TEACHER QUALITY AND TEACHER MOBILITY *

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. While we find no difference between the average quality of teachers who exit and those who remain in teaching, we do find significant quality differences among teachers who change schools. The probability a teacher transfers to a new school within a district decreases the more productive they are in their current school. Further, peer quality plays a significant role in teachers' job decisions. In particular, teachers are more likely to leave their initial placement the greater is the gap between their own productivity and the average quality of other teachers at their school. The most effective teachers who transfer tend to go to schools whose faculties are in the top quartile of teacher quality. As a result, teacher mobility exacerbates differences in teacher quality across schools.

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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, apriori. If high quality teachers possess transferable skills that are valued in other occupations, then 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 across 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.

[1] See recent work by Aaronson, et al. (2007), Hanushek, et al. (2005), Kane, Rockoff and Staiger (2006), Rockoff (2004) and Rivkin et al. (2005) which demonstrate that teacher quality is the most important schooling input in the determination of student achievement.

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 (2007), 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, et al. (2007a), Clotfelter, et al. (2007b), Hanushek et al. (2005), Harris and Sass (2007), Kane, et al. (2006)).

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, et al. (2005), Goldhaber, et al. (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 (2007), Hanushek et al. (2004), Imazeki (2005), Scafidi, et al. (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, et al. (2007b) analyze both attrition and inter-school mobility in New York City and in North Carolina respectively. While all three papers estimate student achievement models in order to derive value-added measures of teacher quality, only one of the papers, (Goldhaber, Gross and Player (2007)) includes student fixed effects to control for unobserved student heterogeneity. If unmeasured student characteristics are correlated with teacher quality, then exclusion of student effects from an achievement model will produce biased estimates of teacher effectiveness or value-added.

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 three different value-added measures of teacher quality and investigate how each is related to individual teacher choices regarding exit from teaching and mobility across schools. We also explore how the quality of faculty colleagues affects teacher job choice and the impact of teacher mobility on the distribution of teacher quality across schools.

II. Methods

A. Measuring Teacher Quality

In order to gauge teacher quality we construct three value-added measures. All of the measures are derived from the following cumulative student achievement model:

$$A_{it} - A_{it-1} = \Delta A_{it} = \boldsymbol{\beta}_1 \mathbf{X}_{it} + \boldsymbol{\beta}_2 \mathbf{P}_{-ijmt} + \boldsymbol{\beta}_3 \mathbf{T}_{kt} + \boldsymbol{\beta}_4 \mathbf{S}_{mt} + \gamma_i + \delta_{kt} + \nu_{it} \quad (1)$$

ΔA_{it} is the gain in student achievement for student i in year t, where achievement is measured by the student's scale score 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 $\mathbf{P}_{-ijmt}$ 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 vector of time-varying characteristics of teacher k at time t, $\mathbf{T}_{kt}$, consists of a set of indicators representing various levels of experience; the omitted category is teachers with zero experience. 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. Unmeasured time-invariant student/family characteristics are represented by a student fixed effect, γ_i. Unobserved teacher characteristics are captured by a year-specific teacher effect, δ_{kt}. ν_{it} is a normally distributed, mean zero random error.

The first measure of teacher quality, which we denote Q1, is simply the raw teacher-by-year effect, δ_{kt}. If we assume that the unmeasured characteristics of teachers do not change over time, then the teacher effect in equation (1) becomes δ_k, which is just a standard teacher fixed effect. Our second teacher quality measure, Q2, equals this teacher fixed effect, δ_k. The teacher fixed effect will vary across teachers both because of true persistent differences in teacher quality as well as from measurement error that generates noise in the estimate of δ_k. To adjust for this measurement error we compute empirical Bayes teacher fixed effects using the procedure employed by Kane, et al. (2006). This effectively "shrinks" noisy estimates for teachers that have taught few classes toward the population mean teacher effect (which equals zero). We denote the empirical Bayes teacher fixed effects estimates of teacher quality Q3.

Each of the three teacher quality measures represents a teacher's contribution to student achievement or "value-added," net of student, peer and school influences. Since teacher experience is included in the student achievement model, each teacher value-added measure is conditional on experience. Further, since there are no school fixed effects in the model, the reference point is the average quality teacher. Thus our three measures can be interpreted as the quality of teacher k relative to the average quality of all teachers with equivalent experience.

Table 1 shows the correlation among these teacher quality indicators for both math and reading. Since there is subject specialization by teachers in middle and high school, the correlations almost universally represent elementary school teachers who teach all subjects in a self-contained classroom. The six teacher-subject quality indicators are all statistically significantly correlated with each other. The cross-subject correlation is higher for the teacher-by-year effects than for the all-year teacher effects. Correlations between the raw teacher effects (Q2) and the Empirical Bayes adjusted teacher effects are relatively high (about 0.7), suggesting only moderate shrinkage is occurring in the Empirical Bayes estimates..

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. A teacher will select among a group of schools based on her individual preferences and the characteristics of the job, including both pecuniary aspects (e.g., relative salary) and non-pecuniary components (e.g., relative working conditions). A teacher will compare the available options and select the school that yields the highest present value of expected utility.

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

$$U = f(Y_{kmrt}, C_{kmrt}, W_{kmrt}, Q_{kmrt}) \qquad (2a)$$

$$max\left[PV\left(U_S, U_W, U_B, U_L\right)\right] \quad (2b)$$

where $\mathbf{Y}_{kmrt}$ is a vector of demographic characteristics of teachers, such as race, gender and age. interactions between age and gender are included to account for women's reproductive decisions.[2] $\mathbf{C}_{kmrt}$ is a vector representing the relative working conditions for teacher k in school m and district r at time t. These include teacher-specific current classroom characteristics, such as the demographic makeup of the student body, the poverty level of the students, student performance on exams, and student behavior. Similar information at both the school and district levels is also included. Alternative working conditions in other schools within a district and in other districts are accounted for as well with conditions in other districts weighted by historical teacher inter-district migration.[3] $\mathbf{W}_{kmrt}$ represents the relative wages for teacher k at school m and district r at time t. This includes both the salary in their current school as well as potential salaries in other school districts and in other professions. Alternative salaries in teaching and other occupations are weighted by historical teacher migration across Florida school districts and by national inter-occupational movement, respectively. Q_{kmrt} is an indicator of teacher quality or effectiveness from equation (1). Two of our teacher quality measures, Q2 and Q3, are based on the performance of all students ever taught by the teacher, and thus are time-invariant. In contrast, Q1 is calculated from the performance of a teacher's current students and thus varies over time. These teacher effectiveness measures could capture a variety of unobserved teacher characteristics that impact teacher productivity, including innate ability, motivation, and pre-service (undergraduate) training.

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

[3] Details on the construction of the alternative working condition and alternative salary measures are provided in Feng (2007).

The utility a teacher obtains from working at a particular school is a function of both the teacher's working conditions and salary. 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 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. In addition, involuntary separations included in the estimation may 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 of the data, we employ a discrete multinomial logit hazard model with both time-variant and time-invariant coefficients. Only new teachers with no prior teaching experience are included in the analysis. Including experienced teachers would produce left-censoring problems since their teaching careers are already in progress. The discrete-time hazard function can be interpreted as the probability of transition at discrete time *t* given survival up to time t:

$$\mathrm{h}_{\mathrm{kmrt}} = Pr\left[\mathrm{T}_{\mathrm{kmrt}} = \mathrm{t} \mid \mathrm{T}_{\mathrm{kmrt}} \geq \mathrm{t}\right] \tag{3}$$

The discrete-time hazard function models the probability that any of the four events—staying, moving within the district, moving between districts, or leaving—happened to teacher k during period t, which is conditional on the event not occurring until that time:

$$h_{kmrt} = Pr\left[T_{kmrt} = t \mid T_{kmrt} \geq t, X_{kmrt}, C_{kmrt}, W_{kmrt}, Q_{kmrt}\right] \quad (4)$$

Given the independence of irrelevant alternatives, assuming the error terms 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.[4] The cumulative probability of leaving a particular school is a summation of the transition probability of exiting teaching, the probability of intra-district moving, and the probability of inter-district moving.

$$\text{Logit}\left[h_{kmrt}(W)\right] = \log\left[\frac{h_{kmrt}(W)}{1 - h_{kmrt}(W)}\right] = \alpha_{Wt} + \beta_{W1}X_{kmrt} + \beta_{W2}C_{kmrt} + \beta_{W3}W_{kmrt} + \beta_{W4}Q_{kmrt} + \varepsilon_{wt} \quad (5A)$$

$$\text{Logit}\left[h_{kmrt}(B)\right] = \log\left[\frac{h_{kmrt}(B)}{1 - h_{kmrt}(B)}\right] = \alpha_{Bt} + \beta_{B1}X_{kmrt} + \beta_{B2}C_{kmrt} + \beta_{B3}W_{kmrt} + \beta_{B4}Q_{kmrt} + \varepsilon_{Bt} \quad (5B)$$

$$\text{Logit}\left[h_{kmrt}(L)\right] = \log\left[\frac{h_{kmrt}(L)}{1 - h_{kmrt}(L)}\right] = \alpha_{Lt} + \beta_{L1}X_{kmrt} + \beta_{L2}C_{kmrt} + \beta_{L3}W_{kmrt} + \beta_{L4}Q_{kmrt} + \varepsilon_{Lt} \quad (5C)$$

The coefficients of primary interest are β_{W4}, β_{B4} and β_{L4}. A positive and statistically significant value of β_{W4} would indicate that high quality teachers are more likely to make intra-district transfers than are their less productive peers. Similarly, positive and significant values for β_{B4} and β_{L4} would indicate that inter-district transfers and attrition from teaching are positively correlated with teacher quality.

[4] One may suspect that intra-district and inter-district moves are not independent as they may represent a decision to stay in teaching whereas leaving is distinct from these two alternatives. To test the multinomial logit model's assumption of the independence of irrelevant alternatives (IIA), we carry out both a Hausman test of the IIA assumption and the Small and Hsiao test of the IIA assumption. Both tests confirm that the null hypothesis of any pair of outcomes as independent of the other cannot be rejected.

In addition to absolute teacher quality, the productivity of a teacher relative to her current colleagues may influence teacher job choice as well. Podgursky, et al. (2004) find that the probability of female teachers exiting increases the higher their ACT college entrance exam score relative to the average scores of their faculty colleagues. There may be positive within-occupation assortive matching whereby more able teachers seek out positions in which their colleagues are also highly productive.[5] To capture these effects we define an additional variable, GAP_{kmrt}, as the difference between a teacher's own quality, Q_{kmrt}, and the average quality of other teachers at the same school, $\overline{Q}_{\sim kmrt}$. We also include the gap measure as a spline with a kink at zero. With the spline, we can examine teachers who are above and below their peers in quality. If assortive matching holds, then we would expect teachers with both above and below peer average quality to be more likely to depart from initial placements.

III. 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.[6] 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. Unlike other statewide databases, however, the FL-EDW links both students and teachers to specific classrooms at all grade levels. Thus we can observe the characteristics of the specific classroom environment a teacher experiences each year for elementary, middle and high school

[5] Note that our teacher quality measures are conditional on experience, so an inexperienced teacher could have experienced colleagues who are unconditionally more productive than the new teacher, but less productive than other experienced teachers.

[6] Detailed descriptions of the Florida data are provided in Sass (2006) and Harris and Sass (2007).

teachers. The available data cover school years 1995/1996 through 2003/2004. 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 student achievement gains, thereby limiting our sample to the years 2000/2001 through 2003/2004 and math and reading teachers in grades 4-10.

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, the problem of emigration is minimized due to the geographic and population characteristics of Florida. Florida is relatively isolated from neighboring states; it is bordered on three sides by water and the northern border area is relatively sparsely populated compared to the central and southern parts of the state. Further, due to population growth and a constitutionally mandated maximum class size, Florida is a net importer of teachers. Thus, unlike many Northern states where the school-age population is shrinking, there is relatively little outflow of teachers from Florida.[7]

A. Teacher Salaries and Classroom Environment Variables

In addition to the demographic characteristics of teachers, the FL-EDW contains detailed data on all forms of monetary compensation received by teachers. We employ annual base teaching salary, excluding bonuses, as our measure of teacher compensation. To account for differences in the cost of living across counties at a point in time within Florida, nominal salaries

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[7] Using national data from the Schools and Staffing Survey and associated Teacher Follow-Up Survey (SASS/TFS) which track teachers across state lines, Feng (2007) finds little difference between teacher mobility and exit rates based on the FL-EDW and those from the SASS/TFS.

are divided by the Florida Price Level Index. The Consumer Price Index is used to account for inter-temporal cost-of-living differences. These adjustments result in real teacher salaries expressed in terms of the statewide population-adjusted average cost of living in 1997.

To control for the classroom environment, and hence the non-monetary costs of teaching, we utilize classroom averages of the number of students in the classroom, the number of disciplinary incidents per student, the proportion of students eligible for free or reduced lunch, and the shares of students who are black and who are Hispanic. In addition, we include classroom average scores on the mathematics portion of the criterion-referenced "Sunshine State Standards Florida Comprehensive Assessment Test (FCAT-SSS) as a measure of student ability and effort.[8,9]

B. School Characteristics

In addition to salary and the characteristics of the students they are required to teach, the general school environment, including perceived campus safety and general parental support may influence teacher labor market decisions. To control for these factors we include school-level averages of the number of disciplinary incidents per student and math achievement scores,

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[8] The State of Florida administers two tests to students in grades 3-10, the FCAT-SSS and the normed referenced Stanford achievement test, also known as the FCAT-NRT. The FCAT-SSS was administered in selected grades from 1997/98 through 1999/00 and has been given in all grades 3-10 since 2000/01. The FCAT-NRT has been administered in all grades 3-10 since 1999/00. Given the earlier coverage of the FCAT-SSS for some grades and the longer consecutive grade coverage of the SSS-NRT we utilize the former as a classroom environment measure and use the later to compute teacher quality measures.

[9] In the current version of the paper, these are contemporaneous measures of test scores. Future versions of the paper will include lagged test scores instead. As mentioned below, our results of interest are invariant to the inclusion or exclusion of test scores from the model.

the proportion of students who are black, the proportion Hispanic and the fraction of students in the school who are eligible for free/reduced-price lunch.[10]

Teachers may also exhibit preferences for working with students of their own race or ethnic group. For example, a black teacher who grew up in poor neighborhood may find it more personally rewarding to teach economically disadvantaged black students than white students from affluent families, even though the latter group may in some sense be "easier to teach." Indeed, Hanushek et al. (2004), Imazeki (2004) and Boyd et al. (2005) all find that minority teachers favor schools with higher shares of minority student enrollment. We therefore also include interactions between a teacher's race/ethnicity and the school-wide racial and ethnic composition of the student body.

Teachers may also have preferences over geographic location which can affect their employment choices. Previous research indicates that teachers in urban inner-city schools are more likely to migrate and leave their schools than teachers in other areas (Ingersoll (2001), Lankford, et al. (2002)). Using the Public Elementary/Secondary School Universe Survey Data in 2003 from the Common Core of Data, we identify geographic location with a set of categorical variables (large city, mid-size city, urban fringe of a large city, urban fringe of a mid-size city, large town, small town, rural inside of a Metropolitan Core Based Statistical Area (CBSA), rural outside of a CBSA).

C. District Characteristics

School districts in Florida are coterminous with counties. To capture differences in working conditions among school districts we employ the following district-level measures:

[10] We have also estimated conditional logit models that condition on the school level. The results of these models are very similar to those presented herein.

student performance on the math section of the FCAT-SSS, number of disciplinary incidents per student, percent of black students, percent of Hispanic students, and percent of students in the free or reduced-price lunch program. If there are rigidities in labor markets, alternative job prospects will depend on the availability of jobs as well as prevailing salaries. Therefore the county-level unemployment rate is used as an additional dimension of the opportunity cost of teaching.

Following Feng (2007), we create two alternative salary measures based on historical teacher movement to capture a teacher's opportunity cost within teaching and outside of teaching. The within-teaching alternative salary is a weighted average of salaries in other school districts where the weights are based on historical teacher flows from the teacher's current district to the 66 other school districts in Florida. To capture alternative wages outside of teaching we use two national representative data sources (the Baccalaureate and Beyond Survey 1993/97/03 and the School and Staffing Survey 1999) to determine the sectors teachers move into when they leave teaching. The sectors teachers most frequently move to are retail trade, information, finance and insurance, services, and public administration. Using county-level data from the Quarterly Census of Employment and Wages for each year, we take a simple average of the salary in the teacher's current county in these sectors to obtain the alternative wage for teachers outside education.

Using the same historic teacher-flow methodology, we also create a weighted average of working conditions in alternative school districts. Working conditions include measures of student ability (proxied by test scores), family income (measured by free/reduced price lunch status) and race/ethnicity, as described above.

Within the same district, all teachers face the same salary schedule; therefore the decision to move within a district will primarily be influenced by working conditions. As with the alternative district salary measures, the historic frequency counts of moves to other schools in a district are used to weight the alternative working conditions at other schools in a district.

V. Results

A. Descriptive Evidence

Table 2 provides means and standard deviations of the six teacher-quality-by-subject measures for each of the teacher mobility categories: stayers, intra-district movers, inter-district movers and leavers. Focusing on teacher quality indicator one in math, we find that the average quality of teachers who stay at their school is higher than that of both intra-district movers and leavers. Intra-district movers exhibit a higher average quality than those stayers. However, none of these differences are statistically significant. Similar results are found for reading. For both math and reading, the mean of teacher quality measure 2 is slightly higher for leavers than stayers. The average quality of inter-district movers is greater than for stayers in reading but lower than that of stayers in mathematics. We observe the same pattern for the Empirical Bayes adjusted teacher quality estimates, Q3. As with the Q1 estimates, none of the differences in teacher average teacher quality across mobility categories are statistically significant for either teacher quality measure 2 or measure 3.

Kernal density distributions of teacher quality for stayers, movers, and leavers are depicted in Figures 1 through 3. Consistent with the insignificant differences in average teacher quality, the kernel density plots indicate no noticeable differences in the teacher quality distribution for stayers, movers, and leavers. Figure one shows that at the upper tail distribution, there are more cases of inter-district movers. This shows the same type of information as Table 3 where teachers who move across district line might be of higher quality than the stayers. However, from the kernel density plots, we cannot rule out the possibility that teachers in both tails of the distribution are moving around.

B. Multivariate Estimates of Absolute Teacher Quality and Teacher Mobility

Table 3 presents estimates of the multinomial logit hazard model for all teachers, female teacher, and male teachers. For each sample, separate regressions are reported based on the three different teacher quality measures. The results indicate there is no significant relationship between teacher quality and exit from the teaching profession, holding other factors constant. In contrast to leavers, we do find a significant relationship between intra-district mobility and teacher quality for female teachers and for teachers as a whole when using quality measure 2. The estimated odds ratio below one indicates a negative correlation between the quality of female teachers and the probability of moving between schools within a district.

The lack of a significant correlation between teacher quality and exit decisions could either mean that exit decisions are unrelated to teacher quality or that that the distribution of teacher quality for exiting teachers (conditional on other factors) is bimodal. It could be the case that relatively high quality teachers exit because they have particularly good outside opportunities and that relatively low quality teachers exit because they recognize they are not particularly effective teachers or do not enjoy teaching. To test this hypothesis we divided teachers into four quality quartiles and estimated the relationship between the quality quartile a teacher was in and the odds of staying, moving and exiting. Results, presented in Table 4, confirm the hypothesized bimodal quality of exiting teachers when employing quality measure 2. Both top-quartile and bottom-quartile teachers are more likely to leave public school teaching than are teachers in the middle two quartiles of the quality distribution. Consistent with the results in Table 3, we also find that top quartile teachers are less likely to change schools within a district than are their colleagues in the middle two quartiles.

C. Estimates of Peer Teacher Quality and Teacher Mobility

Table 5 displays estimates from from two multinomial logit hazard models of teacher job choice. One includes a measure of the difference between a teacher's own productivity and that of other faculty in the same subject at the same school while the other includes bifurcated quality gap measures representing teachers whose measured quality is above or below the average of their current colleagues. Using the continuous quality gap measure, we find female teachers are more likely to move to a new school in the same district as the quality gap with other teachers in their present school grows wider (holding their own productivity constant). Put differently, this implies that for a given quality teacher, the lower the quality of their current colleagues, the more likely they will move. Inter-district mobility and exit are not significantly correlated with the quality gap, however. Confirming earlier results, high-quality female teachers are less likely to move to a new school compared to their counterparts, even when holding peer faculty quality constant. Interestingly, we also find that high-quality female teachers are more likely to move to a school in a different district. As before, these trends do not hold for male teachers. Results from a model where the quality gap is measured as a spline with a kink at zero are presented in the lower half of Table 5. Similar to the results with the continuous gap measure, teachers whose productivity exceeds that of their present colleagues are more likely to move to a new school within the district. However, results from the spline specification also indicate symmetric response on the other side of the teacher-peer quality gap. The further a teacher's own quality is below that of their colleagues, the more likely they are to move to another school in the same school district.

D. Mobility and the Distribution of Teacher Quality

The previous analyses of the impact of faculty quality differentials on teacher mobility suggest that teacher mobility works to increase the dispersion of teacher quality across schools. In order to investigate this further, we first compare the mean characteristics of the "sending" and "receiving" schools for those 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 and fewer disciplinary incidents, a smaller fraction of students are black and a smaller proportion come 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. 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 look more directly at the issue of mobility and the distribution of teacher quality by comparing the quality of a teacher making a move and the quality of faculty at the receiving school. Teacher quality measure number one (teacher-by-year effects) 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 plurality 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 twice as many top-quartile teachers (38 percent) than to schools where average teacher quality is in the bottom quartile (16 percent. Similarly, bottom-quartile schools are disproportionally attracting bottom-quartile teachers (29 percent) compared to top quartile schools (22 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 within their first placements 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 campus-wide faculty quality is important. Holding own quality constant, teachers who are either well above or well below the average quality of the current colleagues tend to move to another school in the same school district. Further, teachers generally move to better schools with higher achieving students and with smaller shares of poor and minority students. Teacher who move tend to go to a school where the average teacher quality is like their own. The fraction of movers hired by schools whose faculty is in the top quartile of the quality distribution is twice that of schools whose faculty are 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

	Q1-Math	*Q2-Math*	*Q3-Math*	*Q1-Reading*	*Q2-Reading*	*Q3-Reading*
Q1-Math	1					
Q2-Math	0.5956	1				
Q3-Math	0.3771	0.7399	1			
Q1-Reading	0.4372	0.2938	0.1930	1		
Q2-Reading	0.2880	0.3895	0.2422	0.5594	1	
Q3-Reading	0.1881	0.2467	0.3469	0.3589	0.6717	1

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

	Mathematics			***Reading***		
Destination	**Teacher Quality Indicator 1 in math**	**Teacher Quality Indicator 2 in math**	**Teacher Quality Indicator 3 in math**	**Teacher Quality Indicator 1 in reading**	**Teacher Quality Indicator 2 in reading**	**Teacher Quality Indicator 3 in reading**
Stayer Average Teacher Quality	.0934 (.5044)	.0533 (.4100)	0.0000 (.1700)	.0786 (.5328)	.0568 (.4137)	-.0025 (.1801)
Intra-district Mover Average Teacher Quality	.0817 (.4730)	.04348 (.4227)	-.0093 (.1623)	.0344 (.5475)	.0414 (.5289)	-.0106 (.1641)
Inter-district Mover Average Teacher Quality	.1454 (.5517)	.0389 (.4638)	-.00265 (.1789)	.1896 (.6223)	.1105 (.5381)	.0052 (.1750)
Leaver Average Teacher Quality	.0624 (.4571)	.0554 (.4656)	-.00625 (.1725)	.0426 (.4795)	.0626 (.4048)	-.0022 (.1860)
All Teacher Average Teacher Quality	.0917 (.5003)	.0523 (.4160)	-.0012 (.1698)	.0750 (.5332)	.0572 (.4271)	-.0030 (.1791)

Figure 1A. Distributions of Math Teacher Quality Measure 1 by Mobility Category

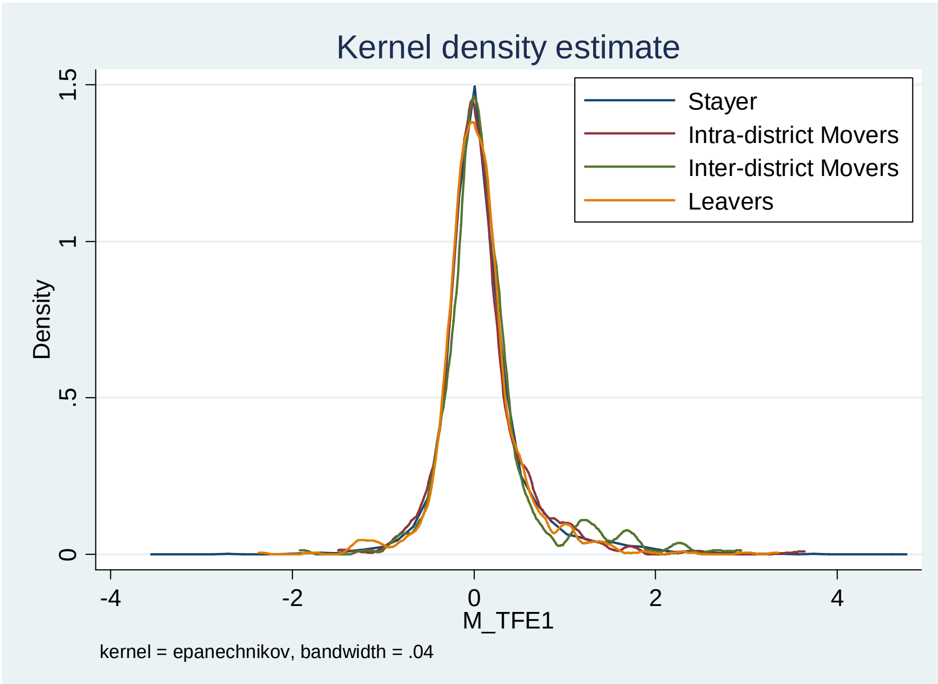

Figure 1B. Distributions of Math Teacher Quality Measure 2 by Mobility Category

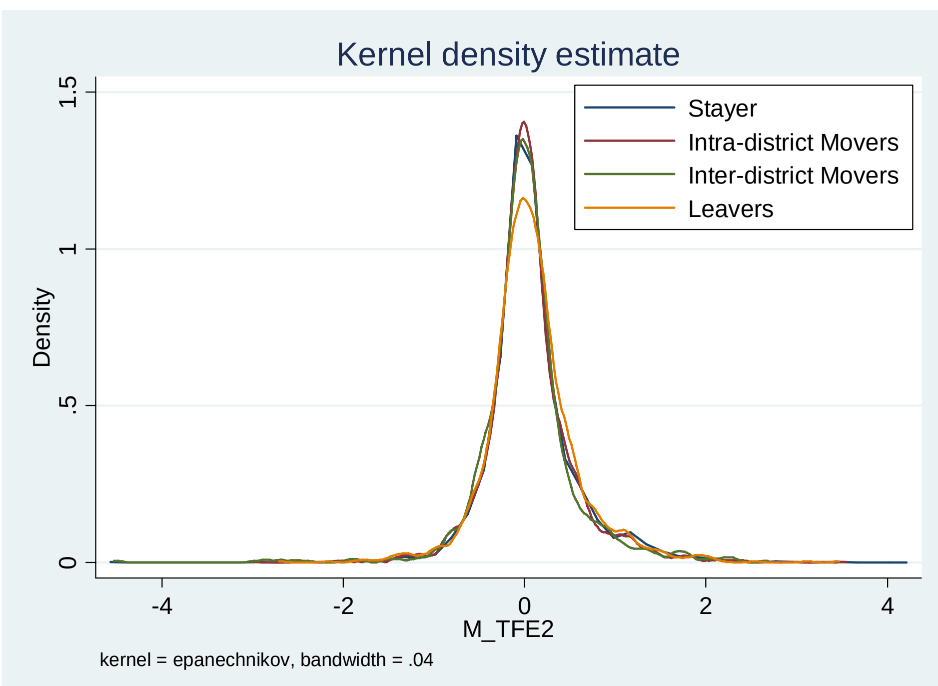

Figure 1C. Distributions of Math Teacher Quality Measure 3 by Mobility Category

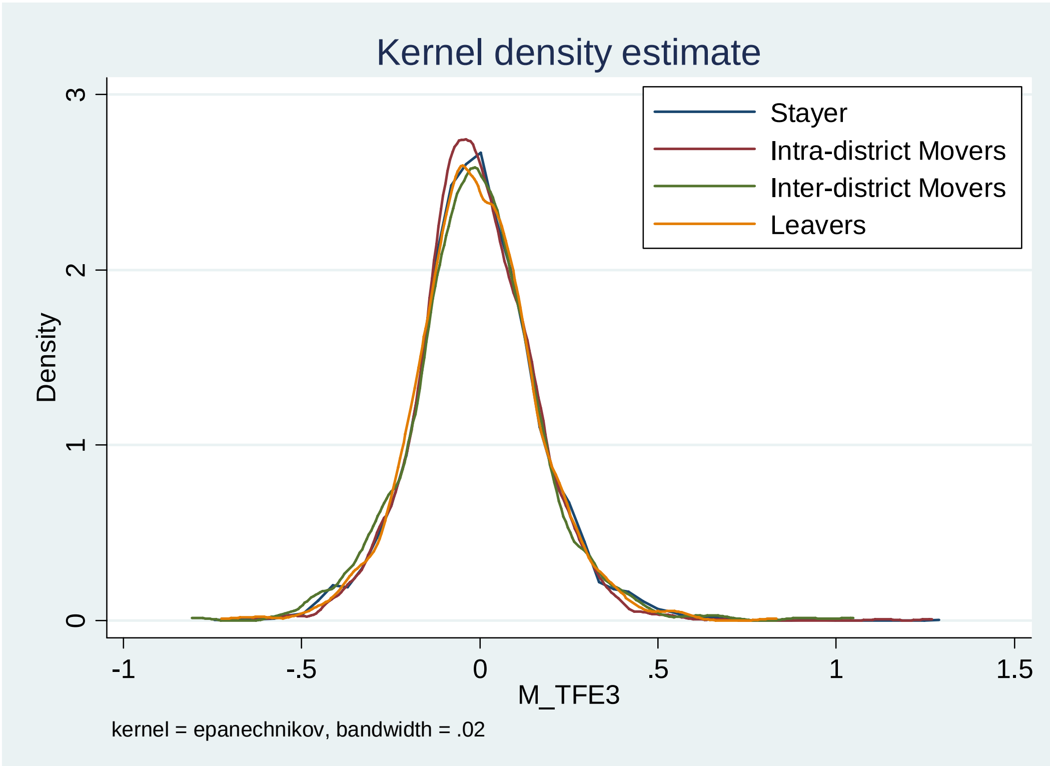

Table 3. Multinomial Logit Hazard Estimates of the Relationship Between Teacher Quality and the Odds of Teacher Mobility

Sample (Number of Teacher-Years)	Teacher quality measure	Intra-district move versus staying	Inter-district move versus staying	Leave FL public schools versus staying
All teachers (N=6,404)	**Q1**	0.867 (0.087)	1.307 (0.24)	0.866 (0.092)
Female teachers (N=4,955)	**Q1**	0.877 (0.10)	1.313 (0.27)	0.881 (0.097)
Male teachers (N=1,449)	**Q1**	0.864 (0.17)	0.991 (0.46)	0.841 (0.26)
All teachers (N=6,308)	**Q2**	0.825* (0.090)	0.918 (0.20)	1.202 (0.18)
Female teachers (N=4,872)	**Q2**	0.802* (0.099)	0.883 (0.21)	1.199 (0.19)
Male teachers (N=1,436)	**Q2**	0.889 (0.21)	0.786 (0.50)	1.367 (0.67)
All teachers (N=5,003)	**Q3**	0.906 (0.29)	0.838 (0.53)	0.853 (0.33)
Female teachers (N=3,813)	**Q3**	0.983 (0.37)	0.916 (0.65)	1.203 (0.54)
Male teachers (N=1,190)	**Q3**	0.616 (0.43)	0.517 (0.84)	0.312 (0.28)

Note: Each row represents a separate regression. Reported numbers are the odds ratios. Standard errors are in parentheses. Explanatory variables include teacher's age, age squared, female, female and age interaction term, teachers' race, 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, the number of working days, urbanicity of the school (six categories: large city, mid-size city, urban fringe of a large city, urban fringe of a mid-size city, large town, small town, rural inside of a Metropolitan Core Based Statistical Area (CBSA), Rural outside of a CBSA.), dummy variables indicating the calendar and cohort year, and teachers' own salaries, relative salaries in the most moved to districts and most moved to professions, and classroom, school, and district characteristics such as class size, average math score on the FCAT, disciplinary incidents, percent of minority students (Black, Hispanic), interaction terms between teacher's race and percent of minority students, and log(years of teaching). ***P<0.01 **P<0.05 *P<0.1

Table 4. Multinomial Logit Hazard Estimates of the Relationship Between Low/High Teacher Quality and the Odds of Teacher Mobility

Sample (Number of Teacher-Years)	Teacher quality measure	Intra-district move versus staying	Inter-district move versus staying	Leave FL public schools versus staying
All teachers (N=6,404)	**Bottom Quartile of Q1 Distribution**	0.968 (0.11)	0.934 (0.22)	1.146 (0.14)
	Top Quartile of Q1 Distribution	0.810* (0.10)	1.410 (0.31)	0.855 (0.11)
All teachers (N=6,308)	**Bottom Quartile of Q2 Distribution**	0.970 (0.11)	1.100 (0.23)	1.491*** (0.20)
	Top Quartile of Q2 Distribution	0.883 (0.11)	1.054 (0.26)	1.838*** (0.24)
All teachers (N=5,003)	**Bottom Quartile of Q3 Distribution**	1.015 (0.13)	1.112 (0.27)	1.166 (0.16)
	Top Quartile of Q3 Distribution	1.061 (0.14)	1.001 (0.26)	1.099 (0.17)

Note: Each pair of rows represents a separate regression. Reported numbers are the odds ratios. Standard errors are in parentheses. Explanatory variables include teacher's age, age squared, female, female and age interaction term, teachers' race, 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, the number of working days, urbanicity of the school (six categories: large city, mid-size city, urban fringe of a large city, urban fringe of a mid-size city, large town, small town, rural inside of a Metropolitan Core Based Statistical Area (CBSA), Rural outside of a CBSA.), dummy variables indicating the calendar and cohort year, and teachers' own salaries, relative salaries in the most moved to districts and most moved to professions, and classroom, school, and district characteristics such as class size, average math score on the FCAT, disciplinary incidents, percent of minority students(Black, Hispanic), interaction terms between teacher's race and percent of minority students, and log(years of teaching). ***P<0.01 **P<0.05 *P<0.1

Table 5. Job match: Multinomial logit hazard estimates of the effect of teacher quality and teacher-campus peer quality gap on the odds of teacher mobility (Quality measure = Q1 in Math)

	All teachers			*Female teachers*			*Male teachers*		
	Intra-district move versus staying	**Inter-district move versus staying**	**Leave FL public schools versus staying**	**Intra-district move versus staying**	**Inter-district move versus staying**	**Leave FL public schools versus staying**	**Intra-district move versus staying**	**Inter-district move versus staying**	**Leave FL public schools versus staying**
Individual Teacher Quality	0.476*** (0.13)	0.978 (0.51)	0.807 (0.19)	0.736* (0.12)	1.517* (0.37)	0.835 (0.14)	1.021 (0.25)	0.914 (0.62)	0.852 (0.42)
Teacher-Campus Peer Quality Gap	1.914** (0.51)	1.213 (0.59)	1.075 (0.26)	1.492* (0.34)	0.692 (0.23)	1.108 (0.26)	0.777 (0.29)	1.022 (0.85)	0.972 (0.54)
Individual Teacher Quality	0.471*** (0.13)	1.076 (0.59)	0.785 (0.20)	0.364*** (0.11)	1.207 (0.76)	0.729 (0.20)	1.996 (1.30)	0.592 (0.80)	1.122 (0.77)
Teacher-Campus Peer Quality Gap < 0	1.853** (0.55)	1.546 (0.83)	0.999 (0.26)	1.857* (0.60)	1.405 (0.80)	1.158 (0.34)	2.485 (2.07)	3.601 (5.28)	0.606 (0.43)
Teacher-Campus Peer Quality Gap > 0	1.991** (0.61)	0.962 (0.55)	1.189 (0.36)	3.187*** (1.06)	0.934 (0.64)	1.260 (0.41)	0.051*** (0.048)	0.540 (0.87)	0.872 (0.83)

Note: Other variables include teacher's age, age squared, female, female and age interaction term, teachers' race, 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, the number of working days, urbanicity of the school (six categories: large city, mid-size city, urban fringe of a large city, urban fringe of a mid-size city, large town, small town, rural inside of a Metropolitan Core Based Statistical Area (CBSA), Rural outside of a CBSA.), dummy variables indicating the calendar and cohort year, and teachers' own salaries, relative salaries in the most moved to districts and most moved to professions, and classroom, school, and district characteristics such as class size, average math score on the FCAT, disciplinary incidents, percent of minority students(Black, Hispanic), interaction terms between teacher's race and percent of minority students, and log(years of teaching). ***P<0.01 **P<0.05 *P<0.1

Table 6. Comparison of student and faculty characteristics at sending and receiving schools

	t-Statistic for Difference in Mean	Sending School		Receiving School	
School average characteristics	**t-statistics**	**Mean**	**S.D.**	**Mean**	**S.D.**
Intra-district Movers					
Math performance	-5.68	293	24	301	26
Disciplinary incidents	1.01	0.40	0.55	0.37	0.52
Percent black students	4.59	0.32	0.27	0.26	0.24
Percent free/reduced price lunch students	7.48	0.58	0.25	0.48	0.26
Math teacher quality (Q1)	1.73	0.09	0.199	0.07	0.27
Reading teacher quality (Q1)	-1.52	0.06	0.24	0.08	0.29
Math teacher quality (Q2)	0.68	0.06	0.19	0.05	0.24
Reading teacher quality (Q2)	0.36	0.06	0.24	0.06	0.24
Math teacher quality (Q3)	-2.40	-0.01	0.09	0.01	0.10
Reading teacher quality (Q3)	-1.63	-0.01	0.12	0.09	0.30
Inter-district Movers					
Math performance	-4.38	294	26	304	24
Disciplinary incidents	1.69	0.46	0.56	0.38	0.47
Percent black students	3.80	0.30	0.27	0.22	0.21
Percent free/reduced price lunch students	3.90	0.54	0.26	0.45	0.24
Math teacher quality (Q1)	-0.08	0.09	0.27	0.10	0.27
Reading teacher quality (Q1)	2.06	0.11	0.27	0.06	0.26
Math teacher quality (Q2)	0.94	0.07	0.21	0.05	0.21
Reading teacher quality (Q2)	1.02	0.08	0.30	0.06	0.27
Math teacher quality (Q3)	-1.95	-0.01	0.10	0.01	0.10
Reading teacher quality (Q3)	-1.40	-0.02	0.12	-0.01	0.13

Table 7. Percent distribution of entering math teacher quality for each quartile of average receiving school teacher quality

Teacher own quality (Q1)	Receiving School Average Teacher Quality (Q1)				Total Teachers
	1st quartile	2nd quartile	3rd quartile	4th quartile	
1st quartile	29.46	24.33	24.11	22.10	448
2nd quartile	23.08	31.00	24.94	20.98	429
3rd quartile	22.30	27.59	28.26	21.85	453
4th quartile	16.36	18.00	27.81	37.83	489
Total Teachers	412	455	479	473	1819

Numbers are column percentages.