# DO CHARTERS RETAIN TEACHERS DIFFERENTLY? EVIDENCE FROM ELEMENTARY SCHOOLS IN FLORIDA

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**Abstract**

We analyze patterns of teacher attrition from charter schools and schools in the traditional public sector. Using rich data on students, teachers, and schools in Florida, we estimate teacher effectiveness based on repeated test scores reported at the student level for each teacher over time. Among all teachers, those in charter schools appear more likely to exit the profession than those in the traditional public sector, and in both sectors the least effective teachers are more likely to exit than their more effective counterparts. Few of these relationships appear evident for within- or between-district transfers, and there are no differential relationships between effectiveness and attrition in the charter sector. We interpret these results as indicating that whatever administrative or organizational differences may exist in charter schools, they do not necessarily translate into a discernible difference in the ability to dismiss poorly performing teachers.

## 1. INTRODUCTION

Of the various educational reform policies operating under the general objective of providing "school choice," charter schools represent the most widely available alternative to the traditional public sector. Less than two decades since the first few charter schools opened in Minnesota as a small experiment, there are now more than 1.5 million students enrolled in nearly five thousand charter schools dispersed across forty-one states and the District of Columbia.[1] There is considerable disagreement in the literature on whether charter schools are effective. Some scholars using quasi-experimental designs have found few benefits or even negative effects associated with charter schooling (Bettinger 2005; Bifulco and Ladd 2006; Hanushek et al. 2007; CREDO 2009), while others have demonstrated positive effects of charter schooling for some groups of students (Greene, Forster, and Winters 2003; Holmes, DeSimone, and Rupp 2003; Witte et al. 2007), and still others a very mixed picture indeed (Buddin and Zimmer 2005; Sass 2006; Zimmer and Buddin 2006; Zimmer et al. 2011). Two large-scale studies of charter schools using a random assignment design have found that charter schools in New York City and Boston have produced substantial student gains (Hoxby, Murarka, and Kang 2009; Abdulkadiroglu et al. 2011). However, another recent study using randomized field trials in several states found that the effects of charters vary across locations and on average have no significant impact on student achievement (Gleason et al. 2010).[2]

One of the prominent explanations for why charter schools should in theory be more effective producers of education is their potential as incubators for experimentation with alternative organizational and staffing policies (Stuit and Smith 2009). Charter supporters argue that these policies could translate into differences between charter and traditional public schools in the type of teacher who is attracted to and retained in their classrooms (Hoxby 2002). The vast majority of charter schools are not bound by collective bargaining agreements, and when such contracts do exist they are often less restrictive than those in the public sector (Price 2011). Restrictive collective bargaining agreements may make it very difficult to fire an unsatisfactory teacher, and, although charter schools are subject to state and federal employment laws, they may be unbound by tenure and seniority policies under which the traditional sector typically operates. Schools operating without such policies may have greater ability to remove particularly ineffective teachers (Ballou and Podgursky 1997),

1. Center for Education Reform. National charter school data (see www.edreform.com/).
2. A related line of work has considered the impacts of charter schools on students who "stay behind" in the traditional sector, with some evidence that such students may benefit (Booker et al. 2008) and some evidence of perhaps a slightly negative impact (Imberman 2011).

and recent research indicates charter schools that provide frequent teacher feedback, the use of data to guide instruction, high-dosage tutoring, increased instructional time, and high expectations tend to be the most effective in that alternative sector (Angrist, Pathak, and Walters 2011; Dobbie and Fryer 2011).

Whether such supposed autonomy implies that charter schools actually do remove less effective teachers is an open question. Although recent studies have demonstrated that turnover among charter school teachers is considerably higher (Stuit and Smith 2009; Newton et al. 2011), there are a variety of competing explanations for this attrition. Charter schools may attract less experienced teachers (Carruthers 2012), who in turn may be more likely to exit public schools of any sort in the first place. The experimental nature of many charter classrooms may translate into a more demanding work environment, and the absence of bargaining agreements may imply lower pay and fewer protections of teacher rights under such conditions (Miron and Applegate 2007), which may make teaching in that sector less appealing in the long run. Despite some disagreement over the implications of charter policies for racial integration, a variety of studies have shown that charter schools serve disproportionately minority student bodies (Booker, Zimmer, and Buddin 2005; Bifulco and Ladd 2006, Witte et al. 2007; Hoxby, Murarka, and Kang 2009), which in general appear to suffer from greater teacher attrition (Hanushek, Kain, and Rivkin 2004).

Further complicating the question of whether charters are better able to remove ineffective teachers are the roles of teacher quality and attrition in the traditional public sector. In the first place, whether traditional schools' collective bargaining agreements actually restrict administrative flexibility in teacher assignment is not a settled question. Several studies have found general evidence for a negative bargaining impact on school district productivity (e.g., Hoxby 1996; Moe 2009; Strunk 2011; Strunk and McEachin 2011). Some recent work has, however, stressed the importance of considering variation in bargaining agreements themselves when studying the productivity question (e.g., Strunk and Grissom 2010; Strunk 2012)—not all agreements are equally restrictive—and other contextual factors, such as management practices, may mitigate negative bargaining effects (Nicholson-Crotty, Grissom, and Nicholson-Crotty 2012). Most directly to the point, other recent work (Koski and Horng 2007) has found that bargaining agreements may have little independent effect on the distribution of teachers between individual schools, although that study was based primarily on teachers who remained in the public system.

Moreover, there is considerable recent evidence that the least effective teachers are indeed the most likely to leave traditional public schools. This is an unsettled question in the literature, and it appears to turn on the use of

observed versus unobserved teacher attributes. Teachers with higher scores on general certification exams are more likely to leave schools with low-ability students (Boyd et al. 2005). Teachers who are National Board for Professional Teaching Standards (NBPTS) certified also appear to be more mobile and may leverage their certification to move out of schools with low-ability and high-minority student bodies (Goldhaber and Hansen 2009). Teachers with higher ACT scores in college—especially math and science teachers—are more likely to leave the profession entirely and are more likely to leave if they work on a comparably low-ability staff (Podgursky, Monroe, and Watson 2004). However, a growing set of studies employing value-added measures of teacher quality generally tells a different story than that focused on observed teacher attributes (Krieg 2006; Boyd et al. 2008; West and Chingos 2009; Goldhaber and Hansen 2010; Feng and Sass 2011; Goldhaber, Gross, and Player 2011; Jacob 2011). These studies have found that the least effective public school teachers are those most likely to exit the classroom.

Taken together, then, the literatures on charter schools and more generally on teacher attrition in the traditional context provide justification for what amounts to a two-sided hypothesis: on the one hand, the lack of bargaining contracts and assumed advantage in managerial flexibility in charter schools may suggest that those schools have greater opportunity to remove their least effective teachers from the classroom than their traditional public school counterparts. On the other hand, if drawing (intentionally or otherwise) from a more transient labor market leads charters to lose teachers at a high rate, or if traditional schools themselves are actually quite capable of removing ineffective teachers, we might expect no charter advantage at all in this regard. To the contrary, some charter schools may have to retain some of their less effective teachers simply to meet their basic staffing needs.

In the context of this theoretical uncertainty, the current article is to our knowledge the first to directly attempt to discern whether the relationship between teacher effectiveness and retention differs in the charter market. We begin by examining student-level data from Florida, with more than three hundred charter schools serving elementary students and operating between the 2002 and 2008 academic years. Using test score data for individual students in both public and charter schools, we specify and estimate each teacher's independent contribution to the learning of his or her students and use this estimate in models predicting teacher movement out of both types of schools. Similar to prior articles that use such value-added models (VAMs) as a measure of quality, we show that more effective teachers may be more likely to remain in teaching. We also find that charter school teachers are considerably more likely to exit than those in traditional public schools, even after accounting for teacher effectiveness.

Our primary finding, however, is that the relationship between teacher effectiveness and teacher retention is similar in both sectors. This implies that differences in the way charters hire or retain teachers in Florida do not translate into observable, structural advantages in the ability to either dismiss poorly performing teachers or prevent a highly skilled teacher from exiting. Although these results may surprise some supporters of charter school autonomy, they are substantively consistent with other work in Florida that has demonstrated relative academic parity between students in the charter and traditional public sectors (e.g., Sass 2006). We conclude the article with a discussion of the results in terms of current public policy and future work on the topic.

## 2. CHARTER SCHOOLS IN FLORIDA

Charter schools were first authorized in Florida by state law in 1996. As of 2008–9, the last year of our data, there were 117,602 students in grades K–12 attending one of Florida's 389 charter schools (FLDOE 2012). Although schools may be founded by a number of groups, the charter for each school is ultimately sponsored by a surrounding school district. As the Florida Department of Education explains:

> Charter schools are created when an individual, a group of parents or teachers, a business, a municipality, or a legal entity submits an application to the school district; the school district approves the application; the applicants form a governing board that negotiates a contract with the district school board; and the applicants and district school board agree upon a charter or contract. The district school board then becomes the sponsor of the charter school.[3]

Charter schools operate throughout the state. However, some districts have a disproportionate number of charter schools, and some districts do not have any at all.[4]

Although charter schools are often referred to as a national educational reform, the rules and regulations under which they operate are often quite different across states. Thus the structure of Florida's law and the effectiveness of its charter schools relative to traditional public schools are important to our expectations for differences in teacher quality across the charter and traditional public school sectors. According to the Center for Education Reform, Florida's charter school law allows for a high level of autonomy relative to other states

3. See www.floridaschoolchoice.org/information/charter_schools/faqs.asp.
4. The majority of districts have at least one charter school. However, Dade, Lake, and Polk counties account for nearly 40 percent of the charter school teachers in our sample. Results of model estimates are robust to specifications with fixed effects for districts.

(Center for Education Reform 2012). Other than statewide regulations governing all public employees, Florida's charter schools are generally not limited by the same restrictions on teacher staffing as those found in the surrounding district's collective bargaining agreement, and of the 411 schools operating in 2010, only in 16 (less than 4 percent) had teachers taken advantage of state law permitting within-school majorities of charter teachers to bargain if desired (Price 2011). Charter schools may not, however, hire indiscriminately. Although there are limited exceptions, charter school teachers in Florida must be certified.

Florida charter schools may not be as effective as those in some other parts of the country. Using a student fixed-effects approach, Sass (2006) found that Florida charter schools are ineffective in their first several years of operation relative to traditional public schools. After their fifth year in operation, Florida's charter schools are as effective as traditional public schools in math and perhaps more effective in reading. This evidence suggests that differences in teacher quality might be slightly or negatively related to the charter sector. However, Florida's charters serving older students were among those studied by Sass and colleagues (Booker et al. 2011; Zimmer et al. 2009), indicating large charter impacts on high school graduation and postsecondary enrollment.

## 3. DATA

We utilize a rich student-level data set provided by the Florida Department of Education's (FLDOE) K20 Data Warehouse. The data set contains test scores and demographic information by year for each student who was administered the state's mandated math and reading exams, the Florida Comprehensive Assessment Test (FCAT), from 2002–3 through 2008–9. Unique student identifiers allow us to follow the performance of each student over time. A separate data set, also provided by the FLDOE, contains information for all teachers in traditional public schools (TPS) and charter schools in Florida. A classroom identifier allows us to match students to teachers in a particular year. In a given year, many students are matched to more than one teacher. This is problematic for estimation and leads us to develop rules for matching each student to the teacher who is likely most responsible for his or her math or reading achievement.[5]

5. First, we include only teachers listed as the head of a self-contained classroom. If a student is still observed to be attached to multiple teachers, we then assign him to particular course numbers. Students are first matched to the teacher in the course listed as third grade, and about 85 percent of students are matched to this teacher. Remaining students are matched to courses specific to elementary math or reading, depending on the analysis. For the reading sample, the progression assigns the student (in order) to the teacher listed as language arts elementary, reading elementary, and finally language arts K–5. For the math sample, the progression assigns the student next to the teacher listed as math elementary and then math K–5. About 96 percent of third-grade students in

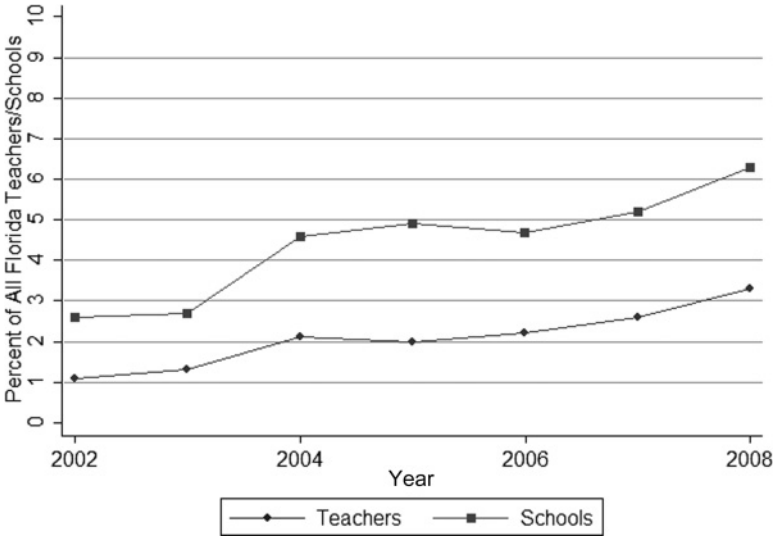


**Figure 1.** Charter Schools and Teachers in Florida, 2002–8 (serving grades 3–5)

We focus on teachers of students in grades 4 and 5. We cannot use observations of student performance prior to the fourth grade because our value-added approach to estimation requires an observation of the student's previous year's test score, and testing begins in Florida in the third grade. We do not use any grades after the fifth because TPS middle and high school students tend to change classrooms in a day and thus might be assigned to several math and reading teachers. Figure 1 indicates the percentage of charter schools and teachers among all schools and teachers serving grades 3–5 from 2002 to 2008. As we discuss in detail below, that the charter sector continues to represent a fraction of the educational context in Florida poses some difficulties for studies of public/charter differences.[6]

## 4. PATTERNS OF MOBILITY IN CHARTER AND TRADITIONAL PUBLIC SCHOOLS

We are primarily interested in teacher exits from the Florida data system, as the policy debate on removing ineffective teachers tends to stress outright dismissal rather than permitting teachers to simply switch schools (e.g., Jacob 2011). However, we also define two other distinct mobility patterns: transfers within a school district (i.e., from school to school) and transfers between

our data set are matched to a teacher according to these progressions, and the remaining students are excluded from the analyses.

6. These figures are similar to those on all charters in Florida reported by Sass (2006), and readers familiar with Carruthers (2012) will note very similar charter percentages for schools and teachers in North Carolina.

**Table 1.** Teacher Mobility Rates by Sector, 2002–7

| | Charter (%) | TPS (%) |
|---|---|---|
| No transfer | 67.0 | 81.6 |
| Transfer schools within sector | 1.8 | 4.4 |
| Transfer districts within sector | 0.3 | 1.2 |
| Transfer schools and sectors | 3.9 | 0.1 |
| Transfer districts and sectors | 1.8 | <0.0 |
| Exit data | 25.3 | 12.7 |
| Teacher-year *N* | 1,185 | 67,838 |

school districts. Table 1 reports teacher mobility patterns separately by sector. Teacher exits are determined by noting whether $t - 1$ is the last year the teacher appears in the data. The last type of pattern could include either retiring or exiting the profession, a point we consider further below. Within-district transfers are determined simply by comparing a teacher's school identification number at $t$ with their school number at $t - 1$ for all teachers whose district identification number did not change. Between-district transfers are determined by comparing a teacher's district identification number at $t$ with their district number at $t - 1$. Recall that by definition, charters are linked to a district location, so the within/between district distinction is essentially one of geographic distance for charter school teachers rather than a signal of a different substantive change per se.

Our unit of analysis is the teacher/year, which means we interpret these statistics as "moves" rather than "teachers." The table indicates very little between-sector mobility, and transfers that do occur tend to be from charter to TPS. For example, 4 percent of all teacher/year combinations in TPS were in a new school but in the same school district at time $t$, a figure that compares similarly with those who transferred out of the charter sector but remained in the same district (i.e., when charter teachers transfer, they tend to transfer to a surrounding TPS school). Very few teachers in the sample transferred between districts, regardless of sector, and even fewer transferred from one charter school to another, making systematic exploration of the latter group difficult to consider here. On the other hand, considerable differences exist for teacher exits: nearly one quarter of teacher/year observations in the charter sector correspond to the last year a particular teacher is in the data, compared with only 13 percent of teachers in traditional public schools. These teacher exits are our primary focus in the analysis below. Table 2 reports descriptive statistics for teachers and schools in our sample by mobility pattern.

**Table 2.** Characteristics of Leavers and Stayers by Sector, 2002–7

| | Charter | | | | TPS | | | |
|---|---|---|---|---|---|---|---|---|
| | **No Move** | **Transfer within Districts** | **Transfer between Districts** | **Exit Data System** | **No Move** | **Transfer within Districts** | **Transfer between Districts** | **Exit Data System** |
| *Teacher Characteristics* | | | | | | | | |
| Years of experience (mean) | 3.71 | 4.05 | 1.60 | 2.47 | 8.84 | 5.95 | 3.45 | 7.64 |
| Certified in subject | 0.86 | 1.00 | 0.90 | 0.87 | 0.78 | 0.79 | 0.80 | 0.81 |
| Certified out of subject | 0.09 | 0.14 | 0.10 | 0.10 | 0.05 | 0.06 | 0.09 | 0.07 |
| Alternative cert. | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.01 | 0.01 | 0.02 |
| Salary ($ per pay period) | 1,780 | 1,509 | 1,586 | 1,669 | 1,963 | 1,838 | 1,717 | 1,947 |
| Ever taught in private sector | 0.29 | 0.14 | 0.40 | 0.22 | 0.11 | 0.10 | 0.08 | 0.11 |
| Ever taught out of state | 0.37 | 0.19 | 0.40 | 0.29 | 0.24 | 0.20 | 0.18 | 0.25 |
| White | 0.87 | 0.90 | 0.70 | 0.90 | 0.83 | 0.81 | 0.82 | 0.81 |
| African American | 0.07 | 0.10 | 0.20 | 0.03 | 0.12 | 0.12 | 0.11 | 0.13 |
| Hispanic | 0.06 | 0.00 | 0.10 | 0.04 | 0.04 | 0.05 | 0.06 | 0.04 |
| Female | 0.87 | 0.86 | 1.00 | 0.84 | 0.87 | 0.86 | 0.88 | 0.87 |
| *School Characteristics (Means)* | | | | | | | | |
| White | 0.60 | 0.59 | 0.33 | 0.55 | 0.48 | 0.41 | 0.41 | 0.42 |
| African American | 0.12 | 0.18 | 0.28 | 0.17 | 0.23 | 0.29 | 0.27 | 0.27 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Hispanic | 0.22 | 0.16 | 0.32 | 0.22 | 0.18 | 0.20 | 0.22 | 0.18 |
| Asian | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Female | 0.50 | 0.54 | 0.52 | 0.49 | 0.49 | 0.49 | 0.49 | 0.49 |
| Special needs | 0.20 | 0.21 | 0.22 | 0.23 | 0.25 | 0.26 | 0.25 | 0.25 |
| Free/reduced price lunch | 0.39 | 0.42 | 0.57 | 0.44 | 0.52 | 0.60 | 0.58 | 0.56 |
| English language learners | 0.15 | 0.10 | 0.26 | 0.16 | 0.16 | 0.18 | 0.19 | 0.17 |
| Enrollment | 284.81 | 200.10 | 227.80 | 230.53 | 333.96 | 333.97 | 339.24 | 316.71 |
| Math (school mean) | 0.05 | 0.02 | −0.36 | −0.13 | 0.04 | −0.10 | −0.10 | −0.04 |
| Reading (school mean) | 0.08 | 0.08 | −0.17 | −0.04 | 0.04 | −0.09 | −0.07 | −0.03 |
| Teacher-year *N* | 1,185 | | | | 67,838 | | | |

*Note:* Math and reading cells refer to school-level student averages of FCAT scores normalized by subject, grade, and year to a mean of 0 and standard deviation of 1.

## 5. ESTIMATING TEACHER EFFECTIVENESS

Table 2 indicates that some observable teacher characteristics are correlated with mobility patterns and that charter school teachers are generally more likely to exit. But these results do not provide a comprehensive answer to the underlying question of whether teacher quality is a particularly relevant factor in determining whether a charter school teacher stays or leaves. As we noted above, many earlier studies have examined such teacher attributes as educational background and certification status, but these measures may provide superficial or even misleading evidence for the importance of teacher quality and retention, particularly if they do not appear strongly related to overall student performance (e.g., Gordon, Kane, and Staiger 2006; Rockoff et al. 2011).

In that context, our first task is to measure the effectiveness of each teacher in our sample. We follow the studies cited above by using a value-added approach to estimate each teacher's individual contribution to student learning. We then use this estimated teacher effect as an explanatory variable in a model of teacher attrition. We separately estimate teacher effectiveness in math and reading using identical frameworks. Our model accounts for student, classroom, and school characteristics, taking the form:

$$A_{ijst} = \beta_0 + \beta_1 A_{ijst-1} + \beta_2 X_{ijst} + \beta_3 C_{jst} + \beta_4 S_{st} + \phi_j + \epsilon_{ijst} \quad (1)$$

where $i$, $j$, $s$, and $t$ index the student, teacher, school, and year, respectively. The most important component of equation 1 is $A_{ijst-1}$, the student's prior test score in the predicted subject (Guarino, Reckase, and Wooldridge 2011). To increase our ability to isolate teacher effects, we include prior measures of both math and reading as predictors of $A_{ijst-1}$ regardless of which of those subjects at $t$ is the outcome. The vector $X$ includes student demographics, including race, gender, special needs status, free/reduced price lunch status, English language learner status, and indicators for whether student $i$ was in a new school at time $t$. The vectors $C$ and $S$ indicate time-variant characteristics of peers in the same classroom under teacher $j$ and students in the same school $s$, respectively, as student $i$ at $t$. The result is that we are able to estimate equation 1 as a very rich model in which the teacher effectiveness measure is obtained after accounting for student, teacher, and school characteristics.

Since teachers are nested within schools, the teacher fixed effect accounts for much of the variance in student achievement that is determined by factors related to the school but not captured in $X$, $C$, or $S$. That is, the estimated teacher fixed effect, $\hat{\phi}_j$, could conceivably include both the teacher's independent contribution to the student's learning and at least part of the school's contribution to the student's achievement that remains uncontrolled even after the rich array

of school characteristics included in the model. We considered alternative specifications in which we subsequently netted out a school fixed effect from $\hat{\phi}_j$ (in the same spirit of Harris and Sass 2007) and let that be our measure of teacher quality, but the results of those specifications do not meaningfully affect our results below. We take that as evidence that the systematic component remaining in $\hat{\phi}_j$ after accounting for the student, classroom, and school observable characteristics in equation 1 is particular to the individual teacher *j*.

Rothstein (2009) points out that estimates of teacher fixed effects can be biased due to nonrandom sorting of students to teachers. We do not account for this problem directly in estimation. However, one proposed solution is to use multiple lags of the student's prior achievement in order to better account for student ability (Koedel and Betts 2011). Estimations of teacher fixed effects using two lags of student proficiency correlate strongly with those estimated from the above models. Since using multiple student lagged test scores effectively removes a year of usable data from our analysis, we proceed with teacher fixed effects using one lag of student scores (Guarino, Reckase, and Wooldridge 2011).

Two final notes are required before we proceed. The first concerns teacher experience. We separately estimate equation 1 for new teachers in Florida, defined as fewer than four years of experience, and we also estimate equation 1 for all teachers in the sample, regardless of experience level. These distinctions allow us to consider a teacher's fixed effect not only over the duration of his or her career but also during the early years, which, in Florida's traditional public sector, correspond to the pre-tenure portion of that career. We discuss this motivation further below. However, it is worth noting that because these measures are by definition taken at very early points in a teacher's career, it is possible that they are more prone to bias than estimates taken across several years of the teacher's time in the profession (Koedel and Betts 2011). The second note concerns post-estimation adjustment. Because we will ultimately use our estimate of teacher effectiveness as an explanatory variable in a regression, we adjust all estimated teacher effects for math and reading by an empirically Bayesian shrinkage factor (e.g., Kane and Staiger 2002; Jacob and Lefgren 2008).[7] In addition, we normalize our estimates against the typical public school teacher in Florida (e.g., Goldhaber, Gross, and Player 2011).

7. Our unadjusted prediction, which we assume to be an unbiased measure of teacher effectiveness, nevertheless includes an error component with an assumed mean of zero. There is no way to add our estimate of teacher effectiveness to the model without adding its error, and thus we may be concerned that the coefficient on teacher effectiveness is biased toward zero. The shrinkage adjustment reduces the variance of this error around zero. See Jacob and Lefgren (2008) for more detail. In addition, the unadjusted estimate of teacher effectiveness could be prone to random measurement error and could lead us to overstate the estimated variance of teacher effectiveness. The shrinkage adjustment essentially penalizes the estimates based on teachers for whom our estimated effect is based on

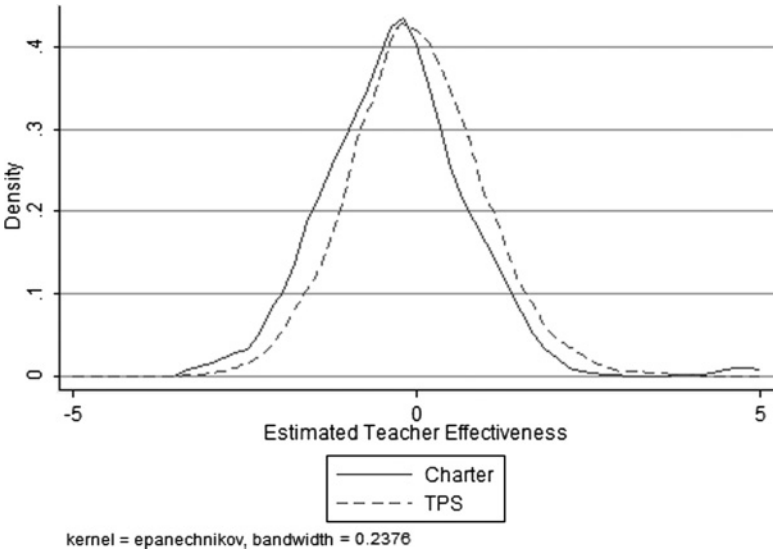


**Figure 2a.** Math Teacher Effectiveness by Sector

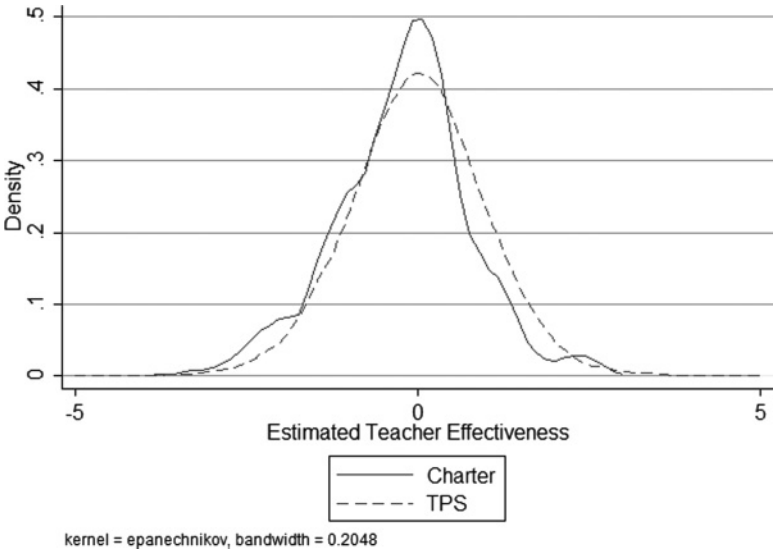


**Figure 2b.** Reading Teacher Effectiveness by Sector

Full results of our estimates of equation 1 for all teachers are presented in the appendix, with additional results for newer teachers (per the preceding discussion) available on request. Figure 2 (panels a and b) compares the estimated

small numbers of students. Although the number of students, teachers, and (compared with some studies) years is substantial here, this does not ensure that each teacher is linked to enough students and years—particularly in the charter sector.

**Table 3.** Percentage of Nonmovers by Teacher Effectiveness Quintile

| | Charter Teachers | | | | | TPS Teachers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Quintile | lowest | 2 | 3 | 4 | highest | lowest | 2 | 3 | 4 | highest |
| Math | 74.14 | 72.13 | 72.07 | 72.29 | 82.72 | 79.49 | 82.72 | 83.96 | 86.67 | 86.81 |
| Reading | 69.06 | 73.39 | 78.99 | 75.27 | 78.08 | 80.71 | 82.80 | 83.82 | 85.04 | 86.88 |

*Note:* Cells represent percentage of teacher-year observations in each quintile that do not transfer within or between schools or exit the data system.

effectiveness distributions by sector. The rightward shift of the estimated TPS distribution relative to charter teachers indicates a difference in favor of TPS teachers in terms of overall effectiveness, especially in math. These differences are statistically significant and translate into mean differences above one-tenth of a standard deviation. On the one hand, we caution readers against an unrestrained interpretation of these results as evidence that TPS teachers vastly exceed charter teachers. Figure 2 indicates that compared with a typical TPS teacher, charter teachers contribute less to student learning. The policy implications of such a result are well outside the scope of this article, in part because they raise the possibility that TPS teachers are simply more effective instructors for the standardized statewide test. These basic results would fit with the notion developed above that teachers in these different sectors are drawn from different labor markets with, perhaps, different teaching needs. On the other hand, the evidence on charter student-level outcomes suggests no meaningful impact on student achievement (e.g., Sass 2006) in Florida. That lack of average charter effects on student outcomes would be expected if charter teachers were particularly ineffective, regardless of what other advantages charters may possess.

## 6. TEACHER EFFECTIVENESS AND TEACHER ATTRITION

As a general summary of the relationship between teacher effectiveness and attrition, table 3 depicts the percentage of teacher-years in each quintile where there is no move (i.e., teachers neither transfer nor exit the data) after each *t*. In both sectors, the most effective teachers are more likely to remain in their schools, although consistent with table 1, TPS teachers are more likely to do so. To consider these relationships in a comprehensive framework, we now turn to a model of teacher attrition that incorporates our estimated effectiveness measure along with observed school and teacher characteristics. We specify conditional probability that a teacher makes one of the three types of moves

described above, relative to the probability of remaining in her given school, as:

$$P(Y_i = m) = \frac{\exp(Z_{mijt})}{1 + \sum_m^M \exp(Z_{mijt})} \tag{2}$$

where

$$Z_{mjst} = \gamma\hat{\phi}_j + \pi_1 X_j + \pi_2 T_{j,t-1} + \pi_3 S_{s,t-1} + \tau_t + e_{jst}$$

and where the probability that teacher $j$ is not in her previous school at time $t$ is conditioned on the estimated teacher effect, $\hat{\phi}_j$, discussed above; a vector of fixed observable teacher characteristics (such as race and gender), $X$; a vector of time-varying teacher characteristics, $T$, such as teacher experience, credentials, and logged salary (adjusted by the Florida Price Level Index to provide county-specific comparisons in purchasing power);[8] time-varying school characteristics, $S$, including the school's sector (charter or traditional public); and year fixed effects $\tau$. We note here that our results below are robust to two alternative specifications, one in which time itself is incorporated as a parameter in the model (i.e., a hazard model) and the other in which we simply predict the linear probability of each type of exit in a model that includes fixed effects for each district location. The model in equation 2 is in some sense the simple formulation of teacher attrition and, given the apparent insensitivity to other specifications, remains our focus here.[9]

We estimate equation 2 in two different ways, each providing a separate piece of policy-relevant information. The first version restricts the sample of teachers to only those in their first three years of experience. In this case, we replace our estimate of teacher effectiveness across all years with the estimate generated during the teacher's first three years of teaching (for teachers who do not remain in the data for more than three years, these are the same estimates). The second version estimates equation 2 across all teachers in our sample and

8. See Florida Bureau of Economic and Business Research for details (www.bebr.ufl.edu). This approach is initially suggested in Feng 2009. In addition, our models do not include teacher education because our data do not provide full educational histories for all teachers. These qualifications are, however, implicit in the combination of base salary and experience included in our model, since education and experience dictate base salary.

9. The similarity between alternative specifications of the transfer/exit probabilities is also characteristic of other approaches that have tried different modeling strategies (e.g., Goldhaber, Gross, and Player 2011 and Jacob 2011). The chief advantage to the hazard approach is that it permits time itself to enter the function as a parameter. Among the disadvantages is the difficulty that fixed effects pose to these, as in many other, nonlinear, models. Our estimate of equation 2 in a hazard format excludes the district fixed effect but includes shared district heterogeneity (i.e., frailty, analogous to a district random effect in this case). Note, too, that the Goldhaber, Gross, and Player (2011) study employs a competing risks specification, which is analogous to the multinomial logit in equation 2 with time as an additional parameter.

includes teacher experience at $t$ among the teacher characteristics in the $X$ vector.

Table 4a displays the full estimates of equation 2 for math teachers and table 4b displays the results for reading teachers. We present results of each teacher and school covariate for readers' review. We note that the quadratic relationship to experience (teachers become less and then more likely again to leave as their career progresses) is qualitatively similar in other studies (see Cowen et al. 2012), but for discussion purposes we focus largely on the charter and teacher effectiveness coefficients. These results indicate that for reading, neither teacher effectiveness nor teaching in a charter school significantly predicts whether a teacher transfers within or between districts in our data, though more effective math teachers may transfer schools. This is true for new teachers (three years or fewer of experience) and for all teachers in our sample. These general results are similar to those demonstrated in other recent work on Florida (Feng and Sass 2011).

On the other hand, among all teachers, teacher effectiveness and teaching in a charter school are related to teacher exits, the mobility type on which we are particularly focused. Confirming the descriptive evidence in table 2, charter school teachers are more likely to exit the data in a given year, at least when we estimate across all teachers. Low-performing teachers are also the most likely to leave, regardless of whether we are estimating across all teachers or newer teachers. The most important result in this article is implied by the slopes of the graphs in figure 3 (panels a and b): although charter teachers are more likely to exit the data, all else equal, the relationship between teacher effectiveness and teacher exit does not appear to dramatically differ by sector. We confirmed the similarity in the slopes in figure 3 by interacting the charter and teacher effectiveness measures. The estimated effectiveness, charter, and interaction coefficients for all math and reading teachers (teacher exits only) are presented in table 5, with full results similar to those in table 4.

Finally, we note that the teacher effect in equation 2 and its corresponding estimates in table 4 are specified as linear with respect to the probability of exit. Other authors (Feng and Sass 2011) have provided evidence of nonlinear effects: in their preferred models specifically, teachers of very high ability are more likely than teachers of average effectiveness to exit the data. The Feng and Sass evidence is especially pertinent because it deals with teachers in Florida, albeit a sample corresponding to different grades and only the earlier years we discuss here. We tested for this pattern in our analytic sample in two ways: first, by allowing teacher effectiveness to have a quadratic relationship to exits and, second, by including indicator variables showing the quintile of effectiveness to which each teacher belonged. Estimates (unreported for space reasons but available from the authors) of the quadratic term for effectiveness

**Table 4a.** Predicting Teacher Mobility (Math Teachers)

| | Transfer Within District | | Transfer Between Districts | | Exit Data System | |
|---|---|---|---|---|---|---|
| | ≤3 | All | ≤3 | All | ≤3 | All |
| **Variables** | **Years** | **Teachers** | **Years** | **Teachers** | **Years** | **Teachers** |
| Teacher effectiveness | 0.042 | 0.053* | −0.043 | −0.071 | −0.260*** | −0.228*** |
| | (0.040) | (0.030) | (0.064) | (0.050) | (0.026) | (0.018) |
| In charter | −0.268 | −0.038 | −0.022 | 0.235 | 0.197 | 0.424*** |
| | (0.355) | (0.287) | (0.370) | (0.364) | (0.139) | (0.128) |
| Experience | 0.143 | −0.066*** | −0.324*** | −0.185*** | −0.272*** | −0.105*** |
| | (0.172) | (0.011) | (0.105) | (0.023) | (0.068) | (0.006) |
| Experience$^2$ | −0.060 | 0.001*** | 0.065** | 0.004*** | 0.072** | 0.003*** |
| | (0.083) | (0.000) | (0.033) | (0.001) | (0.031) | (0.000) |
| Cert. in subj. | −0.122 | −0.310* | 0.483 | 0.436 | −0.348*** | −0.279*** |
| | (0.205) | (0.164) | (0.345) | (0.298) | (0.132) | (0.096) |
| Cert. out of subj. | −0.061 | −0.194 | 0.335 | 0.352* | −0.007 | 0.017 |
| | (0.174) | (0.134) | (0.246) | (0.210) | (0.116) | (0.084) |
| Other cert. | −0.772 | −0.763*** | −0.083 | 0.061 | −0.284 | −0.173 |
| | (0.490) | (0.277) | (0.720) | (0.544) | (0.228) | (0.120) |
| Log salary | −0.057 | −0.040 | −0.040 | −0.085 | −0.115 | −0.074 |
| | (0.157) | (0.121) | (0.205) | (0.172) | (0.093) | (0.063) |
| African American | −0.209 | −0.204* | −0.296 | −0.270 | −0.142* | −0.133** |
| | (0.161) | (0.104) | (0.235) | (0.177) | (0.085) | (0.056) |
| Asian | 0.055 | −0.071 | 0.461 | 0.276 | 0.306 | 0.111 |
| | (0.401) | (0.306) | (0.517) | (0.459) | (0.200) | (0.168) |
| Hispanic | 0.124 | 0.038 | 0.190 | −0.007 | −0.352*** | −0.139* |
| | (0.149) | (0.120) | (0.216) | (0.203) | (0.104) | (0.080) |
| Female | 0.103 | −0.020 | 0.336* | 0.311** | 0.094 | 0.056 |
| | (0.116) | (0.079) | (0.194) | (0.159) | (0.066) | (0.048) |
| Taught in private sect. | −0.278 | −0.020 | −0.124 | −0.263 | −0.170* | −0.021 |
| | (0.173) | (0.108) | (0.230) | (0.195) | (0.090) | (0.057) |
| Taught out of Florida | 0.213* | −0.044 | −0.134 | −0.081 | 0.348*** | 0.176*** |
| | (0.109) | (0.078) | (0.177) | (0.145) | (0.064) | (0.043) |
| African American students | 5.409*** | 1.953 | −3.694 | −2.271 | 0.069 | 0.787 |
| | (2.046) | (1.561) | (2.556) | (2.510) | (1.109) | (0.723) |
| Asian American students | 7.430** | 2.943 | −3.343 | −0.888 | −1.416 | 0.870 |
| | (3.505) | (2.563) | (4.416) | (3.984) | (1.696) | (1.180) |
| Hispanic students | 5.465** | 2.099 | −2.213 | −0.519 | −0.467 | 0.530 |
| | (2.196) | (1.641) | (2.731) | (2.594) | (1.195) | (0.774) |
| White students | 5.942*** | 2.076 | −3.993 | −2.638 | −0.943 | 0.052 |
| | (2.058) | (1.571) | (2.564) | (2.531) | (1.115) | (0.726) |
| Female students | 1.180 | 0.782 | −1.947 | −0.949 | −0.818 | −1.089** |
| | (1.353) | (0.955) | (1.826) | (1.619) | (0.729) | (0.469) |
| Special needs | 0.760 | 1.285 | −1.285 | −0.765 | 0.917** | 0.678** |
| | (1.171) | (0.793) | (1.612) | (1.217) | (0.456) | (0.315) |

**Table 4a.** Continued.

| | Transfer Within District | | Transfer Between Districts | | Exit Data System | |
|---|---|---|---|---|---|---|
| | ≤3 | All | ≤3 | All | ≤3 | All |
| **Variables** | **Years** | **Teachers** | **Years** | **Teachers** | **Years** | **Teachers** |
| Free/reduced price lunch | −0.063 | 0.288 | 0.306 | −0.312 | −0.174 | −0.104 |
| | (0.346) | (0.289) | (0.477) | (0.389) | (0.176) | (0.120) |
| English lang. learners | 0.037 | −0.138 | −1.409* | −1.322* | −0.025 | −0.181 |
| | (0.624) | (0.437) | (0.854) | (0.675) | (0.350) | (0.243) |
| Enrollment | 0.001 | 0.001*** | 0.000 | 0.000 | −0.001*** | −0.001*** |
| | (0.000) | (0.000) | (0.001) | (0.000) | (0.000) | (0.000) |
| School math avg. | −0.982*** | −0.885*** | −1.009** | −1.298*** | 0.110 | 0.187 |
| | (0.361) | (0.282) | (0.479) | (0.385) | (0.170) | (0.123) |
| School reading avg. | −0.278 | −0.289 | 0.544 | 0.370 | 0.083 | −0.291* |
| | (0.448) | (0.349) | (0.628) | (0.514) | (0.225) | (0.162) |
| Constant | −9.161*** | −5.758*** | −0.061 | −1.717 | 0.170 | −0.808 |
| | (2.293) | (1.727) | (2.794) | (2.684) | (1.239) | (0.807) |
| Teacher-year *N* | 15,385 | 43,153 | 15,385 | 43,153 | 15,385 | 43,153 |

*Notes:* Standard errors are clustered by school, and models include year fixed effects. Coefficients are multinomial logit estimates with the base category set at no move.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

were insignificant, and estimates of the indicators for the top quintiles of effectiveness showed that the linear relationship to exits persists. Our lack of evidence for nonlinear relationships notwithstanding, our general finding that the more effective the teacher, the less likely she is to leave the data system is quite similar to the Feng and Sass (2011) results on the whole, as well as to other work in New York City (Boyd et al. 2008) and North Carolina (Goldhaber, Gross, and Player 2011). The latter study, in fact, reports predicted exit probabilities by effectiveness quintile that are quite comparable to those we depict in figure 3.

## 7. DISCUSSION

Do charter schools retain teachers differently than those in the traditional public sector? The evidence provided here suggests the answer is, "yes, but. . . ." We observe no sector differences in within- or between-district teacher mobility—both types of transfers are generally uncommon in Florida schools. Charter school teachers are, however, considerably more likely to exit the data system. These results, coupled with the basic observation that charter teachers in our data are more likely to have taught either out of state or in private schools within Florida, suggest that charter school teachers in Florida are a more

**Table 4b.** Predicting Teacher Mobility (Reading Teachers)

| | Transfer Within District | | Transfer Between Districts | | Exit Data System | |
|---|---|---|---|---|---|---|
| | ≤3 | All | ≤3 | All | ≤3 | All |
| **Variables** | **Years** | **Teachers** | **Years** | **Teachers** | **Years** | **Teachers** |
| Teacher effectiveness | 0.035 | 0.046 | 0.010 | −0.013 | −0.162*** | −0.152*** |
| | (0.041) | (0.030) | (0.071) | (0.056) | (0.025) | (0.017) |
| In charter | −0.299 | 0.062 | 0.031 | 0.183 | 0.101 | 0.365*** |
| | (0.355) | (0.291) | (0.369) | (0.353) | (0.134) | (0.131) |
| Experience | −0.002 | −0.060*** | −0.166** | −0.179*** | −0.143*** | −0.112*** |
| | (0.037) | (0.011) | (0.074) | (0.023) | (0.021) | (0.006) |
| Experience$^2$ | −0.002 | 0.001** | 0.003 | 0.004*** | 0.004*** | 0.004*** |
| | (0.002) | (0.000) | (0.002) | (0.001) | (0.001) | (0.000) |
| Cert. in subj. | −0.028 | −0.210 | 0.392 | 0.317 | −0.375*** | −0.273*** |
| | (0.206) | (0.165) | (0.343) | (0.292) | (0.130) | (0.095) |
| Cert. out of subj. | −0.052 | −0.150 | 0.374 | 0.346 | −0.019 | 0.038 |
| | (0.168) | (0.131) | (0.247) | (0.213) | (0.115) | (0.084) |
| Other cert. | −0.390 | −0.514** | −0.273 | 0.120 | −0.470** | −0.177 |
| | (0.377) | (0.251) | (0.700) | (0.475) | (0.214) | (0.121) |
| Log salary | −0.052 | −0.054 | −0.091 | −0.138 | −0.088 | −0.050 |
| | (0.154) | (0.118) | (0.200) | (0.169) | (0.091) | (0.062) |
| African American | −0.236 | −0.209** | −0.321 | −0.262 | −0.110 | −0.104* |
| | (0.159) | (0.104) | (0.238) | (0.174) | (0.084) | (0.056) |
| Asian | 0.032 | −0.086 | 0.681 | 0.459 | 0.319 | 0.134 |
| | (0.400) | (0.307) | (0.458) | (0.415) | (0.203) | (0.167) |
| Hispanic | 0.060 | 0.016 | 0.315 | 0.060 | −0.319*** | −0.114 |
| | (0.151) | (0.120) | (0.209) | (0.201) | (0.103) | (0.079) |
| Female | 0.143 | 0.005 | 0.366* | 0.328** | 0.114* | 0.039 |
| | (0.115) | (0.079) | (0.197) | (0.161) | (0.066) | (0.048) |
| Taught in private sect. | −0.262 | −0.055 | −0.160 | −0.327* | −0.158* | −0.023 |
| | (0.169) | (0.110) | (0.231) | (0.197) | (0.087) | (0.057) |
| Taught out of Florida | 0.181* | −0.042 | −0.159 | −0.048 | 0.348*** | 0.182*** |
| | (0.108) | (0.078) | (0.176) | (0.142) | (0.063) | (0.043) |
| African American students | 5.605*** | 1.665 | −1.837 | −1.542 | 0.033 | 0.580 |
| | (1.992) | (1.522) | (2.663) | (2.643) | (1.108) | (0.748) |
| Asian American students | 6.848* | 1.850 | 0.221 | 0.590 | −1.071 | 1.044 |
| | (3.516) | (2.563) | (4.325) | (4.029) | (1.688) | (1.190) |
| Hispanic students | 5.582*** | 1.749 | −0.349 | 0.209 | −0.415 | 0.291 |
| | (2.139) | (1.607) | (2.845) | (2.708) | (1.204) | (0.800) |
| White students | 6.049*** | 1.771 | −2.014 | −1.862 | −0.831 | −0.030 |
| | (2.000) | (1.531) | (2.664) | (2.664) | (1.116) | (0.753) |
| Female students | 1.419 | 1.010 | −1.612 | −0.959 | −0.700 | −1.113** |
| | (1.260) | (0.943) | (1.804) | (1.604) | (0.728) | (0.477) |
| Special needs | 0.961 | 1.332* | −0.346 | −0.285 | 0.966** | 0.664** |
| | (1.128) | (0.780) | (1.467) | (1.154) | (0.463) | (0.320) |

**Table 4b.** Continued.

| | Transfer Within District | | Transfer Between Districts | | Exit Data System | |
|---|---|---|---|---|---|---|
| | ≤3 | All | ≤3 | All | ≤3 | All |
| **Variables** | **Years** | **Teachers** | **Years** | **Teachers** | **Years** | **Teachers** |
| Free/reduced price lunch | −0.007 | 0.294 | 0.444 | −0.093 | −0.279 | −0.201 |
| | (0.343) | (0.276) | (0.460) | (0.387) | (0.176) | (0.123) |
| English lang. learners | 0.191 | −0.038 | −1.636* | −1.420** | 0.041 | −0.058 |
| | (0.597) | (0.428) | (0.871) | (0.682) | (0.352) | (0.249) |
| Enrollment | 0.000 | 0.001*** | 0.000 | 0.000 | −0.001*** | −0.001*** |
| | (0.000) | (0.000) | (0.001) | (0.000) | (0.000) | (0.000) |
| School math avg. | −0.938*** | −0.727*** | −1.199*** | −1.512*** | −0.475*** | −0.391*** |
| | (0.337) | (0.272) | (0.464) | (0.377) | (0.164) | (0.119) |
| School reading avg. | −0.200 | −0.412 | 0.760 | 0.754 | 0.497** | 0.185 |
| | (0.437) | (0.355) | (0.648) | (0.530) | (0.230) | (0.168) |
| Constant | −9.505*** | −5.556*** | −2.144 | −2.384 | 0.033 | −0.641 |
| | (2.216) | (1.690) | (2.891) | (2.835) | (1.244) | (0.830) |
| Teacher-year *N* | 15,966 | 42,745 | 15,966 | 42,745 | 15,966 | 42,745 |

*Notes:* Standard errors are clustered by school, and models include year fixed effects. Coefficients are multinomial logit estimates with the base category set at no move.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

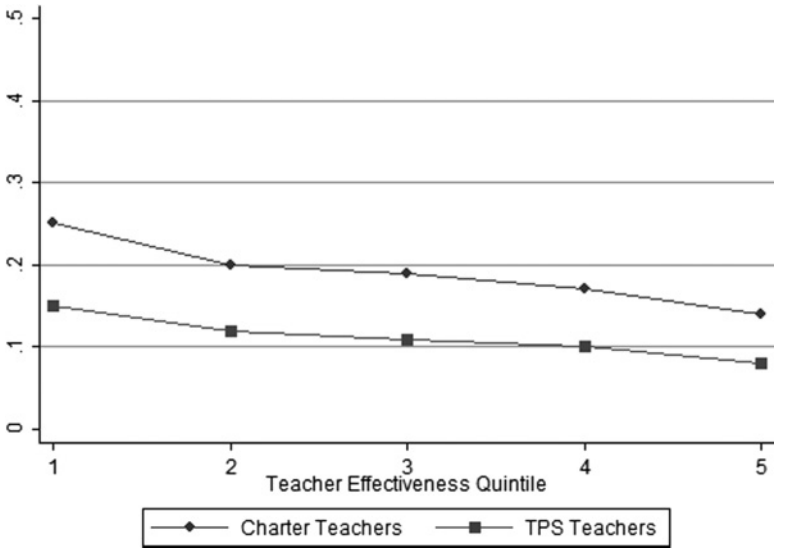


**Figure 3a.** Predicted Probability of Exit by Math Teacher Effectiveness Quintile (all teachers)
*Note:* Estimated based on predictions from table 4a

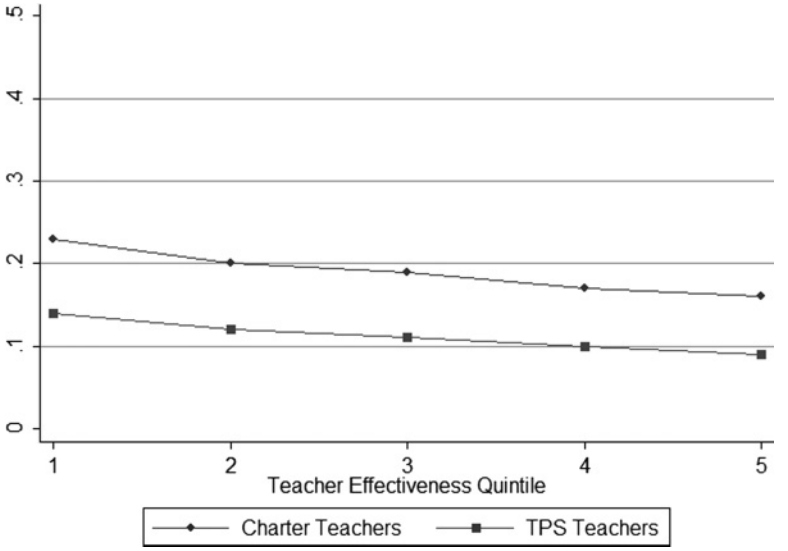


**Figure 3b.** Predicted Probability of Exit by Reading Teacher Effectiveness Quintile (all teachers)
*Note:* Estimated based on predictions from table 4a

**Table 5.** Estimated Effectiveness and Charter Interactions Predicting Teacher Exit (All Teachers)

| Variables | Math Teachers | Reading Teachers |
|---|---|---|
| Teacher effectiveness | −0.250* | −0.161* |
| | (0.019) | (0.017) |
| In charter school | 0.554* | 0.494* |
| | (0.138) | (0.145) |
| Charter * Teach effectiveness | 0.011 | 0.003 |
| | (0.112) | (0.114) |

*Notes:* Standard errors are clustered by district, and models include year fixed effects. Coefficients are linear probability estimates. Full model includes covariates per Table 4.
*$p < 0.01$.

transient population of educators than those serving the traditional public sector. The implication, then, is that entry behavior is at least as important a determinant of the composition of teachers in the charter sector as exit behavior: teacher exits appear to be a fact of life in charter schools.

This is underscored by our finding that teacher effectiveness does not appear differentially related to teacher exits in the charter sector. We have shown that, consistent with other studies (Boyd et al. 2008; Feng and Sass 2011; Goldhaber, Gross, and Player 2011), value-added measures of teacher quality indicate that the worst teachers are more likely to leave Florida public schools, and this is true whether those schools are chartered or part of the traditional sector. We find no evidence that teacher effectiveness matters more

or less in charter schools. To put the point another way, the higher rates of exits from the charter sector cannot be explained by disproportionate attrition among the worst teachers.

Moreover, among new teachers (fewer than four years of experience) the probability of exit is similar between the two sectors. Although such speculation is outside the scope of this article, that result would be consistent with the notion that the tenure process in the traditional public sector has some winnowing effect on the population of teachers in that sector and, in particular, on some of the least effective teachers (see Goldhaber and Hansen 2010 for a more advanced discussion of these possibilities). Our evidence would not support the conclusion that the tenure process in the traditional public sector makes such schools more effective at retaining high-quality teachers. It is consistent, however, with a story in which the tenure process in public schools accomplishes what tends to occur organically in the charter sector.

In that vein, our results provide evidence against the specific notion that one organizational advantage for many charter schools is the absence of a collective bargaining agreement—at least insofar as this absence pertains to the ability to fire poorly performing employees. If bargaining contracts were restricting traditional public schools from dismissing the worst teachers—or perhaps from rewarding the best teachers in some way—we should expect to see that in schools without such agreements, teacher effectiveness played a particularly important role in determining which teachers remain. This simply does not appear to be the case here.

At the same time, other scholarship has found little difference in the academic quality of charter schools compared with public schools in Florida (Sass 2006). This is consistent with our general finding here. If we were to have found that charter schools appeared better able to dismiss ineffective teachers, we would have to explain the overall parity in student performance noted by Sass by demonstrating—or at least assuming—that charter schools replaced poorly performing teachers with particularly effective counterparts. As we have described above, the vast majority of charter teachers in our sample begin (and end) their careers in that sector, so we have little evidence of prior effectiveness. On the other hand, work in North Carolina (Carruthers 2012) has shown that charter schools there do not draw more effective teachers away from the public sector. That empirical result would weaken any assumption we made here about the overall level of effectiveness of teachers entering the charter sector. In this light, our evidence fits with the most pertinent scholarship.

In earlier teacher mobility literature, movement was often considered a problem because teachers with generally desirable, observable credentials appeared to be those most likely to leave the profession. More recent work based

on value-added measures of teacher effectiveness suggests that for traditional public schools, the opposite dynamic seems to be occurring, at least to a point. Although some evidence (e.g., Goldhaber and Hansen 2009; Feng and Sass 2011) suggests that the very best teachers—either in terms of estimated effectiveness or rare credentials such as National Board certification—may still be more likely to leave than teachers of moderate skill, the preponderance suggests that teachers with the lowest value-added measures are most likely of all to leave. The evidence here largely confirms that general trend and extends it into the charter school sector.

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## APPENDIX

**Table A.1.** Teacher and School Characteristics, 2002–8 (Serving Grades 3–5)

| | Charter | TPS | Difference |
|---|---|---|---|
| *Teacher Characteristics* | | | |
| Experience (mean) | 3.50 | 8.70 | −5.20** |
| Certified in subject | 0.85 | 0.78 | 0.07** |
| Certified out of subject | 0.09 | 0.06 | 0.03** |
| Alternative cert. | <0.00 | 0.02 | −0.02** |
| Salary ($ per pay period) | 1498.55 | 1953.71 | −456.16** |
| Ever taught in private sector | 0.26 | 0.10 | 0.16** |
| Ever taught out of state | 0.16 | 0.21 | −0.05** |
| White | 0.74 | 0.75 | −0.01 |
| African American | 0.08 | 0.14 | −0.06** |
| Hispanic | 0.13 | 0.09 | 0.04** |
| Female | 0.84 | 0.87 | −0.03** |
| *School Characteristics (Means)* | | | |
| White | 0.49 | 0.47 | 0.02* |
| African American | 0.16 | 0.24 | −0.07** |
| Hispanic | 0.29 | 0.24 | 0.05** |
| Asian | 0.02 | 0.01 | −0.01** |
| Female | 0.50 | 0.49 | 0.01** |
| Special needs | 0.20 | 0.24 | −0.04** |
| Free/reduced price lunch | 0.44 | 0.57 | −0.13** |
| English language learners | 0.23 | 0.21 | 0.02** |
| Enrollment | 227.25 | 334.65 | −107.40** |
| Math (school mean) | −0.01 | 0.00 | −0.01 |
| Reading (school mean) | 0.04 | 0.00 | 0.04** |
| Teacher-year *N* | 1,185 | 67,838 | |

*Notes:* All teacher characteristics except experience and salary are proportions, and these significance tests are difference-of-proportions based on approximate normal distribution. Math and reading cells refer to school-level student averages of FCAT scores normalized by subject, grade, and year to a mean of 0 and standard deviation of 1.
Charters different from TPS at $^{*}p < 0.05$; $^{**}p < 0.01$.

**Table A.2.** Results of Student-Level Teacher Effectiveness Estimation

| Variables | Math | Reading |
|---|---|---|
| *Student Characteristics* | | |
| lagmath | 0.646*** | 0.223*** |
| | (0.001) | (0.001) |
| lagread | 0.170*** | 0.582*** |
| | (0.001) | (0.001) |
| BLACK | −0.093*** | −0.088*** |
| | (0.003) | (0.004) |
| ASIAN | 0.149*** | 0.024*** |
| | (0.005) | (0.005) |
| HISP | 0.001 | −0.026*** |
| | (0.004) | (0.004) |
| WHITE | 0.015*** | −0.001 |
| | (0.003) | (0.004) |
| FEMALE | −0.036*** | 0.083*** |
| | (0.001) | (0.001) |
| EXED | −0.089*** | −0.114*** |
| | (0.002) | (0.002) |
| ELL | 0.046*** | 0.013*** |
| | (0.002) | (0.002) |
| FRL | −0.056*** | −0.067*** |
| | (0.001) | (0.002) |
| newschool | −0.027*** | −0.009*** |
| | (0.002) | (0.002) |
| *Classroom Characteristics* | | |
| Teacher experience Q2 | 0.015*** | 0.012*** |
| | (0.003) | (0.003) |
| Teacher experience Q3 | 0.002 | 0.009** |
| | (0.005) | (0.004) |
| Teacher experience Q4 | −0.008 | 0.014*** |
| | (0.006) | (0.005) |
| Teacher experience Q5 | −0.038*** | 0.002 |
| | (0.009) | (0.007) |
| Teacher cert. in subject | 0.015*** | 0.012** |
| | (0.005) | (0.006) |
| Teacher cert. out subject | 0.009* | 0.005 |
| | (0.005) | (0.005) |
| Teacher alt. cert. | 0.004 | 0.019*** |
| | (0.006) | (0.006) |
| % black | −0.019* | −0.023* |
| | (0.011) | (0.012) |
| % Asian | 0.048*** | 0.011 |
| | (0.016) | (0.018) |
| % Hispanic | −0.006 | −0.012 |
| | (0.012) | (0.013) |

**Table A.2.** Continued.

| Variables | Math | Reading |
|---|---|---|
| % white | 0.005 | 0.001 |
| | (0.011) | (0.011) |
| % female | 0.001 | −0.006 |
| | (0.004) | (0.004) |
| % ExEd | −0.040*** | −0.050*** |
| | (0.004) | (0.005) |
| % English language learners | 0.010* | −0.008 |
| | (0.006) | (0.007) |
| % free/reduced price lunch | −0.009** | −0.012** |
| | (0.005) | (0.005) |
| % new school | 0.008 | −0.006 |
| | (0.005) | (0.006) |
| Class size | −0.002*** | −0.000*** |
| | (0.000) | (0.000) |
| *School Characteristics* | | |
| % black | −0.036 | −0.093 |
| | (0.058) | (0.063) |
| % Asian | 0.261*** | 0.295*** |
| | (0.094) | (0.103) |
| % Hispanic | −0.011 | −0.066 |
| | (0.061) | (0.067) |
| % white | −0.009 | −0.059 |
| | (0.058) | (0.063) |
| % female | 0.204*** | 0.193*** |
| | (0.027) | (0.029) |
| % ExEd | −0.175*** | −0.134*** |
| | (0.023) | (0.025) |
| % English language learners | 0.011 | 0.032 |
| | (0.022) | (0.023) |
| % free/reduced price lunch | 0.003 | −0.002 |
| | (0.010) | (0.010) |
| % new school | −0.106*** | −0.095*** |
| | (0.013) | (0.014) |
| Total enrollment | −0.000 | −0.000 |
| | (0.000) | (0.000) |
| Observations | 999,325 | 986,482 |
| $R^2$ | 0.686 | 0.637 |

*Notes:* Models estimated with teacher, grade, and year fixed effects; see text for description. These results correspond to the predictions used for "all teachers" regardless of experience level in the text. For space reasons we do not include the separate estimates used for new teachers only in Table 4, but these are comparable and available on request.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.