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The Impact of Incentives to Recruit and Retain Teachers in "Hard-to-Staff" Subjects: An Analysis of the Florida Critical Teacher Shortage Program

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Abstract

We investigated the effects of a statewide program designed to increase the supply of teachers in "hard-to-staff" areas. The Florida Critical Teacher Shortage Program (FCTSP) had three elements: (a) it provided loan forgiveness to teachers who were certified and taught in designated shortage areas; (b) it compensated teachers for the tuition cost of taking courses to become certified in a designated shortage area; and (c) for a single year, it gave bonuses to high school teachers who were certified and taught in a designated subject area. Employing a difference-in-difference estimator, we find that the loan forgiveness program decreased attrition of teachers in shortage areas, although the effects varied by subject. Allowing for variation in the size of payments, we find that the effects were more pronounced when loan-forgiveness payments were more generous. A triple-difference estimate indicated the bonus program also substantially reduced the likelihood of teachers leaving the public school sector. A panel probit analysis reveals that the tuition-reimbursement program had modest positive effects on the likelihood a teacher would become certified in a designated shortage area. We also present qualitative evidence that loan-forgiveness recipients were of higher quality (as measured by value added) than nonrecipients who taught in the same subject but were not certified and thus ineligible.

I. Introduction

Teacher staffing problems are pervasive in certain subject areas—such as secondary math and science, and special education—where the combination of training requirements and relatively high alternative wages makes it difficult to attract and retain high-quality teachers. Ingersoll and Perda (2009) find that roughly three to four times as many secondary schools report significant difficulty in filling positions in mathematics, special education, and science relative to positions in English or social studies. Similarly, Billingsley, Fall, and Williams (2006) report that high percentages of uncertified new special educators enter teaching each year. In Florida, the percentage of new hires in special education, English for Speakers of Other Languages (ESOL), math, and science who are not certified in their subject typically far exceeds the percentage of uncertified new hires among elementary education teachers (Florida Department of Education, 2008).

The problems with staffing such “high-need” areas are exacerbated in urban schools and schools serving high proportions of low-income students, because teachers tend to migrate toward schools with high-achieving students from affluent backgrounds and to avoid schools serving primarily minority students, low-achieving students, and students with disciplinary problems (Boyd, Lankford, Loeb, & Wyckoff, 2005; Feng, 2009; Hanushek, Kain, & Rivkin, 2004; Imazeki, 2005; Lankford, Loeb, & Wyckoff, 2002; Scafidi, Sjoquist, & Stinebrickner, 2007). Furthermore, filling positions in high-need areas with unqualified personnel may worsen supply problems in the long run. Miller, Brownell, and Smith (1999) find uncertified special education teachers are less likely to stay in their positions. Boe, Cook, and Sunderland (2006) find attrition rates among beginning teachers with minimal preparation are twice as high compared to those with more extensive preparation.

The federal government as well as many states and districts have adopted differential-compensation systems designed to attract and retain teachers in hard-to-staff subjects. These programs generally fall into three categories: (a) tuition reimbursement and loan forgiveness for new teachers, (b) one-time “signing bonuses” or moving expense reimbursements for new recruits, and (c) salary enhancements for existing teachers who teach in designated schools and subjects. At the federal level, the U.S. Department of Education will forgive up to $17,500 of debt for highly qualified math, science, or special education teachers who have taught continuously for 5 years in a Title I school (Martin, 2007). At least 40 states also offer some kind of loan forgiveness or scholarship program for teachers, although the specific programs vary considerably (American Federation of Teachers, 2009). One-time payments are less common, but they have been used in a number of states, such as California, Mississippi, and Virginia (Martin, 2007). Although Georgia allows new math and science teachers to start at a pay rate equivalent to teachers with 5 years of experience, most salary differential programs are operated at the district level. Examples include Aldine, Texas; Hamilton County, Tennessee; and Mobile, Alabama (Martin, 2007).

To broaden understanding of the effects of incentives designed to attract and retain teachers in high-need subjects, we study the Florida Critical Teacher Shortage Program (FCTSP). The program has three elements: loan forgiveness, tuition reimbursement, and (for a brief time) retention bonuses. A series of exogenous changes in program coverage and funding levels allow us to evaluate the causal effects of the FCTSP on the attraction and retention of teachers in designated critical shortage areas. For middle- and high-school math teachers and for special education teachers, we provide qualitative evidence on the relationship between program participation and teacher quality (as measured by teacher value-added criteria).

II. Program Details

The FCTSP was established in 1984 by the Florida Legislature to increase the supply of teachers in particular certification areas. Awards were made to qualifying teachers beginning in 1986-87 and continued through 2009-10, after which the Florida Legislature discontinued funding for the FCTSP.[1] The FCTSP had two primary components: a Tuition Reimbursement (TR) program and a Loan Forgiveness (LF) program. The TR program was designed primarily to encourage existing teachers to become certified in a designated critical shortage subject area. To qualify, an individual had to have been employed by a Florida public school during the academic year and taken courses leading to certification or an advanced degree in a critical shortage area. To receive reimbursement for a course the teacher had to have passed the course with a minimum grade of 3.0 on a 4-point scale. In contrast, the LF Program targeted teachers who recently completed an undergraduate or graduate degree and were in their first year of teaching in a critical shortage area in a public school. To be eligible, a teacher had to have taught for at least 90 days in a critical shortage area and possess certification in that area. Initial applications had to be made at the end of their first year of teaching in the relevant critical-shortage area.[2] For both programs, shortage areas were typically announced well in advance (typically 6–8 months prior to the start of the academic year). Applications had to be submitted by early July, based on applicants' teaching and certification status in the just-completed school year. Payments were typically made by the end of September.

Payments to teachers varied considerably across the two programs. In the TR program, eligible teachers could receive payments of up to $78 per credit hour, for a maximum 9 hours per award year or $702 per year. The maximum total amount eligible applicants could receive was $2,808 for up to 36

[1]Funding for both programs was eliminated by the 2011 Florida Legislature, so the last cohort of teachers to receive awards were those who applied in the 2009-10 school year. See Florida CS/HB 7087, 2011 Legislative Session.
[2]See 2002 Florida Statutes 1009.58 (tuition reimbursement) and 1009.59 (loan forgiveness) and Florida Administrative Code 6A-20.012 (tuition reimbursement) and 6A-20.013 (loan forgiveness).

credit hours. Annual awards were prorated based on the number of eligible applicants and the total appropriation provided by the Legislature. The LF program enhanced the compensation of eligible Florida teachers by repaying student loans if they continued teaching in a designated critical shortage area. Compared to the TR program, the potential LF compensation was much more generous. For undergraduate loans, the maximum allowable award was $2,500 per year; for graduate loans the maximum was $5,000 per year. Awards could be received for a maximum of four academic years or a total disbursement of $10,000, whichever came first.[3] As with the TR program, actual compensation varied annually according to the number of applicants and the legislative appropriation. Funding for the programs was relatively stable until 2002, with LF payouts averaging $2,000–$3,000 per teacher, and TR hovering just under $500 per teacher. The 2002 Legislature slashed funding for the programs, resulting in a nearly 48% reduction in funding and a drastic decrease in payments per teacher. Figures 1 and 2 show annual numbers of participants and average payments for both the LF and TR programs. The drop in funding led to an increase in the number of LF recipients, as payments were spread out over more years; the number of initial recipients stayed relatively constant after the cut in funding.

The FCTSP legislation required the Florida State Board of Education to identify critical teacher shortage areas each year. The Florida Commissioner of Education provided a list of recommended areas to the board, based on (a) current vacancies in the discipline, (b) positions filled by teachers lacking proper certification in the relevant field, and (c) the projected supply of future graduates in the relevant area from state-approved teacher preparation programs. Thus the designated shortage areas changed over time. For example, middle and secondary math was a designated shortage area from 1984-85

[3]In the individual-level award data, we observed approximately 20% of LF recipients receiving payments for 5 years or more. It is likely that most of these extended payment periods are due to teachers receiving LF for both an undergraduate degree and a graduate degree. In fact, nearly 15% of LF recipients received payments for both undergraduate and graduate loans.

through 1992-93; it was off the list of shortage areas from 1993-94 through 1999-2000; then it was placed back on the list in 2000-01. A matrix of covered subjects by year is provided in Table 1.

In addition to the long-standing LF and TR programs, the 2000 Florida Legislature appropriated $60 million for one-time recruitment and retention bonuses. To receive a bonus, a teacher had to be a full-time middle- or high-school classroom teacher certified in and teaching foreign languages, science, math, or exceptional student education (special education and gifted). Retention bonuses, which were capped at $1,200, were for teachers who had taught in one of the designated subjects during the 1999-2000 school year, received a favorable performance appraisal, and agreed to continue teaching in one of the designated areas during the 2000-01 school year. Recruitment bonuses were for teachers who were employed by a district for the first time in the 2000-01 school year. Districts had discretion over the form of recruitment bonuses. For example, bonuses could be used to cover moving expenses or to purchase a laptop computer. Like the retention bonuses, the payments were capped at $1,200 per teacher.[4]

The 2001 Florida Legislature also allocated $152 million for recruitment and retention bonuses equal to $850 per teacher. Unlike the bonus program in 2000, the retention bonuses were available to all teachers who had taught during the 2000-01 school year, regardless of grade level or subject. Similarly, the signing bonuses were available to all new teachers.[5]

The intertemporal changes in subject area coverage and funding levels provide an opportunity for uncovering the causal effects of the LF, TR, and bonus programs. The large and abrupt changes in funding for LF and bonuses, as well as the sudden termination of the LF and TR programs can be viewed plausibly as exogenous events that can be used to identify the effects of varying compensation on the recruitment and retention of teachers in high-need areas. While the subject-area designations were

[4] See Florida Department of Education (2000).
[5] Florida Department of Education (2001).

influenced by anticipated supply and demand conditions, the discrete changes in subject-area coverage from 1 year to the next can also be used to identify the effects of the programs.

III. Literature Review

Although LF and TR programs are the most common teacher incentive schemes, we find no prior research on the effect they have on the supply of new teachers into targeted fields or targeted schools. There is evidence that LF programs in medicine have helped to retain physicians in rural and medically underserved areas (Pathman, Konrad, King, Taylor, & Koch, 2004). However, LF programs have been shown to be less effective in attracting students into public interest law than tuition waivers of equivalent value (Field, 2009).

The extant literature on pay differentials for working in hard-to-staff fields is similarly thin.[6] Only one rigorous study currently exists: an analysis of a $1,800 per year retention bonus paid to existing North Carolina teachers (Clotfelter, Glennie, Ladd, & Vigdor, 2008). The North Carolina program was a combination of subject-area and school-type differential pay. To qualify, teachers had to be certified in math, science, or special education and work in middle and high schools that serve primarily low-performing or low-income students. The $1,800 bonus was equivalent to about 4% to 5% of the average pay of teachers in North Carolina. Clotfelter et al. (2008) adopt a difference-in-difference-in-difference strategy to compare teachers before and after the implementation of the program, eligible teachers with ineligible teachers, and teachers in eligible schools with those in ineligible schools. Despite some

[6] There are also three rigorous studies of the effects of programs designed to increase the supply of teachers in high-need schools. Steel, Murnane, and Willett (2009) study a California program that offered a $20,000 bonus to a select group of new teachers who agreed to teach in high-need schools. Glazerman, Protik, Teh, Bruch, and Max (2013) conduct an experimental analysis of the Teacher Transfer Initiative, a federally funded initiative that offered $20,000 in incentives for high-quality teachers to teach in low-achieving schools for 2 years. Falch (2010, 2011) studies a decade-long bonus program for Norwegian teachers. The program paid wage premiums to teachers in schools with chronic staffing shortages.

problems in making teachers aware of the program, the targeted salary increases were sufficient to reduce turnover rates by 17%.

IV. Data

Data on individual-level payments for both the LF and TR programs were provided by the Florida Department of Education's Office of Student Financial Assistance (OSFA). Although awards began in 1986-87, we could obtain individual-level data on LF only from 1996-97 forward and from 2001-02 forward for the TR program. Before 2002-03, the LF data do not distinguish between payments for undergraduate and graduate loans, nor do they distinguish between initial awards and renewals. Thus, for the first year of LF data (1996-97), we do not know whether payments made in that year were for initial awards or renewals.

Data for the universe of Florida public school teachers from 1995-96 through 2012-13 were obtained from the Florida Department of Education's Education Data Warehouse. These data include demographic characteristics, educational attainment, experience, certifications held, and classes taught for each individual teacher. Because the data are statewide, we can determine when a teacher stops teaching in the Florida public schools.

Data for teachers are linked to the students they teach in each classroom, so we can determine the characteristics of students a teacher instructs. The data also contain test scores for individual students. The State of Florida administered the "Sunshine State Standards" Florida Comprehensive Achievement Test (FCAT-SSS) for math and reading in each of the Grades 3–10 beginning in school-year 2000-01 and ending in 2010-11.[7] We can, therefore, compute value-added measures of the effect of

[7] Beginning in 2010-11 the state adopted a new test, dubbed the FCAT 2.0. Scores for the first administration of the FCAT 2.0 were retrofitted to be comparable to the original FCAT scores. The Florida Department of Education does not deem the FCAT 2.0 scores from subsequent years to be comparable to those from the original FCAT, however.

individual teachers in these subjects for each of the years

2001-02 through 2010-11.

V. Methods

As described above, the LF program primarily targeted early-career teachers who were already teaching and certified in a designated subject area. Although the LF program may have had some effect on the supply of new teachers in the long run, the most immediate effect would be on retention of existing teachers.[8] We exploit the fact that teachers had to be both eligible for the LF program and the program had to be available in a given year to receive payment and estimate a difference-in-difference model of the duration of teaching in Florida public schools.

Specifically, we estimate a Cox proportional hazard model of the form:

$$logit[\lambda(t_i)] = \alpha + \beta_{1j}E_{ij}^{LF} + \beta_{2j}Z_{tj}^{LF} + \beta_{3j}(E_{ij}^{LF} \times Z_{tj}^{LF}) + \gamma(X_{it}) \qquad (1)$$

where $\lambda(t_i)$ is the probability that a teaching spell ends at the close of period t for teacher i, conditional on that spell lasting through period t.[9] E_{ij}^{LF} is a set of indicators for teachers who ever meet the LF criteria of being certified and teaching in subject j, where j = 1,N and N is the number of ever-covered subjects. Z_{tj}^{LF} is a set of indicators that signify the LF program was in place in year t for subject j. X_{it} is a vector of teacher and school characteristics that typically impact teacher attrition decisions (e.g., demographic characteristics of students taught, student behavior, students' prior achievement levels, teacher gender, etc.). Also included in X are a set of year indicators to capture any unobserved time-

[8] An analysis of long-run supply effects is problematic due to two data limitations. First, the Florida Education Data Warehouse only includes information on postsecondary students who attend public colleges and universities in Florida; therefore, we cannot track the numbers of students who obtain education degrees in private postsecondary institutions. Second, for students in public colleges and universities we only have course taking and major information for the period 2000-01 through 2011-12. The readily identifiable critical-need subject areas (math, science, special education, and ESOL) were each designated shortage areas throughout this time period, thereby eliminating the possibility of a difference-in-differences analysis.

[9] We determine the end of a spell based on whether a teacher is teaching in a Florida public school in period t + 1.

varying factors affecting teacher labor market decisions. The set of coefficients β_{1j} represents the difference in the hazard rates between ever-eligible teachers (those certified and teaching in each subject *j*) and never-eligible teachers.[10] β_{2j} represents the effect of being in a year in which a subject is covered by the LF program (both designated as a critical-need area and the LF program is in existence for that subject). The coefficients of interest are β_j (*j* = 1, *N*). These coefficients represent the effect of being eligible for the LF program in subject *j* and being in a year in which the program was in effect for the given subject. β_{3j} therefore represents the difference-in-difference estimate of the effect of the LF program on the exit hazard in subject *j*. Although we observe both teaching assignments and certification status of teachers in each year, we do not know whether teachers possessed any student loan debt to be forgiven. The estimated impact, β_3, therefore should be interpreted as the effect of the "intent to treat."

The effects of the one-time retention bonuses can similarly be analyzed in the context of the Cox proportional hazard model. Recall that the year 2000 retention bonus was limited to teachers who taught in a designated set of critical-need subjects at the middle- and high-school level in the 1999-00 school year. Let S_i^B be an indicator for teachers who ever met the retention bonus criteria of being certified and teaching in the set of designated subject areas. G_{it}^B indicates teachers teaching middle- and high-school classes, and Z_t^B is an indicator for the single year the program was in effect. Combining these variables with the LF program factors into a single hazard model yields:[11]

$$logit[\lambda(t_i)] = \alpha + \beta_{1j}E_{ij}^{LF} + \beta_{2j}Z_{tj}^{LF} + \beta_{3j}\left(E_{ij}^{LF} \times Z_{tj}^{LF}\right) + \gamma(X_{it}) +$$

$$\delta_{1j}S_i^B + \delta_2 G_{it}^B + \delta_3 Z_t^B + \delta_4\left(S_i^B \times G_{it}^B\right) + \delta_5\left(S_i^B \times Z_t^B\right)$$

[10] When estimating the model for each subject, we exclude teachers who are ever eligible in another covered subject.

[11] In the estimation of equation (2), some terms are redundant and thus drop out of the equation. Since the bonus subjects are all also LF subjects at one time, the term $\delta_{1j}S_i^B$ is omitted from the estimated equation. Likewise, the term $\delta_3 Z_t^B$ is omitted because it is coincident with the year 1999 indicator that is included in the *X* vector.

$$\delta_6\left(G_{it}^B \times Z_t^B\right) + \delta_7\left(S_i^B \times G_{it}^B \times Z_t^B\right) \qquad (2)$$

The coefficient of interest for the year 2000 retention-bonus program is δ_7, the coefficient on the triple-interaction term. It represents the difference-in-difference-in-difference estimate of the effect of the retention-bonus program on the exit hazard. We also estimate a variant of equation (2) that accounts for the drop in funding for the LF program, beginning in 2001-02. In this alternative specification, we divide the interaction term, $(E_{ij}^{LF} \times Z_{tj}^{LF})$, into two components, $(E_{ij}^{LF} \times Z_{tj}^{LF-low})$ and $(E_{ij}^{LF} \times Z_{tj}^{LF-high})$, where *high* represents the period before 2001-02 and *low* is the period 2001-02 and later.

Unlike the year-2000 program, the retention bonus program in 2001 covered all teachers, regardless of their subject area or grade level. Therefore, the terms S_i^B and G_{it}^B would each equal 1 for all teachers, and all of the bonus-related terms in equation (2) would collapse to a single indicator for the 2000-01 school year. Consequently, it is not possible to isolate the effect of the across-the-board retention-bonus program offered in 2000; any effect of the year-2000 retention-bonus program is subsumed in the year-2000 indicator contained in the *X* vector.

The TR program was designed to encourage teachers to acquire the necessary coursework to become certified in a designated shortage area and was open to all teachers who were not already certified in a given high-need subject. Therefore, we seek to understand how the program affected the certification status of teachers. Because the program was available to all Florida teachers, we cannot use a difference-in-difference estimator in this context. Rather, we estimate a simple panel probit model of the following form:

$$Prob[C_{it} = 1] = \Phi[\alpha + \beta_1 Z_t^{TR} + \beta_2 Z_{t-1}^{TR} + \beta_3(T_{it}) + \beta_4(T_{it-1}) + \beta_5(Y_{it}) +$$

$$\beta_6({Y^2}_{it}) + \gamma(X_{it}) + \delta_i] \qquad (3)$$

where C_{it} = 1 if teacher i becomes certified for the first time in the relevant subject area in period t. Thus we only consider transitions from being uncertified to being certified. Once a teacher becomes certified in the relevant subject area, C_{it} = 0 for all subsequent years. Z_t^{TR} is an indicator that the teacher received a TR payment for the given subject in the current year.[12] It seems reasonable that the program could operate with a lag. Even though critical teacher shortage areas are announced in the preceding year, it takes time to select a program of study, enroll in school, and complete classes to qualify for TR. We therefore also include Z_{t-1}, which indicates that the teacher received a TR payment for the given subject in the prior year. T_{it} is an indicator that the teacher taught in the relevant subject in the current year. Presumably teachers who have been assigned to teach in an area in which they are not certified have a greater interest in teaching in the subject in the future and a greater incentive to take coursework to become certified in that subject compared to teachers who are not currently teaching in the relevant subject. T_{it-1} is an indicator that the teacher taught in the relevant subject in the prior year. Even though a teacher who is teaching out-of-field in a subject may have a greater interest in becoming certified in the subject, it takes time to select a program of study, enroll in school and complete classes in order to qualify for TR. Y_t is the number of years of teaching experience at time t. Presumably, the longer a teacher has taught, the greater the subject-specific human capital he or she has acquired and the less likely he or she will switch subject areas. We include a squared term to allow for nonlinear effects of experience on the likelihood of acquiring certification in a covered subject. X_{it} is a vector of teacher characteristics that could affect the decision to acquire a new certification. δ_i is a vector of

[12] Alternatively, one could let Z_t represent tuition reimbursement being available in period t. This would essentially change the analysis from "treatment on the treated" to "intent to treat." This may be somewhat problematic for the LF program, because the process operates with a lag and we would not be accounting for the timing of take-up by individuals.

individual random effects. The coefficients of interest are $\square_1$ and $\square_2$, which correspond to the effect of current and lagged TR on the likelihood that a teacher will acquire certification in the relevant subject.

Besides the effects on aggregate supply of teachers to designated subject areas, the efficacy of the LF and TR programs also depends on how they affect the quality of teachers in those subjects. If effective, the LF program increases retention of teachers who meet the eligibility criteria, i.e., they are certified and teaching in a designated critical-need subject area. If such teachers had exited, a substantial portion would likely have been replaced with uncertified teachers because finding fully certified teachers in the designated subjects is by definition problematic. Similarly, the TR program is designed to incentivize teachers to obtain certification in a critical-need subject area. Assuming the TR incentive has the intended effect, then absent the program fewer teachers in critical-need areas would be certified.

Thus we compare the quality distribution of LF and TR recipients with teachers who did not receive LF or TR, but were ever certified and teaching in the same subject, and with nonrecipients teaching in the same subject who were never certified. Because achievement tests are administered in consecutive grades for only two subjects, math and reading, we can compute value-added measures only for teachers who are responsible for math or reading instruction. The critical-need subject with the most direct link to state assessments is middle- and high-school math. In addition, because of their large number, we also compare value added for special education teachers.

VI. Empirical Results

A. Summary Statistics

Table 2 provides summary statistics for Florida K–12 teachers and their students. The data are broken down into five categories: (a) teachers who did not participate in any of the three programs, (b) teachers eligible for LF (i.e., those who were certified and taught in a critical need area in the same year), (c) LF recipients, (d) TR recipients, and (e) recruitment-and-retention bonus recipients. Due to the nature of the programs, the recipients tend to be much younger and have less experience than nonrecipients. Recipients appear similar to eligible teachers, suggesting that self-selection of participants may be minimal. The makeup of classrooms appears to be similar for recipients and nonrecipients. The one exception is a higher number of disciplinary incidents per student. However, that is likely due to the fact that designated shortage areas are mainly in middle- and high-school subjects and in special education—areas that tend to have a greater incidence of disciplinary problems than elementary-school regular education classes. More than one-half of LF recipients are special education teachers. The next most common areas are middle- and high-school math and science teachers, each making up about one-fifth of recipients (with some overlap).

Table 3 provides a tabulation of experience for first-time recipients of LF and first-time recipients of TR. As expected, LF primarily affects early-career teachers. Nearly three-fourths of first-time LF recipients are in their first 2 years of teaching, and nearly 90% are in their first 4 years of teaching when they receive their initial award. In contrast, the experience profile of first-time TR recipients shows much more dispersion, suggesting that TR is used by midcareer teachers as well as by recent graduates. Although the modal experience level is one (i.e., second-year teachers), only 66% of first-time recipients have 4 or fewer years of experience, and more than one-fourth of first-time recipients have 5 or more years of experience.

B. Loan Forgiveness, Bonuses, and Teacher Retention

Qualitative evidence on the efficacy of the LF program is provided in Figure 3, which plots Kaplan-Meier survival estimates of teaching in Florida public schools, broken down by whether or not a teacher ever received a LF payment. To account for differences in attrition across subject areas, the sample is limited to teachers who were ever simultaneously certified and taught in a critical shortage area. For the first 6 years of teaching, LF recipients are more likely than nonrecipients to remain public school teachers in Florida. The survival rates are essentially equal in years 7 and 8, and then the survival rate of nonrecipients exceeds that of recipients in subsequent years. Recall that recipients can receive LF for an undergraduate loan for up to 4 years, and the modal experience level of initial recipients is 1 year (i.e., teachers in their second year of teaching). The higher survival rates observed over the first 6 years of teaching are consistent with the LF program's reducing teacher attrition as long as recipients are receiving payments.

In Table 4. we present Cox Proportional Hazard model estimates of the probability of exit (equation 2). Estimates from four models are presented, each with varying numbers of controls.[13] In model 1, with the fewest controls, we find that LF significantly reduces the probability of exit for middle- and high-school science teachers (8.6%), middle- and high-school math teachers (11.1%), foreign language teachers (11.4%), and ESOL teachers (25.0%). The point estimates remain fairly constant as additional controls are added to the model, although the estimate for the effect of LF on foreign language teachers eventually loses statistical significance. Although the estimated hazard for the largest group of loan recipients, special education/gifted teachers, is less than 1, it is statistically insignificant.[14]

The average base salary for teachers during the time period of analysis was approximately $35,000, and the annual LF payments to lenders averaged around $1,200. Thus, the average LF recipient experienced a roughly 3.4% increase in net pay. Given the estimated reductions in exit probabilities of 11.1% for middle and high-school math teachers and 8.6% for middle- and high-school science teachers, this implies exit elasticities for middle- and high-school math and science teachers of –2.5 and –3.3,

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[13] For space considerations, we present only the estimates of the key interaction terms. Estimates of the full set of model coefficients are available upon request.

[14] We determine the subject area an individual is teaching in by the identity of the courses they teach. Special education teachers (the majority of program participants) who are assigned solely to work with students with disabilities in general education classes and do not teach any designated special education courses would not be classified as teaching special education. Such situations are rare, however.

respectively. These estimates are comparable to the estimated elasticity of turnover of –3 from a $1,800 bonus payment in North Carolina (Clotfelter et al., 2008). The estimates are also closely aligned with the quit elasticity of –3.5 estimated from a targeted schoolwide bonus for certified teachers in Norway (Falch, 2010; Falch, 2011).

For the year-2000 bonus program, we find a large and statistically significant effect on the hazard ratio; the bonuses lead to a 24.5% reduction in the probability of exit. This finding is robust for the first three specifications, but it disappears in the fourth model when controls for courses taught and classroom-level student characteristics are included (and the sample size drops by more than 40%).

We exploit the fact that the generosity of LF abruptly dropped after 2000-01 as an additional source of identifying variation by separating the interaction term in equation (2) into two parts—one for the high-payout era prior to 2001-02 and another for the low-payout period after 2000-01. This can be done only for the two subject areas that span the two time periods: special education/gifted and ESOL. Table 5 shows results from estimating this alternative specification.

The effect of the LF program on the probability of exit for special education/gifted teachers in the high-payout period is now estimated to be –12.7% and is statistically significant at better than the .01 level. During this high-payout period, the average LF amount is around $2,000, which is equivalent to a 5.7% increase in net pay for the average teacher. The attrition reduction of 12.7% therefore translates into an exit elasticity of –2.22 for special education teachers. During the low-payout period, the average LF payment was only about $750. This is equivalent to a 2% increase in net pay for a teacher with the average salary. We estimate the effect of this change in net salary on the exit probability of special education/gifted teachers to be small (–0.9%) and statistically insignificant.

For ESOL, the program effects are large and statistically significant in both the high- and low-payout periods, with estimated effects of –32.9% and –23.2%, respectively. Effects for other subject areas remain similar to those from the original specification that did not account for changes in the generosity of payments.

C. Tuition Reimbursement and Certification

Table 6 provides qualitative evidence on the relationship between participation in the TR program, certification status, and teaching assignments. For midcareer teachers (those we can observe 5 years prior to the receipt of their initial LF award), a bit more than one-half are certified in one or more ever-designated shortage areas, and roughly two-thirds are teaching in one or more ever-designated shortage areas 5 years prior to receiving TR. Two-years prior to initial TR receipt, two-thirds of eventual recipients are certified in one or more ever-designated areas, and nearly 80% are teaching in one of the ever-designated shortage areas. This includes both midcareer teachers and some early-career teachers. We do observe modest increases in both certification and teaching just before and immediately after initial receipt (when certification-oriented coursework may be occurring). Between 2 years prior to receipt and 1 year after initial receipt, certification in any ever-designated subject rises by more than 13 percentage points, from 67.2% to 81.7%. Similarly, the proportion teaching in an ever-designated shortage area climbs from 78.8% to 86.9%.

Table 7 shows estimates of the probability of becoming certified in an ever-designated shortage area for the first time (equation 3). Receipt of TR in the current and in the prior year are both positively related to the likelihood of becoming newly certified in one of the ever-designated shortage areas. The point estimates are quite small in absolute terms, although the underlying probabilities are small as well. The receipt of TR (either in the current or prior year) is estimated to increase the likelihood of becoming certified in a designated shortage area by 0.9% to 1.0%. Because the average probability of becoming newly certified in a designated shortage area is 0.8%, this represents this represents a more than doubling of the likelihood of becoming certified. The control variables in the model have the expected signs. Prior teaching experience in a subject raises the probability of becoming certified, and obtaining certification in a new subject area diminishes with experience.

D. Teacher Quality

Ultimately, the efficacy of both LF and TR depends not only on the ability to attract and retain teachers in high-need subjects, but also the quality of the teachers who are enticed to become certified and teach (or induced not to leave). In Figures 4A–C (LF) and 5A–C (TR) we present kernel density plots of teacher value-added in math for middle- and high-school math teachers as well as value added in both math and reading for special education teachers.[15] We compare recipients' value-added distribution to that of nonrecipients teaching in the same subject to two comparison groups: (a) nonrecipients who were ever simultaneously certified and taught in the same subject area and (b) nonrecipients who taught in the same subject area but who were never certified.

In Figure 4A, we see that LF recipients are of essentially equal quality to nonrecipients who are teaching and certified in middle- and high-school math. In contrast, middle- and high-school math teachers who are never certified are of much lower quality than LF recipients. Figures 4B and 4C provide similar comparisons for special education teachers in math and in reading, respectively. The differences are not as stark as for middle- and high-school math teachers. However, it is still the case that the value added for LF recipients is generally comparable to that of nonrecipients who also are certified and teaching in special education, whereas special education teachers who never become certified tend to have lower value-added scores.[16]

[15] Details on the construction of the value-added measures are provided in Feng and Sass (2015).
[16] The positive relationship between subject-area certification and teacher value added may appear atypical at first blush, given the general finding that teacher credentials are uncorrelated with teacher performance. However, much of the value-added literature is based on regular education teachers in elementary and middle school. Clotfelter, Ladd, and Vigdor (2010) find that in-subject certification is associated with higher student test scores in high school. Similarly, Feng and Sass (2013) find that teachers of special education courses who are certified in special education produce higher student test scores in both math and reading than do teachers who are not special-education certified.

The value-added distributions for TR recipients and comparison teachers who are teaching in the same subject are similar to those for LF recipients and their comparison groups. In Figure 5A, we show that the quality distribution for TR recipients who are ever simultaneously certified and teaching middle- or high-school math is nearly identical to that of nonparticipants who are certified and teaching middle- and high-school math. The value-added distribution of nonparticipants who teach middle- or high-school math but are never certified is shifted to the left. As with LF, the differences between certified and uncertified special education teachers are less pronounced, but the effectiveness of special education teachers who are never certified in special education is generally lower

VII. Summary and Conclusions

Given fixed pay scales, many school districts experience chronic shortages in high-need areas such as special education, math, and science. While there have been a few attempts to offer differential pay, the more common policy response has been to subsidize teachers' education to attract and retain teachers in high-need areas. In this paper, we analyze the effects of one of the longest running such programs, Florida's Critical Teacher Shortage Program. The program had two primary components—an LF program targeted to early career teachers were certified and taught in a set of designated shortage areas, and a TR program that provided subsidies to teachers who took coursework that could lead to certification in a designated shortage area. In addition, Florida offered retention bonuses to teachers in designated shortage areas in a single year.

Exploiting variation in program coverage across time and across subjects, as well as variation in the generosity of payments, we find that the LF component did have substantial positive effects on the likelihood an individual would remain in teaching. The effects vary across subjects and depend in part on the magnitude of payments. Positive effects were found for four of seven subject areas (science, math, foreign languages, and ESOL). Positive effects were also found for the largest shortage-area category, special education/gifted teachers, although only when payments were relatively large. We also found that the $1,200 one-time retention bonus offered to high school teachers in designated subject areas decreased teacher attrition in the targeted areas by as much as 25%.

There is also evidence that the TR program increased the likelihood a teacher would become newly certified in a high-need area. Teachers receiving TR in the current or prior year were more than twice as likely as nonrecipients to become certified in a high-need area.

Our findings suggest that educational subsidies, particularly ex-post LF for early-career teachers, can be effective tools at promoting the retention of teachers in high-need areas. Similar to the prior work by Clotfelter et al. (2008), we find that relatively modest payments of $500 to $1,000 per year can reduce attrition in some high-need subjects, although in some subjects, such as special education, only payments on the order of $2,500 per year appear effective. The efficacy of direct payments to teachers appears to be more cost-effective than loan subsidies. A one-time bonus of $1,200 reduced teacher attrition more than loan repayments of comparable magnitude.

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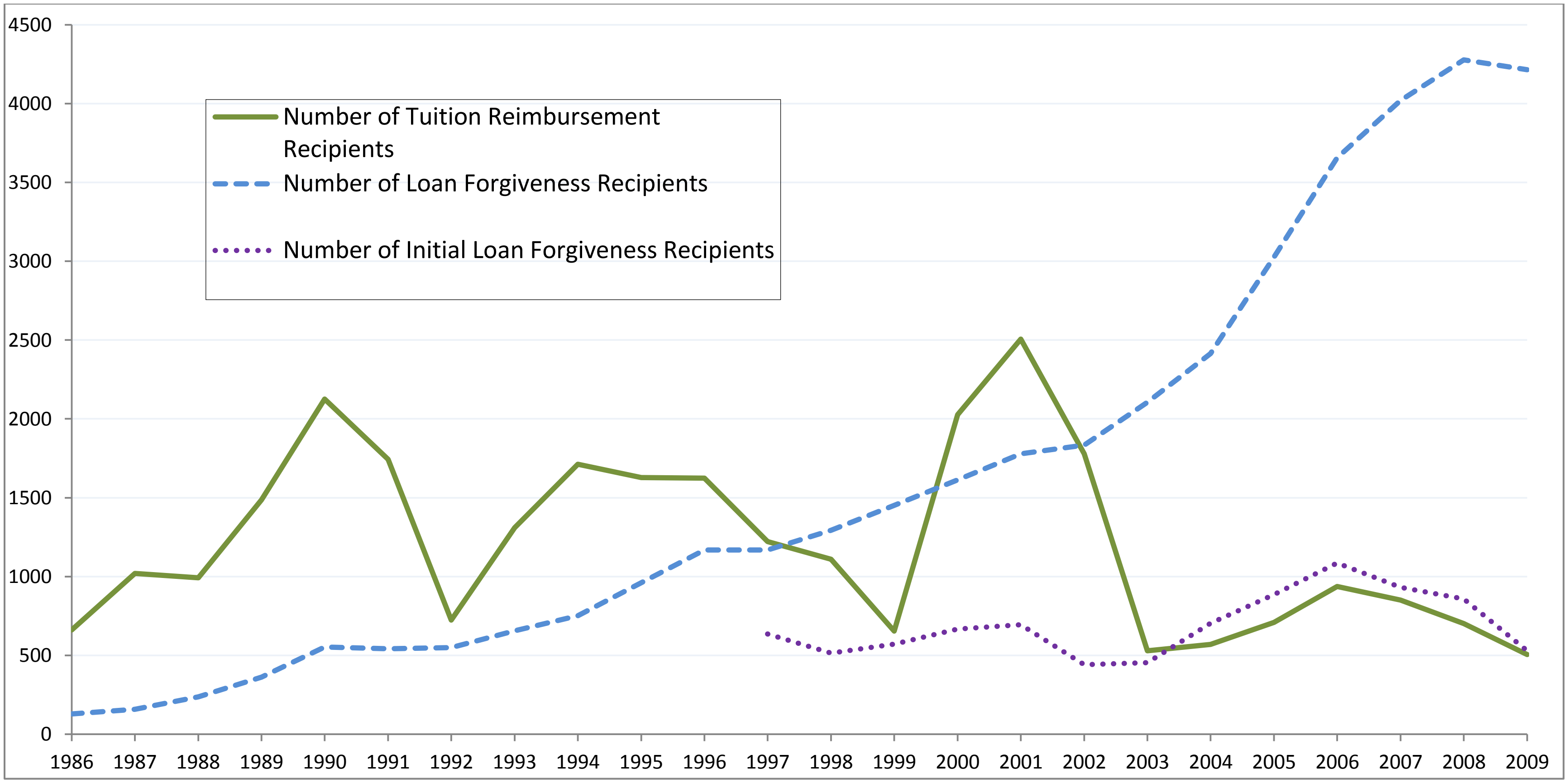
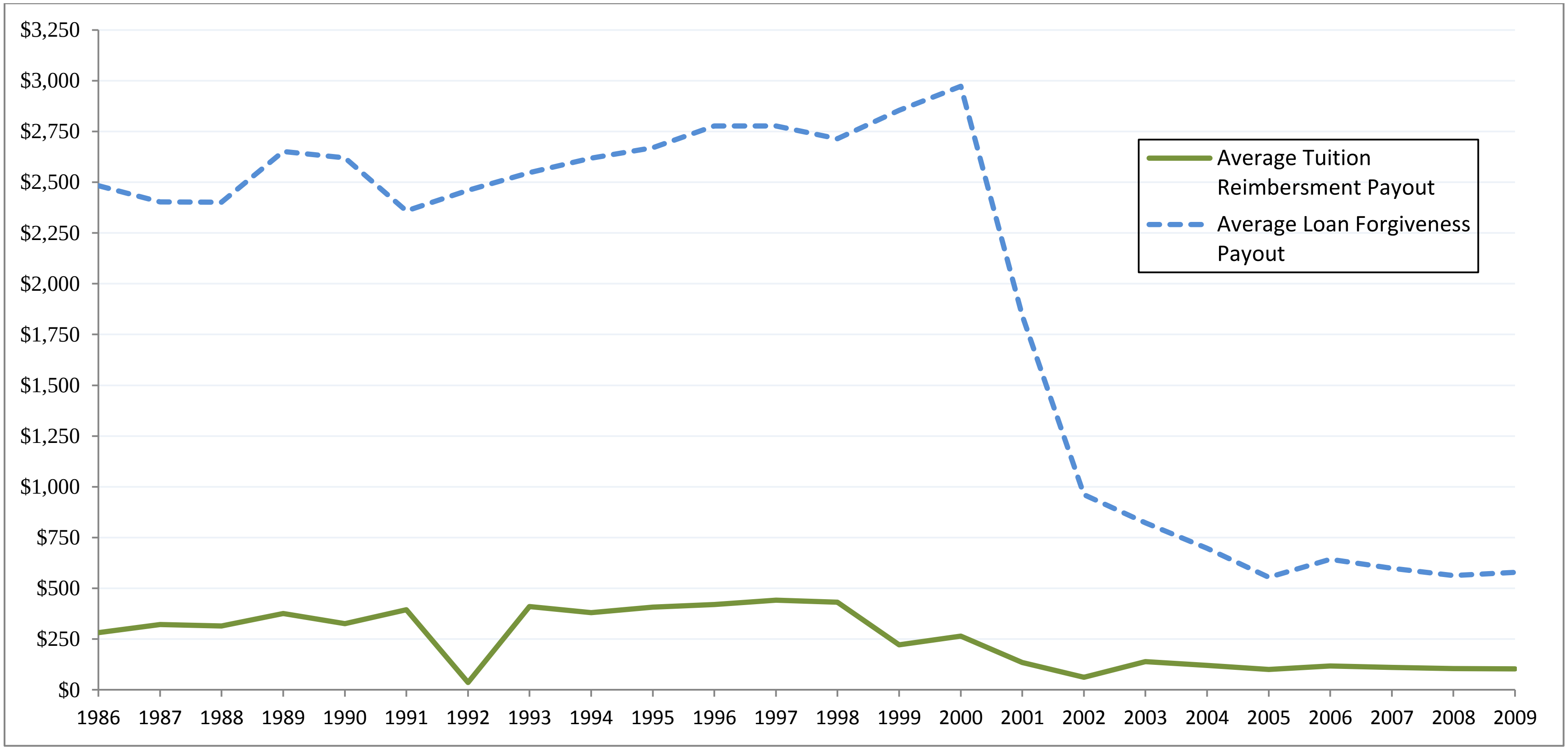
Figures and Tables

Figure 1. Number of Teachers Receiving Tuition Reimbursement and Loan Forgiveness Payments by Year, 1986-87 Through 2009-10



Source: Florida Department of Education, Office of Student Financial Assistance, *Annual Report to the Commissioner* (various years) and authors' calculations from individual-level data.

Figure 2. Average Payment per Recipient in Tuition Reimbursement and Loan Forgiveness Programs by Year, 1986-87 Through-2009-10



Source: Florida Department of Education, Office of Student Financial Assistance, *Annual Report to the Commissioner* (various years).

Table 1. Designated Critical Teacher Shortage Areas, 1984-85 Through 2009-10

	Math	Science	Middle & High Science	Middle & High Math	Speech Ther-apy	Emo-tionally Handi-capped	ESE ("Han-dicap-ped")	ESE (Special Ed.)	Foreign Lang-uages	English	Middle & High English	Read-ing	ESOL	Tech. Ed./ Ind. Arts
1984-1985	x	x			x	x			x					x
1985-1986	x	x				x			x	x				
1986-1987	x	x				x			x	x				
1987-1988	x	x				x			x					
1988-1989	x	x				x			x	x				
1989-1990			x	x			X		x		x			
1990-1991			x	x			X		x		x			
1991-1992			x	x			X		x		x			
1992-1993			x	x				X					x	
1993-1994								X					x	
1994-1995								X					x	
1995-1996								X					x	
1996-1997								X					x	x
1997-1998								X					x	x
1998-1999								X					x	x
1999-2000								X					x	x
2000-2001			x	x				X					x	x
2001-2002			x	x				X	x				x	x
2002-2003			x	x				X	x			x	x	x
2003-2004			x	x				X	x			x	x	x
2004-2005			x	x				X	x			x	x	x
2005-2006			x	x				X	x			x	x	x
2006-2007			x	x				X	x			x	x	x
2007-2008			x	x				X	x			x	x	x
2008-2009			x	x				X	x		x	x	x	x
2009-2010			x	x				X	x		x	x	x	x

Source: Florida Department of Education, *Critical Teacher Shortage Areas* (various years). ESE, elementary special education; ESOL, English for speakers of other languages; Tech Ed./Ind. Arts, technical education/industrial arts. In school year 1992-1993, middle- and high-school-level science was specifically labeled Middle and High Level Physical Sciences. In all years where Industrial Arts appears, except 1984-1985, it appears as Technology Education/Industrial Arts. Thus, they are listed as a combined area. School psychologists were also designated as a shortage area from 2002-03 through 2007-08 but are omitted because they are not instructional personnel.

Table 2. Mean and Standard Deviation of Characteristics of Nonrecipients, Eligible Teachers, Loan-Forgiveness Recipients, Tuition-Reimbursement Recipients, and Bonus Recipients

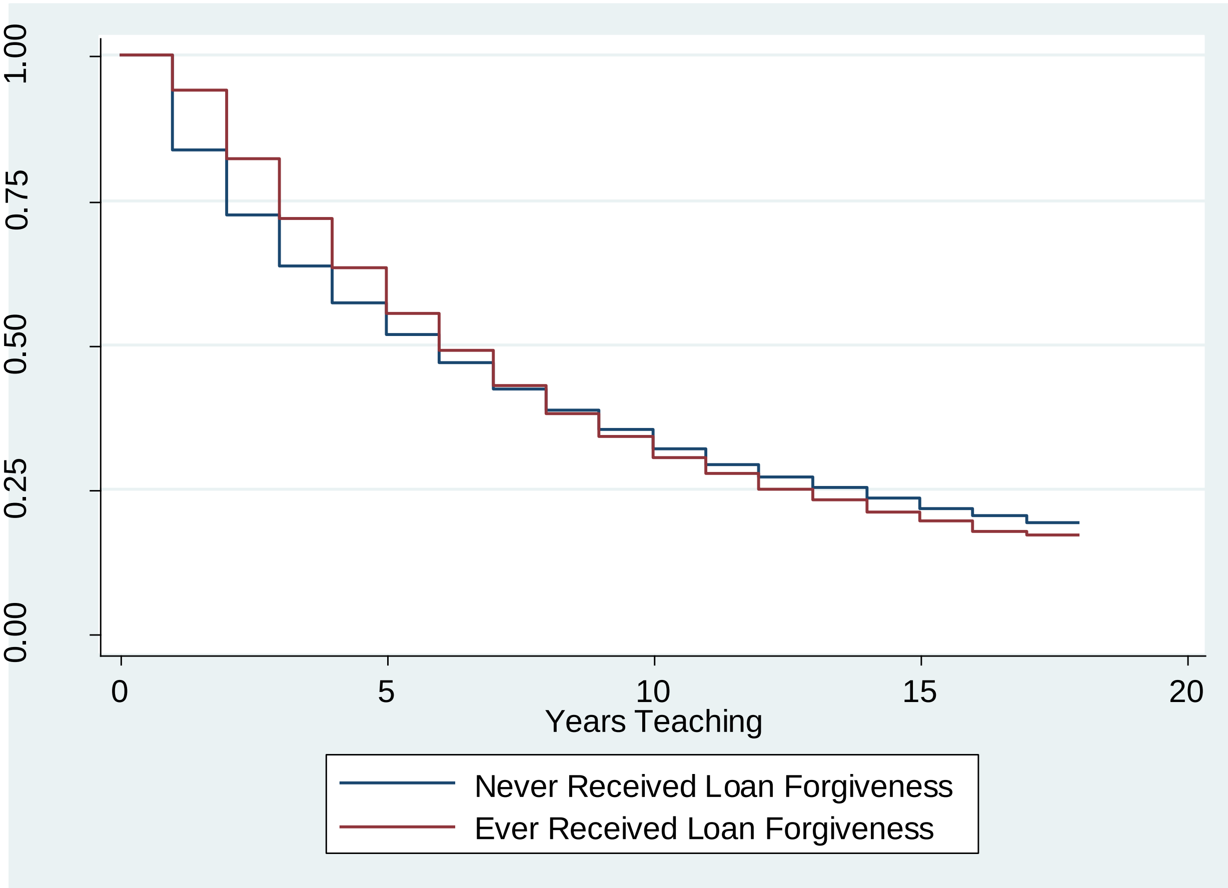
	Nonrecipients	Teachers Eligible for Loan Forgiveness	Loan Forgiveness Recipients	Tuition Reimbursement Recipients	Bonus Recipients
Female	0.78 (0.41)	0.75 (0.43)	0.82 (0.38)	0.83 (0.37)	0.77 (0.42)
Black	0.14 (0.35)	0.12 (0.33)	0.17 (0.38)	0.18 (0.39)	0.11 (0.31)
Hispanic	0.10 (0.30)	0.10 (0.30)	0.12 (0.33)	0.13 (0.33)	0.03 (0.16)
Other non-White	0.01 (0.10)	0.01 (0.12)	0.01 (0.12)	0.02 (0.14)	0.01 (0.08)
Experience in Florida Public Schools	10.26 (9.22)	10.12 (8.93)	5.09 (4.60)	6.72 (6.17)	14.79 (9.07)
Exited Florida Public Schools	0.13 (0.34)	0.12 (0.33)	0.13 (0.34)	0.09 (0.29)	0.08 (0.27)
Amount of loan forgiveness received ($)			1,203.35 (1,272.88)		
Amount of tuition reimbursement received ($)				151.55 (87.76)	
Amount of bonus payment received ($)					1,197.53 (184.67)
Certified in middle/HS math	0.08 (0.27)	0.27 (0.44)	0.13 (0.34)	0.16 (0.37)	0.23 (0.42)
Certified in middle/HS science	0.06 (0.25)	0.23 (0.42)	0.11 (0.31)	0.12 (0.32)	0.21 (0.41)
Certified in foreign languages	0.03 (0.17)	0.08 (0.27)	0.02 (0.15)	0.04 (0.18)	0.06 (0.23)
Certified in reading	0.03 (0.16)	0.01 (0.12)	0.03 (0.16)	0.09 (0.29)	0.01 (0.12)
Certified in middle/HS English	0.11 (0.31)	0.04 (0.21)	0.04 (0.21)	0.10 (0.30)	0.05 (0.22)
Certified in special education	0.15 (0.35)	0.45 (0.50)	0.72 (0.45)	0.30 (0.46)	0.40 (0.49)
Certified in ESOL	0.04 (0.20)	0.03 (0.18)	0.07 (0.26)	0.08 (0.26)	0.01 (0.12)
Certified in industrial arts	0.01 (0.08)	0.00 (0.06)	0.01 (0.09)	0.01 (0.11)	0.01 (0.11)
Taught middle/HS math	0.09 (0.29)	0.30 (0.46)	0.23 (0.42)	0.21 (0.41)	0.28 (0.45)
Taught middle/HS science	0.09 (0.29)	0.25 (0.44)	0.21 (0.41)	0.16 (0.37)	0.26 (0.44)
Taught foreign languages	0.02 (0.15)	0.07 (0.25)	0.01 (0.12)	0.03 (0.17)	0.06 (0.23)
Taught reading	0.04 (0.20)	0.04 (0.19)	0.06 (0.25)	0.08 (0.27)	0.03 (0.17)
Taught middle/HS English	0.11 (0.31)	0.09 (0.29)	0.15 (0.36)	0.13 (0.34)	0.09 (0.28)
Taught special education	0.11 (0.32)	0.34 (0.47)	0.53 (0.50)	0.22 (0.42)	0.36 (0.48)
Taught ESOL	0.08 (0.27)	0.03 (0.17)	0.05 (0.22)	0.08 (0.28)	0.01 (0.10)
Class average disciplinary incidents per student	0.11 (0.44)	0.17 (0.60)	0.18 (0.71)	0.13 (0.54)	0.22 (0.65)
Class average proportion Black students	0.24 (0.25)	0.25 (0.25)	0.28 (0.27)	0.26 (0.26)	0.24 (0.23)
Class average proportion Hispanic students	0.24 (0.26)	0.22 (0.24)	0.25 (0.26)	0.25 (0.26)	0.11 (0.14)
Class average free/reduced-price lunch students	0.53 (0.29)	0.52 (0.28)	0.62 (0.26)	0.57 (0.28)	0.45 (0.28)
Teacher value-added in math	–0.02 (0.33)	–0.10 (0.36)	–0.17 (0.40)	–0.06 (0.36)	–0.11 (0.35)
Teacher value-added in reading	–0.01 (0.28)	–0.11 (0.33)	–0.13 (0.32)	–0.06 (0.28)	–0.12 (0.33)
Number of teacher-year observations	2,418,181	726,458	54,949	32,893	94,833

Note. ESOL, English for speakers of other languages; HS, high school. Eligible teachers are those who were certified and taught in a critical need area in the same year. Means of time varying variables are computed over all years in which a teacher is observed teaching.

Table 3. Percentage Distribution of Years of Experience Teaching in Florida Public Schools at Time of Initial Loan Forgiveness and Initial Tuition Reimbursement Awards

Years of Experience	Loan Forgiveness Initial Award	Tuition Reimbursement Initial Award
0	6.00	3.65
1	62.31	27.64
2	14.85	20.61
3	5.94	13.97
4	3.60	7.26
5	1.79	5.18
6	1.35	3.36
7	1.01	2.77
8	0.66	2.52
9	0.51	2.04
10	0.44	1.20
11	0.40	1.71
12	0.29	0.88
13	0.22	1.02
14	0.09	0.84
15	0.04	0.84
More than 15	0.51	4.52
Total	100	100

Figure 3. Kaplan-Meier Survival Estimates of Teaching in Florida Public Schools—Teachers Who Were Ever Certified and Taught in Any Critical Shortage Area (Only Teachers Observed in Their First Year of Teaching)



Note. Excludes tuition reimbursement recipients.

Table 4: Cox Proportional Hazard Estimates of the Probability of Exit from the Florida Public School System

Independent Variable	Model 1	Model 2	Model 3	Model 4
Ever Eligible in MS/HS Science x MS/HS Science a Designated Area	0.914** (0.024)	0.918** (0.024)	0.918** (0.025)	0.916** (0.029)
Ever Eligible in MS/HS Math x MS/HS Math a Designated Area	0.889** (0.022)	0.891** (0.023)	0.885** (0.024)	0.851** (0.026)
Ever Eligible in Special Ed/Gifted and Special Ed/Gifted a Designated Area	0.962 (0.024)	0.975 (0.025)	0.968 (0.025)	0.951 (0.030)
Ever Eligible in Foreign Languages x Foreign Languages a Designated Area	0.886** (0.038)	0.896* (0.040)	0.914 (0.042)	0.926 (0.049)
Ever Eligible in MS/HS English x MS/HS English a Designated Area	1.033 (0.031)	1.026 (0.032)	1.016 (0.033)	0.975 (0.033)
Ever Eligible in Reading x MS/HS Reading a Designated Area	1.115 (0.077)	1.127 (0.081)	1.112 (0.083)	1.072 (0.090)
Ever Eligible in ESOL x ESOL a Designated Area	0.750** (0.041)	0.747** (0.042)	0.739** (0.043)	0.797** (0.057)
Taught Certified and Taught Covered Subject x MS/HS Teacher x Year 1999	0.755** (0.060)	0.762** (0.062)	0.754** (0.065)	1.074 (0.350)
Controls for Ever Taught and Certified in Each Ever-Designated Area	√	√	√	√
Controls for each Subject Designated a Critical Shortage Area	√	√	√	√
Controls for Teacher Demographics		√	√	√
Controls for Teacher Experience and Advanced Degree Attainment			√	√
Controls for Courses Taught and Classroom-level Student Characteristics				√
Number of Observations	792,828	744,615	708,598	424,770
Number of Teachers	137,046	129,523	127,626	94,328
Log Likelihood	-1,065,748	-994,198	-918,364	-574,428

Note: Standard errors are in parentheses. Teacher demographics include gender and race/ethnicity. Experience/degree attainment controls include indicators for 0, 1, 2, 3, 4-9, 20-29, 30-39, 40+ years of experience and an indicator for possession of an advanced degree. Classroom characteristics include class size, average normed achievement test scores of students in the prior year, average number of disciplinary incidents per student, proportion of students receiving free/reduced-price lunch, proportion of students who are black and proportion of students who are Hispanic.

Table 5: Cox Proportional Hazard Estimates of the Probability of Exit from the Florida Public School System

Independent Variable	Model 1	Model 2	Model 3	Model 4
Ever Eligible in MS/HS Science x MS/HS Science a Designated Area	0.926** (0.024)	0.929** (0.025)	0.930** (0.026)	0.926* (0.029)
Ever Eligible in MS/HS Math x MS/HS Math a Designated Area	0.898** (0.022)	0.900** (0.023)	0.893** (0.024)	0.858** (0.026)
Ever Eligible in special ed/gifted and special ed/gifted a designated area [Low]	0.991 (0.025)	1.002 (0.026)	0.996 (0.027)	0.968 (0.031)
Ever Eligible in special ed/gifted and special ed/gifted a designated area [High]	0.873** (0.027)	0.894** (0.028)	0.887** (0.029)	0.818** (0.042)
Ever Eligible in Foreign Languages x Foreign Languages a Designated Area	0.897* (0.038)	0.905* (0.040)	0.923 (0.043)	0.939 (0.050)
Ever Eligible in MS/HS English x MS/HS English a Designated Area	1.036 (0.031)	1.028 (0.032)	1.019 (0.033)	0.977 (0.033)
Ever Eligible in Reading x MS/HS Reading a Designated Area	1.111 (0.077)	1.123 (0.081)	1.108 (0.077)	1.070 (0.090)
Ever Eligible in ESOL x ESOL a Designated Area [Low]	0.768** (0.043)	0.764** (0.044)	0.760** (0.045)	0.798** (0.058)
Ever Eligible in ESOL x ESOL a Designated Area [High]	0.671** (0.052)	0.676** (0.054)	0.648** (0.054)	0.781 (0.119)
Taught Certified and Taught Covered Subject x MS/HS Teacher x Year 1999	0.723** (0.058)	0.733** (0.060)	0.725** (0.063)	1.002 (0.327)
Controls for Ever Taught and Certified in Each Ever-Designated Area	√	√	√	√
Controls for each Subject Designated a Critical Shortage Area	√	√	√	√
Controls for Teacher Demographics		√	√	√
Controls for Teacher Experience and Advanced Degree Attainment			√	√
Controls for Courses Taught and Classroom-level Student Characteristics				√
Number of Observations	792,828	744,615	708,598	424,770
Number of Teachers	137,046	129,523	127,626	94,328
Log Likelihood	-1,065,732	-994,185	-918,351	-574,421

Note: Standard errors are in parentheses. "High" and "Low" refer to high and low average payout periods (pre-2001/02 and 2001/02 and later). Teacher demographics include gender and race/ethnicity. Experience/degree attainment controls include indicators for 0, 1, 2, 3, 4-9, 20-29, 30-39, 40+ years of experience and an indicator for possession of an advanced degree. Classroom characteristics include class size, average normed achievement test scores of students in the prior year, average number of disciplinary incidents per student, proportion of students receiving free/reduced-price lunch, proportion of students who are black and proportion of students who are Hispanic.

Table 6. Proportion of Teachers by Certification Status and Subject Taught, by Number of Years Before and After Receipt of Initial Tuition Reimbursement Award (Any Ever-Designated Shortage Area)

	Certification		Teaching	
Years Before/After Receipt of Initial Award	Observations	Percent Certified in Any Ever-Designated Shortage Area	Observations	Proportion Teaching in Any Ever-Covered Shortage Area
-5	1,102	55.4%	2,392	66.8%
-4	1,439	57.1%	1,513	70.6%
-3	2,042	61.9%	2,106	74.9%
-2	2,972	67.2%	3,055	78.8%
-1	4,223	73.7%	4,296	84.9%
0	4,546	77.7%	4,624	86.9%
+1	3,841	81.7%	3,899	86.9%
+2	3,473	84.6%	3,522	87.5%
+3	3,228	84.8%	3,273	88.9%
+4	2,777	85.2%	2,820	88.2%
+5	2,355	85.6%	2,392	87.5%

Table 7: Panel Probit Estimates of the Probability of Becoming Certified in a Designated Shortage Area

Independent Variable	Model 1	Model 2
Received Tuition Reimbursement in Current Year	0.00925** (0.00093)	0.00933** (0.00093)
Received Tuition Reimbursement in Prior Year	0.00975** (0.00080)	0.00982** (0.00080)
Taught Shortage-Area Subject in Current Year	0.00349** (0.00028)	
Taught Shortage-Area Subject in Prior Year	-0.00129** (0.00032)	0.00098** (0.00027)
Taught Shortage-Area Subject Two Years Prior	-0.00372** (0.00026)	-0.00322** (0.00026)
Experience	-0.00094** (0.00004)	-0.00095** (0.00004)
$Experience^2$	0.00001** (0.00000)	0.00001** (0.00001)
Number of Observations	1,213,011	1,213,011
Number of Teachers	226,035	226,035
Log Likelihood	-54,721	-54,797

Note: Standard errors are in parentheses. Reported estimates are marginal effects.

Figure 4A. Kernel Density Plot of Math Value-Added Distribution by Loan Forgiveness Receipt—Middle and High School Math Teachers

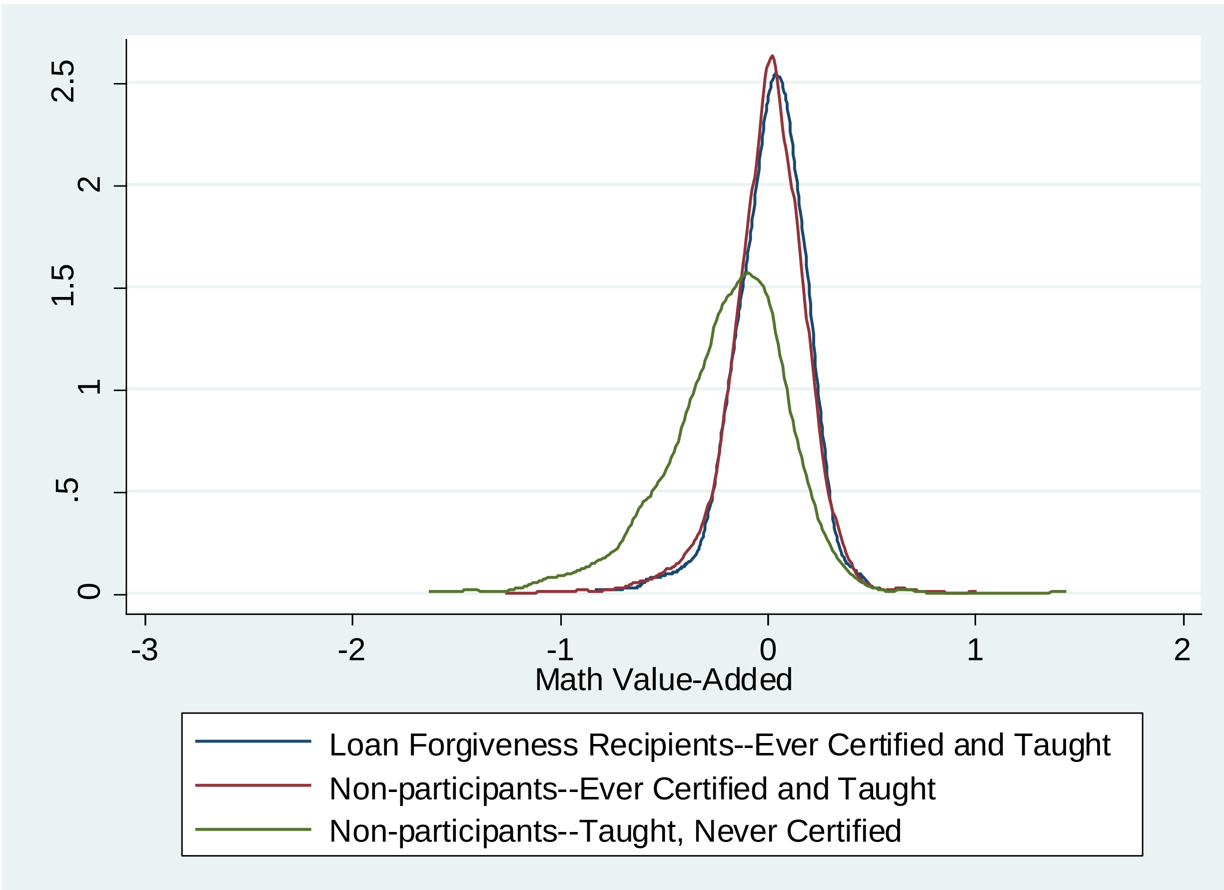


Figure 4B. Kernel Density Plot of Math Value-Added Distribution by Loan Forgiveness Receipt—Special Education Teachers

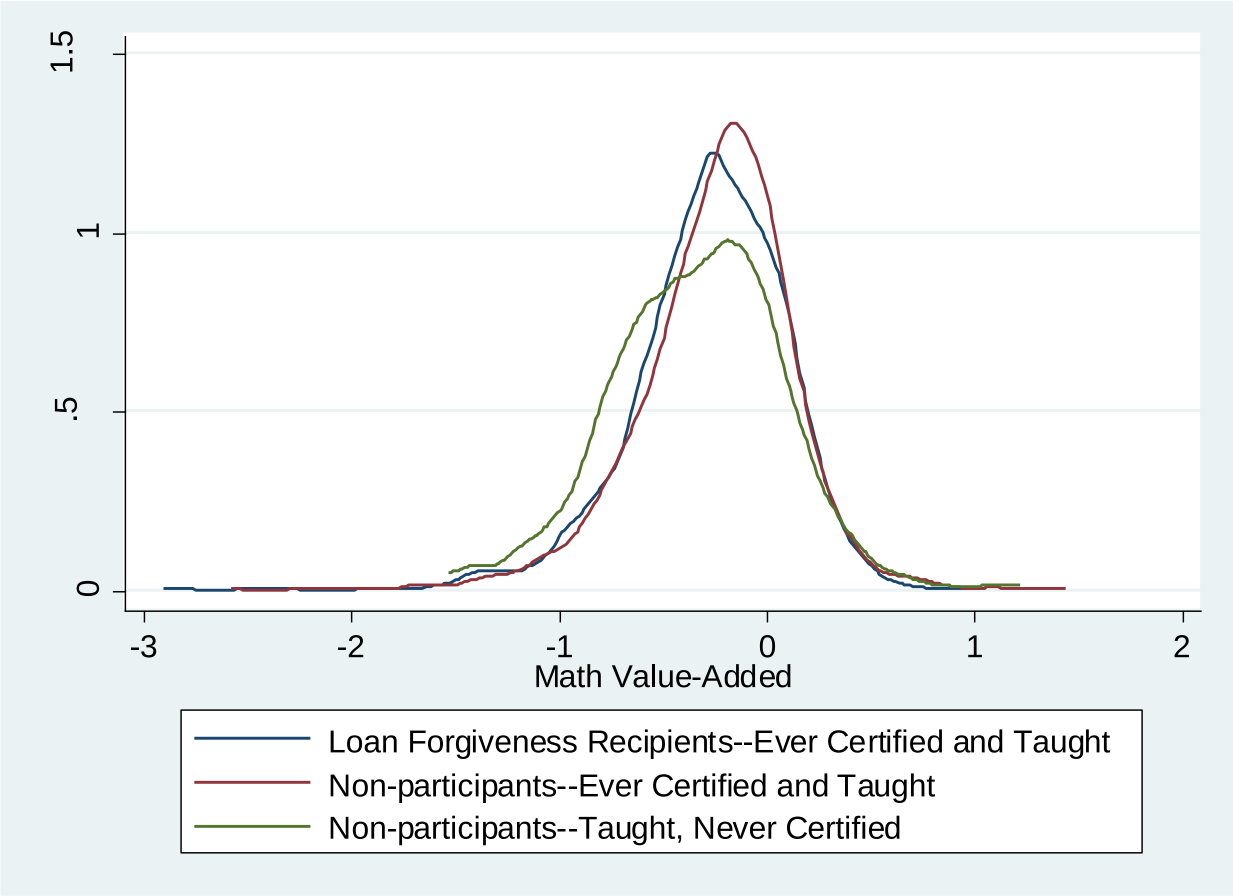


Figure 4C. Kernel Density Plot of Reading Value-Added Distribution by Loan Forgiveness Receipt—Special Education Teachers

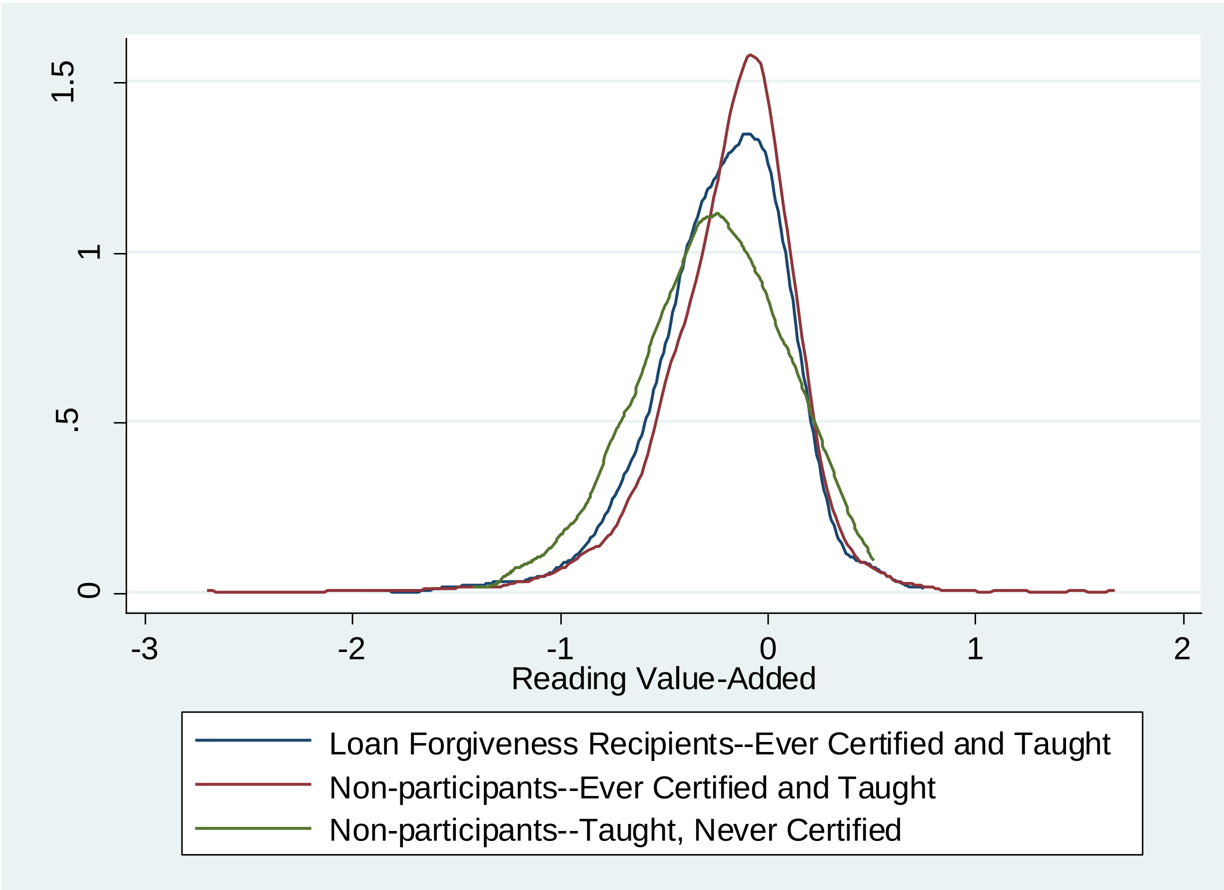


Figure 5A. Kernel Density Plot of Math Value-Added: Distribution by Tuition Reimbursement Receipt—Middle and High School Math Teachers

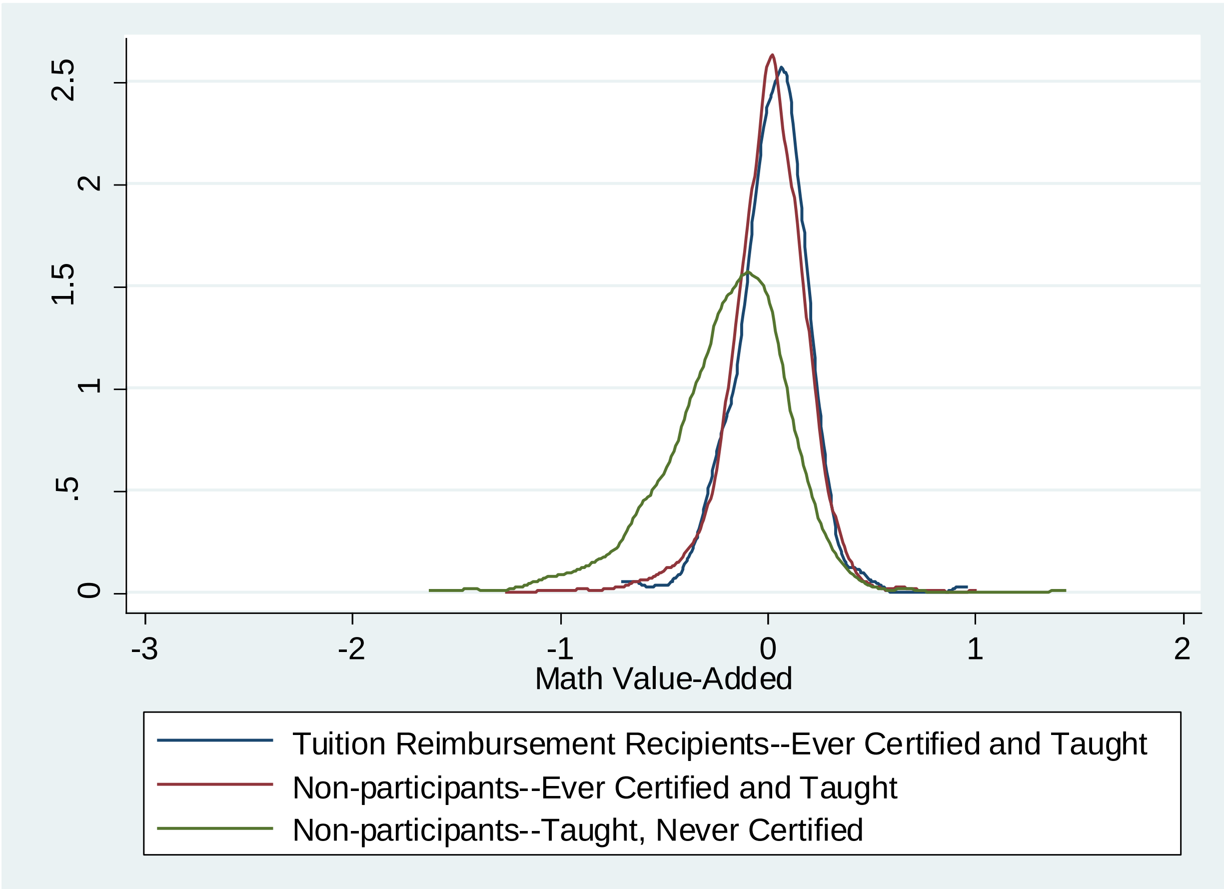


Figure 5B. Kernel Density Plot of Math Value-Added Distribution by Tuition Reimbursement Receipt—Special Education Teachers

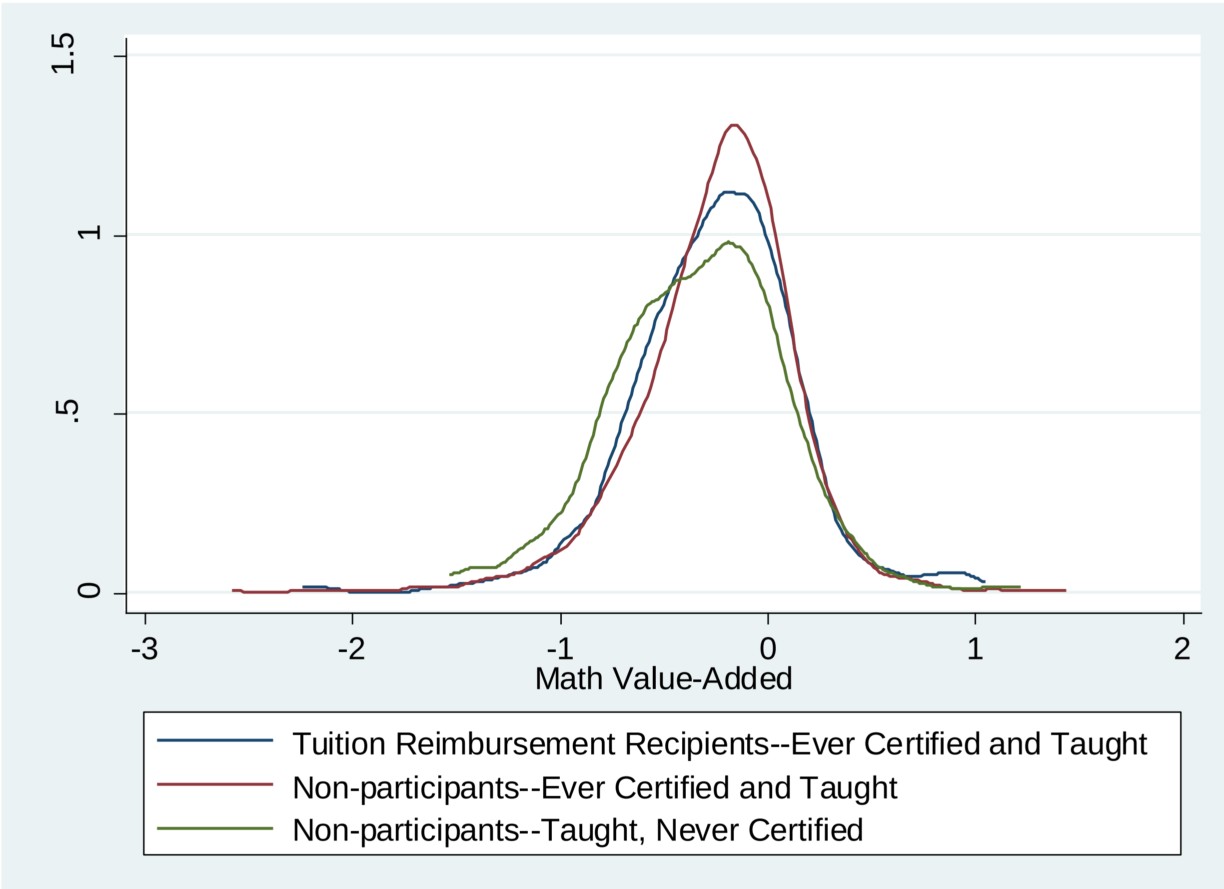


Figure 5C. Kernel Density Plot of Reading Value-Added Distribution by Tuition Reimbursement Receipt—Special Education Teachers