The Qualifications and Classroom Performance of Teachers Moving to Charter Schools*

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JOB MARKET PAPER

Do charter schools draw good teachers from traditional, mainstream public schools? I use a 1997-2007 panel of all North Carolina public school teachers to examine the qualifications and classroom performance of mainstream teachers moving to the charter sector. High rates of inexperienced and uncertified teachers moved to charter schools, but among certified teachers changing schools, the on-paper qualifications of charter movers were better or not statistically different than the qualifications of teachers moving between comparable mainstream schools. Grade 3 - 5 teachers moving to charter schools had lower estimated fixed effects on end-of-grade math exams, but I find statistically weak evidence that charter movers had relatively high fixed effects within the schools they were leaving. Taken together, these findings reveal nuanced patterns of teacher quality flowing into charter schools. Charters drew certified, highly qualified, and perhaps locally effective teachers from mainstream schools, but they also attracted uncertified and less qualified teachers. The distribution of persistent teacher quality among charter participants was significantly lower than, but largely overlapped with, the quality distribution of exclusively mainstream teachers.

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I. Introduction

Charter schools are independently operated public schools, free from most of the district and state regulations faced by traditional, mainstream public schools. Forty states and the District of Columbia have legislation outlining the establishment, operation, and accountability of charter schools. Charter systems are designed to provide families with more choice in their children's education, to provide teachers with more choice in their career paths, to promote innovative instruction, and to target special populations of students that may be under-served by traditional public schools. A charter program represents a new, competitive branch of publicly funded education that entrusts each campus with a degree of autonomy rarely seen in mainstream schools. Autonomy and flexible resource allocation in charters schools may draw good teachers away from the mainstream. A growing body of research has characterized the qualifications of the *stock* of charter teachers, who compare favorably to mainstream teachers in some respects (college selectivity, for instance) but not others (experience, certification). I complement and advance this research by analyzing the qualifications and classroom performance of the *flow* of North Carolina teachers moving from mainstream to charter schools over the years 1998-2007.[1] This allows me to determine whether charters were effectively competing for teaching talent from the corps of active public school teachers.

Charter schools, playing the role of competitive entrants in partially deregulated public education markets, are expected to spur efficiency gains by decreasing industry concentration and challenging incumbents (here, traditional public schools) to improve performance. Proponents of charter schools, and school choice more generally, expect competition between traditional and choice schools to drive up the quality of education overall. Friedman (1955, 1997) proposed vouchers as one way to stoke school competition. Dee (1998), Hoxby (2003), and most recently, Booker, Gilpatric, Gronberg, and Jansen (2008) offer empirical evidence that mainstream student performance improves in light of competition from choice schools. Long-run

[1] I refer to school years by the year of their conclusion. For instance, 2007 refers to the 2006-2007 school year.

gains from competition will require charters to be formidable competitors, however, and the jury is still out as to whether they actually increase student learning relative to mainstream schools. The emerging consensus is that new charters have a negative impact on student achievement growth, a penalty which fades as schools and students gain experience.[2]

In order for charter schools to produce competitive student outcomes, they must pursue teaching talent on par with similar mainstream schools. Teacher quality is a profound factor in student achievement,[3] and charters seeking to produce high achievement (or at least, meet accountability standards) will value high-quality teachers. Charter schools are heterogeneous by nature; some specialize in priming the gifted and college-bound, while others target students at risk of failure. Recruiting and retaining high-quality teachers will be more difficult for the latter group. The teacher mobility literature is thick with evidence of teacher preferences for high-performing and socioeconomically advantaged school environments.[4]

Charter schools may have an advantage in the teachers' labor market, regardless of their student composition. "They are free to recruit the best teachers and to raise money from foundations, corporations, and individuals" (NCCPPR, 2007). Charters are not generally bound by state pay scales, they can allocate budgets as they see fit, and feasibly, they can pay higher teacher salaries. One New York City charter school famously offers teacher compensation packages in excess of $125,000 (Gootman, 2008). Nationwide, charter teacher salaries are more in line with mainstream salaries,[5] but charter teachers in some states earn significantly less than other public school teachers with similar qualifications (Malloy & Wohlstetter, 2003). Even if charter schools cannot outbid mainstream schools on salary alone, school leaders can

[2]Bifulco and Ladd (2006a); Booker, Gilpatric, Gronberg, and Jansen (2007); Hanushek, Kain, Rivkin, and Branch (2005); Sass (2006)

[3]Goldhaber (2008) provides a thorough review of research on teacher quality, teacher credentials, and their relationship to student achievement.

[4]Findings are fairly consistent across source data and specifications: teachers were more likely to exit schools with larger proportions of black students (but to a lesser degree for black teachers) or lower student achievement. See Clotfelter, Ladd, Vidgor, and Diaz (2004), Hanushek, Kain, and Rivkin (2004), Falch and Strøm (2005), and Scafidi, Sjoquist, and Stinebrickner (2007).

[5]Nationally, charter teachers had an average salary of $37,000 in 2004, versus $44,500 for traditional public school teachers. The pay gap coincides with a substantial experience gap: 43.4 percent of charter teachers had three or fewer years' experience, compared to just 17.1 percent of mainstream teachers (NCES, 2006). Podgusrsky and Ballou (2001) and Hoxby (2002) also found competitive teacher salaries in charter schools.

influence teachers' utility in non-pecuniary ways, by reducing their non-instructional duties, encouraging collegiality among faculty, manipulating class size and composition, and granting teachers more creative license and autonomy than they are afforded in mainstream schools. Early advocates of the charter model stressed the professionalization and empowerment of teachers as critical tenets of charter development (Budde, 1988; Kolderie, 1990). High teacher satisfaction rates in charter schools typically stem from greater autonomy ("freedom to teach the way I want"), like-minded colleagues, and innovative teaching philosophies. Teachers who are dissatisfied in charter schools usually cite low pay, lack of benefits, high workload, and insufficient facilities. (Malloy & Wohlstetter, 2003)

In practice, the intangible benefits of working in a charter school may be too low to offset low pay and other resource limitations. Common charter finance models allocate each school a per-pupil rate roughly equal to the surrounding district's average per-pupil cost. If a district enjoys substantial economies of scale, its per-pupil costs will be less than a charter school's average cost. Charters with competing uses for very limited resources may sacrifice some teaching talent in favor of administrative and capital improvements if doing so maximizes their objectives (student achievement, enrollment, and budget size being likely objectives). Furthermore, many states allow charters to employ a high rate of uncertified teachers. This permits charters to attract teachers from outside the traditional pipeline, but also increases the supply of low-cost, low-skilled individuals eligible to work in charter schools, including uncertified mainstream teachers nearing the expiration of temporary licenses. Recently, Wisconsin raised subject-based certification requirements for its charter teachers, prompting school leaders to argue that they could not afford to hire teachers meeting the new standard (Borsuk, 2008). Charter licensure requirements vary across states, and little is known about the qualifications of uncertified teachers in charter schools, or the impact of relaxed licensure standards on student performance in charter schools.

Much of the developing research on charter teacher quality examines the qualifications, workload, and job satisfaction of the stock of charter teachers nationwide or within particular states. Podgursky and Ballou (2001) surveyed teachers in seven states, and found that charter teachers were less likely to be certified, more likely to be inexperienced, and more likely to have merit pay than mainstream teachers. Hoxby (2002), using a 1998 national survey of teachers, showed that charter teachers typically had more impressive qualifications than their peers in traditional public schools. Charter teachers had taken more math and science courses in college, they were more likely to have graduated from a good college, and they logged more extracurricular hours. Interestingly, charters paid a premium for those qualities, but not for certification or master's degrees. Taylor (2005) also failed to find a premium for advanced degrees in Texas charter schools, and showed that teachers typically realized a 7.5 percent pay cut upon moving to a charter school.

While a picture of teacher quality in charter schools is emerging, less is known about the flow of teaching talent between mainstream and charter schools, or the classroom performance of individual charter teachers. Here, I fully characterize the resume qualifications of all North Carolina public school teachers who moved to the charter sector between 1998 and 2007. For a subsample of elementary teachers, I evaluate their classroom performance as well. North Carolina is a rare setting where passively collected administrative data are capable of tracking individual teachers and students as they move in and out of charter schools. Analyzing the flow of teachers from one sector to another allows me to determine if charter schools were "cream skimming" good teachers from mainstream schools. If highly qualified and effective teachers are voting with their feet in favor of charter schools, their migration is a favorable signal of the decentralized model's appeal, and mainstream schools may need to emulate charter features to retain faculty. If charters are drawing less qualified and less effective teachers, whether because of low pay, poor organization, or relaxed licensure standards, the charter model is unlikely to fulfill its promise as a revolutionary vehicle for the improvement of public schools.

I evaluate the resume qualifications of North Carolina charter movers against the qualifications of teachers moving between mainstream schools, controlling for sending and receiving school profiles. Charter movers were more likely to be new or inexperienced teachers, but they were also more likely to have at least twenty-five years' experience. Charters were attracting teachers with higher licensure test scores, but only among certified, regularly licensed teachers. Uncertified teachers moving to charter schools, a large minority, substantially attenuated the average qualifications of all charter movers. Resume qualifications are, at best, incomplete signals of teacher quality. For a subset of elementary grade teachers, I evaluate their classroom performance as well, using estimates of teacher fixed effects on student end-of-grade math and reading exam scores. Charter movers' math fixed effects were lower than those of mainstream movers. A closer look at the distribution of teacher performance within schools provides weak evidence that charter movers were more locally effective (that is, higher in their sending school performance distributions) than mainstream teachers switching schools. I complement these estimated mean differences in teacher quality with analyses of the variance and distribution of persistent teacher quality, by licensure and charter participation. Quality distributions for charter participants largely overlapped the quality distributions for non-participants, but were centered at a significantly lower figure. These nuanced patterns of teacher quality flowing into charter schools neither affirm nor reject the effectiveness with which North Carolina's current charter model draws good teachers from mainstream schools. The system is attracting highly qualified, certified teachers who are perhaps relatively high in their mainstream schools' quality distributions, but low licensure requirements attract uncertified, less qualified teachers who may have few career options in the mainstream sector.

The paper is organized as follows. Section II reviews pertinent details of the North Carolina charter system and describes the data. Section III outlines the analytic methodology and discusses results. Section IV concludes.

II. Charter Schools in North Carolina

A. Background

North Carolina is an almost ideal setting to study teacher mobility into charter schools. The state's charter system is eleven years old, its schools are spread throughout urban, rural, and socioeconomically diverse regions of the state, and extensive data (described fully in section IIB) are collected for all mainstream and charter teachers in the state. Charter legislation and oversight in North Carolina (described below) bear many features in common with other states' charter systems. The largest drawback of studying North Carolina charter schools is their collectively small scale: the state has a 100-school cap,[6] and accordingly, a very small percent of teachers move to charter schools in a given year. The comparison group – mainstream teachers moving to other mainstream schools – is large and varied, as are the schools they move to, so charter and mainstream movers have common support for identification of their relative quality.

The North Carolina legislature authorized the state's system of charter schools in 1996. There are several stated objectives of the system, including increased learning opportunities for students and new professional opportunities for teachers.[7] The state's first thirty-four charter schools opened for the 1998 school year. Table 1 documents the growth of North Carolina's charter system from that year up to 2007.[8] Charter students accounted for 2.0 percent of statewide enrollment by 2007, and charter teachers accounted for 2.1 percent of public school teachers. Figure 1 illustrates the widespread geographic range and concentration of charter enrollment in 2006. Charters were active throughout the state, though less so in the rural eastern counties. Four of the state's largest counties – Durham, Forsyth, Mecklenburg, and Wake – had the largest charter presence in terms of absolute enrollment. But as the second panel illustrates, charter penetration was high in several suburban and rural counties outside

[6]The cap has been binding since 2001, although not all approved charters are active in a given year. Even with the cap, the charter system will continue to grow as schools add grades and campuses.

[7]North Carolina General Statute 115c-238.29a

[8]Some data for 2007 are as yet unavailable.

of the major population centers.[9]

The application, approval, and evaluation of charter schools is closely regulated, but the schools are given wide latitude in their personnel management and daily operations. Charter schools are organized as private, nonprofit organizations.[10] They are allotted funding from state and local boards of education on a per-pupil rate, commensurate with district per-pupil costs. There are restrictions, however, on how government allotments can be used for real property and classroom facilities.[11] Charters can raise additional funds by winning grants or soliciting donations, but they cannot charge tuition. Financial difficulties are common in North Carolina's charter schools. Twenty-four charters were relinquished or revoked between 1998 and 2006; of those, nine cited financial problems as a leading cause of failure.[12]

A distinctive feature of North Carolina's charter school system is a pronounced racial segregation.[13] Figure 2 illustrates a starkly bimodal distribution of the nonwhite student representation in charter schools. The student population in charter schools is required to "reasonably reflect the racial and ethnic composition of the general population"[14] residing in the school district (which, for most schools, is a county district). Exception is given to schools serving a targeted population, in which case, their student body is required to resemble the racial and ethnic composition of the local target population. Since many charters target academically gifted students or those at risk of failure, two groups which are overrepresented by white and nonwhite students, respectively, the segregation of the state's charter schools is an unsurprising, albeit unforseen, consequence of the program's design.

[9] The State Board of Education limits annual charter growth within any one district.

[10] The nonprofit requirement does not preclude for-profit education management organizations like KIPP from granting franchises in North Carolina.

[11] State funds may be used to lease property, facilities, and equipment for charter schools, but not for "any other real interest in property or mobile classroom units." (NC General Statute 115C-238.29H) Loans made to charter schools do not have the backing of any taxing authority.

[12] http://www.wral.com/asset/news/local/2007/11/14/2045129/ClosedCharterSchools.swf

[13] Bifulco and Ladd (2006b) fully explored the segregating effects of North Carolina's charter program.

[14] North Carolina General Statute 115C-238.29F

Charter schools are held to the same ABCs accountability model as mainstream public schools, with some exceptions for charters in their first year. Each year, North Carolina schools are conferred recognition labels according to their students' performance and growth on end-of-grade and end-of-course exams.[15] In 2006, 53 percent of charter schools were given one of the lowest three recognition labels, compared to 48.1 percent of public schools statewide (NCCPPR, 2007). Figure 3 illustrates comparative kernel densities of the percent of students performing at grade level (the "performance composite") for charter and mainstream schools in 2006. Among mainstream schools, the performance composite distribution is left-skewed and centered at 70 - 75 percent. The distribution for charter schools is centered at a lower figure, but the more striking feature of Figure 3 is the wide variance in charter school performance and their healthy representation at both extremes. Charters were much more likely to have performance composites lower than 50 percent,[16] but they were also more likely to have exceptionally high performance composites in the range of 85 - 100 percent.

Figures 2 and 3 underscore the importance of controlling for student body composition and school-wide performance when evaluating the quality of teachers moving to charter schools. Each school's profile will affect the type of candidates willing to work there.

Charter schools are allowed great flexibility in the recruitment, retention, and pay of their faculties. The state imposes very little regulation on who can teach in a charter school. At least 75 percent of charter teachers in kindergarten through fifth grade classrooms must hold teaching certificates. This number falls to 50 percent for charter teachers of grades six through

[15]"School of Excellence," "School of Distinction," and "Low-Performing School" were three of the seven 2006 labels. A school's recognition is based on the percent of students who performed at grade level on year-end exams (the schools' performance composite), whether or not the school met state-mandated growth expectations, and whether or not students made "adequate yearly progress," a metric related to the federal No Child Left Behind Act. Schools are then charged with the coming year's growth expectations, which will in part determine the coming year's recognition. (NCSBE, 2006, HSP-C series)

[16]Schools with sub-50 performance composites that fail to make expected growth benchmarks are given "Low-Performing" recognition. Schools with repeat low-performing status, including charter schools, must collaborate with evaluation teams assigned by the State Board of Education to develop corrective action plans. Charters with sub-60 performance composites for three consecutive years are denied 10-year renewal. (NCSBE Policy Manual, EEO-U series)

twelve.[17] Uncertified teachers are much less common in mainstream schools. Only certified teachers are eligible for tenure after four consecutive years of teaching in a mainstream public school. Tenured mainstream teachers who wish to teach in a charter school are granted one year's leave, meaning that they can return to their original school after a year, space permitting. Charters are not required to offer tenure, nor are they required to participate in the state retirement plan.

Low licensure requirements for charter faculties were put in place to attract new, nontraditional teachers from fresh sources - non-teaching vocations, Teach for America, and so forth. Recent work by Kane, Rockoff, and Staiger (2006) and Boyd, et al. (2006) suggest there is little difference in the quality distribution of teachers with traditional certification, alternative certification, or even no certification.[18] States vary in their treatment of teacher licensure in charter schools. Of the forty states with active charter systems in 2008, fifteen require all charter teachers to be certified. Others, like North Carolina, hold each faculty to a minimum percentage. Only Arizona, Washington, D.C., and Texas place no restrictions on charter teacher certification or education. (Center for Education Reform, 2008)

B. Data

I use data for the universe of North Carolina public schools, students, and teachers over the years 1997 to 2007. The data are maintained by the North Carolina Education Research Data Center at Duke University, in collaboration with the state Department of Public Instruction.[19] School-level variables include yearly performance composites and student demographic statistics from the NCES Common Core. For teachers and students, the Data Center processes a vast amount of detailed, passively collected administrative data. Each public school teacher and student is assigned a unique, anonymous identifer, allowing researchers to build longitu-

[17] Uncertified charter teachers are supposed to meet the federal definition of "Highly Qualified." Generally, this means they they must have majored or passed a Praxis II exam in their subject area.

[18] We would expect this to be true within schools if administrators hire equivalently skilled candidates regardless of licensure. It may be the case, however, that low licensure standards put downward pressure on the across-school distribution of teacher quality.

[19] NCERDC website: http://childandfamilypolicy.duke.edu/ep/nceddatacenter/index.html

dinal panels and track teachers and students across schools.[20] I collect teachers' demographic information and school assignments from student activity reports, which are detailed records of every activity involving students and public school personnel, including charter school personnel. Unfortunately, this is nearly the extent of data available for charter school teachers. Nonetheless, the North Carolina data provide a rare, comprehensive picture of the flow of labor between mainstream and charter schools. For mainstream teachers, I collect additional information from personnel files: experience, education, degree-granting institutions, type of licensure, and licensure test scores. I merge data from school activity reports and several personnel files to produce a longitudinal panel of public school teachers spanning the years 1997-2007. School-wide statistics (grades served, school age, and student body demographic and performance indicators) are merged with the teacher panel to provide a robust statistical picture of teachers' work environments and career paths.

Two features of North Carolina public school data are especially valuable for this study. First, I can track teachers as they change schools. This allows me to evaluate teachers' resumes at the point when they move to a new school or opt into the charter sector. Second, many mainstream elementary students can be reliably matched to their classroom teacher. I utilize this link between the inputs and observable production of student achievement to estimate teacher fixed effects. Thus, for a small subset of mobile teachers, I evaluate their classroom performance in addition to on-paper qualifications.

Table 2 describes teacher mobility patterns between charter and mainstream schools for the 5,346 teachers who were working in a charter school at some time between 1998 and 2007. The majority, 55.1 percent, were never observed teaching outside of the charter sector. Another 33.6 percent taught in a mainstream public school before moving to a charter. Of these, two-thirds moved directly to a charter school, without leaving the panel between schools. The remaining third taught in a mainstream school, left the panel for one or more years, and then

[20]Teachers who return to public schools following an absence retain their old identifier.

re-entered in a charter school. I focus on direct movers, who were continuously employed over their transition to the charter sector. I compare the qualifications of charter movers to the qualifications of other teachers making direct moves between mainstream schools.[21] By evaluating charter movers against other mobile teachers (as opposed to public school teachers more generally), I avoid selection biases from omitted variables contributing to mobility *per se*, and I can judge what sort of talent charter schools were drawing from the pool of teachers willing to change schools. After controlling for sending and receiving school characteristics, I determine if charter schools were recruiting more or less of a specific teacher characteristics than their mainstream counterparts. Results shed light on the quality and qualifications of teachers flowing into charter schools, and implicitly, the degree to which charter schools compete for good teachers.

III. Analytic Methods and Results

A. The Qualifications of Teachers Moving to Charter Schools

Table 3 lists summary statistics for North Carolina's mainstream public school teachers from 1997 to 2007. Teachers were identified as school personnel with teaching assignments in school activity reports, excluding teaching assistants, facilitators, and DARE officers. I determined the highest degree attained by each teacher: 30.8 percent of teachers held a post-baccalaureate degree of some kind. A teacher's degree-granting institution was "competitive" if it was classified as such (or "competitive plus," "very competitive," etc.) by the 1995 edition of *Barron's Profiles of American Colleges*.[22] Just over three-quarters of North Carolina teachers graduated from a competitive college or university. North Carolina teachers may take a variety of licensure exams, most of which are in the Praxis family. In order to include all available test information, I scaled raw licensure test scores to have a mean of zero and standard deviation

[21] Seventy-eight percent of mainstream movers did not leave the panel between schools. The results to follow in sections IIIA and IIIB are qualitatively similar, but with varying statistical precision, if I adopt more liberal definitions of teacher mobility. The section IIIC analysis approximates the distribution of persistent teacher quality among all pre-charter teachers, whether or not they took breaks between schools.

[22] The 1995 edition roughly corresponds with the graduation date of mobile teachers with six years (the median) of experience.

of one within each test code and test year. I calculated the mean standardized licensure test score for each teacher, equal to the average from all of her unique exams records.[23] Regularly licensed teachers are those who have completed an approved teacher education program and passed the Praxis Series of exams, or attained licensing by reciprocal or interstate agreement. The complements to regularly licensed teachers are uncertified teachers holding temporary, emergency, or provisional licenses.[24] Teaching experience was derived from teachers' pay level code, or if that was missing, imputed empirically where possible. Teachers' race, gender, and school assignment were determined from school activity reports. Teachers assigned to multiple schools in any one school year were not included in the panel.[25]

Mobile teachers, summarized in the second column of Table 3, were earlier in their careers on average, and they were less likely to have a graduate degree than teachers who were not changing schools.[26] Mobile teachers had lower licensure test scores than non-movers, by 0.015 standard deviations. Mainstream teachers moving to charter schools, summarized in the fourth column of Table 3, were typically less qualified than other moving teachers. Teachers going into the charter system were 4.5 percentage points less likely to have graduated from a competitive college or university, and 9.9 percentage points less likely to be regularly licensed.[27] North Carolina's policy of permitting more uncertified teachers in charter schools may have the consequence of drawing untenured mainstream teachers nearing the expiration of their temporary licenses. I observe 1,142 teachers moving directly to charter schools - of these, 20.9

[23]Although exams were scaled to have mean zero, teacher test scores were positive on average (0.030). This is probably reflective of selective survival and longevity among active teachers. That is to say, teachers with higher exam scores tend to stay in the panel longer.

[24]In compliance with the federal No Child Left Behind Act, all North Carolina teachers of core subject areas were to be "Highly Qualified" by June 30, 2006. With some exceptions, Highly Qualified teachers are fully licensed, hold at least a bachelor's degree, and demonstrate competence in each subject they teach. For mainstream elementary teachers, this effectively eliminates every alternative licensure path, including lateral entry. North Carolina, along with nine other states and the District of Columbia, failed to make adequate progress toward staffing every class with a Highly Qualified teacher by the 2007 school year, and no state made total progress (Feller, 2006). I find virtually no change in teacher certification rates in the later years of the panel.

[25]This affected a non-trivial percent of teacher-year observations (6.1), including teachers with roving assignments and teachers who switched schools mid-year.

[26]A mobile teacher is defined throughout as one observed in school a in year t and school $a' \neq a$ in year $t+1$.

[27]Charter movers were also more likely than mainstream movers to have missing license data (8.1 versus 4.8 percent) The main results are unaffected if I classify these individuals as unlicensed. A more problematic data quality issue is the high rate of missing licensure test scores among charter movers (11.8 versus 7.8 percent for mainstream movers). Below, I discuss where this could affect results and the sensitivity tests I use to evaluate potential biases. See footnote 30.

were uncertified, twice the rate of uncertified teachers moving to another mainstream school. Charter movers were less experienced as well, by 1.5 years on average, and they were 11.4 percentage points more likely to have three or fewer years of teaching experience. Interestingly, charter movers were also more likely to have *at least* twenty-five years of experience. The rate of nonwhite teachers was much higher among charter movers (26.4 percent) than among mainstream movers.

Figure 4 illustrates comparative kernel densities for the teaching experience of mobile teachers, by charter/mainstream destination. Clearly, charter movers were more likely to have just a few years of experience, relative to mainstream movers. They were also more likely to have around 30 years of experience. In the lower panel of Figure 4, limited to regularly licensed movers, the bimodality of charter teachers' experience is more pronounced. The distribution of charter movers' licensure test scores in Figure 5 also hints at bimodality. Figure 5 implies that charter movers, particularly those with regular licensure, were somewhat more likely than their mainstream counterparts to have high licensure test scores, 0.5 - 2.0 standard deviations above the mean.

Figures 4 and 5 offer visual depictions of the range of experience and achievement that teachers bring with them when they move to the charter system, but comparative kernel densities do not permit the conclusion that charters were attracting more or less qualified teachers than similar mainstream schools. Toward that end, I conduct more parametric analyses of charter and mainstream movers by estimating equation (1) via ordinary least squares for each North Carolina teacher (j) observed in year t (1997-2007), school s, and county l:

$$Q^k_{jslt} = \delta^m_{jt}\mathbf{1}(moving) + \delta^c_{jt}\mathbf{1}(tocharter) + \mathbf{X}^s_{jslt}\theta^s + \mathbf{X}^r_{jsl(t+1)}\theta^r + \alpha_{l(t+1)} + \varepsilon_{jslt} \quad (1)$$

Equation (1) is a reduced form expression for qualification k, where k indexes the on-paper qualifications summarized in Table 3: graduate degree, competitive college education, mean licensure test score, regular licensure, and three measures of experience.[28] All mobile teachers have the indicator $\mathbf{1}(moving)$ equal to one. Teachers moving to a charter school additionally have $\mathbf{1}(tocharter)$ equal to one. The estimates of interest, $\hat{\delta}^c_{jt}$, are interpreted as the difference in qualification k between teachers moving to charter and mainstream schools. The coefficients $\hat{\delta}^m_{jt}$ are the difference in k between mainstream movers and non-movers. Controls include sending and receiving school characteristics ($\mathbf{X}^s_{jslt}$ and $\mathbf{X}^r_{jsl(t+1)}$), and receiving county-by-year effects ($\alpha_{l(t+1)}$). If charter schools had higher demand for certain qualifications, and if they were able to outbid comparable mainstream schools by manipulating employment terms and working conditions, then $\hat{\delta}^c_{jt}$ should be positive. If charters had lower demand, or if they were unable to realize an advantage in the teachers' labor market, then $\hat{\delta}^c_{jt}$ may be negative. School characteristics include dummy variables representing student body composition quintiles (the percent who were nonwhite and the percent performing at grade level), the range of grades served, and a set of dummy variables controlling for missing data. Variables in $\mathbf{X}^s_{jslt}$ control for the opportunity cost of moving to a new school, which is related to the qualifications of teachers willing to do so. Variables in $\mathbf{X}^r_{jsl(t+1)}$ control for school environments that affect the type of candidates drawn to a particular school. County-by-year effects control for unobserved heterogeneity in regional variables, like non-teaching job opportunities. Robust standard errors allow for clustering within each sending school and year.

More experienced teachers may seek graduate degrees or additional certifications to increase their pay, so I control for teacher experience categories (indicators for less that three years' experience or more than twenty-five years' experience) when estimating equation (1) for licensure and education variables. Since licensed and unlicensed teachers may represent fundamentally different sections of the labor market, I limit equation (1) to regularly licensed movers and produce separate "licensed mover" estimates of δ^m_{jt} and δ^c_{jt} for all qualifications except licensure

[28]Equation (1) is estimated separately for each qualification k. An alternative would be to project a teacher's mobility choices onto the space of her qualifications, sending school characteristics, and likely receiving school characteristics to get a sense of the factors affecting the supply of charter school teachers. I instead pursue a reduced-form empirical strategy to underscore the descriptive, non-causal inference gained by examining a relatively small set of idiosyncratic labor decisions.

itself.

Table 4 presents estimates of δ^c_{jt} and δ^m_{jt} for each resume qualification.[29] Specifications vary as to whether school variables are included for sending schools, receiving schools, or both. The fourth column of Table 4 lists coefficient estimates for δ^m_{jt}, the typical difference in qualification k between non-moving mainstream teachers and teachers moving to other mainstream schools, controlling for sending and receiving school characteristics. Estimates of δ^m_{jt} serve as the baseline to which δ^c_{jt} estimates are compared. Movers were significantly different than non-movers with respect to most qualifications, but with the exception of experience, the estimated gap was very small. Movers were 0.5 percentage points less likely to be regularly licensed. Movers were much less experienced, by 3.40 years on average, than their non-moving counterparts. They were 12.3 percentage points more likely to have three years' experience or less, and 6.8 percentage points less likely to have at least twenty-five years' experience.

The first column of Table 4 presents estimates of δ^c_{jt} from equation (1), excluding controls for receiving school characteristics. Column I coefficients answer the question, "are charter movers more or less qualified than teachers *leaving* comparable schools?" With respect to competitive college education, licensure, and teaching experience, charter movers were significantly less qualified. Column II lists estimates of δ^c_{jt} when receiving, but not sending, school controls are included. Column II coefficients answer a new question: "are charter movers more or less qualified than teachers *moving to* comparable schools?" The distinction is important, given the heterogeneity of charter school working environments illustrated in Figures 2 and 3. Charter movers appear to have slightly more impressive resumes under the column II specification, relative to column I, but coefficient estimates are not significantly different. Nonetheless, column II results provides further evidence that charter movers were less qualified than mainstream

[29]Unreported coefficients for school variables and teacher experience were largely unsurprising. Relative to schools in the top quintile of grade-level performance, teachers from schools in lower quintiles were successively less likely to hold a graduate degree, a competitive college pedigree, or regular licensure. They were less experienced, and had lower licensure test scores. The same can be said for teacher qualifications in schools in the higher quintiles of percent nonwhite students, with the exception of graduate degrees. Teachers in schools with higher proportions of non-white students were more likely to hold a graduate degree. High school teachers tended to have higher qualifications, relative to middle and elementary school teachers.

movers in terms of licensure, experience, and the quality of their colleges.

Column III lists coefficient estimates when both sending and receiving school characteristics are included. The question, then, is "are charter movers more or less qualified than other teachers *leaving* and *moving to* comparable schools?" This specification best characterizes school characteristics affecting the type of candidates seeking new schools and the type of candidates pulled to particular schools. Column III coefficients show that charter schools were, on average, attracting less qualified teachers from mainstream public schools. Teachers moving to the charter sector had 1.24 fewer years of teaching experience (and were 10.4 percentage points more likely to have fewer than three years of experience), they were 3.0 percentage points less likely to have graduated from a competitive college or university, and 7.6 percentage points less likely to be regularly licensed. The difference in licensure test scores was not statistically significant in the full sample.

Results for the sample of licensed teachers, the bottom coefficient for each qualification in Table 4, paint charter movers in a more optimistic light. The difference between the full and limited sample is particularly stark for licensure test scores. In every specification, the test score coefficient for charter movers is positive and significant when the analysis is restricted to licensed teachers.[30] Table 4 indicates that teachers moving to charter schools typically had better test scores than their licensed colleagues, whether or not those colleagues were changing schools. In column III, licensed teachers moving to a charter school had an average test score 7.8 hundredths of a standard deviation higher than that of mainstream movers. By comparison, relative test scores for licensed mainstream movers showed no significant improvement

[30] The estimated difference in charter and mainstream movers' mean licensure test scores could be attributed to selection bias. Charter movers had significantly higher rates of missing licensure test data than mainstream movers (11.8 and 7.8 percent, respectively), though less so if they were licensed (5.5, 4.0). Licensure test scores proxy for each teacher's underlying knowledge. If teachers with missing test score data came from lower in the underlying distribution, then the average observed test score of all teachers would be biased upwards from the true average of underlying knowledge. If charter movers with missing test data came from much lower in the underlying distribution than mainstream movers with missing data, the estimated difference between charter and mainstream movers' test scores would be biased in favor of the charter movers. I simulate situations like this using the Table 4, column III specification to gage the sensitivity of charter movers' test score advantage to various counterfactual scores for teachers with missing data. The result that licensed charter movers had significantly higher test scores is robust up to a 0.5 standard deviation penalty for charter movers with missing test data. A 2.0 standard deviation gap was necessary to produce the result that licensed charter movers had significantly lower test scores than mainstream movers.

over test scores for mainstream movers generally. It is sensible that charter schools would be able to attract teachers with higher licensure test scores. Conditional on licensure itself, test scores are not rewarded in the state's pay scale. Yet a teacher's test scores are good indicators of how well his or her students will do on their own tests. Goldhaber (2007) and Clotfelter, Ladd, and Vigdor (2007) have shown that North Carolina teachers with higher licensure test scores are associated with higher student achievement on end-of-grade math and reading exams. Charter schools, perhaps recognizing teacher test scores as good signals of teacher quality, had more success recruiting individuals with higher test scores than comparable mainstream schools.

Table 4 confirms the bimodal pattern of experience observed in Figure 4. Licensed charter movers were 5.7 percentage points more likely to have less than three years of teaching experience, and 3.9 percentage points more likely to have more than twenty-five years' experience. These findings raise the possibility that teachers view the charter sector as a low-cost job change preceding retirement or a permanent career change. Sample attrition tends to be high among new teachers, experienced teachers nearing retirement, and uncertified teachers,[31] and these are the same groups I observe disproportionately flowing into the charter sector. Following a school change, charter movers with three or fewer years' experience stay in the sample an average of 2.57 years (uncensored), compared to 2.86 years for mainstream movers. The difference is statistically significant, but represents just a 10% gap in duration post-move. The post-move duration of uncertified charter movers and those with more than twenty-five years' experience is not statistically different from the average post-move duration of the equivalent groups of mainstream movers. So the charter sector does not appear to be a strong substitute for attrition among unlicensed or highly experienced teachers, but inexperienced charter movers do tend to leave teaching somewhat faster than other teachers changing schools.

[31] There were 89,311 uncensored sample exits in the North Carolina teachers' panel. Of these, 42.5 percent had three or fewer years' experience, 18.1 percent had at least twenty-five, and 30.6 percent were uncertified or had missing license data.

The results discussed in this section lend some support to the idea that charter schools had a realized advantage in the labor market for public school teachers; among licensed teachers changing schools, charters were better able to attract highly experienced teachers, and teachers with high licensure test scores. But a large minority of mainstream teachers moving to charter schools were not fully licensed and attenuated the average qualifications of charter movers. This is likely a consequence of the state's low licensure requirements for charter schools. What remains to be seen is if the migration of uncertified teachers to the charter sector is predominantly driven by the charters' demand for low-cost labor, or by uncertified teachers' willingness to supply it.

Some resume line-items like experience and licensure test scores are robust signals of teacher quality, and charter schools were effectively competing for teachers with high levels of experience and high test scores. Were charters competing for teachers with a history of success in the classroom? In the following section, I evaluate the classroom performance of charter movers who can be reliably matched to the students they teach.

B. The Classroom Performance of Teachers Moving to Charter Schools

Teachers' on-paper qualifications are readily observable to schools and econometricians, but the performance of their students is of greater value when assessing teacher quality. North Carolina students in the 3rd through 8th grades take end-of-grade (EOG) exams each spring. Each student has an exam proctor, whose name is recorded along with the student's test scores, demographic and socioeconomic information, and survey responses. For test-takers in elementary grades (typically 3 - 5 in North Carolina), exam proctors are usually classroom teachers. The Data Center matches proctor names with the encrypted teacher identifiers used in other files, and then links these identifers to student test data. I utilize this valuable feature of the data to assess the classroom performance of mainstream grade 3 - 5 teachers who ultimately move to the charter sector.[32] I estimate teacher fixed effect coefficients in EOG test score re-

[32] Charter school students are included in the EOG test data; however, more than half of all charter EOG records are missing a teacher/proctor identifier.

gressions, and then evaluate fixed effect estimates in the same way that I analyzed on-paper qualifications above – by parametrically comparing the fixed effects of charter movers, mainstream movers, and non-movers.

The proctor associated with each student's test score is not necessarily his or her classroom teacher. To minimize the likelihood of bad teacher-student matches, I focus on teachers with self-contained classrooms of students in grades 3 - 5. Self-contained classrooms embody the traditional structure of elementary education, where a class of students spend all or the majority of each day with one teacher. I assembled grade 3 - 5 student EOG records for more than 2.8 million student-years spanning 1997 to 2007. A teacher-student match was considered invalid if any of the following four conditions were met. In parentheses are the percent of students for which each condition was true.

1. The student's proctor was unknown or not found in the assembled teacher panel.[33] (18.5%)
2. The student's proctor did not have a self-contained classroom assignment. (22.1%)
3. The grade-g student's proctor did not have a teaching assignment with students in grade g. ($< 1.0\%$)
4. The student's exam group was larger than 30 or smaller than 5. ($< 1.0\%$)

The remaining 59.0 percent of students had a proctor who was a teacher, and who led a self-contained classroom with students in the same grade as a reasonable number of EOG test-takers linked to that teacher. These limitations lend considerable validity to each allowed teacher-student match. Of the 122,064 EOG test-taking classrooms with a known teacher, 71.2 percent were considered valid matches.

North Carolina's end-of-grade exams are interval-scaled, meaning that a one-point increment reflects the same difference in learning anywhere on the scale of raw scores. Scores are

[33] The teacher panel excluded teaching assistants and facilitators, who may have proctored exams.

comparable within and across grades each year, and the minimum proficient score rises for each grade. The range of raw scores changes over time, so I scaled them to have mean zero and standard deviation one across grades 3 - 5 within each year. As with the interval-scaled raw scores, the standard normal scaling across grades allows me to interpret student gains over time as advancing knowledge. Table 5 compares the classroom-averaged math and reading scores for students in the analysis sample (students in exam groups with proctors who were very likely to be their teachers) and rejected sample (students whose proctor was unlikely to be their teacher). If future charter teachers with high (low) performing classes were disproportionately sorted into the rejected sample relative to other mainstream teachers, average fixed effects for charter movers may be comparatively driven down (up). Twenty-three percent of exam sessions proctored by future charter teachers were rejected as invalid matches, compared to twenty-nine percent for exclusively mainstream teachers. Flagged classrooms, the vast majority of which were not self-contained, had higher average math and reading scores regardless of whether the teacher ultimately moved to a charter school. The gap was statistically significant for exclusively mainstream teachers, but not for future charter teachers.

Consider the following equation describing the standardized test score Z^k_{ijcgst} in subject k (math or reading) for student i in teacher j's classroom c, grade g, school s, and year t:

$$Z^k_{ijcgst} = \mathbf{A}_{ict}\beta_A + \bar{\mathbf{A}}_{-ict}\beta_{\bar{A}} + \mathbf{T}_{jt}\beta_T + \mathbf{X}_{st}\beta_X + \theta_j + \alpha_{gt} + \varepsilon_{ijcgst} \tag{2}$$

Variables in $\mathbf{A}_{ict}$ are student characteristics, including race, gender, parental education, and learning disability indicators. $\bar{\mathbf{A}}_{-ict}$ is a vector of average student characteristics in i's classroom (excluding student i), and $\mathbf{T}_{jct}$ controls for two measures of teacher inexperience. $\mathbf{X}_{slt}$ has school-level variables, including indicators for student body composition quintiles, grade levels, and a dummy variable equal to one when student i is in a new school. The coefficients θ_j and α_{gt} are teacher fixed effects and grade-by-year effects, respectively.[34] I estimate

[34]With controls for teacher inexperience, estimated teacher fixed effects will account for any penalties that are common to all new teachers.

equation (2) and save estimated teacher fixed effects, $\hat{\theta}_j$.

Table 6 presents coefficient estimates for equation (2). Female students had lower math scores than males, by 0.043 standard deviations, but scored 0.098 standard deviations higher in reading. Nonwhite students had lower scores in both subjects, as did students without college-educated parents. Learning disabilities were strongly associated with lower scores, more so for disabilities directly related to the tested subject. Students with inexperienced teachers had lower test scores in both subjects, especially if their teacher was in her first year as opposed to her second or third. The penalty from teacher inexperience fell about 80 percent following a teacher's first year.

In this setting, teacher fixed effects are interpreted as each individual's history of classroom performance relative to expectations, given the composition of her students, inter-district sorting, and the teacher's own experience. This should be important to schools looking to hire teachers with a record of success in raising student test scores, but does not necessarily permit the interpretation of $\hat{\theta}_j$ as a transitive index of teachers' inherent quality or value added. The latter view relies on two strong assumptions: (1) $\hat{\theta}_j$ are consistent estimates of θ_j, and (2) errors, ε_{ijcgst}, are uncorrelated with θ_j. The first assumption is invalid for fixed effect estimates generally, which are inconsistent in short panels (Cameron & Trivedi, 2005). And although teacher fixed effect estimates benefit from multiple student-level signals each year, finite class size leads to considerable sampling error. Teacher fixed effect estimates are noisy, and their variance overstates the true variance in teacher quality (Rockoff, 2004). I address this in the following subsection by isolating the variance in persistent teacher value added. The second assumption is invalid if there are unmeasured student variables affecting test scores, like motivation or inherent intelligence, and if these variables systematically affect the teacher to whom a student is assigned. In that case, estimates of θ_j will be a reflection of teacher quality *and* student sorting. Positive matching, where better students gravitate to better teachers, would bias $\hat{\theta}_j$ away from zero. Negative matching, which may be the case if better students are assigned to struggling teachers to ease their burden, would bias $\hat{\theta}_j$ toward zero. Clotfelter, Ladd, and Vigdor (2006) find evidence of teacher-student matching, particularly positive matching, in North Carolina schools. The bulk of student sorting is Tiebout (1956) sorting between schools. Families with high-ability children tend to live near good schools, thus reinforcing the quality of those schools.

Positive teacher and student sorting across schools will manifest as a strong, positive correlation between student residuals and teacher fixed effects, θ_j, therein biasing teacher fixed effect estimates away from zero. If charter movers are more likely to come from better (worse) schools, their estimated fixed effects will be biased up (down). I address this with an alternative specification that controls for unobserved school-by-year effects, α_{st}:

$$Z^k_{ijcgst} = \mathbf{A}_{ict}\beta_A + \bar{\mathbf{A}}_{-ict}\beta_{\bar{A}} + \mathbf{T}_{jt}\beta_T + \theta_j + \alpha_g + \alpha_{st} + \varepsilon_{ijcgst} \quad (3)$$

Equation (3) replaces school characteristics ($\mathbf{X}_{st}$) and grade-by-year effects (α_{gt}) with school-by-year effects (α_{st}) and grade dummies (α_g).[35] Teacher fixed effects generated by equation (3) are a measure of teachers' classroom performance relative to school-wide, rather than statewide, benchmarks. School-by-year effects will fail to control for any nonrandom sorting of students within schools, such as would be the case if parents were successfully lobbying school administrators to put their children in a particular classrooms.[36] Two additional adaptations to equation (2) - estimating student gains, or including lagged student test scores - would address likely pathways by which students are non-randomly matched to teachers within schools. Either method would eliminate 3rd grade teachers from the analysis here, an impractical solution given the fairly small number of charter movers for which $\hat{\theta}_j$ can be estimated. Furthermore, estimating student gains, even with student fixed effects, is not a fail-safe method for examining teachers' value added (Rothstein, 2008), nor will it circumvent the inherent sampling error

[35]While it is possible to control simultaneously for school-by-year and grade-by-year effects, I find substantial collinearity between grade-year and school-by-year effects.

[36]The existence of "teacher shopping" by parents has considerable anecdotal and analytical support. (Hui, 2003; Crombie, 2001; Clotfelter, Ladd, & Vigdor, 2006)

of teacher fixed effects.

The analysis to follow compares the estimated fixed effects of charter and mainstream movers. Although teacher fixed effects may be a flawed measure of underlying teacher quality, sorting biases would only affect the comparison if one type of mover was disproportionately subject to non-random student sorting across and within schools prior to their move. Even then, estimated teacher fixed effects will provide insight to the relative performance of teachers' classrooms, both within and across schools, and these fairly observable measures of teacher quality would be of interest to potential employers.

I estimated more than 28,000 teacher fixed effects for both subjects. Teachers are observed an average of 5.89 years each. There are 13,715 mobile teachers in the sample, 229 of which were moving to a charter school. Teacher fixed effects under the equation (2) specification reflect teachers' classrooom performance, evaluated against teachers statewide with comparable class and school compositions. The inclusion of school-by-year effects in equation (3) mitigates any correlation between ε_{ijcgst} and θ_j driven by between-school sorting on unobservables. Teacher fixed effects, then, reflect teachers' relative performance within their schools. This limits the scope of interpretation and understates the variance in teacher quality across schools, but adequately addresses between-school Tiebout (1956) sorting. I find that average fixed effects are 60 - 70 percent smaller in absolute value when calibrated to typical performance within schools.

To see if charter schools were attracting teachers with histories of higher or lower classroom performance, I regress teacher fixed effect estimates against mobility indicators, sending and/or receiving school characteristics, and county-by-year effects:

$$\hat{\theta}_j^k = \delta_{jt}^m \mathbf{1}(moving) + \delta_{jt}^c \mathbf{1}(tocharter) + \mathbf{X}_{jslt}^s \theta^s + \mathbf{X}_{jsl(t+1)}^r \theta^r + \alpha_{l(t+1)} + \varepsilon_{jslt} \quad (4)$$

Subjects (math and reading) are indexed by k, teachers by j, schools by s, counties by l, and years by t. Table 7 presents estimates of δ_{jt}^{m} and δ_{jt}^{c}. Column I analyzes teacher fixed effects generated by equation (2), without school-by-year effects, and column II uses fixed effect estimates from equation (3), with school-by-year effects. So the first column identifies the point in the statewide distribution of teacher performance from which a typical charter mover is drawn, controlling for observable sending and receiving school characteristics. As in the above analysis of resume qualifications, the "any mover" coefficients ($\hat{\delta}_{jt}^{m}$) serve as baselines to which "charter mover" estimates ($\hat{\delta}_{jt}^{c}$) are compared. In the column I specification, teachers moving to non-charter schools had lower math fixed effects than non-movers, by about 2 percent of a standard deviation. Charter movers had even lower math fixed effects, by 2.2 - 2.6 percent of a standard deviation (with 90% confidence). In terms of reading fixed effects, charter movers were not significantly different.

Column II in Table 7 identifies where a typical mover's class performance lies relative to other teachers in her sending school, controlling for observable characteristics of the school she left and the one she moved to. With weak statistical significance, the math and reading class performance of licensed charter movers was higher in their within-school performance distributions, by 3.6 - 3.7 hundredths of a standard deviation. The sign reversal for $\hat{\delta}_{jt}^{c}$ between the column I and column II specifications means that charter movers typically came from a higher point in their within-school performance distribution than they did in the statewide performance distribution.

Class performance is one dimension, along with licensure test scores, where charter schools may be able to exercise a competitive advantage in the teachers' labor market. North Carolina's public education pay scale does not have provisions for merit pay, with the notable exception of $1,500 bonuses for teachers in schools meeting "exemplary" growth standards. Charters have the allocative freedom to recruit and reward high-performing teachers,budget permitting. I find, however, that charter schools were not effectively competing for teachers high in the statewide distribution of performance. Is this disparity driven by charters' failure to outbid mainstream schools for good teachers, by a greater willingness among teachers with low-performing classrooms to work in charter schools, or by non-random teacher and student sorting across schools? My analysis of within-school teacher performance distributions lends weight to the sorting bias explanation. Charter movers appear to have been drawn from higher in their respective within-school performance distributions than mainstream movers. That is, charter schools were drawing more locally effective teachers. This conclusion has limited scope for generalization, however, as the sample was limited to grade 3 - 5 teachers of self-contained classrooms.

C. Variation in Classroom Performance

Teacher fixed effects are strong predictors of student achievement, but collectively, they yield a poor approximation of the overall distribution of teacher quality. Sampling error from finite panel length and class sizes cause the variance of teacher fixed effects to overstate the variance of true value added. If sampling error disproportionately affects certain groups of teachers (new teachers, for instance), then the variance and transitivity of teacher quality distributions would be distorted. This subsection evaluates the quality of teachers from a second-moment perspective and explicitly accounts for the inflating effects of sampling error. I compute the variance in persistent teacher quality generally, and then do the same for specific subsamples: regularly licensed teachers, uncertified teachers, future charter teachers ("charter participants"), and teachers observed exclusively in mainstream public schools. Results complement the mean differences in classroom performance discussed in the previous subsection. First, I estimate equation (3), omitting θ_j.

$$Z^k_{ijcgst} = \mathbf{A}_{ict}\beta_A + \bar{\mathbf{A}}_{-ict}\beta_{\bar{A}} + \mathbf{T}_{jt}\beta_T + \alpha_g + \alpha_{st} + e_{ijcgst} \tag{5}$$

Suppressing notation for grade and school, the errors are $e_{ijct} = \theta_j + \varepsilon_{ijct}$. There are two components to each student residual, e_{ijct}: teacher j's persistent value-added (θ_j), and non-persistent noise (ε_{ijcgst}) encompassing sampling error and transient shocks to average classroom performance. I calculate the average student residual for each class:

$$\hat{\bar{e}}_{jct} = \theta_j + \frac{1}{N_{jct}} \sum_{i=1}^{N_{jct}} \varepsilon_{ijct},$$

where N_{jct} is class size in year t. If θ_j and $\bar{\varepsilon}_{jct}$ are independent, the variance of $\bar{e}_{jct}$ across teachers can be decomposed into the the variance of persistent value added and the variance of non-persistent error: $\mathbb{E}[\bar{e}_{jct}^2] = \sigma_\theta^2 + \sigma_\varepsilon^2$, where σ_θ^2 is the variance of persistent teacher quality within schools, and σ_ε^2 is the variance of error within schools. Consider two average residuals associated with the same teacher: $\bar{e}_{jct}$ and $\bar{e}_{jc't'}$, where $c \neq c'$ and $t \neq t'$. If θ_j and ε_{jct} are uncorrelated, and if the measurement errors, ε_{jct} and $\varepsilon_{jc't'}$, are uncorrelated as well, then

$$\mathbb{E}[\bar{e}_{jct}\bar{e}_{jc't'}] = \sigma_\theta^2.$$

The assumption that θ_j and ε_{jct} are uncorrelated is non-trivial – in fact, it is one of the assumptions that must be met in order to interpret estimated teacher fixed effects as an index of teacher quality. Positive matching of better students with better teachers will increase estimates of σ_θ^2. Additionally, omitting teacher fixed effects in equation (5) may bias other coefficients if they are correlated with θ_j; this, in turn, will bias the residuals, $\hat{e}_{ijct}$. I include school-by-year fixed effects in equation (5) to limit biases from between-school sorting, but within school teacher-student matching patterns may nonetheless affect σ_θ^2 estimates. So long as the correlation between θ_j and ε_{jct} is not systematically different for subsamples of interest (uncertified teachers or charter participants), the calculated variance of persistent residuals within groups can be compared. I follow Carrell and West (2008) and estimate σ_θ^2 for all teachers in the sample, and for selected subsamples, by computing the average covariance of all classroom residual pairs between teacher j's class c in year t and $c' \neq c$ in year $t' \neq t$:

$$\sigma_\theta^2 = \left[\sum_{j=1}^{J} \sum_{c=1}^{C_j} \hat{\bar{e}}_{jct} \hat{\bar{e}}_{jc't'} \right] / N \qquad (6)$$

J is the number of teachers, C_j is the number of classes taught by teacher j, and N is the number of pairs. Table 8 presents estimates of total and signal standard deviations.[37] All standard errors (in parentheses below each standard deviation estimate) are estimated by bootstrap, with an equal number of charter participants and non-participants selected in each sampling. The third and sixth columns of Table 8 list the standard deviation of teacher fixed effects, by group. As expected, estimates of the variation in persistent teacher residuals are much smaller than the variation in teacher fixed effects. The distribution of teacher fixed effects suggests that a one-standard-deviation increase in teacher quality improves student math performance by 0.236 standard deviations, almost three times the bonus from having an experienced teacher rather than a new one. But judging by the preferred measure of dispersion ("signal"), a one-standard-deviation increase in teacher quality would yield a still-substantial 0.128 standard deviation increase in student math performance, closer to the difference between having a college-educated parent versus a parent with "some college." Estimates of signal variance are smaller for reading; a one-standard deviation increase in persistent teacher quality is predicted to increase student achievement by 0.093 standard deviations. Signal variation is 40 to 53 percent of total variation, suggesting that differences in teacher quality account for much, but not all, of the variation in class performance within schools.

In section IIIA, I showed that a high rate of charter movers were uncertified and underqualified. This would not be problematic for charter schools if certified and uncertified teachers had the same underlying distribution of teaching quality, so long as charters did not draw heavily from the lower end. Separate estimates of the standard deviation of signal quality for teachers with regular and temporary licensure paths are listed in Table 8. Teachers with regular licensing paths were fully licensed each year they were observed, whereas temporary

[37] Two modifications to this procedure yielded notably different results. First, I estimated σ_θ^2 using student, rather than classroom-averaged residuals. I computed the average covariance of all residual pairs between student i in teacher j's classroom c and $i' \neq i$ in teacher j's classroom $c' \neq c$. Estimates of signal variances, available on request, were remarkably similar under this alternative method. Estimates of total variance in individual student residuals were 2 - 3 times the size of those shown in Table 8. Second, I estimated equation (5) without school-by-year effects. Computed signal variances were about 25 percent larger under this method. The difference may be due to interpretation - the preferred, reported signal variance reflects the variance of teacher quality within schools, whereas the alternative reflects the variance across schools. The latter would be expected to be larger, but the difference was probably driven in part by sorting biases across schools.

licensing paths involved a temporary, emergency, or provisional license in one or more years. There was no significant difference in the signal variance of math or reading value added across licensing paths.

Table 8 also lists signal standard deviations for charter participants and non-participants. Charter participants are predominantly future charter teachers, in that their class performance is observed before they move to a charter school. The variance of teachers' class performance on math exams was wider for charter participants than it was for non-participants. For reading exams, the variance of charter participants' performance was narrower. Both statistics were within one standard error of the corresponding signal estimate for non-participants. These variance estimates give some perspective to the mean differences observed in section IIIB. Licensed teachers moving to charter schools had math fixed effects that were 0.037 higher than other mobile teachers, who in turn had fixed effects that were 0.018 lower than non-movers, controlling for receiving school characteristics. So if a typical charter mover's relative class performance was 0.019 standard deviations above the mean, this would put her as high as the 56th percentile in the cumulative distribution of sending school performance.[38] When evaluated against all teachers in the state (but controlling for school characteristics), a typical charter mover's class performance in math will be as low as the 40th percentile.[39]

Following Kane, Rockoff, and Staiger (2006), I construct a simple Bayesian shrinkage estimator to account for sampling error in class residuals attributed to teacher quality. I use estimates of signal and noise variance (the corresponding standard deviations are listed in Table 8), along with the number of classes observed for each teacher (C_j) to scale average class residuals ($\bar{e}_j$):

[38] This calculation assumes that the distribution of teacher performance is normal, has mean zero within each school, and has a standard deviation equal to 0.128, from the first row of Table 8. The 56th percentile is an upper bound, since fixed effect estimates were affected by sampling error.

[39] I use coefficient estimates from the column I specification reported in Table 7 and an estimated σ_θ of 0.191 from unreported computations using equation (5) without school-by-year effects.

$$\tilde{\theta}_j = \bar{e}_j \left(\frac{C_j}{C_j + \sigma_\varepsilon^2 / \sigma_\theta^2} \right) \tag{7}$$

Equation (7) shrinks each teacher's average residual towards zero according to the terms in parentheses. Residuals for teachers with more classes and groups with larger signal-to-noise ratios will be scaled by less, since their residuals are expected to be less affected by sampling error. Figure 6 plots comparative kernel densities for teachers who followed regular license paths versus teachers who followed temporary license paths. In agreement with Kane, Rockoff, and Staiger (2006), there is very little observable difference in teacher quality between licensure groups, but a fairly wide (albeit scaled) variance within each group. Given the small number of charter movers with classroom performance estimates, the vast majority of which were regularly licensed, I do not evaluate the distribution of charter mover quality by licensure path. Figure 6 provides evidence that among mainstream teachers generally, there is little difference in within-school teacher quality distributions across licensure paths. For both subjects, a Wilcoxon rank-sum test fails to reject the hypothesis that teachers with regular and temporary license paths had the same distribution of persistent teacher quality. North Carolina's policy of relaxing licensure requirements for charter schools could be questioned if unlicensed charter movers were heavily drawn from the lower end of schools' performance distributions. But if not, low licensure requirements may be one way to retain effective teachers in public education. The implications of relaxed licensure standards for charter schools (and public schools in general) remains an important topic for future research. Figure 8 plots comparative densities of within-school teacher quality by charter participation. The persistent quality distribution is significantly lower for charter participants than non-participants, especially for math. Wilcoxon rank-sum tests reject the hypothesis that charter participants and non-participants had the same distribution of teacher quality. Figures 7 provides evidence that teachers flowing into the charter sector typically had lower relative class performance within their schools than exclusively mainstream teachers. So charters were not skimming above-average teachers from the stock of school faculties, although according to the more parametric classroom performance analyses of section IIIB, charters may have been drawing higher-ranked teachers from the pool of teachers changing schools.

IV. Conclusions

A founding purpose of North Carolina's charter legislation was to "create new professional opportunities for teachers" (N.C. General Statute 115c-238.29a(4)). I examine the value that mainstream teachers bring with them when they take advantage of these opportunities and move to charter schools. In terms of resume line-items like experience, education, licensure, and licensure test scores, I find mixed evidence that charters were hiring good teachers away from mainstream schools. Teachers moving to charter schools were more likely to be inexperienced, but they were also more likely to have at least twenty-five years of experience. Among regularly licensed teachers, the licensure test scores of charter movers were better than the scores of mainstream movers. But a large minority of teachers without regular licensure attenuated the average qualifications of charter movers. Low licensure standards for charter faculties have the consequence of drawing into the charter system a high rate of uncertified teachers, some of which may be nearing the expiration of temporary licenses and running low on career options in mainstream schools. Alternatively or temporarily licensed teachers are not necessarily bad teachers (Goldhaber 2007; Kane, Rockoff, and Staiger, 2006), although in North Carolina they are associated with lower student achievement (Clotfelter, Ladd, and Vigdor, 2007). I find no significant difference in persistent teacher quality between broad licensure types, but a wide range of quality within each type. Ideally, charter schools would recruit uncertified teachers who were high in the quality distribution but unable or unwilling to attain traditional certification. This would help to retain effective teachers in public schools. Some states allow charter teachers to meet a compromised certification standard, contingent on their education (requiring at least a bachelor's degree, for instance), teaching experience, and performance on alternative certification exams. To the extent that these signals are correlated with underlying teacher quality, compromised certification standards would induce charter schools to attract relatively high-quality uncertified teachers from mainstream schools.

For a limited sample of grade 3 - 5 teachers, I use estimated teacher fixed effects to evaluate the performance of their classes on standardized end-of-grade exams. Were charter schools cream skimming good teachers with high class performance? The answer depends on what benchmark of teacher quality I use and how I account for the empirical hazards of approximating teacher quality with nonexperimental data. Teachers who moved to charter schools typically did so with a less impressive history of class performance on math exams, relative to teachers moving to qualitatively similar, non-charter schools. The difference is statistically significant, but likely to be biased by the way students and families sort across schools. When teachers are evaluated against colleagues in the same school, I find weak evidence that charter movers had relatively higher class performance than teachers moving to comparable mainstream schools. Charter schools may be winning battles for good teachers within particular schools, but they appear to be losing the war for teachers with high classroom performance statewide. This is not to say that the teachers who move to charter schools hold a common deficiency in class performance. I show that the distribution of future charter teacher quality, even when its persistent component is formally dissected, is wide and largely overlaps with the quality distribution of teachers who work exclusively in mainstream schools.

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TABLE 1

NORTH CAROLINA CHARTER SCHOOLS, STUDENTS, AND TEACHERS, 1998-2007

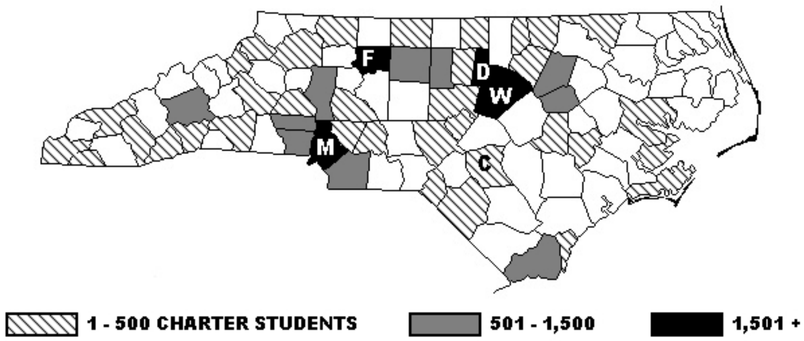
YEAR	SCHOOLS	(%)	STUDENTS	(%)	TEACHERS	(%)
1998	34	(1.7)	4,642	(0.4)	330	(0.5)
1999	57	(2.7)	8,555	(0.7)	601	(0.8)
2000	76	(3.6)	12,691	(1.0)	862	(1.1)
2001	90	(4.1)	15,523	(1.2)	1,086	(1.4)
2002	93	(4.2)	18,235	(1.4)	1,292	(1.6)
2003	93	(4.2)	20,420	(1.5)	1,390	(1.7)
2004	93	(4.1)	21,955	(1.6)	1,509	(1.8)
2005	97	(4.3)	25,248	(1.8)	1,669	(1.9)
2006	97	(4.2)	27,441	(1.9)	1,789	(2.0)
2007	92	(3.9)	27,700	(2.0)	1,894	(2.1)

NOTES: Each count of charter schools, students, and teachers represents the indicated percent (%) of all public schools, students, or teachers in the sample. Teacher and school counts were tabulated from the teachers' panel, described fully in section IIB. Student counts were tabulated from NCES Common Core data.

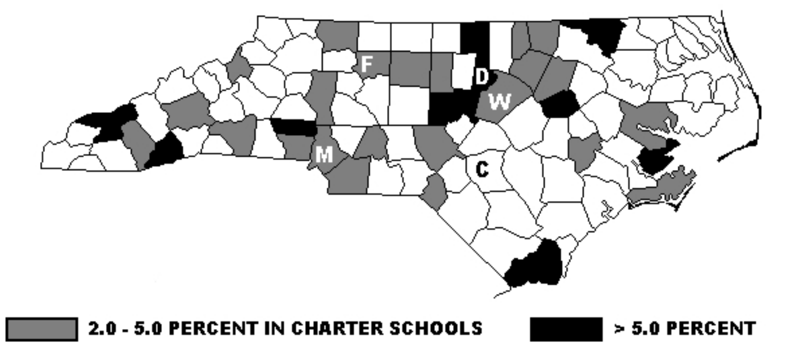
FIGURE 1

2006 CHARTER ENROLLMENT AND PENETRATION

Charter enrollment, by county



Charter penetration, by county



NOTES: Major population centers are in Cumberland (C), Durham (D), Forsyth (F), Mecklenburg (M), and Wake (W) counties.

FIGURE 2

DENSITY ESTIMATES
PERCENT OF STUDENTS WHO WERE NONWHITE IN SCHOOLS, 2006

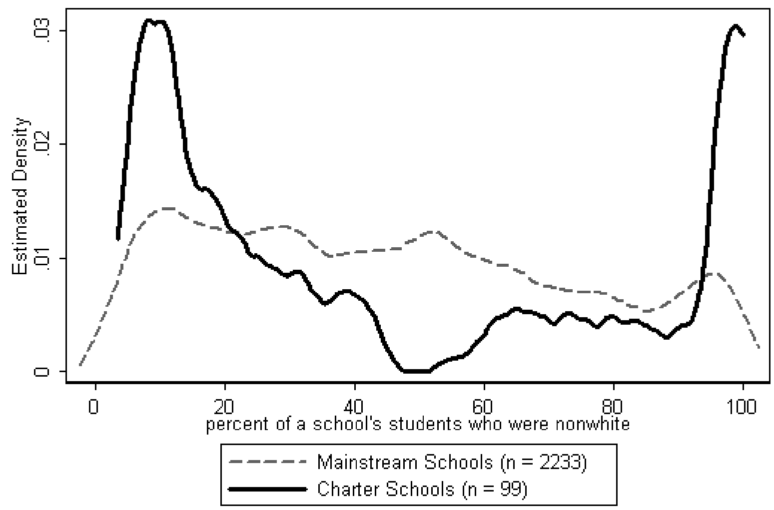
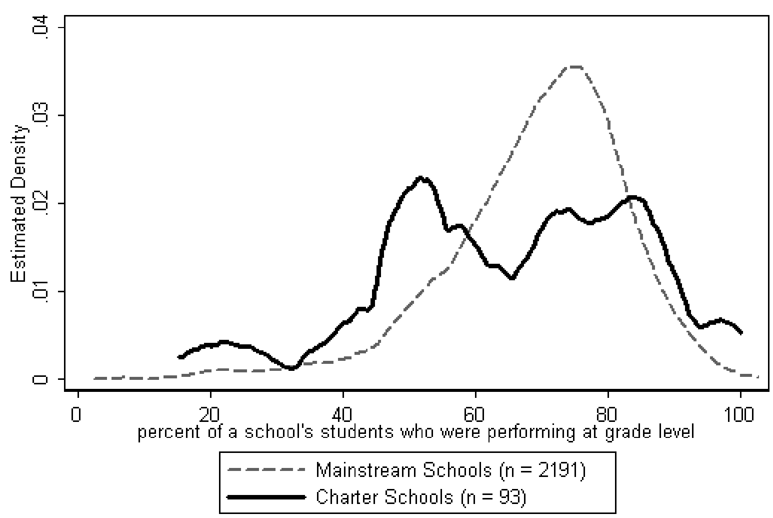


FIGURE 3

DENSITY ESTIMATES
PERCENT OF STUDENTS WHO WERE PERFORMING AT GRADE LEVEL IN SCHOOLS, 2006



NOTES: Figures 2 plots kernel density estimates for the percent of charter and mainstream schools' students who were nonwhite, and Figure 3 plots densities for the percent of students performing at grade level in 2006. All densities were estimated with an Epanechnikov kernel function and halfwidth of 2.5 percentage points.

TABLE 2

IN-SAMPLE MOBILITY PATTERNS OF CHARTER TEACHERS

TEACHER MOBILITY PATTERN	PERCENT
started and ended in the charter system (right censored)	21.5
started and ended in the charter system (uncensored)	33.6
mainstream to charter	25.1
mainstream to charter to mainstream	8.5
charter to mainstream	10.7
other patterns	<1.0
$n = 5,346$ teachers	

NOTES: The first two mobility patterns apply to teachers who taught exclusively in charter schools. Right censored charter teachers entered the sample in the charter system and were still teaching there in 2007, the last year of the panel. Uncensored teaching spells ended before 2007. The following four mobility patterns apply to teachers who taught in charter and mainstream schools. The percent of all charter participants who followed each pattern is indicated at right.

TABLE 3

NORTH CAROLINA PUBLIC SCHOOL TEACHERS: SUMMARY STATISTICS

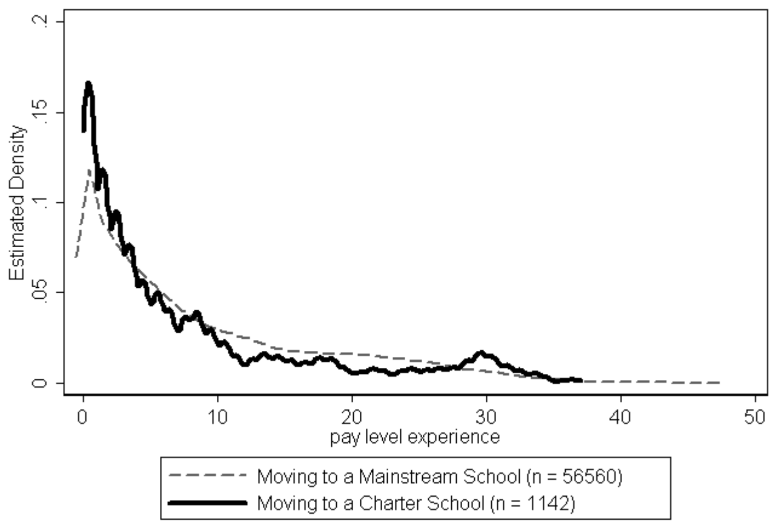
TEACHER CHARACTERISTIC	ALL TEACHERS	MOVING TEACHERS: ALL MOVERS	MOVING TEACHERS: MOVING TO MAIN	MOVING TEACHERS: MOVING TO CHARTER
holds graduate degree (%)	30.8 (46.2)	27.5 (44.6)	27.5 (44.7)	25.2 (43.4)
attended competitive college (%)	76.2 (42.6)	75.0 (43.3)	75.1 (43.3)	70.6 (45.6)
mean licensure test score	0.030 (0.857)	0.015 (0.839)	0.015 (0.838)	0.029 (0.905)
regularly licensed (%)	89.5 (30.7)	88.8 (31.6)	89.0 (31.3)	79.1 (40.7)
teaching experience (years)	11.93 (9.92)	8.89 (8.72)	8.92 (8.71)	7.45 (8.97)
experience ≤ 3 years (%)	26.1 (43.9)	36.3 (48.1)	36.1 (48.0)	47.5 (50.0)
experience ≥ 25 years (%)	14.5 (35.2)	7.5 (26.3)	7.5 (26.3)	8.9 (28.5)
nonwhite (%)	16.9 (37.4)	18.1 (38.5)	17.9 (38.3)	26.4 (44.1)
female (%)	79.8 (40.1)	79.8 (40.2)	79.8 (40.2)	79.2 (40.6)
n (teacher-years)	886,343	58,629	57,487	1,142

NOTES: Standard deviations appear in parentheses below each mean. Data for “Moving” teachers are evaluated in the year immediately preceding a school change.

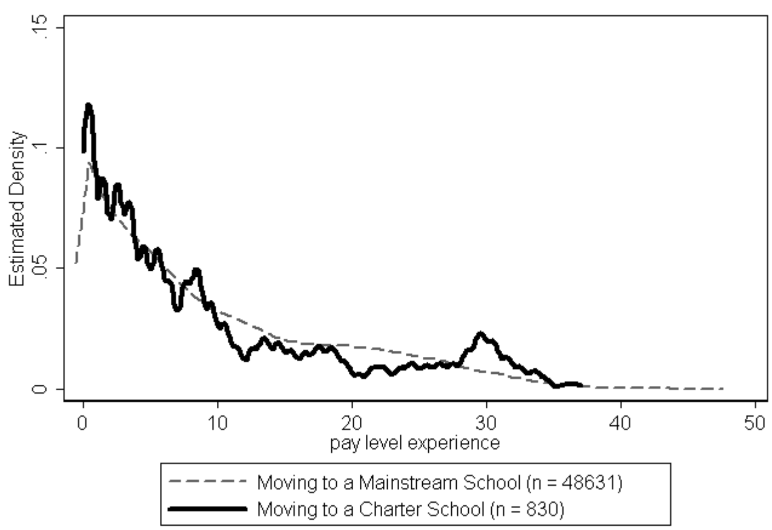
FIGURE 4

DENSITY ESTIMATES: YEARS' EXPERIENCE OF MOBILE TEACHERS, BY LICENSURE AND CHARTER/MAINSTREAM DESTINATION

All teachers changing schools



All regularly licensed teachers changing schools

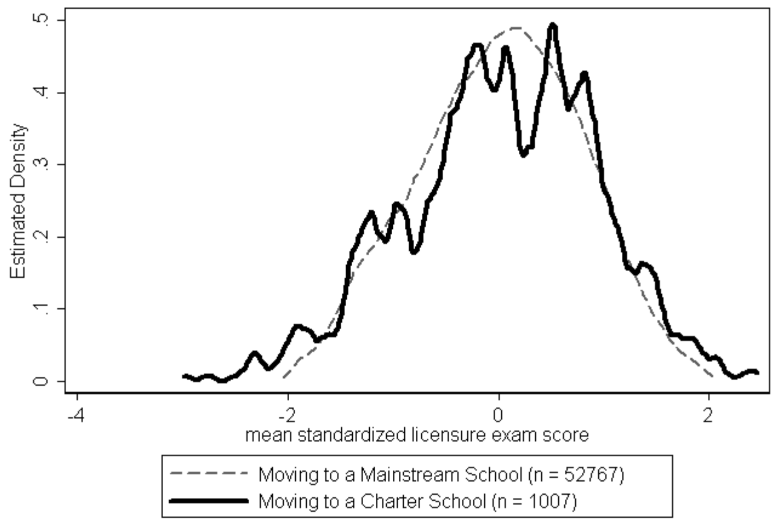


NOTES: The figures plot kernel density estimates of the years' experience of teachers changing schools. The lower panel is restricted to regularly licensed (certified) teachers, who make up 89.5 percent of the sample with non-missing license data. Both densities were estimated with an Epanechnikov kernel function and halfwidth of 0.50 years.

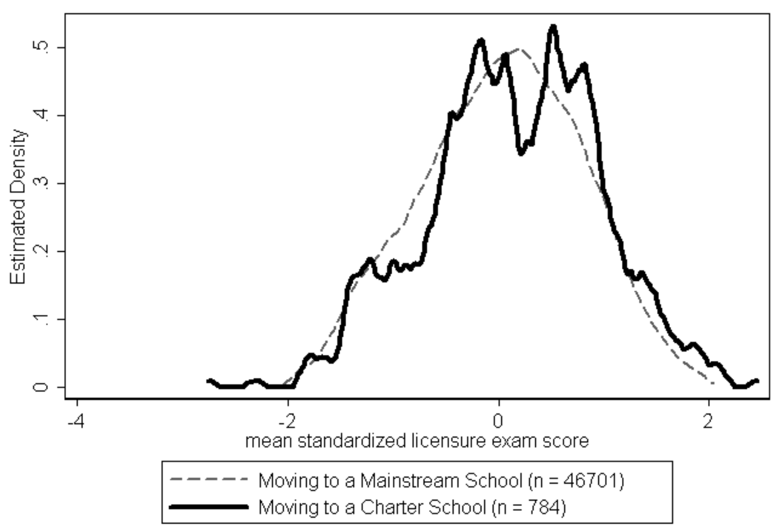
FIGURE 5

DENSITY ESTIMATES: LICENSURE TEST SCORES OF MOBILE TEACHERS, BY LICENSURE AND CHARTER/MAINSTREAM DESTINATION

All teachers changing schools



All regularly licensed teachers changing schools



NOTES: The figures plot kernel density estimates of the mean licensure test score of teachers changing schools. Licensure test scores were scaled to have mean zero and standard deviation one within each test code and year. A teacher's mean standardized licensure test score is the average of all unique exam scores. The lower panel is limited to regularly licensed (certified) movers. Both densities were estimated with an Epanechnikov kernel function and halfwidth of 0.05 standard deviations.

TABLE 4

ESTIMATED QUALIFICATIONS OF MOBILE TEACHERS,
BY LICENSURE AND CHARTER/MAINSTREAM DESTINATION

	I		II		III		IV	
Sending school covariates:	yes		no		yes		yes	
Receiving school covariates:	no		yes		yes		yes	
Type of mover (coefficient)	charter mover (δ^c_{jt})		charter mover (δ^c_{jt})		charter mover (δ^c_{jt})		any mover (δ^m_{jt})	
QUALIFICATION (k)								
graduate degree (0,1)								
mover	-0.011	[0.81]	-0.022	[1.66]	-0.014	[1.05]	0.001	[0.50]
licensed mover	-0.009	[0.53]	-0.023	[1.42]	-0.015	[0.88]	0.003	[1.17]
competitive college (0,1)								
mover	-0.038	[2.77]	-0.030	[2.24]	-0.030	[2.19]	-0.004	[1.80]
licensed mover	-0.012	[0.83]	-0.010	[0.70]	-0.008	[0.52]	-0.001	[0.52]
mean licensure test								
mover	-0.032	[1.16]	-0.002	[0.07]	-0.010	[0.37]	-0.017	[4.39]
licensed mover	0.056	[2.02]	0.077	[2.75]	0.069	[2.46]	-0.012	[3.18]
licensed (0,1)								
mover	-0.075	[6.33]	-0.075	[6.25]	-0.076	[6.36]	-0.005	[3.48]
experience (years)								
mover	-1.29	[4.54]	-1.26	[4.34]	-1.24	[4.26]	-3.40	[74.87]
licensed mover	-0.36	[1.02]	-0.45	[1.26]	-0.38	[1.07]	-3.44	[70.99]
experience ≤ 3 years (0,1)								
mover	0.108	[7.05]	0.105	[6.76]	0.104	[6.65]	0.123	[52.56]
licensed mover	0.057	[3.33]	0.063	[3.61]	0.059	[3.35]	0.114	[47.74]
experience ≥ 25 years (0,1)								
mover	0.018	[2.01]	0.018	[2.02]	0.017	[1.86]	-0.068	[52.58]
licensed mover	0.039	[3.35]	0.039	[3.27]	0.038	[3.18]	-0.073	[49.49]

$n = 886,343$ teachers

NOTES: "Mover" cells in columns I through III represent the estimated difference in qualification k between teachers moving to charter schools and teachers moving to another mainstream school (δ^c_{jt} in equation (1)). Cells in column IV represent the estimated difference in k between mainstream movers and non-movers (δ^m_{jt} in equation (1)). "Licensed mover" cells are estimates of δ^c_{it} or δ^m_{jt} when equation (1) is limited to regularly licensed teachers. Control variables include sending school characteristics and/or receiving school characteristics (quintile indicators for student racial composition and performance composite, school age, grade ranges served), a set of dummy variables for missing data, and county-by-year effects. The absolute values of t-statistics are reported in brackets to the right of each coefficient. Robust standard errors are clustered within each school and year.

TABLE 5

CLASSROOM-AVERAGED STUDENT TEST SCORES,
BY SAMPLE AND TEACHERS' CHARTER PARTICIPATION

	EVER A CHARTER TEACHER			NEVER A CHARTER TEACHER		
sample	analysis sample	rejected sample	diff.	analysis sample	rejected sample	diff.
average student math score	-0.112 (0.705)	-0.096 (0.623)	-0.016 [0.30]	-0.028 (0.656)	-0.001 (0.647)	-0.027 [5.82]
average student reading score	-0.120 (0.639)	-0.089 (0.575)	-0.031 [0.63]	-0.027 (0.582)	-0.004 (0.595)	-0.023 [5.43]
n (classroom-years)	763	175		86,105	25,265	

NOTES: Student math and reading scores for grades 3 - 5 are scaled to have mean zero and standard deviation one within each school year. Each student's end-of-grade test score is linked to the test proctor, who was possibly his or her classroom teacher. "Analysis sample" classrooms refer to exam groups whose proctor who very likely to be the students' teacher. Teachers in these classrooms were verified as having a self-contained classroom assignment for the same grade level(s) as those represented in end-of-grade test scores linked to that teacher, and their classes were no smaller than 5 and no larger than 30. "Rejected sample" classrooms refer to exam groups where the proctor had no self-contained classroom assignment, did not teach students in the test-takers' grade level, and/or had a class size smaller than 5 or larger than 30. Individuals who were "ever a charter teacher" were predominantly future charter teachers, and those who were "never a charter teacher" were exclusively observed in mainstream schools.

TABLE 6

COEFFICIENT ESTIMATES: GRADE 3 - 5 EOG TEST SCORE REGRESSIONS WITH TEACHER AND FIXED EFFECTS

	MATH		READING	
Student characteristics ($\mathbf{A}_{ijcslt}$)				
female	-0.043	[40.98]	0.098	[84.40]
black, non-Hispanic	-0.425	[283.73]	-0.422	[256.68]
Hispanic	-0.129	[47.10]	-0.205	[67.85]
other, non-white	-0.055	[21.23]	-0.131	[46.60]
free or reduced-price lunch	-0.124	[73.45]	-0.160	[85.92]
academically gifted	0.871	[507.54]	0.797	[423.48]
parent education - high school	-0.501	[173.40]	-0.558	[175.82]
parent education - some college	-0.282	[95.36]	-0.299	[92.20]
parent education - college graduate	-0.112	[39.72]	-0.118	[38.23]
Learning disabled - reading	-0.151	[22.84]	-0.494	[67.87]
Learning disabled - math	-0.480	[57.08]	-0.211	[22.88]
Learning disabled - writing	-0.225	[39.40]	-0.274	[43.64]
Learning disabled - language	-0.192	[36.50]	-0.259	[44.85]
Teacher experience ($\bar{\mathbf{T}}_{jct}$)				
new teacher	-0.083	[18.72]	-0.060	[12.33]
teacher has 1-2 years experience	-0.015	[5.48]	-0.011	[3.74]
Class average characteristics ($\bar{A}_{-ijcslt}$)				
class size	-0.004	[18.01]	-0.002	[9.93]
female	0.001	[9.48]	3.9e-4	[5.51]
black, non-Hispanic	-0.002	[21.42]	-0.002	[19.76]
Hispanic	-0.001	[10.48]	-0.002	[12.84]
other, non-white	-0.001	[5.57]	-0.001	[5.98]
free or reduced-price lunch	-1.2e-4	[2.46]	-3.72e-4	[0.69]
academically gifted	-0.001	[20.81]	-0.001	[19.01]
parent education - high school	0.001	[13.21]	0.001	[11.57]
parent education - some college	-1.7e-4	[1.97]	-2.1e-4	[2.12]
parent education - college graduate	-8.1e-4	[9.02]	-8.3e-4	[8.48]
Learning disabled - reading	-1.9e-4	[0.62]	-7.8e-4	[2.33]
Learning disabled - math	0.001	[1.48]	0.001	[2.75]
Learning disabled - writing	-1.8e-4	[0.67]	-2.1e-4	[0.70]
Learning disabled - language	-3.8e-4	[1.57]	-3.1e-4	[1.19]
School characteristics ($\mathbf{X}_{slt}$)				
percent at grade level	0.016	[113.38]	0.015	[92.71]
percent nonwhite	0.004	[36.62]	0.003	[26.33]
new school	-0.017	[3.62]	-0.005	[0.92]
n (student-years)	1,664,393		1,663,741	
t (teachers)	28,356		28,352	
overall $F(66, n-t-66)$	12,334		9,857	
teacher fixed effects $F(t, n-t-66)$	5.67		3.26	

NOTES: Shown are the estimated coefficients of equation (2), where student math and reading scores are regressed against student characteristics, teacher experience indicators, peer characteristics, teacher fixed effects, and grade-by-year effects. Excluded categories are “white” for student race, and “post-baccalaureate” for parental education. The absolute value of t-statistics are reported in brackets to the right of each coefficient.

TABLE 7

CLASSROOM PERFORMANCE OF TEACHERS CHANGING SCHOOLS, BY LICENSURE AND CHARTER/MAINSTREAM DESTINATION

	I		II	
sending school covariates	yes		yes	
receiving school covariates	yes		yes	
school-by-year effects	no		yes	
Type of mover	charter mover	any mover	charter mover	any mover
(coefficient)	(δ^c_{jt})	(δ^m_{jt})	(δ^c_{jt})	(δ^m_{jt})
MATH				
mover	-0.026	-0.022	0.032	-0.019
	[1.65]	[9.53]	[1.73]	[7.30]
licensed mover	-0.022	-0.021	0.037	-0.018
	[1.29]	[8.81]	[1.81]	[6.84]
READING				
mover	-0.009	-0.019	0.028	-0.017
	[0.61]	[9.86]	[1.56]	[7.50]
licensed mover	-0.001	-0.019	0.036	-0.016
	[0.08]	[9.28]	[1.89]	[7.11]
$n = 167,088$ teacher-years				
number of movers	229	13,715	229	13,715

NOTES: "Charter mover" cells are the estimated difference in teacher fixed effects between teachers moving to charter schools and teachers moving to another mainstream school (δ^c_{jt} in equation (4)). "Any mover" cells are the estimated difference in k between mainstream movers and non-movers (δ^m_{jt} in equation (4)). The Column I specification uses teacher fixed effects generated from equation (2), without school-by-year effects, so coefficients in these columns represent the difference in movers' classroom performance evaluated on a statewide scale. The column II specification uses teacher fixed effects estimated in equation (3), with school-by-year effects. Coefficients in column II represent the difference in movers' relative classroom performance within their sending schools. "Licensed mover" cells are estimates of δ^c_{it} or δ^m_{jt} when equation (1) is limited to regularly licensed teachers. Unreported control variables include sending school characteristics and/or receiving school characteristics (quintile indicators for student racial composition and performance composite, school age, grade ranges served), a set of dummy variables for missing data, and county-by-year effects. The absolute values of t-statistics are reported in brackets to the right of each coefficient. Robust standard errors are clustered within each school and year.

TABLE 8

VARIATION IN TEACHER QUALITY

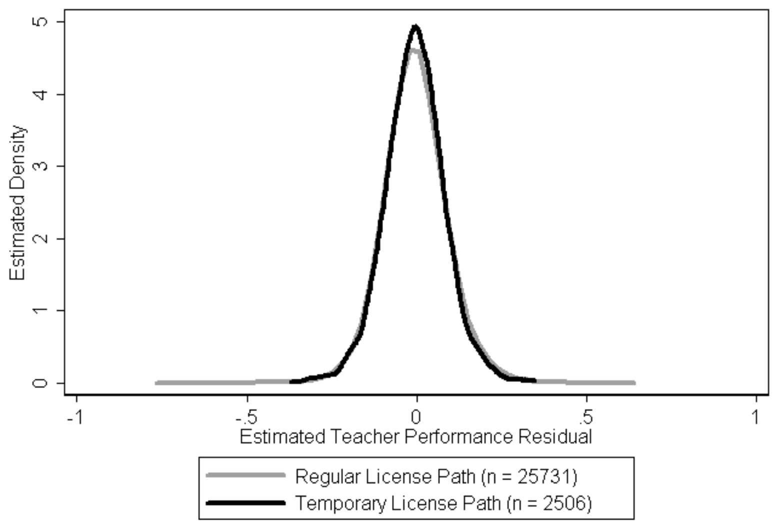
	MATH			READING		
	Total	Signal	SD(FE)	Total	Signal	SD(FE)
All teachers	0.240 (0.008)	0.128 (0.013)	0.236 (0.015)	0.220 (0.007)	0.093 (0.011)	0.205 (0.014)
Temporary license path	0.244 (0.008)	0.132 (0.015)	0.265 (0.016)	0.231 (0.007)	0.096 (0.014)	0.251 (0.020)
Regular license path	0.240 (0.007)	0.128 (0.015)	0.235 (0.016)	0.219 (0.008)	0.093 (0.012)	0.203 (0.014)
Never a charter teacher	0.240 (0.008)	0.128 (0.014)	0.236 (0.016)	0.220 (0.007)	0.093 (0.013)	0.205 (0.011)
Ever a charter teacher	0.242 (0.008)	0.130 (0.013)	0.240 (0.009)	0.222 (0.007)	0.086 (0.012)	0.221 (0.009)

NOTES: Student math and reading scores were regressed against student characteristics, teacher experience indicators, peer characteristics, and school-by-year effects (equation (6)). "Total" is the standard deviation of student residuals from equation (6) estimates. "Signal," calculated by equation (7), is the standard deviation of teachers' persistent value-added, by group. "SD(FE)" is the standard deviation of teacher fixed effects, estimated by equation (2). Standard errors, in parentheses below each standard deviation estimate, were estimated by bootstrap with an equal number of charter participants and non-participants selected in each sampling.

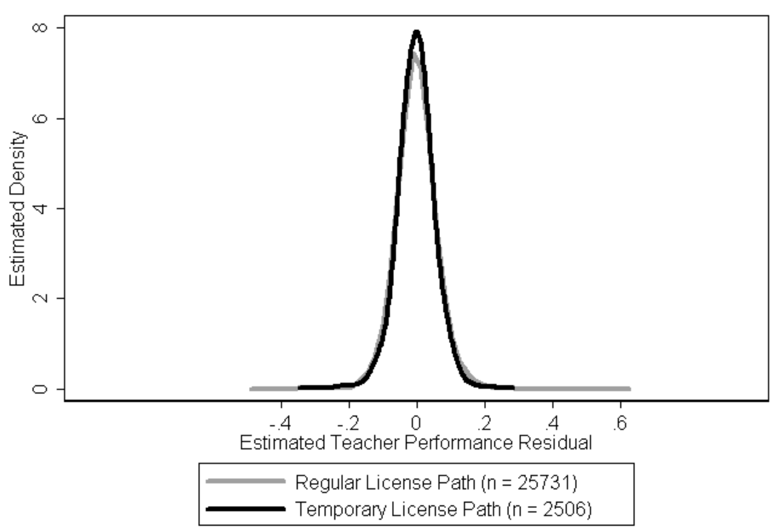
FIGURE 6

PERSISTENT TEACHER QUALITY: ESTIMATED DENSITIES BY LICENSURE

MATH



READING

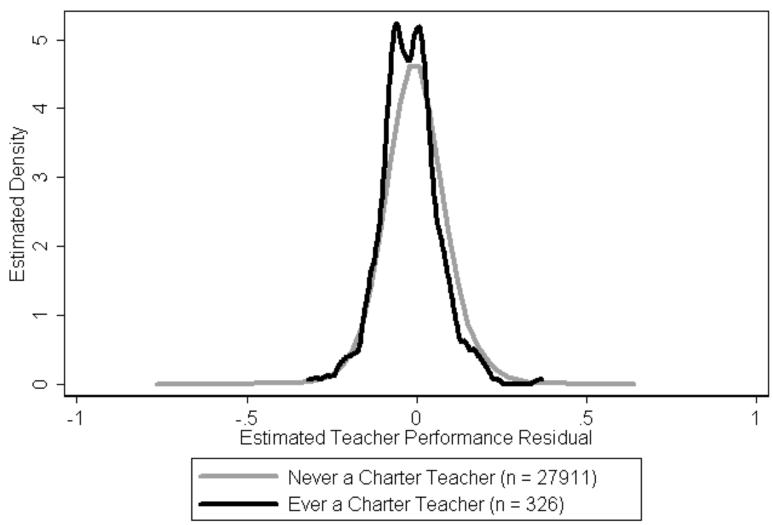


NOTES: The figures plot kernel density estimates of scaled teacher performance residuals, calculated by equation (7), by type of licensure. Teachers following a "regular license path" ($n = 25,732$) were fully licensed each year they were linked to student EOG scores. Teachers following a "temporary license" path ($n = 2,506$) held emergency, provisional, or other temporary licenses in at least one year of their EOG record. All densities were estimated with an Epanechnikov kernel function and halfwidth of 0.015 scaled standard deviations.

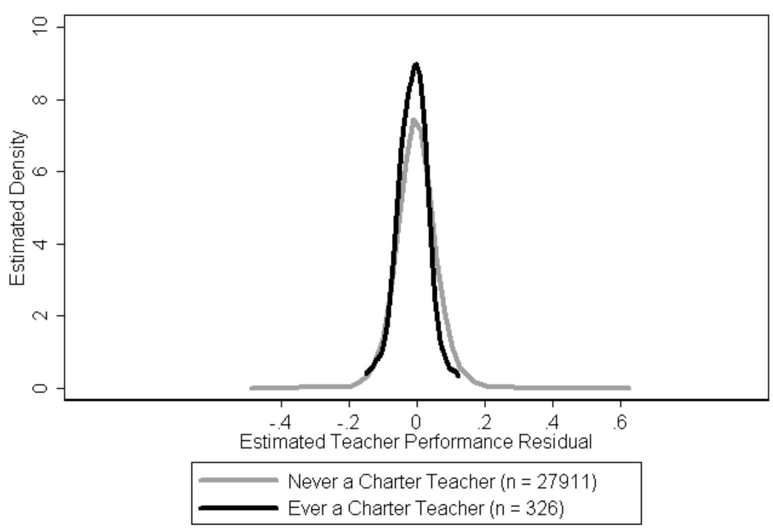
FIGURE 7

PERSISTENT TEACHER QUALITY: ESTIMATED DENSITIES BY CHARTER PARTICIPATION

Math



Reading



NOTES: The figures plot kernel density estimates of scaled teacher performance residuals, calculated by equation (7), by charter participation. Individuals who were "ever a charter teacher" ($n = 326$) are predominantly future charter teachers, and those who were "never a charter teacher" ($n = 27,912$) were exclusively observed in mainstream schools. All densities were estimated with an Epanechnikov kernel function and halfwidth of 0.015 scaled standard deviations.