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The academic quality of public school teachers: an analysis of entry and exit behavior

Michael Podgursky*, Ryan Monroe, Donald Watson

Department of Economics, University of Missouri—Columbia, 118 Professional Building, Columbia, MO 65211 6040, USA

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Abstract

The authors investigate how the labor market decisions of recent college graduates, new teachers, and employers affect the academic quality of the teaching workforce in public schools. They use a rich longitudinal data set of Missouri college graduates and public school teachers to examine the behavior of college graduates concerning an initial decision to secure certification and teach in a public school, and subsequent decisions as to whether to continue. They find that college graduates with above-average ACT scores tend not to select into teaching, however, the effect is most pronounced for elementary school teachers. At any level of academic achievement, women are far more likely than men to teach, however, the relative aversion of high-ability women to teaching is at least as great as that of men. High-ability men and women who do enter public school teaching are more likely to leave than their less talented counterparts. Examination of non-teaching earnings for exiting teachers finds little evidence that high-ability teachers are leaving for higher pay. The results also highlight very different mobility patterns by teaching field. For both men and women, the attrition of math and science teachers with high ACT scores is greater than in other teaching fields. Finally, peer group effects may be a factor explaining female exit behavior. Controlling for own ACT, high-ability women who work with low-ability colleagues are more likely to exit.

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1. Introduction

Teacher quality is playing an increasingly important role in the analysis of the performance of public K-12 education. Recent studies have highlighted the contribution of teacher quality to earnings growth and academic achievement (Hanushek, Kain, & Rivkin, 1998; Tamura, 2001). Proposals to improve teacher quality figured prominently in the reauthorization of the federal Higher Education Act in 2001 and the No Child Left Behind Act in 2002, and many states are revamping their teacher training and licensing systems to this end.

The central focus of this study is how labor market decisions affect the academic quality of the teaching workforce in public schools. We explore this question using a rich longitudinal data set of recent Missouri public college graduates and new public school teachers. This is not the first study to use state administrative data to analyze teacher labor market dynamics, however, it does make several contributions to the literature on teacher labor markets. First, we are able to link the records of new public school teachers and recent cohorts of college graduates to a master file of ACT scores. Since nearly all college-bound seniors in Missouri take the ACT, this gives us an important external benchmark for the academic quality of college graduates and teachers not available in most other studies. Second, we link the records of exiting teachers and recent college graduates to Unemployment

* Corresponding author. Tel.: +1-573-882-4574; fax: +1-573-882-2697.

E-mail address: podgurskym@missouri.edu (M. Podgursky).

Insurance (UI) earnings files. This gives us an accurate measure of non-teaching earnings for those who exit (or do not choose) public school teaching. We are aware of only one other academic study that has linked teacher with UI earnings records in a state.¹

Finally, since we are using the full universe of available records, we have a very large sample that permits disaggregated analysis of academic quality interactions by gender, race, and teaching field. Labor market decisions involve opportunity costs and labor economics suggest that the opportunity cost of choosing teaching or remaining in teaching may vary along these dimensions. The full universe of records also allows us to explore school peer group effects on teacher turnover. However, throughout this study, the question of how these labor market choices affect the academic quality of the workforce is our primary focus.

2. Literature review: teacher quality, entry, and turnover

Researchers have analyzed samples of teachers and students from national longitudinal surveys such as High School and Beyond or the NLS surveys (e.g., Hanushek & Pace, 1995; Manski, 1987; Murnane, Singer, Willett, Kemple, & Olsen, 1991; Stinebrickner, 2001, 2002). These studies find that higher ability students are less likely to enter teaching and more likely to exit if they do enter teaching. However, the relatively small samples of teachers in national survey data sets generally prevent more disaggregated analysis of teacher mobility. State administrative data have been widely used in studies of teacher attrition, however, teacher quality data are usually lacking in these studies. Two exceptions should be noted. Murnane and Olsen (1990) examine the relationship between teacher licensing exam scores (National Teacher Exam, NTE) and teacher turnover in a large administrative panel data set of North Carolina public school teachers. They find that teachers with higher NTE scores were more likely to exit teaching. Unfortunately, licensing exam scores are available only for individuals who have chosen to become teachers, so it was not possible to analyze initial selection into teaching with such data.² More recently, Lankford, Loeb, and Wyckoff (2002) use New York state administrative records and several measures of teacher quality to analyze patterns of teacher sorting. They find substantial differences in the quality of teachers across schools in that state. These quality gaps derive both from initial sorting as well as differential attrition. They document large teacher quality gaps

between New York city and other metropolitan areas in the state.

3. Data

We developed panel data on students and teachers from several administrative data sets maintained by Missouri state education agencies. Data on graduates from public higher education institutions come from student-level longitudinal files maintained by the Missouri Department of Higher Education. Characteristics of K-12 schools and teachers come from the administrative files maintained by the Missouri Department of Elementary and Secondary Education. Specific district and school characteristics such as average district household income, student poverty, and percent minority students are from state administrative data. Finally, student and teacher records were linked to a master file of ACT scores maintained by ACT in Iowa City. ACT scores were only available for individuals taking the test in 1972 or later and are normed to current standards.

The primary measure of academic quality used in this study is teacher ACT scores. Many research studies have found a positive statistical relationship between general measures of teacher academic ability such as ACT scores and student achievement. Ferguson and Ladd (1996), for example, find a positive relationship between student achievement scores and teacher ACT scores in Alabama public schools. Ferguson (1991) finds a positive association between student test scores and the mean scores on a test of teachers' verbal skills in Texas. An earlier study by Hanushek (1971) finds a positive relationship between a measure of teachers' verbal ability and student achievement scores using student longitudinal data for a large California school district. Ehrenberg and Brewer (1993) find a similar relationship using a national data set. Frequently, teacher academic quality is proxied by the selectivity of the undergraduate college attended by the teacher. Several studies find a positive association between the selectivity of the college attended by teachers and measures of student achievement (Ehrenberg & Brewer, 1994; Summers & Wolfe, 1977; Winkler, 1975).³ We

³ The association between general measures of teacher academic ability and student achievement is routinely noted in surveys of the literature. A meta-analysis by Greenwald, Hedges, and Laine (1996) finds that the largest standardized effect of all the measured school and teacher characteristics on student achievement was the academic ability of the teachers. Hanushek's surveys of the same literature on school inputs and student achievement (Hanushek, 1981, 1986) led him to a similar conclusion; "The only relatively consistent finding is that 'smarter' teachers seem to do better in terms of student achievement." (Hanushek, 1981: p. 29; also see National Research Council, 2002: pp. 121–132).

¹ Scafidi, Sjoquist, and Stinebrickner (2002a,b), examine the non-teaching earnings of exiting teachers in Georgia.

² In addition, teacher licensing exams have changed over time (e.g., from NTE to Praxis II).

will also use college quality as a check on the robustness of our results.

4. Relative academic quality of new teachers

The first column in Table 1 reports the average ACT scores of new teachers entering Missouri public school classrooms each academic year from 1989–1990 to 1999–2000 along with related statistics. A “new teacher” is a teacher in her first year of public school teaching. In this period, Missouri reflected the national trend in the rapid growth of new teacher hires. New teachers in public school classrooms rose from 4.7% of the teaching workforce to 6.9% by the 1999–2000 school year, nearly doubling the number of new and inexperienced teacher hires. In spite of the increase in the volume of hiring, the ACT scores of the new teachers held steady. However, the steady teacher ACT scores masked an erosion in the standing of new teachers relative to their ACT-tested high school peers. The final columns in Table 1, labeled “Standard gap HS Seniors”, report the gap in standard deviations by gender between mean teacher ACT scores and the average scores of Missouri high school test-takers five years earlier (when most new teachers took the ACT). Thus, the 1996–1997 entry for females indicates that the ACT scores of the new teachers were 0.26 standard deviations above the mean for all female test-takers in 1991–1992. The standardized gap estimates suggest that the relative standing of teachers in the high school pool of test-takers is relatively similar for males and females, and for both groups there was an erosion in relative position of new teachers during the 1990s.

While new teachers are above the average of ACT-tested high school students, the picture differs if our benchmark is college graduates, since many ACT-tested high school students never attend college or fail to complete four-year degrees. Table 2 presents data on the distribution of test scores for two cohorts of recent graduates of public four-year institutions.⁴ Once again, the results for males and females are strikingly similar. For both males and females, the average ACT of teaching graduates is 0.23 standard deviations below that of non-teaching graduates. However, this gap is almost entirely due to the exceptionally low scores of elementary school teachers. Male and female elementary school teachers, respectively, are 0.53 and 0.35 standard

deviations below the average non-teaching graduate, whereas the differences for secondary teachers are much smaller (0.09 and 0.05 standard deviations).⁵

The simple patterns observed in Table 1 cannot tell us whether the differences in teacher quality between college graduates arise from supply (teachers) or demand (employers). Ballou (1996), for example, finds that graduates of more selective colleges were slightly less likely to receive teaching job offers. In order to shed some light on this question, we matched the records of these two cohorts of Missouri public higher education graduates against both the state teacher certification file and the district employment file. This permits us to decompose the teacher employment outcome (E) into two steps: whether a graduate obtains a Missouri teaching certificate (C), and takes a job in a Missouri public school classroom conditional on obtaining certification ($E|C$).

$$P(E = 1) = P(E = 1 | C = 1)P(C = 1) \quad (1)$$

Distinguishing these two steps permit at least partial identification of supply behavior. The initial certification decision is clearly a supply decision. Prospective teachers incur both time and direct monetary costs securing certification. The certification process involves completing a state-approved teacher training program, applying for Missouri teacher certification, and passing a licensing examination. Presumably only candidates interested in a Missouri teaching job would undertake such an investment.⁶ The second step of the process, $P(E|C)$, likely involves both supply and demand fac-

⁵ These findings mirror those in a national study of teacher candidates taking Praxis II, the teacher licensing exam (Gitomer, Latham, & Ziomek, 1999). The SAT scores of the elementary education candidates were below those of all fields except physical and special education. Both Hanushek and Pace (1995) and Manski (1987) find that high-ability college graduates are less likely to choose to teach. Neither of these studies stratified by teaching field.

⁶ Some of these graduates will ultimately become teachers in private schools, however, there is no state requirement that private school teachers must be certified, and many private schools routinely hire uncertified teachers (Ballou & Podgursky, 1997). Note that we have distinguished majoring in education from securing certification. Education majors are not automatically certified. They must make the additional investment in applying for certification (with the associated paperwork and criminal background check) and passing the licensing exam. Moreover, some non-education majors take sufficient pedagogical coursework to qualify for regular or provisional certification. This suggests that certification is a much better signal of a labor supply decision than is completion of an education major. Finally, this certification decision as we stated since the decision to invest in training for a particular type of license may be influenced by available job vacancies in the desired labor market.

⁴ The tabulations in Table 2 can only be made for Missouri public four-year graduates. However, Missouri public four-year higher education institutions account for the majority of new teachers. In 1999–2000, certification records indicate that 51% of new teachers earned baccalaureate degrees from Missouri public institutions, 22% from Missouri private institutions, 18% from out-of-state (9% could not be identified).

Table 1
Academic quality of new teachers in Missouri public schools^a

Year	Total public school teachers	Number of new public school teachers	Percent new teachers	Females				Males			
				Percent of new teachers	ACT tested (%)	Average ACT composite score	Standard gap HS seniors ^b	Percent of new teachers	ACT tested (%)	Average ACT composite score	Standard gap HS seniors ^b
1989–1990	51,786	2412	4.7	76.5	72.9	21.7	–	23.5	74.4	22.2	–
1990–1991	52,992	2477	4.7	77.0	78.7	21.9	–	23.0	76.3	22.5	–
1991–1992	53,755	2197	4.1	76.1	77.8	22.0	–	23.9	74.0	22.3	–
1992–1993	54,113	2302	4.3	77.1	81.6	22.0	–	22.9	75.9	22.7	–
1993–1994	56,042	3056	5.5	76.4	78.9	21.9	–	23.6	71.2	22.4	–
1994–1995	57,825	3265	5.6	76.0	82.0	21.8	0.26	24.0	75.6	22.4	0.26
1995–1996	59,083	3328	5.6	75.7	83.3	21.7	0.20	24.3	78.3	22.3	0.22
1996–1997	60,530	3674	6.1	75.6	80.3	21.9	0.26	24.4	76.8	22.2	0.22
1997–1998	61,889	3876	6.3	75.0	81.3	21.9	0.22	25.0	73.4	22.1	0.15
1998–1999	63,254	4069	6.4	76.2	80.8	21.8	0.17	23.8	77.4	22.1	0.17
1999–2000	64,973	4453	6.9	75.6	83.6	22.0	0.19	24.4	76.6	22.1	0.15

^a Teachers who took the ACT between 1972 and 2000. Scores for teachers who took ACT prior to 1972 were not available.

^b Difference in ACT scores between teachers in year t and Missouri high school seniors in year $t-5$ expressed in standard deviations of the male or female population of high school test-takers.

Table 2
Initial selection into teaching: distribution of ACT scores for 1997–1998 and 1998–1999 Missouri public four-year graduates who taught in public schools the year following graduation and those who did not

	Males			Non-teachers	Females			Non-teachers
	Teachers		Total		Teachers		Total	
	Elementary	Other			Elementary	Other		
19 or lower	33.6%	13.7%	20.0%	18.5%	23.2%	16.2%	20.5%	19.3%
20–21	16.8%	19.5%	18.7%	14.9%	25.2%	20.6%	23.5%	17.3%
22–24	26.9%	32.8%	30.9%	23.8%	32.0%	30.6%	31.5%	25.8%
25–26	11.8%	14.1%	13.3%	13.8%	10.8%	12.6%	11.5%	14.7%
27 or above	10.9%	19.9%	17.1%	28.9%	8.8%	19.9%	13.1%	22.9%
Average ACT	21.5	23.4	22.8	23.8	21.8	23.1	22.3	23.3
Standardized difference— teacher–non-teacher	–0.53	–0.09	–0.23	0	–0.35	–0.05	–0.23	0
Number	119	256	375	6909	909	562	1471	8545

tors. Teachers may apply for more desirable jobs and receive no offer but decline to apply for less attractive positions. Unfortunately, we do not know how many teaching applications certified candidates make and to which districts, nor do we know how many job offers they receive. Hence, it is not possible to separately identify supply and demand factors in the second stage.

The results of this exercise are reported in Table 3 below. The first row of the table reports the three components of Eq. (1) above. The lower probability of male teaching employment (0.048 versus 0.125) is entirely explained by the certification/supply decision. For both males and females, the conditional probability of public school teaching given certification is

0.61. More interesting for our analysis of teacher quality dynamics are the probit estimates in the next several rows. Our simple probit model estimates have only two covariates: composite ACT scores and a race indicator variable (white).⁷ The upper rows report the estimated effect on the latent variable and in the lower rows the marginal effect at the sample mean.

The probability of public school teaching employment is negatively related to ACT scores for both men

⁷ These are independent probit estimates. We also estimated this as a censored probit model (i.e., E is observed only when $C = 1$). For both men and women, we were unable to reject the hypothesis that the two choice decisions were independent.

Table 3

Probability that Missouri public four-year graduates becomes certified ($C = 1$) and teaches in a Missouri public school ($E = 1$): sample means and probit estimates

	Males			Females		
	$P(E = 1)$	$P(C = 1)$	$P(E = 1/C = 1)$	$P(E = 1)$	$P(C = 1)$	$P(E = 1/C = 1)$
Sample mean	0.048	0.079	0.611	0.125	0.205	0.609
Probit estimates						
ACT	-0.0269**	-0.0254**	-0.0140	-0.0372**	-0.0309**	-0.0340**
White	0.1435	0.1518*	-0.0210	0.3308**	0.4785**	-0.3193**
Marginal effects ^a						
ACT	-0.0027**	-0.0037**	-0.0052	-0.0083**	-0.0093**	-0.0127**
White	0.0133	0.0201*	0.0078	0.0644**	0.1229**	-0.1131**
N	7272	7272	570	9988	9988	2296

* Significant at 0.05.

** Significant at 0.01.

^a For ACT, estimated effect on probability of gain of one ACT point, for white indicator variable, difference between probability of white and non-white graduates. Male marginal effects are evaluated at the male sample mean, and similarly for females.

and women. The results in Table 3 suggest that whatever may have been true in years past, there is no longer any evidence of occupational segregation or “crowding” of females into teaching.⁸ If the latter were true, we would expect a flatter relationship between ACT scores and teaching employment for women, reflecting the fact that high-ability women have fewer non-teaching options (as compared to men). In the limit, with complete crowding into teaching, there would be no relationship between ACT scores and the probability of teaching employment since high-ability women would have nowhere else to go. In fact, the point estimate of the magnitude of the ACT coefficient is significantly larger for women than for men. Thus, while women at all ability levels are more likely to enter teaching, high-ability women are relatively more reluctant than high-ability men to enter teaching.

When we decompose the total employment effect into certification and employment stages, a very different pattern emerges for men and women. For men, the negative ACT effect on employment derives entirely from the initial certification decision. Conditional on certification, ACT has no effect on teaching employment. For women, however, higher ACT scores are associated with a lower likelihood of initial certification and a lower likelihood of employment given initial certification. As noted above, this is a reduced-form result that conflates supply and demand factors. However, it seems unlikely that high-ability women actually receive fewer attractive job offers than low-ability women. A more plausible explanation is that the high ACT

women are somewhat more selective in choosing which schools to submit their applications, or do not submit applications at all.

Some evidence on the latter point is found in an examination of data in Table 4 on the characteristics of schools and districts in which teachers were employed. Consistent with findings in Ballou (1996), there is no evidence of a pecuniary return to ability for new public school teachers. In fact, both male and female teachers with ACT scores of 27 or higher, on average, earn slightly less than teachers with ACT scores of 19 or lower. The next two columns of the table suggest that the market clears in a non-pecuniary dimension, with higher ability teachers sorting into schools with lower levels of student poverty rather than higher rates of pay. The sorting patterns for males and females with respect to ability are similar. The final two columns report quarterly earnings data for Missouri public higher education graduates who did not become public school teachers, but who took jobs covered by Unemployment Insurance in Missouri following graduation. Conditional on ACT scores, earnings for male teachers are somewhat below those of non-teachers while the reverse is true for females. Unlike teachers, average earnings for both men and women are positively associated with ACT scores for non-teaching public four-year graduates.⁹

⁸ A “crowding” model of discrimination labor market discrimination against women is described in Ehrenberg and Smith (2000: pp. 444–445).

⁹ The positive association between ACT and non-teacher earnings is likely downward biased due to substantially higher out-migration of high-ability graduates. The match rate for female non-teachers fell from 63% in the lowest ACT category to 45% in the highest for women, and from 60% in the lowest to 44% in the highest ACT category for men. It is reasonable to assume that these higher ability graduates left Missouri to pursue more remunerative employment elsewhere.

Table 4

Initial pay and non-pencuniary benefits of 1997–1998 and 1998–1999 Missouri public higher education graduates: public school teachers and non-teachers

ACT score	Teachers				Non-teachers ^a	
	Average teacher pay		Percent of students in school free and reduced lunch eligible		Missouri UI earnings	
	Male	Female	Male	Female	Male	Female
19 or lower	\$25,637	\$24,552	43.1	45.2	\$25,994	\$22,213
20–21	\$25,657	\$24,377	35.3	41.6	\$28,468	\$22,252
22–24	\$25,478	\$24,191	33.9	38.5	\$28,015	\$23,351
25–26	\$25,439	\$24,303	32.4	36.4	\$27,223	\$23,870
27 or above	\$24,930	\$24,346	31.2	32.9	\$29,637	\$24,554

^a Sum of four quarters of earnings one year following graduation. For 1997–1998 graduates 98:4–99:3 earnings, for 1998–1999 graduates 99:4–00:3 earnings. Tabulations from Missouri UI wage record files.

5. Academic quality and teacher exits

We use our data on Missouri public school teachers to estimate models of teacher attrition for new teachers. We pooled six cohorts of new public school teachers, 1990–1991 through the 1995–1996 school year, and tracked them forward in time in the Missouri public school system to the 1999–2000 school year. A teacher exits if she does not show up in a Missouri public school in the subsequent school year.

We model a new teacher's exit decision using a discrete Cox proportionate hazards model:

$$h(t|X, \text{ACT}) = k(t) \exp(\beta_1 X_t + \beta_2 \text{ACT})$$

where $k(t)$ is the discrete baseline hazard function, X_t is a vector of characteristics of the teacher and the teacher's school, some of which (e.g., salary, alternative earnings) may be time-varying, and ACT scores. We control for alternative wages by including mean county-level ES-202 earnings in each year. A complete list of the variables and descriptive statistics is provided in Appendix A.

We focus our analysis on the teacher quality and pay variables. Results from different specifications of the Cox proportionate hazards model are presented in Table 5. The simple bivariate relationship is presented in column (1). A one point increase in ACT scores is associated with an increase in the log exit hazard of 0.026 and 0.027, respectively, for males and females. (Thus, in the former case, a one point increase in the ACT score increases the exit hazard by a factor of $\exp(0.026) = 1.026$). The results in column (2) condition on teacher and school/district characteristics. We have seen in our previous discussion that ACT scores, in fact, play a role in initial teacher selection of schools and districts. Even given this potential endogeneity, the ACT score remains large and statistically significant in the exit hazard. The estimates for men and women are also similar.

Estimates in column (4) provide a robustness check of the effect of teacher academic ability on teacher attrition. Recall from Table 2 that roughly 15% of new teachers are not ACT-tested. Teachers with missing ACT scores are excluded from our estimation sample in column (2). In column (4), we use an alternative measure of teacher quality—the selectivity of the undergraduate institution attended by the teachers, a measure available for virtually the entire sample. Undergraduate college selectivity is a dummy variable indicating whether the teacher graduated from an institution in the two most selective classifications or the third most selective tier in Barron's Profiles of American Colleges. As with ACT scores, male and female graduates of highly selective institutions are more likely to exit. The coefficient for the most selective tiers indicates that a male (female) teacher with such a pedigree has an exit hazard 53% (46%) higher than a teacher graduating from a less selective college.¹⁰ The coefficients for the next selectivity tier (which in Missouri includes the University of Missouri—Columbia, the University of Missouri—Kansas city and Truman state University) indicate an exit hazard 24% higher for both males and females.

As is well known, teacher pay in the public sector is not market-based. Rather, pay is determined virtually entirely by salary schedules that base pay on years of seniority and graduate academic credits. When pay increases occur, it is common to inflate the entire salary

¹⁰ There are too few public school teachers in Missouri in the most selective Barron's category to break them out separately, thus we combined the top two Barron's categories. The only Missouri school in the most selective tier is Washington University, and in tier two, St. Louis University. Tier three schools would include University of Missouri—Columbia, University of Missouri—Kansas city, Truman State University, and several private colleges.

Table 5
Cox proportional exit hazard estimates: Initial teaching spell Missouri new public school teacher cohorts 1990–91 to 1995–96 tracked through 2000–2001

	All (1)	All (2)	All (3)	All (4)	Math and science (5)	Other second. (6)	White (7)	African American (8)
A. Males								
ACT composite	0.026** (0.007)	0.024** (0.008)	0.0007 (0.035)	–	0.040** (0.015)	0.019* (0.010)	0.021** (0.008)	0.136** (0.046)
Earnings/000	–	–0.023* (0.009)	–0.037 (0.032)	–0.023** (0.007)	–0.026 (0.020)	–0.024* (0.011)	–0.021* (0.009)	–0.031 (0.045)
Earnings/000×ACT	–	–	0.0007 (0.001)	–	–	–	–	–
College selectivity ^a	–	–	–	0.428* (0.188)	–	–	–	–
Tier 1,2	–	–	–	.219** (.064)	–	–	–	–
Tier 3	–	–	–	–	–	–	–	–
Other controls	N	Y	Y	Y	Y	Y	Y	Y
N observation	14,627	14,066	14,066	17,698	3245	8647	13,426	640
N subject	2874	2768	2768	3533	744	1823	2655	121
B. Females								
ACT composite	0.027** (0.004)	0.020** (0.005)	0.040* (0.021)	–	0.044** (0.012)	0.019* (0.008)	0.020** (0.004)	0.010 (0.021)
Earnings/000	–	–0.019** (0.006)	–0.0014 (0.018)	–0.017** (0.005)	–0.015 (0.019)	–0.031** (0.010)	–0.021** (0.006)	0.021 (0.023)
Earnings/000×ACT	–	–	–0.0008 (0.001)	–	–	–	–	–
College select. ^a	–	–	–	0.379** (0.114)	–	–	–	–
Tier 1,2	–	–	–	–	–	–	–	–
Tier 3	–	–	–	0.215** (0.035)	–	–	–	–
Other controls	N	Y	Y	Y	Y	Y	Y	Y
N observations	51,041	48,756	48,756	59,183	4773	14,310	46,219	2537
N subjects	9651	9305	9305	11,268	1135	3617	8866	479

Other covariates: average ES-202 earnings in county in which school district is located in year *t*, white (1 = yes), rural, building percent free and reduced lunch, building percent minority students, district average income (1999), for “all” samples; teaching field indicator variables: math, science special education, other field, elementary.

^a Selectivity of undergraduate institution attended by teacher. Selectivity categories from Barron’s Profiles of American Colleges. The only Missouri tier 1 institution is Washington University. The only tier 2 institution in Missouri is Saint Louis University. Tier 3 institutions in Missouri include the University of Missouri—Columbia, the University of Missouri—Kansas city, and Truman State University as the only public four-year institutions along with several private institutions.

* Significant at 0.05.

** Significant at 0.01.

schedule in a proportionate manner. In theory, it is possible that non-targeted, across-the-board pay increases could raise average teacher quality in the incumbent workforce if higher ability teachers are more responsive to pay increases. The evidence in column (3) in Table 5 suggests that this is not the case. For neither males nor females is an ACT interaction with pay significant.

The nature of teacher training and the character of the work differs greatly by field. The academic preparation and teaching practice of first grade teachers differs greatly from that of high school science teachers. Thus, there is no reason to expect that the effect of pecuniary and non-pecuniary conditions on teacher turnover would be identical for teachers in different teaching fields, nor would we expect an identical ACT effect. Fortunately, our large sample size permits us to stratify the sample by broad teaching field. Since the number of male elementary school teachers is relatively small, we report only secondary teachers. For both males and females, the coefficient on ACT is much larger for math and science teachers than other teaching fields indicating that sorting by ability is even more potent for this group. Interestingly, the effect of pay on turnover is largest for female elementary school teachers. The point estimate of the pay effect is twice as large as that for female math and science teachers. Once again, this points to possible inefficiencies arising from rigid pay schedules for teachers. Many public school districts report recruitment difficulties for science, math, and special education teachers. However, these results suggest that across-the-board increases in the salary schedule (i.e., for all teachers regardless of field) will disproportionately affect turnover of elementary teachers and not teachers in short-age fields.

The final two columns report results for white and African-American teachers (a small number of other minority teachers are excluded). For males, the point estimate of the effect of ACT scores for African-American teachers is over six times larger than for whites. Although this estimate must be treated with some caution given the large standard error, it does suggest very rapid exit rate of high-ability male African-American teachers from public school classrooms. For women, the relationship is reversed—ACT is associated with higher attrition only for white teachers. Recent papers by Hanushek, Kain, and Rivkin (2001) and Scafidi et al. (2002b) highlight the differences in job mobility of teachers between schools and districts with high and low minority enrollments. We also explored this issue by testing for interactions between ACT and building characteristics such as student poverty and percent minority students in our exit hazard model. Interactions were never statistically significant.

A traditional job search model suggests that high-ability men and women are leaving teaching in response to attractive non-teaching earnings opportunities (Murnane & Olsen, 1990). A recent study of female teachers in the NLS-72 (Stinebrickner, 2002) casts some doubt on the traditional search model. Stinebrickner finds that most teachers terminate initial teaching spells for family reasons, not for alternative employment. In order to explore this issue, we created a file of all new teachers who terminated initial teaching spells in a Missouri public school between 1990–1991 and 1999–2000. We then matched these records against the Missouri master Unemployment Insurance earnings files in the subsequent academic year.¹¹ We used a file of district salary schedules to compute the counterfactual earnings of the teachers had they remained employed in the same school districts. The results are reported in Table 6 below.

For males, non-teaching earnings are slightly lower than teaching earnings. In part this may be due to greater prevalence of part time employment in non-teaching earnings. (UI data do not permit us to distinguish between hours and earnings.) The ratio of non-teaching to teaching earnings tend to drop with ACT. For women, however, the non-teaching earnings are well below teaching earnings and tend to drop more sharply with ACT scores. By far the largest gap between teaching and non-teaching pay is observed for women with ACT scores of 27 and above. The Missouri reemployment rates for women tend to drop with ACT scores but the difference is not great. The latter finding casts doubt on a “tied mover” interpretation of our findings. If high-ability women exit Missouri teaching because they are married to well-educated and geographically mobile men, we would expect to see a sharp decline in female Missouri reemployment rates by ACT.¹² These

¹¹ We summed earnings in the fourth quarter and first quarter immediately following the year of exit and then annualized by multiplying by two, e.g., for teachers who quit teaching in the 1999–2000 school year this would be the sum of earnings in 2000:4 and 2001:1 multiplied by two.

¹² An alternative version of the differential matching thesis might be the following: high-ability women are married to high-ability males with above-average earnings. The higher mean income of the husbands permits the high-ability females to take longer leaves from the workforce after childbirth, thus explaining their higher exit rates. If such is the case, we would expect to see a partial recovery of ACT scores with age as these high-ability females return to the teaching workforce as their children age. In fact, cross-section data show that for women the ACT score drops consistently with age and the rate of decline is virtually identical to that of men.

Table 6

Teaching and non-teaching earnings of teachers who quit teaching between 1992 and 2000 who were reemployed in a UI-covered Missouri job

ACT score	Total number of teachers	Estimated teaching earnings ^a	UI earnings after leaving teaching ^b	Ratio non-teaching to teaching earnings	Percent of exiting teachers found in UI data with usable salary schedule data	Percent of exiting teachers with UI earnings greater than simulated teaching earnings
<i>Males</i>						
19 and below	222	\$25,716	\$25,550	0.99	64	43
20–21	299	\$25,287	\$26,759	0.99	70	37
22–24	316	\$25,001	\$24,702	0.99	64	45
25–26	164	\$24,742	\$24,087	0.97	67	44
27 and above	209	\$25,138	\$23,471	0.93	63	44
All	1210	\$25,192	\$25,109	1.00	66	43
<i>Females</i>						
19 and below	845	\$24,811	\$19,512	0.78	57	27
20–21	1055	\$24,466	\$17,703	0.72	58	22
22–24	1071	\$24,923	\$18,505	0.74	55	27
25–26	460	\$24,498	\$18,145	0.74	57	28
27 and above	532	\$25,241	\$15,750	0.62	53	17
All	3963	\$24,773	\$18,109	0.73	56	25

^a Earnings of the teacher based on former salary and estimated returns to experience from the salary schedule of the district in which they were employed.

^b Sum of earnings in the fourth quarter and first quarter immediately following the year of exit then annualized by multiplying by two, e.g., for teachers who quit teaching in the 1999–2000 school year this would be the sum of earnings in 2000:4 and 2001:1 multiplied by two.

results do not suggest that high-ability women are leaving teaching for higher pay.¹³

Why, then, are they leaving? A substantial economics literature has focused on the issue of job match quality as a factor in employee turnover (Parsons, 1986). We explore this issue for teachers by respecifying our model to include not only the teacher's own ACT score but also the gap between her score and those of

her fellow teachers in the school ($ACT_i - \text{mean school ACT} - \text{teacher } i$). We entered this as a spline with the kink at zero. Thus, we are allowing a different effect of the ACT gap for teachers above their school peers versus teachers below their school peers. If the job match hypothesis is correct, teachers who are significantly above or below their peers' ACT should have higher turnover rates than teachers who are at or near their peers' mean, independent of the level of their own ACT. The results are reported in Table 7. For males, when the full set of controls is included (column 2), there is no significant effect of either individual ACT or the ACT gap on exit behavior. Also, the coefficient on the gap variable is positive for teachers above and below the building mean. For females, however, we find evidence of a kink. Teachers who are significantly above or below the average ACT of their building peers are more likely to exit, although the estimate for below average teachers is not consistently significant. More consistent is the finding that teachers with ACT scores above their building peers are more likely to exit.

6. Conclusion

High-ability college graduates are less likely to teach in public schools and, if they do, are more likely to

¹³ A recent paper by Scafidi et al. (2002a) analyzes teacher reemployment using a linked teacher administrative-UI file for Georgia teachers similar to the one used in this paper. They note that many new teachers who leave teaching do not, in fact, leave K-12 education. In a similar universe of new teachers, they find that roughly 35–40% of young exiting teachers are reemployed in the public education sector, which we interpret to mean SIC 8211 (Elementary and Secondary Education) and a government employer. We find a roughly similar pattern in our data. However, only roughly one-half or 20% are reemployed as regular certified professionals in public schools (e.g., assistant principals, principals, counselors, media specialists). The rest have ES-202 records from public SIC 8211 employers but only receive small payments from one or more public school districts, most likely for substitute teaching, but possibly from other temporary or part-time school district employment such as coaching. However, for our purposes, all teachers identified as exiters are no longer a teacher of record and have left full time teaching in a public school classroom.

Table 7

Quality of job match: effect of ACT gap between a teacher and her colleagues on teacher exit hazards. Cox proportional exit hazard estimates: initial teaching spell. Missouri new public school teacher cohorts 1990–1991 to 1995–1996 tracked through 2000–2001

	Males			Females		
	(1)	(2)	(3)	(1)	(2)	(3)
Individual ACT composite	–0.007 (0.017)	0.0003 (0.021)	–	0.037** (0.009)	0.010 (0.012)	–
Teacher—building ACT gap ^a						
>0	0.039* (0.019)	0.025 (0.022)	0.025* (0.010)	0.011 (0.011)	0.030* (0.013)	0.039** (0.007)
≤0	0.029 (0.021)	0.023 (0.023)	0.024 (0.017)	–0.047** (0.011)	–0.023 (0.013)	–0.015 (0.009)
Other controls	N	Y	Y	N	Y	Y
N observations	14,581	14,040	14,040	50,714	48,673	48,673
N subject	2869	2765	2765	9631	9303	9303

Other covariates: average ES-202 earnings in county in which school district is located in year t , white (1 = yes), rural, building percent free and reduced lunch, building percent minority students, district average income (1999), for “all” samples, teaching field indicator variables: math, science special education, other field, elementary.

^a i th teacher ACT gap = i th teacher ACT – school building average teacher ACT (other than teacher i).

* Significant at 0.05.

** Significant at 0.01.

leave after a few years. These patterns are similar for men and women, however, the reasons for exit may be different. The exit patterns for males are somewhat more consistent with a traditional job search model. Males who leave teaching are much more likely than women to be reemployed and their non-teaching earnings one year later approximately match those in teaching. Females, on the other hand, are much less likely than men to be reemployed in a non-teaching job and their non-teaching earnings are well below those as teachers. However, for neither men nor women do we find evidence that high-ability teachers are exiting for higher non-teaching earnings. We find evidence that job match quality may be a factor in female quits. A woman whose ACT score is above those of her school peers is more likely to quit, regardless of the absolute level of her own ACT score.

Finally, these results highlight very different mobility patterns by teaching fields. It is well-known that math and science teachers have higher attrition rates than other fields. However, for both men and women, the attrition of high ACT ability math and science teachers is higher than in other teaching fields. Among women, math and science teachers are less

sensitive to pay differences than are elementary school teachers. This means that larger pay increases would be necessary to reduce the attrition of high-ability math and science teachers as compared to elementary school teachers.

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Appendix A. Longitudinal new teacher file: descriptive statistics

	Males		Females	
	Mean	Standard deviation	Mean	Standard deviation
ACT composite score	22.34	3.77	21.76	3.47
Teacher's salary (\$000)	26.28	5.82	24.70	5.33
Age	30.80	5.81	31.27	6.83
Building percent minority students	13.27	23.21	14.43	24.44

Building percent of students eligible for free and reduced lunch	32.82	20.64	39.22	22.42
Building pupil/teacher ratio	15.66	2.99	15.53	2.95
Teacher's race is white	0.9545	0.2084	0.9480	0.2221
Teaching in a rural school district	0.5377	0.4986	0.5060	0.5000
Math teacher	0.0985	0.2980	0.0536	0.2253
Science teacher	0.1322	0.3388	0.0443	0.2057
Special education teacher	0.0489	0.2157	0.1601	0.3667
Teaching in other field	0.6147	0.4867	0.2935	0.4554
Household income per tax return in district (\$000)	36.99	15.27	36.92	13.34
New teacher in 1992	0.1474	0.3545	0.1467	0.3538
New teacher in 1993	0.1447	0.3519	0.1528	0.3598
New teacher in 1994	0.1751	0.3801	0.1770	0.3817
New teacher in 1995	0.1809	0.3850	0.1800	0.3842
New teacher in 1996	0.1651	0.3713	0.1591	0.3658
Opportunity wage—average earnings in county (\$000)	22.72	5.99	23.00	5.84

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