Licensure and Worker Quality: A Comparison of Alternative Routes to Teaching

Tim R. Sass *Georgia State University*

Abstract

In this paper I use a rich longitudinal database from Florida to compare the characteristics of alternatively certified teachers with their traditionally prepared colleagues. I analyze the relative effectiveness of teachers who enter the profession through different pathways by estimating value-added models of student achievement. In general, alternatively certified teachers have stronger preservice qualifications than graduates of traditional university-based teacher preparation programs do, with the least restrictive alternative route attracting the most qualified prospective teachers. Teachers who enter through the path requiring no coursework have a substantially larger effect on student achievement. In contrast, the alternative pathway that requires substantial occupation-specific human capital investment yields teachers who are less effective than either traditional-route teachers or teachers who entered the profession through other alternative pathways. These results suggest that any benefits from preservice training are overwhelmed by the adverse selection into programs that require nontransferable human capital investments.

1. Introduction

Workers in licensed occupations make up a large and growing proportion of the US workforce, with nearly three out of 10 US workers being required to hold a license in order to do their job (Kleiner and Krueger 2010). There are two opposing views on the prevalence of licensure. In the public interest approach, licens-

Previous versions were circulated under the title "Certification Requirements and Teacher Quality: A Comparison of Alternative Routes to Teaching." This research was supported by the National Center for the Analysis of Longitudinal Data in Education Research, funded through grant no. R305C120008 to the American Institutes for Research from the Institute of Education Sciences, US Department of Education. I wish to thank the staff of the Florida Department of Education's Education Data Warehouse and the Office of Teacher Certification for their help in obtaining and interpreting the data used in this study. Thanks also go to Micah Sanders for able research assistance and to Jeanne Burns, Stuart Elliot, Cory Koedel, George Noell, Steve Rivkin, Jake Vigdor, Jim Wyckoff, and seminar participants at the University of Missouri for valuable conversations and suggestions. Any opinions or errors are solely attributable to me.

[*Journal of Law and Economics,* vol. 58 (February 2015)]

ing is viewed as a mechanism for ensuring quality when consumers are poorly informed. By setting minimum quality standards, licensure indirectly provides consumers with information and avoids the classic lemons problem whereby consumers' inability to distinguish quality differences leads to only low-quality practitioners in the market (Akerlof 1970; Leland 1979). The public interest approach implies that professional licensure is most likely to be present where the cost to consumers of obtaining information is high and the loss from consuming low-quality services is great. Consumers who highly value improvements in service quality will benefit from licensure, while consumers who prefer lower quality (at a lower price) could be made worse off (Shapiro 1986). In contrast, the capture theory of regulation posits that professionals will seek out licensure as a means of restricting entry into a profession, thereby raising wages (Stigler 1971; Peltzman 1976). Under this scenario, consumers face higher service prices and reductions in quantity with no concomitant increase in service quality, which leaves consumers unambiguously worse off.

Empirical analysis of the effects of licensure has been hampered by two factors. First, most studies rely on cross-state comparisons in order to generate identifying variation in licensure restrictiveness. This is problematic because it is difficult to account for other state-level factors that may be correlated with both the extent of regulation and outcomes of interest like wages or employment. Second, it is often difficult to measure the quality of output, which has led to a paucity of studies that directly gauge the impact of licensure on the quality of services provided.

In order to overcome the dual hurdles of within-state variation in licensure regulations and measurement of service quality, I analyze the multiple pathways by which a person can be licensed to teach in the state of Florida.[1] Florida has one of the most diverse set of routes to licensure for teachers, with wide variation in human capital attainment requirements. It is also one of the few places in which data exist to link individual teachers to their own preservice educational records as well as to the performance of students they subsequently teach, thereby creating multiple ways in which provider quality can be measured.

Besides the data advantages inherent in studying the pathways to licensure for teachers, there are many policy-relevant rationales for analyzing their licensure. First, teaching is the licensed occupation with the largest number of workers (Kleiner 2000). Second, there is intense interest in improving educational outcomes for students, and research has demonstrated that the most important school-based determinant of student achievement is teacher quality (Rivkin, Ha-

[1] In the economic literature, "licensure" refers to regulations that prohibit workers who do not meet specific criteria, such as passing an exam and/or completing an approved course of study, from legally working. In contrast, "certification" refers to the situation in which workers who meet certain criteria are given a designation of being certified but noncertified individuals are also allowed to offer their services in the market. The least restrictive form of occupational regulation is registration, whereby individuals file information about their qualifications but there are no specific requirements for professional standing or limitations on who may practice. In education, the term "certification" refers to state statutes that set out requirements that must be met for an individual to teach on a permanent basis and is thus equivalent to the economic concept of licensure. For consistency, I use the term "licensure" throughout.

nushek, and Kain 2005; Aaronson, Barrow, and Sander 2007; Kane, Rockoff, and Staiger 2008). Third, there is little evidence that training or incentives received after becoming a teacher lead to improvements in teachers' performance (Garet et al. 2008, 2010; Harris and Sass 2011; Jacob and Lefgren 2004; Springer et al. 2010, 2012; Glazerman and Seifullah 2012), which suggests that altering the quality of new teachers is a crucial policy lever. Finally, the number of teachers entering the profession through means other than the traditional route of completing a university-based program in teacher education has been rapidly expanding. In 1985–86 fewer than 300 teachers in the United States obtained licensure through routes other than a traditional teacher preparation program. Two decades later, in 2005–6, the number of teachers who became licensed through alternate routes mushroomed to 59,000.[2] This rapid rise in alternative routes to licensure begs the question of how these alternative-route teachers perform relative to their traditionally prepared colleagues.

I begin by briefly reviewing the empirical literature on licensure and worker quality, including a discussion of research on alternative routes to teaching. I then outline a theoretical framework that is used to motivate the empirical work. Next I describe the teacher licensure environment in Florida and the available data. The analysis of the data proceeds in two steps. First, I provide descriptive statistics on the preservice education, demographics, and test performance of teachers by the route they take to licensure. In the second part of the analysis I estimate cumulative achievement functions in order to determine the relative productivity or value added of teachers who obtain certification by completing a traditional teacher preparation program vis-à-vis various alternative routes.

2. Existing Evidence of the Effects of Licensure on Quality

2.1. Occupations Other than Teaching

While there is a large empirical literature on the effects of licensure, most of the extant research investigates wage and employment effects.[3] There is relatively little evidence of the impact of licensing restrictions on the quality of licensed professionals and the services they provide. Of the few extant studies, most utilize relatively crude proxies for quality, such as numbers of consumer complaints or numbers of accidents, or rely on indirect connections between the quality of services received and the licensed professionals who provided the services. Maurizi (1980) investigates the licensing of contractors in California and finds that increases in the number of consumer complaints are correlated with the rise of exam preparation schools, which allegedly weakened the licensure system by increasing the ability of incompetent or poorly trained contractors to pass the licensure exam. Carroll and Gaston (1981), employing a cross section of data on the 50 states, find that licensing restrictions are associated with fewer journeyman

[2] See Teach-Now, Overview of Alternate Routes to Certification (http://www.teach-now.com/overview).

[3] For reviews of the empirical literature on occupational licensing, see Gaumer (1984), Kleiner (2000), Stephenson and Wendt (2009), Ramseyer and Rasmusen (2012), and Larsen (2013).

electricians and that the corresponding reduction in the density of electricians is associated with a greater number of accidental deaths by electrical shock. Similarly, when comparing dental licensing across states, they find that imposing citizenship requirements for the licensure of dentists is associated with a reduction in the number of dentists per capita, which in turn is correlated with longer wait times for appointments. Johnson and Loucks (1986), also using cross-sectional state-level data, find that reductions in the number of real estate agents per capita are associated with a decrease in the number of complaints per transaction. However, neither pass rates on the licensure exam nor continuing-education requirements are correlated with the frequency of consumer complaints.

In contrast to earlier work, two more recent studies employ microlevel data to explore the relationship between licensure restrictions and service quality. Kleiner and Kudrle (2000) analyze the results of dental exams that were given to nearly 500 Air Force recruits. Using survey information, they link recruits to dental licensure requirements in the recruits' prior state of residence. Controlling for a number of intervening factors, like parents' education and income, prior dental insurance coverage, and access to fluoridated water, they find no association between recruits' present state of dental health and the dental licensing environment where the recruits grew up. Currie and Hotz (2004) employ individual-level data from the National Longitudinal Survey of Youth and National Vital Statistics mortality records to investigate the impact of day care center licensure requirements on the incidence of accidental injuries. To avoid possible bias from endogenous regulations, they employ state fixed effects or child-specific fixed effects. They find that increases in the minimum education requirement for day care center directors (which tends to be correlated with educational requirements for teachers and aides) significantly reduce the risk of unintentional injuries. More restrictive regulation also tends to reduce the use of day care centers and preschools and increase the use of informal child care providers, presumably by raising the cost of formal providers. Given that informal care tends to be less safe, this indirect effect could partly offset any safety gains from more stringent regulation.

2.2. Licensure Requirements and Teacher Quality

A trio of studies investigates the effects of educational and testing requirements on the quality of teachers. In the earliest work, Berger and Toma (1994) analyze the relationship between educational requirements for teachers and scores on the Scholastic Achievement Test (SAT) with a panel of state-level data. Holding constant a variety of state-level policy and demographic variables, they find that requiring teachers to hold a master's degree is associated with a significant reduction in SAT scores. Angrist and Guryan (2008) use school-district-level data from the Schools and Staffing Survey (SASS) to compare testing requirements with the qualifications of teachers. They find no evidence that the incidence of state testing requirements for teachers is associated with the selectivity of the institutions from which early-career teachers graduated (based on average SAT

scores of entering freshman and research university designation). Most recently, Larsen (2013) combines the approaches of Berger and Toma and Angrist and Guryan and measures the impact of testing requirements on both student test scores and teacher qualifications. Like Angrist and Guryan, he uses data from SASS and measures teacher input quality by the average SAT scores of entering students at the undergraduate institution that a teacher attended. Output quality is measured by individual-level eighth-grade scores on the National Assessment of Educational Progress (NAEP). For his sample of 259 first-year teachers, subject area, basic skill, and professional knowledge test requirements did not have an impact on input quality. However, requiring a test of subject area knowledge for licensure is associated with a significant increase in the average input quality of all teachers (2,277 teachers in total). Requiring first-year teachers to take a subject area test is associated with a decrease in the upper tail of input quality, which suggests that the exam requirement may dissuade the most talented individuals from entering teaching. However, these distributional effects do not carry over when analyzing the effects on students' NAEP scores.

2.3. Traditional versus Alternative Routes to Teaching

While prior research on various aspects of teacher preparation dates back to the 1960s (Wilson, Floden, and Ferrini-Mundy 2001), only recently has there been rigorous quantitative research that compares the effectiveness of teachers who complete traditional teacher preparation programs with that of those who enter teaching through alternative routes. Two recent quasi-experimental studies, Boyd et al. (2006) and Kane, Rockoff, and Staiger (2008), examine elementary and middle school teachers in New York City. In New York City, alternative routes involve the same requirements as the traditional teacher preparation program pathway, but entrants are allowed to begin teaching after 200 hours of preservice training and passage of the requisite teacher exams. The alternative-route teachers must then enroll in teacher education programs and complete the coursework required for certification while they are teaching.

Boyd et al. focus their analysis on the two primary alternative pathways in New York City, the NYC Teaching Fellows (Fellows) program and the Teach for America (TFA) program. These programs target different types of potential teachers. The TFA program recruits graduates of elite colleges and universities to teach in high-poverty schools. In contrast, the Fellows program is designed to attract both midcareer professionals and recent college graduates into teaching.

When using student covariates to control for student heterogeneity, Boyd et al. find that Fellows are less effective than traditionally prepared teachers in teaching both math and English language arts (ELA). When student fixed effects are added to the model, however, the difference in math teaching effectiveness is no longer statistically significant and the ELA teaching effectiveness differential is cut in half, which suggests that Fellows are more likely to teach in classes with lower-achieving students. Boyd et al. also find that Fellows tend to improve over time relative to their traditionally prepared colleagues. In the elementary grades,

Fellows are initially less effective, but by their third year they are equally as effective as traditional-route teachers. At the middle school level, Fellows in their third year of teaching are actually more effective in teaching both math and ELA.

Teach for America teachers tend to be stronger than Fellows in teaching math, although they follow similar patterns with respect to experience and grade level of instruction. Combining grades 4–8 and using student covariates to control for student heterogeneity, Boyd et al. find that TFA teachers are just as effective as traditionally prepared teachers in math but less effective than graduates of teacher preparation programs in ELA instruction. These results are unchanged when student fixed effects are used to control for observed and unobserved student characteristics. The effectiveness differential in ELA is driven primarily by results for rookie teachers; after the first year, TFA teachers and traditionally prepared teachers are equally effective in teaching ELA. There are also interesting cross-grade differences as well. Teach for America middle school math teachers appear to be more effective in their first year than traditionally prepared middle school math teachers. In contrast, the lower level of effectiveness of first-year TFA teachers, relative to traditionally prepared teachers, is observed at both the elementary and middle school levels.

Kane, Rockoff, and Staiger (2008) perform a similar analysis but possess an additional year of data and can thus produce more precise estimates of the effectiveness of alternatively certified teachers, particularly those with more than 2 years of experience. They find no difference between the effectiveness of Fellows and traditionally prepared teachers in math. Fellows are slightly less effective in ELA instruction initially but close the gap by their third year of teaching. Teach for America teachers are more effective than traditionally prepared teachers in math but no different in ELA instruction.

The TFA program is distinctive in that it targets new college graduates, participants commit to teaching for 2 years, and they are typically assigned to schools with a high proportion of students living in poverty. All of these factors would tend to lead to high attrition rates, as many TFA teachers may view participation as a short-term public service rather than as initiation of a long-term career. Both Boyd et al. (2006) and Kane, Rockoff, and Staiger (2008) find evidence to support these expectations. Boyd et al. find that after their requisite 2 years of service, attrition among TFA teachers is more than double that of traditionally prepared teachers. Even when adjusting for school quality, the 4-year cumulative attrition rate among TFA teachers is nearly twice that of traditionally prepared teachers. Kane, Rockoff, and Staiger estimate that the differential attrition leads to a steady state in which 45 percent of TFA teachers are in their first or second year, whereas only 20 percent of traditionally prepared teachers are rookies or second-year teachers. Since teacher effectiveness increases with early-career experience, the high attrition rate tends to mitigate any gains from employing TFA teachers. Kane, Rockoff, and Staiger estimate that the greater effectiveness of TFA teachers in mathematics (relative to traditionally prepared teachers) is essentially offset in the steady state by their higher attrition rate.

In another recent quasi-experimental study, Xu, Hannaway, and Taylor (2011) examine the performance of TFA teachers at the high school level in North Carolina. Using school effects and cross-subject student fixed effects to control for nonrandom assignment of teachers to schools and to classrooms in a school, they find that TFA teachers generally outperform their traditionally prepared colleagues. If one takes into account the fact that TFA teachers generally possess less experience than traditionally prepared teachers, TFA teachers boost student achievement by 13 percent of a standard deviation, averaged over all subjects. For math, the difference in student learning is also 13 percent of a standard deviation, and for science it is 19 percent of a standard deviation, which suggests a smaller effect for subjects like English. When experience is not controlled for, the differential in math is reduced by more than half and is statistically insignificant, but in science the differential falls only slightly, to 16 percent of a standard deviation, and is significantly different from 0.

Two teams of researchers from Mathematica have conducted experimental evaluations of alternative certification programs. Glazerman, Mayer, and Decker (2006) compare TFA teachers with traditionally prepared teachers teaching in the same grade and school where students were randomly assigned to classrooms. The evaluation was conducted in 17 schools in six geographic areas. Their results are strikingly similar to those of Xu, Hannaway, and Taylor (2011). Glazerman, Mayer, and Decker find that TFA teachers outperform traditionally prepared teachers in math by 15 percent of a standard deviation, but the difference in reading achievement is not significantly different from 0. As in Xu, Hannaway, and Taylor, the differential in teacher effectiveness is larger when TFA teachers are compared with traditionally prepared teachers with similar experience.

Like Glazerman, Mayer, and Decker (2006), Constantine et al. (2009) compare outcomes for pairs of teachers in the same grade and school in which classroom assignment was random. However, rather than analyze TFA teachers, Constantine et al. study less-selective alternative certification programs with data from 63 schools in 20 school districts. Alternative certification programs were divided into two categories, those requiring relatively less coursework (75–274 hours) and those requiring more coursework (275–795 hours). Thus, both groups received considerable formal training in education. In contrast to the selective TFA program, the alternatively certified teachers studied by Constantine et al. were no different than traditionally prepared teachers in terms of the selectivity of the college they attended or their scores on college entrance exams. The study found no significant differences in effectiveness between alternative and traditionally prepared teachers or between alternatively certified teachers with high and low levels of required coursework. Similarly, the content of preservice coursework or receipt of a bachelor's degree in education was uncorrelated with teachers' effectiveness. While the results certainly cast doubt on the notion that traditional teacher programs boost the productivity of classroom teachers, the implications must be tempered by the fact that the alternatively certified teachers in fact had substantial coursework in education prior to becoming teachers.

3. Theoretical Framework

As in many other professions, there are two components to the licensure of teachers in most states. First, there is a minimum educational requirement. Traditionally, teachers have had to complete a teacher preparation program at a college or university and receive a bachelor's degree in a specific field of education. Most alternative routes still require attainment of a bachelor's degree but do not require a particular major. Second, most states also require passage of one or more examinations for a teacher to become fully certified. The exam requirements typically apply to both traditionally prepared and alternatively certified teachers.

The effect on teacher quality of loosening educational requirements depends on which theory of regulation holds sway. If teacher licensure serves to promote quality by requiring coursework that makes teachers more effective, then alternatively certified teachers, who are not required to take as many education courses as traditionally prepared teachers, should be less productive. If licensure is primarily motivated by capture, then alternatively certified teachers would be of equal or even higher quality than traditionally prepared teachers. Lott (1996) argues that minimum educational requirements could actually reduce quality by differentially raising the cost of licensure for the most talented potential entrants into a profession. For example, in the education context, potential teachers working in other occupations may be discouraged from entering teaching because of the high opportunity cost of taking required coursework before being certified to teach. Likewise, undergraduates who possess talents in noneducational fields may find requirements mandating numerous education courses that do not produce transferable skills particularly burdensome.

To formalize these notions regarding the impact of the varying educational requirements that are embodied in traditional and alternative routes to teacher licensure, I adapt the licensure-testing model of Ramseyer and Ramusen (2012). The population of potential teachers (who for parsimony are called "students") has ability x, where $x \sim U(0, 1)$. Initially there is a single pathway to licensure that requires a student to complete a course of study of length ℓ and pass an exam. The probabilities of completion and passage are denoted p_c and p_p. Both the probability of successful course completion and exam passage are increasing functions of ability, x. Assuming that training provides some valuable knowledge, p_p is also increasing in ℓ. The costs of completing a course of study, C_c, are primarily time costs. Assuming that the opportunity cost of lost wages rises with ability, course completion costs can be denoted $c_c(x, \ell)$, with $\delta c_c/\delta x > 0$ and $\delta c_c/\delta \ell > 0$. I further assume that the marginal cost of completion is nondecreasing in ability, so $\delta^2 c_c/\delta x^2 \geq 0$. There is a fixed cost to taking the exam that is independent of ability, c_p. The value of obtaining a license to teach is w. A student's expected payoff from entering the pathway to licensure is thus

$$\pi(x) = [p_c \times p_p(x, \ell) \times w] - [c_c(x, \ell) + c_p]. \quad (1)$$

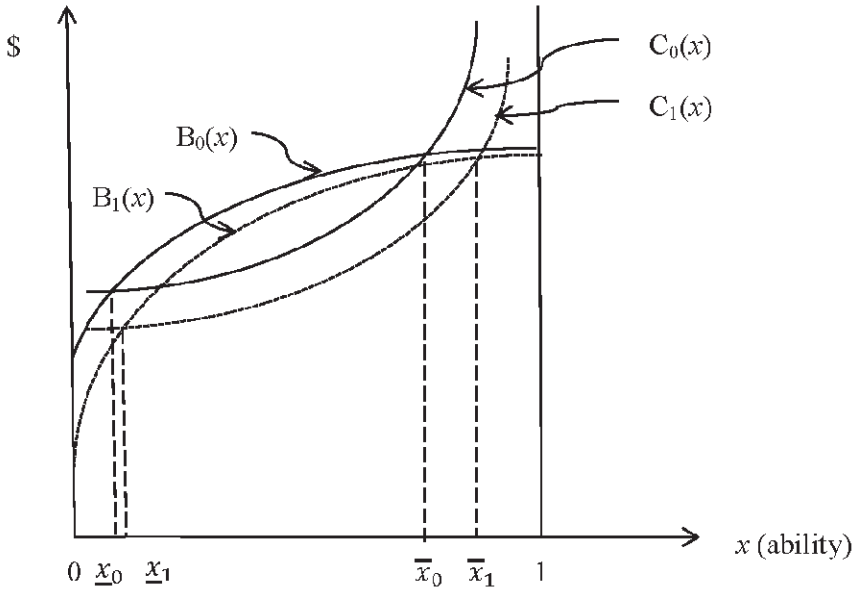

Figure 1. Gains and costs of licensure for pathways of varying length, by level of ability

Any student for whom $\pi(x) > 0$ will enter the pathway for teaching. The first bracketed term is the expected gain from taking the pathway to licensure, and the second bracketed term is the total cost. For a given length of study, ℓ_0, the expected gain and total cost are B_0 and C_0, respectively. Denote by $\underline{x}_0$ and $\overline{x}_0$ the lowest- and highest-ability types taking the test; that is, $\pi(\underline{x}_0) = 0$ and $\pi(\overline{x}_0) = 0$. I assume that there are some low-ability and some high-ability students who do not choose the pathway, so $\underline{x}_0 > 0$ and $\overline{x}_0 < 1$. The situation is illustrated in Figure 1.

As noted above, pathways generally vary in terms of the extent of required coursework, c_c. The effect of an increase in required coursework is

$$\delta\pi(x)/\delta\ell = \{p_c(x) \times \delta[p_p(x, \ell)]/\delta\ell \times w\} - \delta[c_c(x, \ell)]\delta\ell. \quad (2)$$

A shorter course of study will decrease the probability of passing the exam and hence the benefit from entering the pathway. However, it seems reasonable to assume that ability and training are substitutes, so the marginal benefit of program length is decreasing in ability ($\delta^2 p_p/\delta\ell\delta x \leq 0$); that is, "smarter" students lose less from a longer course of study than do less able students. Further, given the assumption that the marginal cost of completion is nondecreasing in ability, the impact of a reduction in pathway length will be greater for high-ability students than for low-ability students. This is illustrated in Figure 1, where the subscript 1 denotes a program of length ℓ_1, where $\ell_1 < \ell_0$. Whether the ability of

the highest-ability and lowest-ability entrants increases or decreases depends on the effects of program length on opportunity costs and the degree to which the decrease in program length affects the likelihood of passing the exam. Figure 1 illustrates a case in which the reduction in costs dominates for both high- and low-ability students. As a result, the shorter pathway attracts higher-ability students at each end of the quality spectrum, although the increase is greater at the upper end of ability. Given the assumed uniform distribution of ability, the average ability of students entering the shorter pathway is higher than for the longer pathway. Of course, if the training is particularly productive, B_1 would be far below B_0, and both the maximum and average ability of students entering the shorter pathway could be lower. Thus, the effects of program length on the quality of entrants are ambiguous a priori.

4. Pathways to Teaching in Florida

Table 1 presents the 10 different sets of certification requirements, any one of which can be met in order to obtain a professional teaching certificate in Florida.[4] They are organized into eight general pathways. The traditional pathway (Florida teacher preparation) requires completion of an approved teacher preparation program at a postsecondary institution in Florida. Those who complete the program must also pass general knowledge and professional education certification tests as well as any necessary subject certification exams.

At present, the most common alternative pathway to certification in Florida is the district alternative certification option. Unlike TFA or the Fellows program in New York City, the district alternative certification option does not involve any special recruitment procedures, and teachers are not required to work toward an education degree while teaching. In fact, no formal education coursework is required. To become certified under this option, one must pass the standard general knowledge and professional education certification exams and complete a competency-based alternative certification program. The details of the program vary somewhat across districts but involve an initial assessment of skills, an individualized training plan, mentoring, a training curriculum that targets a set of accomplished teacher practices, and a summative assessment that documents mastery of the practices. The training programs are frequently web based, but some also involve collaborations with local community colleges or universities.

Three additional alternative routes to certification, the educator preparaion institute (EPI) option, American Board for Certification of Teacher Excellence (ABCTE) passport, and the college-teaching experience options, are all relatively new.[5] The EPIs are essentially two-semester nondegree programs, nearly all of

[4] Professional certificates are valid for 5 years and are renewable. Individuals who have not met all of the requirements for professional certification may receive a temporary certificate that is valid for 3 years and is nonrenewable. The criteria for certification are specified in 48 Fla. Stat. 1012.56 (2012). The initial statute authorizing alternative routes became effective July 1, 2002 (see Fla. Stat. 1012.56 [2002]).

[5] Provisions for the American Board for Certification of Teacher Excellence option became effective June 10, 2004 (see Fla. Stat. 1012.56 [2004]). In 2004, Fla. Stat. 1004.85 provided the opportunity

Table 1
Pathways to Becoming a Teacher in Florida: Certification Requirement Options

Pathway	Certification Requirement Option
Florida teacher preparation	Initial-degree college courses in a traditional teacher preparation program in Florida
District alternative certification	After degree—district alternative certification competency-based program
Educator preparation institute	After degree—education preparation institute competency-based program
ABCTE	After degree—a valid American Board for Certification of Teacher Excellence passport certificate in the subject area
College-teaching experience	After degree—two semesters of successful full-time college teaching experience
Course analysis	Initial and after-degree approved college professional training option—content major and college education courses per rule 6A-4.006; After degree—professional preparation college courses per rule 6A-4.006
Certified in another state	After degree—full reciprocity After degree—a valid National Board for Professional Teaching Standards certificate in the subject area
Out-of-state teacher preparation	Initial-degree college courses in a traditional teacher preparation program outside Florida

Note. The initial degree is a bachelor's degree.

which are housed in community colleges. They typically consist of seven required classes and a field experience component. Courses are specific to the EPI program, and credits are not transferable to traditional education majors. Coursework is often a combination of face-to-face meetings and online instruction. Individuals completing the EPI program must also pass the standard certification exams to receive professional certification. The ABCTE passport option requires individuals to obtain a certificate issued by ABCTE and demonstrate professional education competence in the classroom. To obtain the ABCTE certificate, candidates must pass both a professional teaching knowledge exam and a subject area exam administered by ABCTE. Candidates prepare for the exams with online and electronic documents provided by ABCTE. As its name implies, the college-teaching experience option requires that one have successfully taught for two semesters at a community college or 4-year university. No general knowledge or professional education exams are required; applicants need only pass a subject area certification exam.

The approved college professional training and professional preparation college courses options are essentially indistinguishable. In both cases an individual must complete a handful of core education courses, obtain teaching experience, and pass the teacher certification exams. The former option encompasses individuals who receive a noneducation college degree but minor in education and take the required core classes as part of that minor. This education-minor route is very new. The latter option encompasses individuals who have successfully completed the required core education courses. The courses need not be part of a formal course of study or from a single institution. Thus, this route includes individuals with a variety of educational backgrounds. Education majors who do not complete all of their institution's teacher preparation program requirements but who pass the required core education courses can obtain certification through this route. Likewise, individuals who earn a noneducation college degree and either take the required education courses while an undergraduate or complete the required courses once they start teaching can obtain certification in this manner. In the analysis these two routes are combined under the rubric "course analysis."

Because of population growth and constitutionally mandated class-size restrictions, there was a high demand for new teachers in Florida until the economic downturn in fall 2008. As a result, unlike New York and other states in the Northeast and Midwest, Florida has been a net importer of teachers until recently. There are three avenues by which individuals from out of state can obtain certification when they move to Florida. New graduates of teacher preparation programs outside of Florida must meet the same requirements as those completing traditional teacher preparation programs in Florida. Experienced teachers receive certification in Florida if they possess a valid standard teaching certificate issued by another state or if they hold a valid certificate from the National Board for Professional Teaching Standards (NBPTS). To obtain NBPTS certification, a teacher must be certified to teach in his or her state, have 3 years of experience,

for postsecondary institutions to create educator preparation institutes (EPIs). The first EPI programs were approved by the Florida Department of Education in August 2005.

submit a portfolio of materials for evaluation, and pass an exam. Since NBPTS requires preexisting state certification, the NBPTS option is relevant only for teachers whose state-issued certificate has lapsed or who require certification in a subject area not covered by their state certification. The few teachers who achieve professional certification in this way are combined with certified teachers from states other than Florida in the analysis.

Given the specifics of the certification provisions, my initial analysis of pathways to certification in Florida considers the eight categories described in Table 1. However, the descriptive analysis demonstrates that graduates from traditional preparation programs, be they recent in-state or out-of-state graduates or experienced out-of-state teachers, possess similar characteristics. Likewise, individuals entering through the catchall category of course analysis are similar to graduates of teacher preparation programs. I therefore focus on the three distinctly different alternative routes—district alternative certification, EPIs, and ABCTE—in the subsequent analysis of teacher productivity.

5. Data

Data for the analysis come from two sources. The Florida Education Data Warehouse (FL-EDW) provides longitudinal information about all public school students, including demographic information, enrollment and attendance, program participation, disciplinary actions, and achievement test scores, beginning in 1995. The state administers reading and math tests, known as the Florida Comprehensive Achievement Test Sunshine State Standards (FCAT-SSS), to all third through 10th graders in Florida. The FCAT-SSS is a criterion-based exam designed to test for the skills that students are expected to master at each grade level. It is a high-stakes test used to determine school grades and student retention in some grades, and passage of the 10th-grade exam is a requirement for graduation from high school.[6] The FCAT-SSS was first administered in consecutive grades during the 2000–2001 school year, and results are currently available through 2009–10.

The FL-EDW data also contain administrative data on individual teachers, including demographic information, experience, educational attainment, and certification status. Each classroom has a unique identifier, so I can reliably link teachers and students to specific classrooms at each grade level.

I determine pathways into teaching and teacher certification exam scores by linking data files from the Florida Department of Education's Office of Teacher Certification with the FL-EDW data. I determine pathways from information indicating the method by which each teacher was certified.

[6] Beginning in 1999–2000, a second test, the FCAT Norm-Referenced Test (FCAT-NRT), was given in grades 3–10. The FCAT-NRT was a version of the Stanford Achievement Test that is used throughout the country and thus provided a national benchmark. No accountability measures were tied to student performance on the FCAT-NRT, which was last administered in spring 2008. Since the FCAT-SSS exam covers recent years in which many alternatively certified teachers began teaching, I utilize it in the primary analysis of teacher productivity presented here. However, results using the FCAT-NRT are very similar and are available on request.

The ability to link teachers to their university coursework is an additional strength of the Florida data. For relatively young teachers (those who attended a Florida public university or community college since 1995), the FL-EDW data contain complete college transcript information, including entrance exam scores, courses taken, majors, and degrees received. Because Florida has a uniform course-numbering system, I am able to determine the subject area of each course taken. Certification records allow identification of the undergraduate institution attended by new teachers, whether they graduated from a public or private university in Florida or elsewhere. However, information on college major and college coursework is available only for teachers who attended public community colleges and universities in Florida.[7]

In order to align the analysis with previous work in New York City and to avoid possible biases, I restrict the sample in two ways. First, students who skip a grade or who repeat a grade are excluded.[8] Second, in order to identify the teacher responsible for instruction, I restrict the analysis to students who receive instruction in the relevant subject area from a single teacher.

6. Methods

In order to gauge the impact of the pathway into teaching on subsequent teacher performance, I estimate a value-added model that relates current student achievement to a vector of student and family inputs, $\boldsymbol{X}_{it}$ (where students are indexed by i); a vector of classroom peer characteristics, $\boldsymbol{P}_{-ijmt}$ (where $-i$ denotes students other than individual i in classroom j in school m); a vector of time-varying teacher characteristics, $\boldsymbol{T}_{kt}$ (where k indexes teachers); a vector of time-invariant teacher characteristics, $\boldsymbol{Z}_k$; and time-invariant school characteristics denoted by the school fixed effect, φ_m (where m indexes schools). Student achievement in the prior year, A_{it-1}, serves as a sufficient statistic for all prior schooling inputs. The model can thus be expressed as

$$A_{it} = \beta_0 + \beta_1 A_{it-1} + \boldsymbol{\beta}_2 \boldsymbol{X}_{it} + \boldsymbol{\beta}_3 \boldsymbol{P}_{-ijmt} + \boldsymbol{\beta}_4 \boldsymbol{T}_{kt} + \boldsymbol{\beta}_5 \boldsymbol{Z}_k + \varphi_m + \nu_{it}, \qquad (3)$$

where ν_{it} is a normally distributed, mean 0 error. The effects of teacher preparation pathways are captured by a set of indicator variables contained in the vector $\boldsymbol{Z}_k$. As discussed in Mihaly et al. (2013), the inclusion of school fixed effects in achievement models designed to evaluate teacher preservice programs can be problematic because identification requires that a school have early-career teachers from multiple programs. Even if the minimum requirements for identification are met, biases can still result if the schools with teachers from multiple programs are atypical or the teachers from different programs who teach in the same school are not representative of the average teacher from their program. Because

[7] If students transfer from out of state or between public and private postsecondary institutions in Florida, the FL-EDW data will not capture their entire undergraduate record. Therefore, coursework information is used for teachers only when at least 100 credit hours are included in the data.

[8] Including students who repeated a grade has only trivial effects on the estimated parameters. Results using the sample that includes grade repeaters are reported in online appendix Table A1.

of the problems associated with simultaneously identifying pathway and school effects, both models with and without school effects are estimated.

The basic model I use to estimate student achievement, in which student heterogeneity is accounted for by observable student characteristics and the impact of prior educational inputs is allowed to decay over time (that is, β_1 can be less than 1), is just one of many possible specifications. However, recent experimental and simulation-based evidence suggests that this model is likely to produce relatively unbiased estimates of teacher effects under a range of conditions (Kane and Staiger 2008; Guarino, Reckase, and Wooldridge 2012).[9] Further, the use of student fixed effects to account for student heterogeneity is problematic in this case because identification requires that a student be taught by teachers from different pathways; the large proportion of students who encounter only traditionally prepared teachers would add nothing to the identification of pathway effects.[10]

7. Results

7.1. Summary Statistics

Table 2 reports the mean characteristics of teachers who obtained certification by graduating from a Florida teacher preparation program versus those who entered from each of the other seven routes. Teachers who obtain certification through the three distinctly alternative routes (district alternative certification, EPIs, and ABCTE) tend to be older and are more likely to be male and white than traditionally prepared teachers. They also have stronger credentials than graduates of Florida teacher preparation programs. A greater proportion

[9] Rothstein (2010) argues that value-added models may yield biased estimates of teachers' productivity as a result of nonrandom assignment of students to teachers in schools. For example, if students who demonstrate an unusually high achievement gain in 1 year are assigned to particular teachers the following year and there is mean reversion in students' test scores, the estimated value added for the teachers with students possessing high prior-year gains will be biased downward. Rothstein proposes falsification tests based on the idea that future teachers cannot have causal effects on current achievement gains. I conducted tests of this sort using the methodology employed by Koedel and Betts (2011). I failed to reject the null hypothesis that future teacher pathway effects are jointly equal to 0 in elementary school but not in middle and high school. It is possible that the rejection of strict exogeneity in middle and high school could reflect tracking in the upper grades that may induce a degree of bias (Jackson 2014). To test this, I modified the value-added model to include indicators for basic/remedial and advanced/honors courses and reran the Rothstein tests. I still failed to reject the null hypothesis of no future teacher pathway effects for elementary math and reading and also failed to reject the null hypothesis for high school math. However, even with track effects, I still rejected the null hypothesis for middle school math and for middle and high school reading. Results of the two sets of Rothstein tests are reported in online appendix Table A2. Adding track effects to the value-added model yields pathway estimates similar to those of the baseline model without track effects. This is demonstrated in online appendix Table A3. Although the results of the Rothstein test suggest the possibility of bias due to nonrandom teacher assignment among middle and high school reading teachers and middle school math teachers, the tests are not definitive. For example, Goldhaber and Chaplin (2012) show that the Rothstein test may reject the null hypothesis of strict exogeneity even when there is no bias.

[10] Although not reported here, I also estimated pathway effects from an achievement model with complete persistence ($\beta_1 = 1$, which makes the dependent variable the achievement gain, ΔA_{it}). Results from this gain-score specification were qualitatively similar and are available on request. See Sass, Semykina, and Harris (2014) for a detailed discussion of value-added models.

Table 2
Select Characteristics of Certified First-Year Teachers by Pathway

Pathway	Most Competitive Colleges	Least Competitive Colleges	Passed Exam on First Attempt		Nonwhite	Male	Median Age (Years)	Total SAT Score (Average)
Florida teacher preparation (N = 27,503)	.142	.182	Math	.691	.308	.130	25.0	940
			Reading	.818				
			English	.836				
			Essay	.914				
Course analysis (N = 39,525)	.195[a]	.157[a]	Math	.650[a]	.327[a]	.232[a]	29.0[a]	958[a]
			Reading	.824				
			English	.828				
			Essay	.879[a]				
Certified in another state (N = 18,991)	.077[a]	.211[a]	Math	.599[a]	.167[a]	.190[a]	32.0[a]	994[a]
			Reading	.814				
			English	.815				
			Essay	.866[a]				
Out-of-state teacher preparation (N = 8,627)	.072[a]	.229[a]	Math	.586[a]	.277[a]	.225[a]	33.0[a]	894[a]
			Reading	.722[a]				
			English	.743[a]				
			Essay	.725[a]				
District alternative certification (N = 3,615)	.231[a]	.121[a]	Math	.769[a]	.269[a]	.316[a]	31.0[a]	1015[a]
			Reading	.920[a]				
			English	.925[a]				
			Essay	.923				

Educator preparation institute (N = 772)	.287[a]	.098[a]	Math	.835[a]	.214[a]	.236[a]	26.0[a]	1006[a]
			Reading	.917[a]				
			English	.950[a]				
			Essay	.955[a]				
ABCTE (N = 137)	.236[a]	.157	Math	.947[a]	.175[a]	.307[a]	30.0[a]	1081[a]
			Reading	1.00[a]				
			English	1.00[a]				
			Essay	.982[a]				
College-teaching experience (N = 106)	.344[a]	.083[a]	Math	.600	.276	.462[a]	45.0[a]	949
			Reading	.750				
			English	.650				
			Essay	.947				

Note. Values are proportions unless otherwise indicated. The category of most competitive colleges includes the Barron's ratings designations "most competitive," "highly competitive," and "special." The category of least competitive colleges includes the Barron's ratings designations "less competitive" and "noncompetitive." The omitted category includes "very competitive" and "competitive" schools. The number of observations is based on gender; observations may be fewer for other variables. Values are not reported if relevant data are available for fewer than 10 percent of teachers from the given pathway or if the total number of teachers in a pathway is less than 25. SAT = Scholastice Achievement Test; ABCTE = American Board for Certification of Teacher Excellence.

[a] A t-test (for means) or χ^2-test (for medians) indicates that the mean (median) is significantly different from the mean (median) for graduates of Florida teacher preparation programs at the 95 percent confidence level.

graduated from the most competitive colleges. Similarly, teachers entering via the district alternative certification and EPI pathways were more likely to pass the general knowledge certification exams on the first try. Virtually all ABCTE teachers passed each of the certification exams on the first try. The variation in performance on certification exams appears to be due in part to differences in precollege ability; combined SAT scores are significantly higher for alternatively certified teachers, about 70 points greater for district alternative certification and EPI teachers and more than 140 points greater for ABCTE teachers.

If alternatively certified teachers are entering teaching as a second career (as suggested by their more advanced ages), they might be more likely to teach in middle and high schools. This could skew the comparisons, since the majority of traditionally prepared teachers teach at the elementary school level. However, when comparing the characteristics of traditionally prepared and alternatively certified teachers who are certified in elementary education in Table 3, the same general pattern of differences remains. While the differences are slightly smaller, the results are similar to those for the full sample.

Data on the modal college majors of teachers, broken down by pathway and certification subject area, are provided in Table 4. Teachers who entered via the course analysis pathway were most often elementary education majors who evidently simply submitted proof of their college coursework rather than proof of completion of their university's preparation program to satisfy initial certification requirements. In contrast, teachers who entered via one of the distinctly alternative routes—district alternative certification, EPIs, or ABCTE—possessed bachelor's degrees in a very different set of majors. For the district alternative certification and ABCTE pathways, the modal college major is English language and literature, while for EPI it is psychology.[11] Similarly, for elementary education and middle school math certifications, the most common route for traditionally prepared teachers is elementary teacher education, whereas for the alternate routes, business administration and psychology dominate. At the high school level, traditionally prepared teachers tend to earn degrees in the relevant subdiscipline of education (for example, mathematics teacher education), while teachers from the district alternative certification and ABCTE pathways are most likely to hold degrees in the relevant subject area (for example, math or biology). In contrast, teachers who entered via the EPI route tend not to have a bachelor's degree in a closely related field.

Information about the coursework of Florida teacher preparation program graduates relative to that of entrants from the three distinctly alternative routes is provided in Table 5. Graduates of Florida teacher preparation programs earn over half their credits in education courses, whereas alternate-route teachers average one 3-credit-hour education course or less.[12] Interestingly, both tradition-

[11] Information about major is available only for degree recipients of Florida public universities. Thus, college major is known for only about half of the teachers who obtained certification through pathways other than completion of a Florida teacher preparation program.

[12] The education coursework category includes only traditional education courses; courses included in EPI programs are not counted.

ally prepared and alternatively certified teachers average about two math or statistics courses. Course-taking differences in the sciences are more pronounced. Whereas traditionally prepared teachers average just under three science courses (8.54 credit hours), district alternative certification and EPI teachers take nearly five science courses on average. The few ABCTE teachers with complete college transcripts average about 10 science courses (30.92 credit hours).

7.2. Value-Added Model Estimates

Estimates from equation (3) are presented in Table 6. Estimates of the value added of district alternative certification and the EPI and ABCTE programs for math and reading achievement are displayed.[13] Test scores are normalized by grade and year, so coefficient estimates can be interpreted in standard deviation units of student achievement. In order to minimize the influence of differential on-the-job training, such as learning from peer teachers, the sample is limited to teachers in their first 3 years of teaching in Florida.[14]

In math, the differences in teacher productivity are all highly significant and quantitatively substantial. Teachers certified by ABCTE, who face no course requirements and need to make virtually no specific investments to become a teacher, outperform traditionally prepared teachers by 6–8 percent of a standard deviation in student achievement. This is about 2–3 times the difference in productivity between a rookie teacher and one with 3–5 years of experience. Given the standard deviation in math, I find that teacher value added in Florida is about .38; this is equivalent to 17–21 percent of a standard deviation in teacher effectiveness. Using the recent estimates of the long-run impacts of teacher quality by Chetty, Friedman, and Rockoff (2011), I find that this implies an earnings differential of about .2 percent at age 28, or roughly a $1,000 increase in the present value of lifetime income at age 12. Given an average (math) class size of 23.7, the per-class differential in present-value terms is nearly $24,000. Teachers who re-

[13] The reading sample sizes are smaller than those for math because of the restriction that students must be taught by a single teacher in a single course in the relevant subject. The prevalence of multiple teachers and courses is much greater in language arts than in math. For example, in 2009, the average number of distinct math courses per student was 1.13, whereas for language arts it was 1.35. Correspondingly, the average number of math teachers was 1.14, and the number of language arts teachers was 1.75.

[14] The value-added analysis includes teachers with 0–2 years of experience, whereas the descriptive statistics of teachers by pathway are only for teachers in their first year of teaching. Consequently, the samples are different. Estimates based on a sample including teachers with more than 2 years of experience are reported in online appendix Table A4. The results are qualitatively similar to those from the early-career-only sample. However, the point estimates are generally smaller, as one would expect if preservice training depreciates over time and on-the-job training becomes relatively more important with experience. Online appendix Table A5 reports estimates (based on the expanded sample) of a model that allows the effect of teacher experience to vary by pathway. There are few significant differences between the marginal effect of experience for traditionally prepared teachers and that for teachers from alternative pathways. If on-the-job experience substitutes for the lack of formal preparation received by alternatively certified teachers, one would expect that the gain from experience would be greater for alternatively prepared teachers. This is not the case, however. In fact, the point estimates of the interactions of experience and pathway are mainly negative.

Table 3
Select Characteristics of First-Year Teachers by Pathway: Those with Elementary Education Certification

Pathway	Most Competitive Colleges	Least Competitive Colleges	Passed Exam on First Attempt		Nonwhite	Male	Median Age (Years)	Total SAT Score (Average)
Florida teacher preparation (N = 18,991)	.113	.197	Math	.685	.299	.067	25.0	928
			Reading	.815				
			English	.839				
			Essay	.918				
Course analysis (N = 15,297)	.170*	.178[a]	Math	.630*	.300	.090[a]	29.0[a]	945[a]
			Reading	.811				
			English	.812*				
			Essay	.888*				
Certified in another state (N = 11,208)	.066*	.217[a]	Math	.603*	.158[a]	.099[a]	30.0[a]	988[a]
			Reading	.830				
			English	.844				
			Essay	.916				
Out-of-state teacher preparation (N = 4,333)	.064*	.246[a]	Math	.584*	.244[a]	.101[a]	32.0[a]	891[a]
			Reading	.755*				
			English	.770*				
			Essay	.761*				
District alternative certification (N = 636)	.219*	.119[a]	Math	.789*	.186[a]	.127[a]	32.0[a]	994[a]
			Reading	.951*				
			English	.947*				
			Essay	.936				

Educator preparation institute ($N = 330$)	.281	.063[a]	Math	.871*	.139[a]	.097	27.0[a]	995[a]
			Reading	.926*				
			English	.949*				
			Essay	.959*				
ABCTE ($N = 56$)	.255*	.191	Math	1.00*	.179[a]	.143	33.5[a]	1108[a]
			Reading	1.00*				
			English	1.00*				
			Essay	1.00*				
College-teaching experience ($N = 26$)	.318	.00[a]	Math	.500	.308	.077	39.5[a]	924
			Reading	.889				
			English	.667				
			Essay	1.00*				

Note. Values are proportions unless otherwise indicated. The category of most competitive colleges includes the Barron's ratings designations "most competitive," "highly competitive," and "special." The category of least competitive colleges includes the Barron's ratings designations "less competitive" and "noncompetitive." The omitted category includes "very competitive" and "competitive" schools. The number of observations is based on gender; observations may be fewer for other variables. Values are not reported if relevant data are available for fewer than 10 percent of teachers from the given pathway or if the total number of teachers in a pathway is less than 20. The sample sizes refer to the number of teachers with demographic information. The numbers of teachers with test scores and college selectivity information are smaller. SAT = scholastic achievement test; ABCTE = American Board for Certification of Teacher Excellence.

[a] A t-test (for means) or χ^2-test (for medians) indicates that the mean (median) is significantly different from the mean (median) for graduates of Florida teacher preparation programs at the 95 percent confidence level.

Table 4
Modal Major of First Bachelor's Degree by Pathway and Certification Area

	All Certifications		Elementary Education		Middle School Math		High School Math		Biology	
Pathway	Degree	*N*	Degree	*N*	Degree	*N*	Degree	*N*	Degree	*N*
Florida teacher preparation	ETE	17,323	ETE	12,010	ETE	315	MTE	424	B	210
Course analysis	ETE	11,699	ETE	4,662	ETE	422	MTE	368	B	300
Certified in another state	ETE	383	ETE	212	ETE	14	MTE	13	B	11
Out-of-state teacher preparation	ETE	109	ETE	44						
District alternative certification	ELL	1,108	P	185	BA	89	M	50	B	73
Educator preparation institute	P	331	P	131	BA	24	A	19	LAS	14
ABCTE	ELL	35	P	10						
College-teaching experience	ETE	17	P	11						

Note. Values are not reported if the total number of teachers in a pathway is less than 10. Data are available only for graduates of public universities in Florida. ETE = elementary teacher education; MTE = mathematics teacher education; B = biology, ELL = English language and literature; P = psychology; BA = business administration; M = mathematics; A = anthropology; LAS = liberal arts and sciences or liberal studies; ABCTE = American Board for Certification of Teacher Excellence.

ceive district alternative certification, who face somewhat greater requirements to enter teaching than do ABCTE-route teachers, exhibit a smaller productivity edge over traditionally prepared math teachers, equal to 1.0–2.5 percent of a standard deviation in student achievement. Teachers certified via EPI programs, who face the greatest coursework requirements and must incur the highest level of occupation-specific investment to become a teacher, are substantially less productive than other alternative-route teachers. Their value added lags behind that of traditionally prepared teachers by 2–4 percent of a standard deviation in student achievement.

Consistent with prior studies, the observed differences in teachers' value added across pathways are less pronounced in reading than in math. As with math, teachers who receive ABCTE and district alternative certification outperform traditionally prepared teachers, although the magnitude of the difference is much smaller, roughly 1.5–2.0 percent of a standard deviation in student achievement. Teachers certified via EPI programs lag behind traditionally prepared teachers; their value added is 2–3 percentage points lower.

Table 7 presents results from the same achievement model as in Table 6 but for the more homogeneous sample of middle and high school teachers. The results are quite similar to the full-sample results in Table 6. As with the full sample, ABCTE teachers exhibit significantly higher value added, particularly in math. Teachers who receive district alternative certification also outperform their traditionally prepared peers but by a smaller margin. Teachers from EPI programs lag behind traditionally prepared teachers in both math and reading, and their value added trails that of ABCTE teachers by as much as .1 of a standard deviation in students' math achievement.

Table 8 presents results broken down by three student characteristics: gender, race and ethnicity, and family income (proxied by free or reduced-price lunch status). A few interesting patterns emerge. First, teachers with district alternative certification appear to be relatively more effective in teaching both math and reading to male students. This gender difference does not appear to be driven by the fact that such teachers are 2.5 half times more likely to be male than are traditionally prepared teachers (see Table 2). When instructor gender is taken into account (results not shown), the differences in effectiveness by student gender remain. Second, teachers with district alternative certification appear to be more effective in teaching math to nonwhite students and students from low-income families. Third, ABCTE teachers appear to be relatively more effective in teaching reading to nonwhite and economically disadvantaged students. These latter two findings do not seem to be driven by racial matching of teachers and students; teachers with district alternative certification are about as likely as traditionally prepared teachers to be nonwhite, and ABCTE teachers are less likely than graduates of traditional teacher preparation programs to be nonwhite (see Table 2). While the causes of the differences in effectiveness across student types are uncertain, it seems clear that teachers from nontraditional pathways that require little specific human capital investments are no less effective than traditionally

Table 5
Coursework Credit Hours by Alternative Pathway: All Certifications

	Florida Teacher Preparation (N = 5,485)	District Alternative Certification (N = 456)	Educator Preparation Institute (N= 63)	ABCTE (N = 15)
All education coursework	62.99	3.53	2.13	1.20
	(22.60)	(8.51)	(5.04)	(2.73)
Education, field-based	14.96	.41	.39	.18
	(6.43)	(1.30)	(1.07)	(.72)
Math education	3.41	.07	.00	.00
	(4.75)	(.62)	(.00)	(.00)
Science education	2.10	.03	.00	.00
	(2.63)	(.31)	(.00)	(.00)
Language arts education	8.37	.38	.04	.00
	(6.30)	(1.26)	(.37)	(.00)
ESL education	2.31	.07	.00	.20
	(2.94)	(.67)	(.00)	(.77)
Math	5.66	4.95	5.83	6.50
	(7.66)	(6.57)	(5.16)	(9.88)
Statistics	1.43	1.82	2.04	1.37
	(2.16)	(2.35)	(2.47)	(1.98)
All science coursework	8.54	15.39	13.56	30.92
	(8.91)	(21.29)	(14.85)	(35.78)
Biology	3.16	6.55	4.70	15.39
	(4.82)	(11.41)	(7.75)	(19.91)

Chemistry	1.64	4.05	3.85	8.57
	(3.64)	(7.57)	(6.51)	(11.43)
Physics	1.78	2.69	3.15	4.89
	(2.74)	(3.79)	(3.81)	(5.21)
Engineering	1.29	4.89	6.98	2.20
	(2.98)	(13.97)	(18.24)	(2.88)
English literature	7.60	13.92	11.58	10.94
	(7.85)	(15.41)	(13.48)	(15.17)
Other credits	49.09	89.92	96.76	76.30
	(26.87)	(30.26)	(29.27)	(43.36)
Arts	9.74	6.83	11.25	10.00
	(20.65)	(16.25)	(23.40)	(23.96)
Social science	7.07	14.04	15.98	12.91
	(7.46)	(15.17)	(16.55)	(17.56)
Foreign language	2.31	7.65	7.24	7.36
	(5.08)	(10.32)	(11.31)	(7.28)
Business	1.07	8.53	8.05	9.48
	(5.24)	(18.41)	(17.85)	(22.61)

Note. The sample includes only teachers with 100 or more known credit hours in university-designated courses from Florida public community colleges and universities prior to the first year of teaching in Florida public schools. Data are means, with standard deviations in parentheses. Other credits are those not in education, math, statistics, science, engineering, or health sciences. ABCTE = American Board for Certification of Teacher Excellence; ESL = English as a second language.

Table 6
Effect of Teacher Pathways on Student Achievement in Math and Reading, 2000–2001 to 2009–10: Grades 4–10

	Math		Reading	
	(1)	(2)	(1)	(2)
District alternate certification	.0251**	.0104*	.0148**	.0132**
	(.0050)	(.0052)	(.0046)	(.0051)
Educator preparation institute	−.0159	−.0409**	−.0170	−.0280*
	(.0127)	(.0141)	(.0110)	(.0112)
ABCTE	.0783**	.0641**	.0162	.0198
	(.0280)	(.0243)	(.0167)	(.0180)
School fixed effects	Yes	No	Yes	No
R^2	.665	.665	.608	.600

Note. The reference group is teachers who completed a Florida teacher preparation program and have less than 3 years of experience. All models include time-varying teacher and peer explanatory variables and indicators for each pathway. Standard errors adjusted for clustering at the teacher level are in parentheses. ABCTE = American Board for Certification of Teacher Excellence. For math, N = 1,370,937; for reading, N = 971,049.

*Significant at the 5% level.

**Significant at the 1% level.

Table 7
Effect of Teacher Pathways on Student Achievement in Math and Reading, 2000–2001 to 2009–10: Grades 6–10

	Math		Reading	
	(1)	(2)	(1)	(2)
District alternate certification	.0263**	.0103+	.0153**	.0128*
	(.0058)	(.0061)	(.0053)	(.0058)
Educator preparation institute	−.0205	−.0494**	−.0168	−.0325**
	(.0153)	(.0162)	(.0125)	(.0124)
ABCTE	.0775*	.0554*	.0157	.0194
	(.0315)	(.0251)	(.0175)	(.0188)
School fixed effects	Yes	No	Yes	No
R^2	.682	.674	.600	.591

Note. The reference group is teachers who completed a Florida teacher preparation program and have less than 3 years of experience. All models include time-varying teacher and peer explanatory variables and indicators for each pathway. Standard errors adjusted for clustering at the teacher level are in parentheses. ABCTE = American Board for Certification of Teacher Excellence. For math, N = 944,337; for reading, N = 688,551.

+Significant at the 10% level.

*Significant at the 5% level.

**Significant at the 1% level.

prepared teachers in teaching economically disadvantaged students and students of color.

As noted above, changes in licensing requirements can have important impacts on the tails of the teacher quality distribution, even if average quality is unaffected. To gauge the effects of licensure requirements on the quality range of teachers, I present kernel density plots of the distribution of estimates of teacher

Table 8
Effect of Teacher Pathways on Student Achievement in Math and Reading by Student Characteristics, 2000–2001 to 2009–10: Models without School Fixed Effects

	Male	Female	White	Nonwhite	No FRL	FRL
Math:						
District alternate certification	0178**	.0025	.0069	.0155**	.0040	.0192**
	(.0056)	(.0061)	(.0058)	(.0064)	(.0057)	(.0064)
Educator preparation institute	−.0399**	−.0431**	−.0432**	−.0348*	−.0534**	−.0237
	(.0152)	(.0162)	(.0144)	(.0177)	(.0160)	(.0170)
ABCTE	.0683**	.0619*	.0692**	.0521+	.0435+	.0930**
	(.0265)	(.0276)	(.0249)	(.0305)	(.0257)	(.0351)
R^2	.659	.652	.659	.622	.660	.601
N	683,039	687,898	638,261	732,676	695,472	675,465
Reading:						
District alternate certification	.0190**	.0075	.0122*	.0131*	.0095+	.0172**
	(.0059)	(.0055)	(.0059)	(.0064)	(.0058)	(.0066)
Educator preparation institute	−.0253+	−.0315*	−.0279*	−.0273+	−.0387**	−.0124
	(.0144)	(.0130)	(.0132)	(.0149)	(.0127)	(.0153)
ABCTE	.0317+	.0087	.0015	.0365*	−.0023	.0519**
	(.0193)	(.0203)	(.0215)	(.0183)	(.0212)	(.0186)
R^2	.599	.600	.556	.602	.550	.579
N	474,057	496,992	500,017	471,032	556,500	414,549

Note. The reference group is teachers who completed the Florida teacher preparation program, teach grades 4–10, and have less than 3 years of experience. All models include time-varying teacher and peer explanatory variables and indicators for each pathway. Standard errors adjusted for clustering at the teacher level are in parentheses. FRL = free or reduced-price lunch; ABCTE = American Board for Certification of Teacher Excellence.

+Significant at the 10% level.

*Significant at the 5% level.

**Significant at the 1% level.

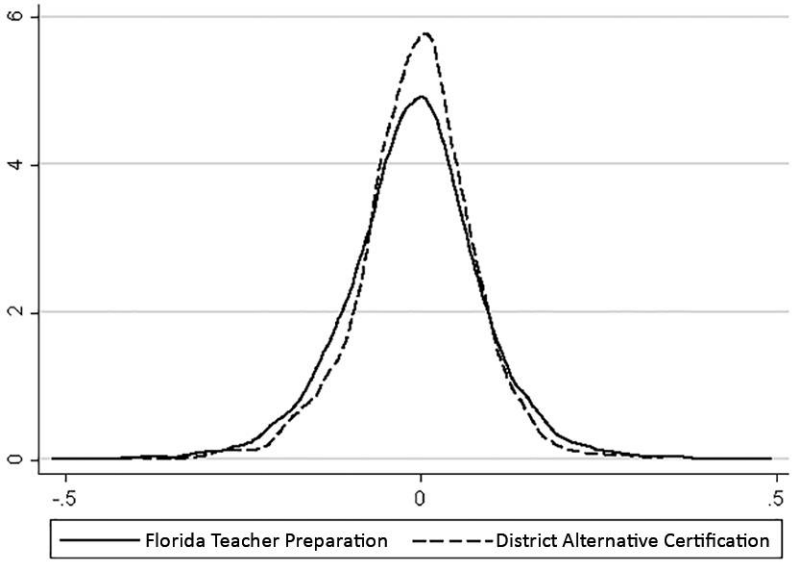

Figure 2. Distribution of estimated teacher effects on math achievement: Florida teacher preparation program and district alternative certification.

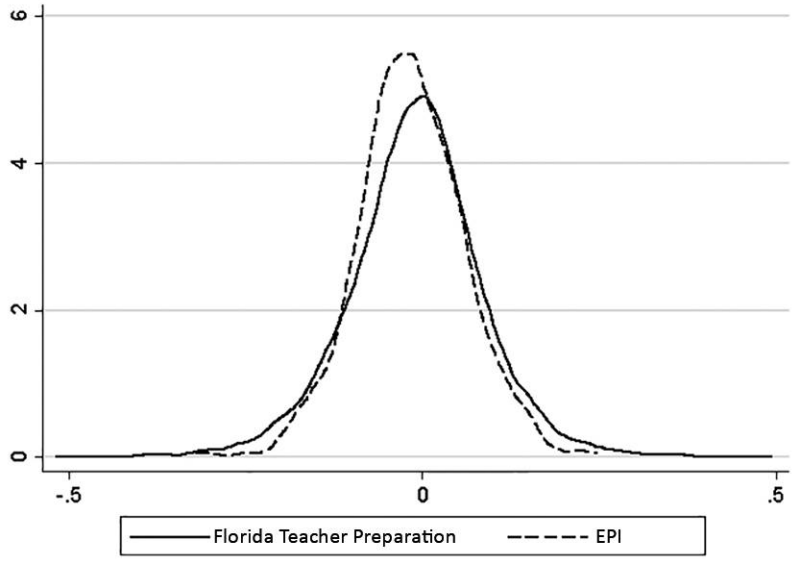

Figure 3. Distribution of estimated teacher effects on math achievement: Florida teacher preparation program and educator preparation institute.

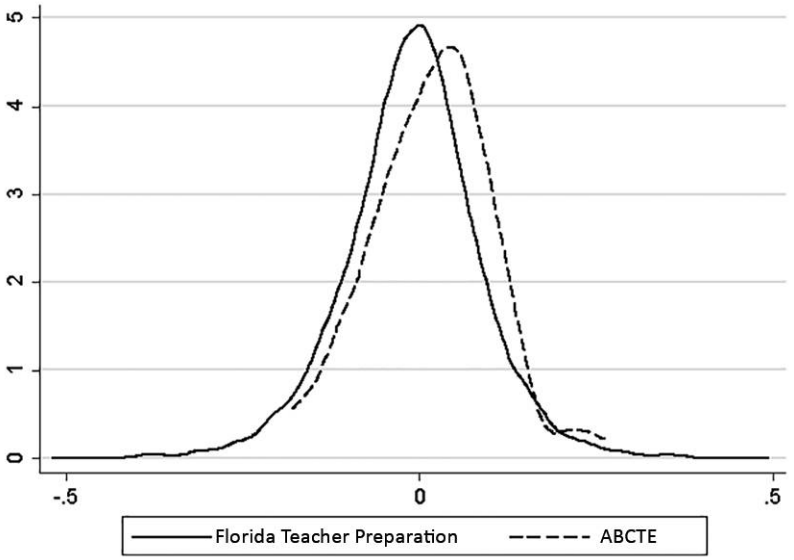

Figure 4. Distribution of estimated teacher effects on math achievement: Florida teacher preparation program and American Board for Certification of Teacher Excellence.

effect broken down by pathway in Figures 2–4 (for math) and Figures 5–7 (for reading). Like the pathway effects, the teacher effects represent impacts on normalized student test scores and thus are measured in standard deviations. The teacher effect estimates are obtained by estimating equation (3), replacing the pathway indicators with individual teacher fixed effects.[15] (School fixed effects are not included.) While it is difficult to make definitive judgments about the differences in the distributions of teacher quality, the teacher effect distribution for the ABCTE pathway, which exhibits the greatest average difference in teacher quality from the traditional pathway, appears to have a shorter left tail and a somewhat smaller proportion of below-average-quality teachers. It also appears that the EPI pathway, which has the most course requirements of the three major alternative pathways, is essentially a leftward shift of the traditional pathway distribution, with fewer teachers at the extremes. The distribution of teacher quality with district alternative certification exhibits the smallest deviation from the quality dis-

[15] Empirical Bayes's (shrunken) estimates of individual value added were used to construct the kernel density plots. These were derived using the methods employed by Kane, Rockoff, and Staiger (2008). The empirical Bayes approach shrinks less-precise teacher effect estimates toward 0 and thus avoids the possibility of inappropriately placing individual teachers with few students in one of the tails of the distribution. The use of empirical Bayes's methods is unnecessary in the main analysis, which does not compute value added for individual teachers. The main analysis is concerned with comparing the average performance of teachers from differing pathways, where the number of students taught by teachers from a given pathway is relatively large.

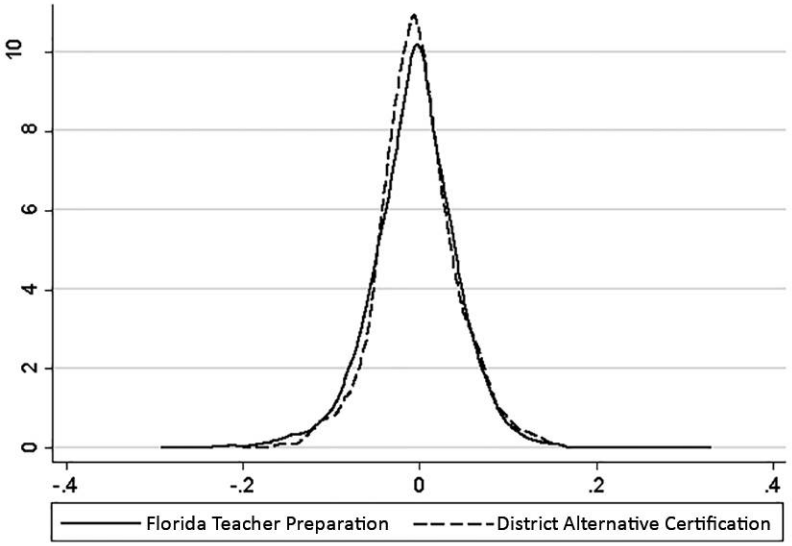

Figure 5. Distribution of estimated teacher effects on reading achievement: Florida teacher preparation program and district alternative certification.

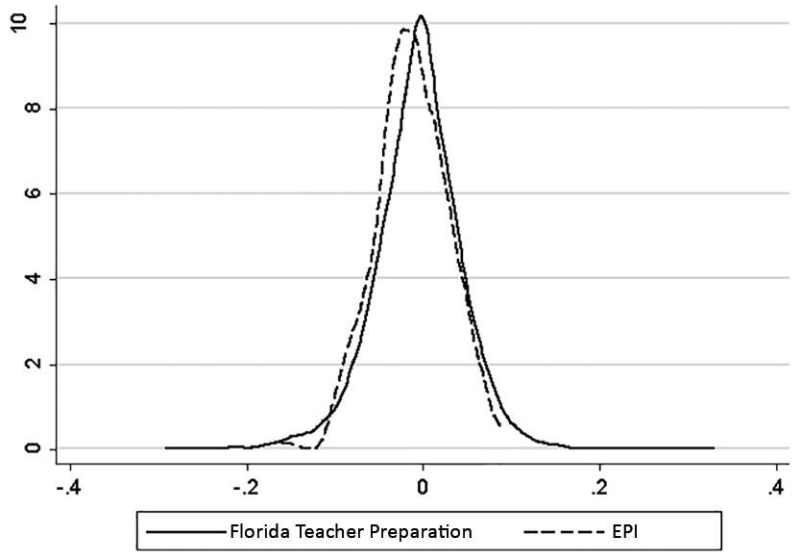

Figure 6. Distribution of estimated teacher effects on reading achievement: Florida teacher preparation program and educator preparation institute.

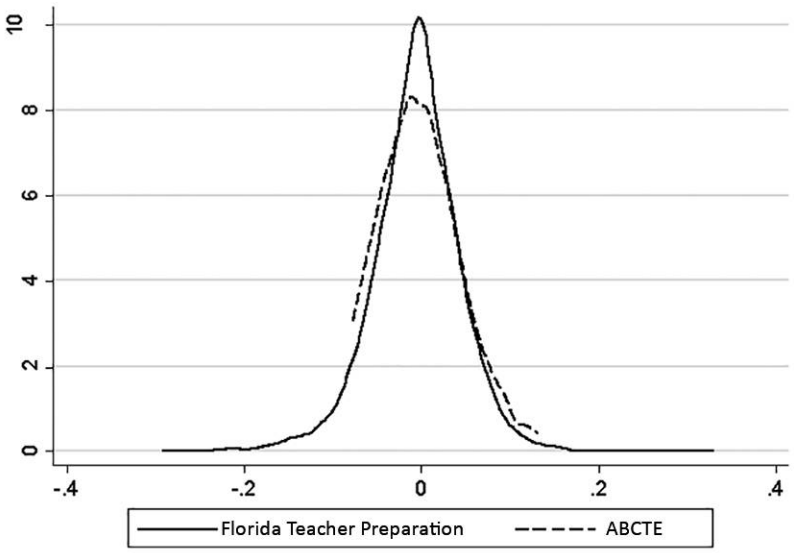

Figure 7. Distribution of estimated teacher effects on reading achievement: Florida teacher preparation program and American Board for Certification of Teacher Excellence.

tribution of teachers from the traditional pathway; the variance is smaller, with the range of teacher effects being less than that from the distribution of traditionally prepared teachers.

8. Summary and Conclusions

Traditionally, the only way to be licensed to teach was to major in education and complete a university-based teacher preparation program. In recent years there has been a shift away from this paradigm as many states have adopted laws and regulations permitting individuals to enter the teaching profession in other ways. Much attention has been paid to the Peace Corps–style program Teach for America, which recruits graduates from prestigious universities to work in urban schools for a minimum of 2 years. Indeed, TFA has received the most examination of any alternative certification program. However, TFA teachers make up only a small minority of alternatively prepared teachers in most states. In this paper I explore the effects of more generic alternative certification programs that have no special recruitment efforts and no minimum time commitment and do not require participants to take formal university-based education courses while teaching.

Using a rich panel data set from Florida, I explore the characteristics of individuals who enter teaching through alternative certification programs and measure their effectiveness in promoting student achievement. Florida has three distinct

alternative certification programs. The largest is the district alternative certification program, which allows applicants to become certified through an individualized training program that includes mentoring and online training but does not require any formal education coursework. Smaller, but growing in popularity, are EPIs, which involve taking two semesters of nontransferrable coursework at a community college, and the ABCTE pathway, which has no coursework requirement and requires only the passing of a test.

In general I find that alternatively certified teachers have stronger preservice academic skills than traditionally prepared teachers, as evidenced by their higher initial pass rates on certification exams and higher college entrance exam scores. The measured contribution of alternatively certified teachers varies considerably across pathways, however. The value added of teachers who receive district alternative certification is generally 1–2 percent of a standard deviation higher than that of recent Florida teacher preparation program graduates. In contrast, the value-added scores of EPI graduates are 2–4 percent of a standard deviation below those of traditionally prepared teachers. Most stark are the differences in the performance of ABCTE teachers relative to traditionally prepared teachers in teaching math. The ABCTE teachers outperform their traditionally prepared colleagues by a wide margin—6–8 percent of a standard deviation in student achievement.

The positive results for ABCTE math teachers must be interpreted with caution, given the modest sample of ABCTE teachers in tested grades. However, when combined with prior evidence on TFA teachers in other locales, some important trends emerge. For both TFA and ABCTE, no prior coursework in education is required, but prospective teachers come from more competitive schools and have better precollege test scores. It appears that the low entry requirements of both programs attract individuals with greater intellectual ability and that (at least for math) this trumps any human capital enhancement that may accrue from coursework in education. In contrast, the EPI pathway, which requires essentially two semesters of nontransferable coursework, attracts individuals with somewhat weaker measured ability, and EPI-pathway teachers end up performing worse (in terms of value added), on average, than traditionally prepared teachers in math.

The varied findings for the three programs in Florida highlight the fact that alternative certification programs are in fact quite diverse and one should be cautious about making blanket statements about the relative performance of alternatively certified teachers. However, it does appear that certification programs with low entry requirements can produce teachers that are as productive, or even more productive, than traditionally prepared teachers. Given the opportunity cost of a 4-year degree in education, this implies that allowing some low-cost portals into the teaching profession appears to be an efficient mechanism for increasing the supply of teachers. Whether a large-scale increase in the number of alternatively certified teachers would be welfare enhancing depends on the supply elasticity of high-quality candidates who would enter through alternative routes. My findings suggest that, at present levels, the average teacher who enters the profession

through alternative routes that require relatively little specific human capital investments produces greater student achievement.

References

Aaronson, Daniel, Lisa Barrow, and William Sander. 2007. Teachers and Student Achievement in the Chicago Public High Schools. *Journal of Labor Economics* 25:95–135.

Akerlof, George A. 1970. The Market for "Lemons": Quality Uncertainty and the Market Mechanism. *Quarterly Journal of Economics* 84:488–500.

Angrist, Joshua, and Jonathan Guryan. 2008. Does Teacher Testing Raise Teacher Quality? Evidence from State Certification Requirements. *Economics of Education Review* 27:483–503.

Berger, Mark C., and Eugenia F. Toma. 1994. Variation in State Education Policies and Effects on Student Performance. *Journal of Policy Analysis and Management* 13:477–91.

Boyd, Donald, Pamela Grossman, Hamilton Lankford, Susanna Loeb, and James Wyckoff. 2006. How Changes in Entry Requirements Alter the Teacher Workforce and Affect Student Achievement. *Education Finance and Policy* 1:176–216.

Carroll, Sidney L., and Robert J. Gaston. 1981. Occupational Restrictions and the Quality of Service Received: Some Evidence. *Southern Economic Journal* 47:959–76.

Chetty, Raj, John N. Friedman, and Jonah Rockoff. 2011. The Long-Term Impacts of Teachers: Teacher Value-Added and Student Outcomes in Adulthood. Working Paper No. 17699. National Bureau of Economic Research, Cambridge, MA.

Constantine, Jill, Daniel Player, Tim Silva, Kristin Hallgren, Mary Grider, and John Deke. 2009. An Evaluation of Teachers Trained through Different Routes to Certification. NCEE 2009-4043. Washington, DC: US Department of Education.

Currie, Janet, and V. Joseph Hotz. 2004. Accidents Will Happen? Unintentional Childhood Injuries and the Effects of Child Care Regulations. *Journal of Health Economics* 23(1):25–59.

Garet, Michael S., Stephanie Cronen, Marian Eaton, Anja Kurki, Meredith Ludwig, Wehmah Jones, et al. 2008. The Impact of Two Professional Development Interventions on Early Reading Instruction and Achievement. NCEE 2008-4031. Washington, DC: US Department of Education.

Garet, Michael S., Andrew J. Wayne, Fran Stancavage, James Taylor, Marian Eaton, Kirk Walters, et al. 2010. Middle School Mathematics Professional Development Impact Study: Findings after the First Year of Implementation. NCEE 2010-4009. Washington, DC: US Department of Education.

Gaumer, Gary L. 1984. Regulating Health Professionals: A Review of the Empirical Literature. *Milbank Memorial Fund Quarterly: Health and Society* 62:380–416.

Glazerman, Steven, Daniel Mayer, and Paul Decker. 2006. Alternative Routes to Teaching: The Impacts of Teach for America on Student Achievement and Other Outcomes. *Journal of Policy Analysis and Management* 25:75–96.

Glazerman, Steven, and Allison Seifullah. 2012. An Evaluation of the Chicago Teacher Advancement Program (Chicago TAP) after Four Years. Washington, DC: Mathematica Policy Research.

Goldhaber, Dan, and Duncan Chaplin. 2012. Assessing the "Rothstein Falsification Test": Does It Really Show Teacher Value-Added Models Are Biased? CEDR Working Paper No. 2012-1.3. University of Washington, Center for Education Data and Research, Seattle.

Guarino, Cassandra, Mark Reckase, and Jeffrey Wooldridge. 2012. Can Value-Added Measures of Teacher Education Performance Be Trusted? Working Paper No. 18. Michigan State University, Education Policy Center, East Lansing. http://education.msu.edu/epc/library/documents/WP18Guarino-Reckase-Wooldridge-2012-Can-Value-Added-Measures-of-Teacher-Performance-Be-T_000.pdf.

Harris, Douglas N., and Tim R. Sass. 2011. Teacher Training, Teacher Quality and Student Achievement. *Journal of Public Economics* 95:798–812.

Jackson, Kirabo. 2014. Teacher Quality at the High-School Level: The Importance of Accounting for Tracks. *Journal of Labor Economics* 32:645–84.

Jacob, Brian A., and Lars Lefgren. 2004. The Impact of Teacher Training on Student Achievement: Quasi-Experimental Evidence from School Reform Efforts in Chicago. *Journal of Human Resources* 39:50–79.

Johnson, Linda L., and Christine Loucks. 1986. The Effect of State Licensing Regulations on the Real Estate Brokerage Industry. *AREUEA Journal* 14:567–82.

Kane, Thomas J., Jonah E. Rockoff, and Douglas O. Staiger. 2008. What Does Certification Tell Us about Teacher Effectiveness? Evidence from New York City. *Economics of Education Review* 27:615–31.

Kane, Thomas J., and Douglas O. Staiger. 2008. Estimating Teacher Impacts on Student Achievement: An Experimental Evaluation. Working Paper No. 14607. National Bureau of Economic Research, Cambridge, MA.

Kleiner, Morris M. 2000. Occupational Licensing. *Journal of Economic Perspectives* 14(4): 189–202.

Kleiner, Morris M., and Alan B. Krueger. 2010. The Prevalence and Effects of Occupational Licensing. *British Journal of Industrial Relations* 48:676–87.

Kleiner, Morris M., and Robert T. Kudrle. 2000. Does Regulation Affect Economic Outcomes? The Case of Dentistry. *Journal of Law and Economics* 43:547–82.

Koedel, Cory, and Julian R. Betts. 2011. Does Student Sorting Invalidate Value-Added Models of Teacher Effectiveness? An Extended Analysis of the Rothstein Critique. *Education Finance and Policy* 6:18–42.

Larsen, Bradley. 2013. Occupational Licensing and Quality: Distributional and Heterogeneous Effects in the Teaching Profession. Unpublished manuscript. Massachusetts Institute of Technology, Department of Economics, Cambridge.

Leland, Hayne E. 1979. Quacks, Lemons and the Market Mechanism: A Theory of Minimum Quality Standards. *Journal of Political Economy* 87:1328–46.

Lott, John R., Jr. 1996. Why Does Professional Licensing Rely on Minimum Schooling Requirements? Working paper. University of Chicago Law School, Chicago.

Maurizi, Alex. 1980. The Impact of Regulation on Quality: The Case of California Contractors. Pp. 299–333 in *Occupational Licensure and Regulation*, edited by S. Rottenberg. Washington, DC: American Enterprise Institute for Public Policy Research.

Mihaly, Kata, Daniel McCaffrey, Tim R. Sass, and J. R. Lockwood. 2013. Where You Come from or Where You Go? Distinguishing between School Quality and the Effectiveness of Teacher Preparation Program Graduates. *Education Finance and Policy* 8:459–93.

Peltzman, Sam. 1976. Toward a More General Theory of Regulation. *Journal of Law and Economics* 19:211–40.

Ramseyer, J. Mark, and Eric B. Rasmusen. 2012. Improving the Bar by Lowering the Bar: Licensing Difficulty and Attorney Quality in Japan. Unpublished manuscript. Harvard Law School, Cambridge, MA.

Rivkin, Steven G., Eric A. Hanushek, and John F. Kain. 2005. Teachers, Schools and Academic Achievement. *Econometrica* 73:417–58.

Rothstein, Jesse. 2010. Teacher Quality in Educational Production: Tracking, Decay, and Student Achievement. *Quarterly Journal of Economics* 125:175–214.

Sass, Tim R., Anastasia Semykina, and Douglas N. Harris. 2014. Value-Added Models and the Measurement of Teacher Productivity. *Economics of Education Review* 38:9–23.

Shapiro, Carl. 1986. Investment, Moral Hazard and Occupational Licensing. *Review of Economic Studies* 53:843–62.

Springer, Matthew G., Dale Ballou, Laura Hamilton, Vi-Nhuan Le, J. R. Lockwood, Daniel F. McCaffrey, et al. 2010. *Teacher Pay for Performance: Experimental Evidence from the Project on Incentives in Teaching*. Nashville: National Center on Performance Incentives.

Springer, Matthew G., John F. Pane, Vi-Nhuan Le, Daniel F. McCaffrey, Susan Freeman Burns, Laura S. Hamilton, et al. 2012. Team Pay for Performance: Experimental Evidence from the Round Rock Pilot Project on Team Incentives. *Educational Evaluation and Policy Analysis* 34:367–90.

Stephenson, E. Frank, and Erin E. Wendt. 2009. Occupational Licensing: Scant Treatment in Labor Texts. *Econ Journal Watch* 6:181–94.

Stigler, George J. 1971. The Theory of Economic Regulation. *Bell Journal of Economics and Management Science* 2:3–21.

Wilson, Suzanne, Robert E. Floden, and Joan Ferrini-Mundy. 2001. *Teacher Preparation Research: Current Knowledge, Gaps, and Recommendations*. Seattle: Center for the Study of Teaching and Policy.

Xu, Zeyu, Jane Hannaway, and Colin Taylor. 2011. Making a Difference? The Effects of Teach for America in High School. *Journal of Policy Analysis and Management* 30:447–69.