	(0.10)	(0.04)
	4th quartile	0.864***	1.068	0.889**			4th quartile	0.857***	0.983	0.920*
		(0.05)	(0.11)	(0.04)				(0.05)	(0.10)	(0.05)

Table 4 Continued

		Intra-district move	Inter-district move	Exit FL public schools			Intra-district move	Inter-district move	Exit FL public schools
Q1-Reading	2nd quartiles	0.947 (0.05)	0.853 (0.09)	0.934 (0.05)		Q4-Reading	2nd quartiles	0.857*** (0.04)	0.820* (0.09)	0.672*** (0.04)
	3rd quartiles	0.866*** (0.05)	0.925 (0.09)	0.950 (0.05)			3rd quartiles	0.803*** (0.04)	0.839 (0.09)	0.735*** (0.04)
	4th quartiles	0.863*** (0.04)	0.975 (0.10)	0.842*** (0.04)			4th quartiles	0.901** (0.04)	1.012 (0.10)	0.860*** (0.04)
Q2-Reading	2nd quartiles	1.018 (0.05)	0.932 (0.10)	1.059 (0.05)		Q5-Reading	2nd quartiles	0.930 (0.05)	0.960 (0.10)	0.812*** (0.04)
	3rd quartiles	0.990 (0.05)	1.028 (0.11)	0.911* (0.05)			3rd quartiles	0.951 (0.05)	1.029 (0.11)	0.780*** (0.04)
	4th quartiles	0.896** (0.05)	0.885 (0.10)	0.925 (0.05)			4th quartiles	1.005 (0.06)	0.996 (0.12)	0.974 (0.06)
Q3-Reading	2nd quartiles	0.980 (0.05)	0.768** (0.08)	0.953 (0.05)		Q6-Reading	2nd quartiles	0.835*** (0.04)	0.820* (0.08)	0.678*** (0.03)
	3rd quartiles	0.949 (0.05)	1.020 (0.10)	0.947 (0.05)			3rd quartiles	0.811*** (0.04)	0.714*** (0.08)	0.682*** (0.03)
	4th quartiles	0.873*** -0.05	1.054 -0.11	0.915* -0.05			4th quartiles	0.861*** (0.04)	0.952 (0.09)	0.850*** (0.04)

Note: Each of the six math teacher quality indicator represents separate regression results. For example, first six rows presents one set of results from one multinomial logit hazard regression. Reported numbers are the odds ratios. Robust standard errors clustered at school level are in parentheses. Explanatory variables include teacher's age, age squared, female, female and age interaction term, teachers' race, teacher's education level, professional certification, reading certification, middle school math certification, high school math certification, indicator variables for special education teachers, middle school education teachers, high school teachers, English teacher, math or science teachers, self-contained class teachers, social studies teachers, indicator variable for regular and full time teachers, teacher's experience and experience squared term, dummy variables indicating the cohort year, and teachers' own salaries, and classroom, school, and district characteristics such as class size, average math score on the FCAT, disciplinary incidents, percent of minority students (Black, Hispanic), percent of students on free or reduced lunch program, indicator variables for the school grade in 1999, and log(years of teaching). ***P<0.01 **P<0.05 *P<0.10

Table 5 Job match: Multinomial Logit Hazard Estimates of the Effects of Teacher Quality, Quality Rank, Peer Teacher Quality, and Peer Teacher Characteristics on the Odds of Teacher Mobility (Measure Six of Teacher Quality in Math Results)

	Model 1: Peer teacher quality			**Model 2: Peer teacher quality in quartiles**			**Model 3: Teacher quality school rank**			**Model 4: Peer teacher characteristics**			**Model 5: Peer teacher quality quartiles, quality rank, and peer teacher characteristics**		
	Intra-district move	Inter-district move	Exit FL public schools	Intra-district move	Inter-district move	Exit FL public schools	Intra-district move	Inter-district move	Exit FL public schools	Intra-district move	Inter-district move	Exit FL public schools	Intra-district move	Inter-district move	Exit FL public schools
Teacher Quality(Math)															
2nd quartiles	0.890** (0.045)	0.968 (0.097)	0.686*** (0.035)	0.885** (0.045)	0.973 (0.098)	0.683*** (0.035)	0.828*** (0.044)	0.992 (0.105)	0.670*** (0.036)	0.896** (0.046)	0.962 (0.096)	0.684*** (0.035)	0.827*** (0.045)	0.974 (0.105)	0.663*** (0.036)
3rd quartiles	0.879** (0.047)	0.945 (0.095)	0.744*** (0.038)	0.873** (0.047)	0.949 (0.096)	0.737*** (0.038)	0.769*** (0.049)	0.998 (0.114)	0.709*** (0.041)	0.889** (0.048)	0.951 (0.095)	0.737*** (0.037)	0.763*** (0.050)	0.952 (0.116)	0.694*** (0.042)
4th quartiles	0.856*** (0.045)	0.956 (0.098)	0.924 (0.047)	0.853*** (0.045)	0.965 (0.099)	0.919* (0.046)	0.710*** (0.052)	1.039 (0.136)	0.866** (0.057)	0.870*** (0.046)	0.977 (0.097)	0.920* (0.046)	0.698*** (0.054)	0.969 (0.142)	0.846** (0.060)
Peer math quality	0.961 (0.151)	1.641** (0.413)	0.913 (0.130)												
Peer math quality															
2nd quartile				1.164** (0.071)	0.951 (0.094)	1.050 (0.055)							1.199*** (0.073)	0.96 (0.096)	1.066 (0.056)
3rd quartiles				1.093 (0.068)	1.091 (0.112)	1.106* (0.057)							1.162** (0.073)	1.095 (0.115)	1.132** (0.061)
4th quartiles				1.004 (0.063)	1.124 (0.117)	0.980 (0.054)							1.117* (0.075)	1.119 (0.126)	1.015 (0.059)
Teacher quality rank							1.028*** (0.008)	0.992 (0.013)	1.009 (0.007)				1.029*** (0.008)	0.999 (0.014)	1.012 (0.007)
Number of faculty on campus							1.002 (0.001)	0.996* (0.002)	1.000 (0.001)				1.003* (0.002)	0.995** (0.002)	1.000 (0.001)
Number of observations	59771			59771			59952			59952			59771		

Table 5 Continued

	Model 1: Peer teacher quality			**Model 2: Peer teacher quality in quartiles**			**Model 3: Teacher quality school rank**			**Model 4: Peer teacher characteristics**			**Model 5: Peer teacher quality quartiles, quality rank, and peer teacher characteristics**		
	Intra-district move	Inter-district move	Exit FL public schools	Intra-district move	Inter-district move	Exit FL public schools	Intra-district move	Inter-district move	Exit FL public schools	Intra-district move	Inter-district move	Exit FL public schools	Intra-district move	Inter-district move	Exit FL public schools
Peer percent of masters degree holder										0.560*** (0.104)	0.868 (0.255)	1.570*** (0.223)	0.557*** (0.104)	0.904 (0.263)	1.587*** (0.228)
Peer percent of national board certified										1.012 (0.014)	1.016 (0.022)	1.028*** (0.010)	1.024 (0.015)	1.001 (0.021)	1.029*** (0.011)
Peer percent of professional certified										0.363*** (0.125)	0.48 (0.267)	0.275*** (0.089)	0.363*** (0.126)	0.429 (0.236)	0.271*** (0.088)
Peer percent of middle school math certified										0.806 (0.578)	3.11 (3.734)	0.94 (0.592)	0.574 (0.422)	3.726 (4.339)	0.831 (0.528)
Peer percent of high school math certified										0.289 (0.320)	2.284 (3.841)	0.694 (0.642)	0.117* (0.137)	6.613 (11.199)	0.673 (0.639)
Peer percent of reading certified										1.018 (0.810)	28.491** (38.228)	2.104 (1.446)	0.932 (0.762)	24.224** (31.944)	2.085 (1.439)
Number of observations	59771			59771			59952			59952			59771		

Note: Reported numbers are the odds ratios. Robust standard errors clustered at school level are in parentheses. Explanatory variables include teacher's age, age squared, female, female and age interaction term, teachers' race, teacher's education level, professional certification, reading certification, middle school math certification, high school math certification, indicator variables for special education teachers, middle school education teachers, high school teachers, English teacher, math or science teachers, self-contained class teachers, social studies teachers, indicator variable for regular and full time teachers, teacher's experience and experience squared term, dummy variables indicating the cohort year, and teachers' own salaries, and classroom, school, and district characteristics such as class size, average math score on the FCAT, disciplinary incidents, percent of minority students (Black, Hispanic), percent of students on free or reduced lunch program, indicator variables for the school grade in 1999, and log(years of teaching). ***P<0.01 **P<0.05 *P<0.10

Table 6 Comparison of Student and Faculty Characteristics at Origin and Destination School

	t-Statistic for Difference in Mean	Destination School		Origin School	
School average characteristics	t-statistics	Mean	Standard Error	Mean	Standard Error
Intra-district Movers					
Percent black students	-13.49	0.247	0.003	0.300	0.004
Percent free/reduced price lunch students	-22.46	0.457	0.004	0.544	0.004
Disciplinary incidents	2.73	0.398	0.008	0.372	0.009
Math performance	11.76	303.457	0.363	298.671	0.351
Math teacher quality (Q1)	1.04	-0.002	0.002	-0.004	0.002
Math teacher quality (Q2)	0.91	0.007	0.002	0.005	0.002
Math teacher quality (Q3)	1.74	-0.004	0.003	-0.011	0.003
Math teacher quality (Q4)	0.48	0.009	0.001	0.008	0.001
Math teacher quality (Q5)	7.86	0.032	0.002	0.017	0.002
Math teacher quality (Q6)	1.07	0.006	0.002	0.003	0.002
School Grade	9.95	2.780	0.017	2.580	0.017
Inter-district Movers					
Percent black students	-3.63	0.235	0.006	0.264	0.007
Percent free/reduced price lunch students	-6.44	0.443	0.007	0.500	0.007
Disciplinary incidents	1.04	0.427	0.016	0.408	0.014
Math performance	3.36	304.252	0.659	301.462	0.614
Math teacher quality (Q1)	2.28	-0.001	0.004	-0.014	0.004
Math teacher quality (Q2)	1.32	-0.004	0.005	-0.013	0.005
Math teacher quality (Q3)	1.93	0.010	0.008	-0.010	0.006
Math teacher quality (Q4)	1.72	0.007	0.003	-0.001	0.003
Math teacher quality (Q5)	3.41	0.031	0.004	0.014	0.003
Math teacher quality (Q6)	2.02	0.018	0.005	0.004	0.004
School Grade	1.76	2.736	0.030	2.668	0.031

Table 7 Frequency and Percent Distribution of Entering Math Teacher Quality for Each Quartile of Average Receiving School Teacher Quality Using Math Teacher Quality Measure Six

Teacher own quality (Q6-Math)	Receiving School Average Teacher Quality (Q6-math)				Total
	1st quartile	2nd quartile	third quartile	fourth quartile	
1st quartile	508 (28.52)	429 (24.09)	410 (23.02)	434 (24.37)	1781 (100)
2nd quartile	327 (23.27)	384 (27.33)	360 (25.62)	334 (23.77)	1405 (100)
third quartile	286 (21.38)	350 (26.16)	354 (26.46)	348 (26.01)	1338 (100)
fourth quartile	342 (23.17)	317 (21.48)	339 (22.97)	478 (32.38)	1476 (100)
Total	-1463 (24.38)	1480 (24.67)	1463 (24.38)	1594 (26.57)	6000 (100)
Observations	6000				