# The Effects of NBPTS-Certified Teachers on Student Achievement

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**Abstract**

In this study we consider the efficacy of a relatively new and widely accepted certification system for teachers established by the National Board for Professional Teaching Standards (NBPTS). To address the limitations in past research on the subject, we utilize a unique database covering the universe of teachers and students in Florida for a four-year span to determine the relationship between NBPTS certification and the impact of teachers on student test scores from both low-stakes and high-stakes exams. We find evidence that NBPTS certification provides a positive signal of teacher productivity in some cases, though the ability of NBPTS certification to identify high quality teachers varies considerably across subjects and grades. There is little evidence that the process of becoming NBPTS certified increases teacher productivity or that NBPTS-certified teachers in a school enhance the productivity of their colleagues.

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## I. Introduction

There is growing evidence that teacher quality plays a central role in determining student achievement (Rivkin, Hanushek and Kain (2005), Rockoff (2004)), yet measuring teacher quality and rewarding superior teachers has proved difficult. Most states' teacher certification statutes require prospective public school teachers to pass paper-and-pencil tests of subject matter and teaching skills in order to teach.[1] In addition, many states mandate that public-school teachers have a degree from a university-based college of education that includes specific coursework and/or a minimum grade point average. However, there is little empirical evidence that these state regulations effectively distinguish between high and low-quality teachers.[2] There is also growing interest in measuring the quality of existing teachers in order to develop merit pay systems that would link teacher compensation to teacher performance.[3]

An alternative to state-imposed teacher certification and merit pay initiatives is a voluntary system of teacher certification established by the National Board for Professional Teaching Standards (NBPTS) and adopted throughout the United States. The NBPTS has created a form of certification that is substantially more involved than state certification systems. There are three main components to the process: initial screening, preparation of a portfolio and successful completion of a set of assessment exercises. To be eligible to submit an application, teachers must have a bachelor's degree from an accredited institution of higher education, hold a state teaching license and have taught for three years prior to submitting their applications for NBPTS certification. Teachers meeting these requirements must then submit a portfolio that includes video-taped instruction in actual classroom settings, samples of student work, as well as a written commentary by the teacher regarding their own

[1] State regulations governing the standards individuals must meet in order to teach in public schools are typically referred to as "teacher certification" requirements. This is rather different than the nomenclature in economics where entry requirements fall under the rubric of "licensure" and "certification" determines the right to use a particular professional title, but does not generally restrict who may practice.

[2] See Hanushek (1986, 1997), Harris and Sass (2006a) and Angrist and Guryan (2004).

[3] At least one statewide merit pay plan has been tried (Tennessee) and another is being implemented (Florida). More common are district-level merit pay systems (e.g., Dallas, Denver, Houston). While most of these systems are too new to evaluate their efficacy, Dee and Keys (2004) provide an analysis of the impact of Tennessee's system on student achievement.

teaching practices. In addition, teachers must submit documentation regarding interactions with students' families, colleagues, and other educational actors and take part in computer-administered tests that focus on content knowledge. The combination of portfolio preparation and assessment involves a substantial amount of time outside the classroom; most candidates spend 200-400 hours on preparing the portfolio alone. Many states subsidize the application process and grant monetary awards to teachers that become NBPTS-certified. Unlike merit pay programs, however, NBPTS participation is voluntary and renewals are only required once every ten years.[4]

The present study examines several questions regarding NBPTS certification and teacher quality. First, are teachers who become NBPTS-certified teachers (NBCTs) more effective than other teachers? That is, does NBPTS certification provide a valid signal of a teacher's contribution to student achievement? We determine the relative effectiveness of NBCTs for students as a whole as well as sub-groups of students who vary based on race, ethnicity, family income and prior academic achievement. Second, given the extensive process that teachers go through to become certified, is there evidence that the process itself influences teacher effectiveness and increases their human capital? Third, do NBCTs affect the performance of their fellow teachers? In other words, are there spillovers that arise from mentoring or other interactions of NBCTs with their colleagues? Finally, even if NBPTS certification does provide a signal of teacher effectiveness, does it provide information above and beyond other commonly available information, such as state certification requirements and educational attainment?

To address these questions we employ a unique panel dataset covering the universe of public school teachers and students in Florida over a four-year span. We are able to link students and teachers to specific classrooms and are able to track the performance of students on standardized exams over time. Thus we are able to associate student learning gains with the specific teacher who is responsible for instruction in the academic area that is tested while controlling for other factors that affect student achievement, including unmeasured student

[4] It is also increasingly common for merit pay plans to be based on student test score gains. NBPTS, in contrast, is focused on demonstrated teacher knowledge and the qualities of observed teacher practice.

characteristics and peer influences. We focus on teachers in math and reading/language arts, the two subjects tested in each of grades 3-10 in Florida.

Our work is similar in many respects to that of Goldhaber and Anthony (forthcoming), but builds on their work in important ways. First, because they possess at most three observations for each student and academic subject, they base most of there conclusions on the efficacy of NBPTS certification from models that use only observable characteristics to control for student heterogeneity..[5] In other work (Harris and Sass (2006b)) we demonstrate that failure to account for unobserved student heterogeneity can significantly bias estimates of teacher quality. We therefore estimate models of student achievement gains that include student-specific fixed effects over three years. Second, our data from Florida include information about teachers in middle and high school, rather than just elementary school. Third, our sample of teachers and students at each grade level is much larger, allowing us to account for cohort effects and therefore to separate the effect of NBPTS from intertemporal changes in the types of teachers receiving the certification. Fourth, Florida has a system of bonuses for NBCTs who agree to act as mentors. Thus we are able to determine if non-NBCTs receive positive spillovers from their NBPTS-certified colleagues who are actively engaged in mentoring.

In the next section, we provide more detail on NBPTS certification, followed by a literature review in section III that summarizes existing empirical evidence. In sections IV and V we explain our methodology and describe the Florida data. Our findings are presented in section VI. A final section discusses the implications of our findings for policy.

## II. History and Description of NBPTS

NBPTS arose from a report by the Carnegie Task Force on Teaching as a Profession (1986) that called for the formation of a non-profit private organization to create a new form of teacher certification separate from state certification systems. More than just identifying

[5] Goldhaber and Anthony do estimate a model with student fixed effects. However, they do not draw conclusions from their fixed effects estimates since there are relatively few students with multiple observations in their panel who are taught by NBPTS certified teachers. We discuss their findings in more detail below.

the most effective teachers, NBPTS was part of a larger move to establish a set of professional norms, standards and career stages and to "professionalize" teaching (Koppich et al. (2006)).

Since the organization's establishment in 1987, more than 47,000 teachers have earned NBPTS certification and an additional 20,000 have applied for one of the 24 different certificates, covering 14 different subject areas.[6] One reason for such extensive participation in NBPTS among teachers is that 50 states and at least 544 school districts have adopted policies that provide incentives that both reduce the cost to teachers of seeking certification and provide long-term financial rewards for becoming certified. In most locations, state or local governments pay some or all of the $2,300 application fee charged by NBPTS and provide a permanent increase in salary for those who successfully complete the certification process. The fees from applicants, plus government grants, have been estimated to generate $600 million for NBPTS (Goldhaber and Anthony, forthcoming). In addition, the NBPTS-related salary enhancements have reached nearly $1 billion annually (Podgursky (2001)).

As of 2004, the state of Florida had more than 6,300 NBPTS-certified teachers, the second largest number of any U.S. state and 15 percent of the national total. As in other states, this is partially a result of a state law adopted in 1998 that subsidizes applications and rewards NBPTS certification recipients.[7] The state pays 90 percent of the NBPTS application fee and provides $150 for portfolio preparation. For those who achieve certification, Florida offers a salary bonus equal to 10 percent of the prior year's average statewide teacher's salary. NBPTS certified teachers in Florida receive an additional 10 percent bonus if they agree to provide the equivalent of 12 workdays of mentoring services to public school teachers within the state who do not hold NBPTS certification.[8] Some school

[6] Unless otherwise noted, the evidence in this section comes from the NBPTS web site, www.nbpts.org.

[7] See Florida Statutes § 1012.72 (2004) and http://www.firn.edu/doe/etp/legislation.html. Originally named the Excellent Teaching Program Act, the program was renamed as the Dale Hickam Excellent Teaching Program in 2002. For descriptions of the incentives provided in some other states see Goldhaber, Perry and Anthony (2004) and Humphrey, Koppich and Hough (2005).

[8] The teachers must also have passed their school district's annual performance appraisal to receive these bonuses.

districts within Florida provide additional incentives, such as extra stipends and allowing time spent on NBPTS certification to count toward professional development requirements.

## III. Literature Review

A handful of recent studies provide empirical evidence on the impact of NBPTS-certified teachers on student achievement. Most relevant to the present study is the analysis of Goldhaber and Anthony (forthcoming), which examines the relationship between NBPTS certification status and a teacher's contribution to student achievement in North Carolina for three years, 1996/97 through 1998/99. Goldhaber and Anthony analyze 600,000 student-year observations and 32,000 teacher-year observations in grades 3, 4 and 5. A total of 416 unique current and future NBCTs are included in the analysis, 230 of which are certified by the last year of their analysis, 1998/99. They use these data to test both the signaling and human capital hypotheses associated with NBPTS certification.

Goldhaber and Anthony find that for both reading and math, the contribution of future NBPTS-certified teachers to student achievement ("value-added") exceeds that of the average teacher who does not eventually become NBPTS certified. This suggests that, before they go through the certification process, teachers who later apply for and obtain NBPTS certification are better than the average teacher who is never certified.[9] The size of the differential suggests that having a teacher who later becomes NBPTS certified boosts student achievement gains by at most 0.10 standard deviations for the average student. This finding is based on a model that relies on student covariates (race/ethnicity, gender, participation in free or reduced-price lunch (FRL), limited English proficiency and disability status) to control for student heterogeneity. However, the results are robust when estimating models with student fixed effects, as well as when adding other measures of teacher quality that could be used as alternatives to NBPTS certification. These results suggest that NBPTS certification provides a valid signal of teacher effectiveness.

[9] Depending on the specification, the comparison group in Goldhaber and Anthony varies between non-applicants and never-NBPTS certified teachers (which includes some unsuccessful applicants). In our discussion of their paper, we focus on their specifications where they compare successful applicants with those teachers who never apply.

In addition to finding that future NBCTs (prior to applying for certification) are more effective than the average never-NBPTS-certified teacher, Goldhaber and Anthony find that future NBCTs are disproportionately effective with minority and FRL students. The largest difference between the two types of teachers increases to 0.16 standard deviations for FRL students in mathematics.[10]

While teachers who eventually achieve NBPTS certification start out being more effective than their peers who do not become NBPTS certified, they become less effective during the application process. Goldhaber and Anthony estimate that the effectiveness of teachers during the application year is actually lower than teachers who do not become certified and the differential is equal or greater in magnitude to the advantage they initially held prior to certification. Goldhaber and Anthony posit that the 200 or more hours involved in preparing application materials may take away from class preparation time and thus have a negative effect on student achievement during the application process.

The effectiveness of NBCTs after they actually achieve certification is much less clear. Employing models that account for student heterogeneity with student covariates, Goldhaber and Anthony find that the value-added of teachers in their first year of certification is above the average of teachers who do not apply for NBPTS certification and somewhat higher than the average of future NBCTs. However, after the first year of certification, NBCTs are no more effective than their peers who never apply for NBPTS certification. When student fixed effects are used to capture both observed and unobserved time-invariant student heterogeneity, both first-year and post-first-year NBCTs are no more effective in reading than are teachers who never obtain NBPTS certification. For math, newly-NBPTS-certified teachers are estimated to be more effective than the average non-applicant teacher, but after the first year of certification they appear to be *less* effective than the average teacher who never applies for NBPTS certification.

[10] Limiting the samples in this way could change the comparison group of teachers. Rather than the average non-NBPTS teacher, the comparison group is now the average non-NBPTS teacher who is assigned to at least one disadvantaged student. If these students are disproportionately assigned to lower quality teachers, then the difference estimated by Goldhaber and Anthony may reflect more the change in comparison group than any difference in the effectiveness of NBPTS teachers. However, the only teachers who would be excluded would be those who do not teach a single student in the respective category. Therefore, the influence of this on the results is likely to be small.

The fragility of Goldhaber and Anthony's post-certification estimation of NBCT's effectiveness highlights a more general concern about their methodology. Most of the models they estimate exclude student (or school) fixed effects and thus may not adequately control for unobserved characteristics of students and schools. Even when they do include fixed effects, only one set of effects (students or schools) is included at a time. If NBCTs are not randomly assigned to schools and students are not randomly assigned to NBCTs within a school then omission of school and/or student fixed effects will yield biased estimates of the effectiveness of NBCTs. Any measured differences in the performance of NBCTs and non-NBCTs will reflect differences in the unobserved characteristics of the schools they work in and the students they teach, not just any true differences in teacher effectiveness.

There is ample evidence that NBCTs are in fact not randomly distributed among schools and students. Goldhaber and Anthony (2004) and Humphrey, Koppich and Hough (2005) find that NBPTS teachers are less likely to be working in schools with high percentages of poor, minority and low-performing students.[11] This is not surprising given the relatively high turnover of teachers in schools serving disadvantaged students and the tendency of teachers to migrate to schools serving more affluent populations.[12] In addition, Vandervoot, Amrein-Beardsley and Berliner (2004) find that few principals deliberately assign NBPTS teachers to disadvantaged students within schools. As discussed below, we also find evidence that the schools in which NBCTs work and the students that NBCTs teach in Florida are atypical. To account for these potential sources of selection bias, we estimate models that include both student and school fixed effects.

[11] Humphrey, Koppich and Hough analyzed a cohort of the 18,806 teachers who earned NBPTS certification since 1998 in six states: California, Florida, Mississippi, North Carolina, Ohio, and South Carolina. (According to the NBPTS web site, www.nbpts.org, these six states represent more than 58 percent of all NBCTs nationwide since 1998.) The results showed that 19 percent of the NBPTS teachers were in schools ranked in the bottom 30 percent according to the respective state assessment systems. In addition, only 12 percent of NBPTS teachers work in high-poverty schools with more than 75 percent students eligible for FRL and 16 percent of the total teach in high-minority schools that more than 75 percent of their students are minority. Compared with the state average for all teachers, those with NBPTS certification are underrepresented in these schools, except California. The authors hypothesize that different patterns in distribution of NBPTS in California might be attributable to the large financial incentives for NBPTS teachers to work in low-performing schools.

[12] See Hanushek, Kain and Rivkin (1999).

The ability of Goldhaber and Anthony to determine the post-NBPTS-certification effectiveness of teachers is also hampered by possible changes in the cohorts of NBCTs over time. Their time period of analysis is 1996/97-1998/99, just when NBPTS certification began to gain widespread popularity. In their North Carolina data they observe only 75 teachers in their second year of NBPTS certification and all but 12 of these teachers are from a single cohort (those certified in 1998), making it difficult to distinguish certification effects from cohort effects. If teachers who achieve NBPTS certification later are different in unmeasured ways than prior recipients then what appears to be changes in teacher effectiveness could in fact represent differences in the pre-certification effectiveness of teachers.

Cavalluzzo (2004) provides an analysis similar to Goldhaber and Anthony, although her study is limited to ninth and tenth grade students in a single large school district, Florida's Miami-Dade County. Her data include mathematics test scores for ninth graders in years 2000/01-2002/03 and for tenth graders in 2001/02-2002/03. She observes only 61 NBCTs and 101 applicants. In her model with student fixed effects she estimates the determinants of student achievement *levels* (rather than achievement gains) thereby ignoring the possible impact of prior school inputs on current achievement.[13] Her results are similar to those of Goldhaber and Anthony in that NBPTS teachers are more effective than other teachers in boosting student math achievement. However, they are different in several other ways: Cavalluzzo finds that the NBPTS effect is larger for students who are eligible for FRL, but not for minority students. Cavalluzzo's estimates of the effects of NBCTs on student achievement are generally smaller than those in Goldhaber and Anthony. Also, she finds there is no difference between teachers who applied and were rejected for NBPTS certification and those who became certified.

[13] Cavalluzzo also estimates achievement models that control for prior schooling inputs by including the lagged test score as an independent variable. Unfortunately, she uses ordinary least squares to estimate this formulation which produces biased estimates in achievement models with a lagged dependent variable on the right hand side (see Harris and Sass (2006b). In her full sample there are 108,000 student-year observations and 101 NBPTS applicants of whom 61 obtain certification during her period of study. Estimation with student fixed effects requires multiple observations per student, which reduces her sample to 72,000 student-year observations and presumably something less than 61 NBPTS-certified teachers. Since each student must be observed at least twice and can be observed at most three times, the number of students in her fixed-effects sample is likely less than 30,000.

In addition to the analyses of NBPTS certification effects by Goldhaber and Anthony and by Cavalluzzo, there exist studies of NBPTS certification in Arizona (Vandevoort, Amrein-Beardsley and Berliner (2004)), South Carolina (Stephens (2003)) and Tennessee (Stone (2002)). However, each of these studies uses very small samples of NBCTs and employs less sophisticated analytical techniques. Consequently, the reliability of their findings is quite limited.[14]

## IV. Methods

In order to gauge the impact of NBPTS certification we begin with a general specification of the "value-added" model that relates student achievement to vectors of time-varying student/family inputs (X), classroom-level inputs (C), school inputs (S) and time-invariant student/family characteristics ($\psi$):

$$A_{it} - A_{it-1} = \Delta A_{it} = \boldsymbol{\rho}_1 \mathbf{X}_{it} + \boldsymbol{\rho}_2 \mathbf{C}_{ijmt} + \boldsymbol{\rho}_3 \mathbf{S}_{mt} + \psi_i + \varepsilon_{it} \quad (1)$$

The subscripts denote individuals (i), classrooms (j), schools (m) and time (t).

Equation (1) is a restricted form of the cumulative achievement function specified by Todd and Wolpin (2003) where the achievement level at time t depends on the individual's initial endowment (eg. innate ability) and their entire history of individual, family and schooling inputs.[15] Although often not stated, there are a number of implicit assumptions underlying the value-added model function specified in (1). First, it is assumed that the cumulative achievement function does not vary with age, is additively separable and linear. Second, family inputs are constant over time and the impact of these parental inputs on

[14] Vandevoort, Amrein-Beardsley, and Berliner (2004) examine 35 NBPTS teachers using student gains on SAT-9 scores in reading, math, and language arts in grade levels 3-6. Stone (2002) analyzes 16 NBPTS teachers in 3rd through 8th grades using value-added scores from Tennessee's Value-Added Assessment System (TVASS). Stephens (2003) studies math achievement of 154 students in classrooms taught by NBPTS teachers in South Carolina using an ANOVA technique.

[15] It is important to note that while the dependent variable is the change in student achievement, equation (1) is a model of student achievement levels, not achievement growth. The lagged value of achievement on the left hand side serves to represent the cumulative effect of all prior schooling inputs on current achievement.

achievement, along with the effect of the initial individual endowment on achievement, change at constant rates. This allows the combination of these time-invariant inputs to be represented by the student-specific fixed component, $\psi_i$. Third, the marginal impacts of all prior school inputs decline geometrically with the time between the application of the input and the measurement of achievement at the same rate. Thus lagged achievement serves as a sufficient statistic for all prior schooling inputs. Fourth, school inputs each have an immediate one-time impact on achievement that does not decay over time.[16] A thorough discussion of these assumptions and the derivation of the linear value-added model can be found in Todd and Wolpin (2003) and Harris and Sass (2006b).

The vector of classroom inputs can be divided into four components: peer characteristics, $\mathbf{P}_{-ijmt}$ (where the subscript –i students other than individual i in the classroom), time-varying teacher characteristics (eg. experience and certification), $\mathbf{T}_{kt}$ (where k indexes teachers), time-invariant teacher characteristics (eg. innate ability and pre-service education), $\delta_k$. and non-teacher classroom-level inputs (such as books, computers, etc.), $\mathbf{Z}_j$. If we assume that, except for teacher quality, there is no variation in education inputs across classrooms within a school, the effect of $\mathbf{Z}_j$ becomes part of the school-level input vector, $\mathbf{S}_m$. If we further assume that school-level inputs are constant over the time span of analysis, they can be captured by a school fixed component, $\phi_m$. Direct estimation of the school fixed effects, $\phi_m$, while also controlling for student fixed effects is problematic since it requires inclusion of thousands of dummy variables, one for each school in the sample. In order to make the problem computationally tractable we combine the student and school fixed effects into a single effect, $\theta_{im} = \psi_i + \phi_m$, representing each unique student/school combination or "spell."[17] The value-added model can then be expressed as:

[16] Thus, for example, the quality of a child's kindergarten must have the same impact on their achievement at the end of age 5 as it does on their achievement at age 18. While a strong assumption, this allows the impact of all prior schooling inputs to be captured by the lagged achievement score, $A_{it-1}$, on the left-hand side of the equation. Otherwise, equation (1) would contain a lagged dependent variable on the right hand side and thus could not be consistently estimated by ordinary least squares. In other work, Harris and Sass (2006b), we find that, except for extreme values, the degree of assumed persistence in the effect of prior schooling inputs has little effect on estimates of teacher effectiveness.

[17] For a more detailed discussion of the spell fixed-effects approach see Andrews, Schank and Upward (2004). Estimated standard errors for the spell-fixed-effects model are robust to general heteroskedasticity but are not adjusted for clustering at the school level. The school fixed effect should account for any systematic error that is common to all students attending a particular school, however.

$$\Delta A_{it} = \boldsymbol{\beta}_1 \mathbf{X}_{it} + \boldsymbol{\beta}_2 \mathbf{P}_{-ijmt} + \boldsymbol{\beta}_3 \mathbf{T}_{kt} + \theta_{im} + \delta_k + \nu_{it} \quad (2)$$

where $\nu_{it}$ is a normally distributed, mean zero error.

Teachers can be distinguished according to whether or not they ever receive NBPTS certification.[18] Denote the average fixed effect for teachers who never become NBPTS certified as $\bar{\delta}^{\text{never NBCT}}$, which is simply a constant, $\alpha$. We can then denote the difference in the average fixed effect for teachers who at some point become NBCTs and those who never become NBCTs $(\bar{\delta}^{\text{ever NBCT}} - \bar{\delta}^{\text{never NBCT}})$ as $\gamma$(Ever NBCT), where $\gamma$ is a fixed parameter which is multiplied by (Ever NBCT), a dummy variable representing teachers who become NBCTs at some point in time. The average fixed effect for teachers who become NBCTs at some point is thus $\alpha+\gamma$(Ever NBCT). Our value-added model can re-written as:

$$\Delta A_{it} = \alpha + \boldsymbol{\beta}_1 \mathbf{X}_{it} + \boldsymbol{\beta}_2 \mathbf{P}_{-ijmt} + \boldsymbol{\beta}_3 \mathbf{T}_{kt} + \gamma(\text{Ever NBCT}) + \theta_{im} + \nu_{it} \quad (3)$$

If the average effectiveness of future NBCTs exceeds the average of teachers who never become NBCTs then $\gamma$ should be positive.

The effectiveness of teachers who become NBPTS certified may change during the certification process. Following the work of Goldhaber and Anthony, it may be that teacher productivity temporarily falls during the certification process, but later recovers. In addition, it may be that the certification process itself enhances future teacher productivity. If the certification process leads teachers to re-evaluate their teaching methods or if preparation for the exam components causes teachers to sharpen their content knowledge then their

[18] By comparing ever-NBCTs with never-NBCTs, we are comparing teachers who apply for and receive NBPTS certification with those who either never apply or who apply but fail to be certified. This comparison is relevant for determining if the voluntary system currently in place rewards teachers who are more effective in boosting student achievement. Alternatively, one could compare unsuccessful applicants and successful applicants. This comparison would indicate if the certification process is successful in sorting out superior teachers within the group of applicants. This would be relevant if a state mandated that all teachers apply for NBPTS certification. However, we are unaware of any states that are considering making the NBPTS certification process mandatory.

effectiveness could rise after the certification process. To account for these possible intertemporal changes in the effectiveness of teachers who become NBPTS-certified we interact the (Ever NBCT) variable with dummy variables denoting the three time periods: pre-application, application year and received certification. This yields:

$$\begin{aligned}\Delta A_{it} = {} & \alpha + \boldsymbol{\beta}_1 \mathbf{X}_{it} + \boldsymbol{\beta}_2 \mathbf{P}_{-ijmt} + \boldsymbol{\beta}_3 \mathbf{T}_{kt} + \gamma_1(\text{Ever NBCT} \times \text{Pre-Application}) + \\ & \gamma_2(\text{Ever NBCT} \times \text{Application Year}) + \gamma_3(\text{Ever NBCT} \times \text{Received Certification}) + \\ & \theta_{im} + \nu_{it}\end{aligned} \tag{4}$$

The coefficients $\gamma_1$, $\gamma_2$ and $\gamma_3$ represent the difference between the average effectiveness of teachers who are ever-NBPTS-certified and those who are never-NBPTS-certified during the relevant periods.[19] Tests of whether these coefficients are statistically different from zero provide evidence regarding the signaling hypothesis. Evidence on the validity of the human capital hypothesis is provided by differences between the estimated coefficients, ie. $\gamma_2$-$\gamma_1$ and $\gamma_3$-$\gamma_1$.

## V. Data

### *A. Students, Teachers, and Related Non-Achievement Data*

The primary source of our data is the Florida Department of Education's K-20 Education Data Warehouse (EDW), an integrated longitudinal database covering all Florida public school students and school employees from pre-school through college. The EDW currently contains data for the 1995/1996 through 2003/2004 school years. Both the student and employee data can be linked to specific classrooms. Although student and teacher records are available since the 1995/1996 school year, curriculum-based statewide testing in

[19] Ideally, in order to test the hypothesis that certification increases a teacher's human capital one should compare the effectiveness of teachers who have received NBPTS-certification to their own effectiveness prior to receiving certification, rather than the average of ever-NBCTs in the pre-application period. This requires estimation of a model with teacher (plus student and school) fixed effects. Such three-way models are computationally burdensome, so we do not employ them in most of the analysis. However, we do estimate some three-way fixed effects models as a robustness check.

consecutive grade levels did not begin in Florida until school-year 2000/2001. Thus our analysis is limited to the four-year period, 2000/2001–2003/2004.

Data on NBPTS certification have been matched to employee records in the EDW to identify which teachers are NBPTS certified and the timing of their certification. As shown in Table 1, the NBPTS data cover all 6,355 certifications issued through calendar-year 2004. Thus for the last year of our achievement data, school-year 2003/2004, we are able to determine the teachers who become certified the following year. Table 1 also shows the number of teachers receiving each type of NBPTS certification in each year.[20] While the "generalist" certification is the most common, they do not represent a majority and there are hundreds of teachers in the Florida data who have certification in relevant subject-specific areas such as language arts, special education, science and math.

In addition to demographic and experience information, the EDW also includes detailed salary and benefits information for each teacher in Florida. Thus we can determine which NBCTs are being paid to mentor other, non-NBPTS-certified, teachers. This information will allow us to determine if certification provides positive spillovers to other teachers.

Unlike previous studies, we are able to estimate the effects of NBCTs in elementary, middle and high school. Different types of challenges arise at each level. In elementary grades, students usually have only one teacher and it is therefore relatively easy to assign student learning gains to specific teachers. The disadvantage of elementary school data is that it is more difficult to identify the influences of teachers and peers on student achievement because students generally have just a single teacher and peer group for the entire year. In middle and high school, the challenges are reversed: each student has many teachers, all of whom may affect measured student learning. But, it is easier to identify teacher and peer effects because the multiple classrooms provide variation in peer groups within a school year. In order to clearly determine which teacher is responsible for a student's academic achievement we limit our analysis to students who are enrolled in a single course in the

[20] It is possible for teachers to earn more than one type of certification, although this is extremely rare in practice. This may in part be due to the fact that Florida's law only provides financial rewards for the first NBPTS; no additional rewards are provided for subsequent certifications.

relevant academic area. Also, we eliminate any students receiving instruction in classes where there is more than one primary teacher in the class.

We place two additional restrictions on the sample we analyze. First, to avoid atypical classroom settings we consider only courses in which 10-50 students are enrolled. Second, we eliminate students enrolled in charter schools from the analysis since they may have differing curricular emphases and student-peer and student-teacher interactions may differ in fundamental ways from traditional public schools.

Despite these sample restrictions our data set is much larger than those used in previous analyses of NBPTS certification. For both math and reading we measure achievement for over one million students. As noted in Table 2, we observe over 30,000 math teachers, roughly 1,250 of which are NBPTS-certified at some point. We also observe over 33,000 reading/language arts teachers of which over 1,500 achieve NBPTS certification.[21] This is approximately three times the number of NBCTs analyzed by Goldhaber and Anthony and about 20 times the number included in Cavaluzzo's analysis.

Table 2 also describes the characteristics of teachers who are ever certified by NBPTS and of the students they teach, which is relevant to the issue of whether NBCTs are randomly assigned across different types of students. On average, teachers who at some point become NBPTS-certified are more experienced and are more likely to have earned an advanced degree than their peers who do not obtain NBPTS certification. Florida teachers who have or will become NBPTS-certified tend to have a smaller proportion of Black students in their classes (16 percent) than teachers who never become certified (23 percent). They also have fewer FRL students—31 percent compared to 43 percent for never-NBPTS-certified teachers. It is not surprising, then, that students with prior test scores in the lowest national achievement quintile are also less likely to be taught by NBCTs.[22] The differences in the students being taught may partly reflect the characteristics of the teachers who become

[21] The number of NBCTs used in the analysis, and shown in Table 2, is much smaller than the total in Table 1 because most of NBCTs teach in non-tested grades and subjects.

[22] The test score quintiles are based on national (rather than state) norms and therefore have unequal numbers of students. Specifically, there are substantially more students in the top quintile than the bottom, suggesting either that Florida students are above average on this test compared with the nation as a whole or the national norms are inflated.

certified. Black students are more likely to be taught by Black teachers in general and, as the table shows, Black teachers in Florida are much less likely than Hispanic and non-Hispanic white teachers to receive NBPTS certification.

*B. Student Achievement Data*

During our period of analysis, the state administered two sets of reading and math tests to all third through tenth graders in Florida. The "Sunshine State Standards" Florida Comprehensive Achievement Test (FCAT-SSS) is a criterion-based exam designed to test for the skills that students are expected to master at each grade level. The second test is the Stanford-9 achievement test, known as the FCAT Norm-Referenced Test (FCAT-NRT) in Florida.

We focus our analysis on changes in developmental scale scores from the FCAT-SSS.[23] Since the FCAT-SSS is aligned with the state curriculum benchmarks and is the basis for various forms of accountability, it should be well aligned with the curriculum taught in schools and therefore sensitive to changes in the quality of instruction.[24] A disadvantage of the FCAT-SSS, however, is that it is not designed as a "vertical scaled" test, meaning that a one-point increase in the test may not reflect the same substantive increase in learning at all points on the scale.[25] Some research suggests that estimated teacher effects in value-added models may be sensitive to the scaling procedure, especially when specific teachers serve a disproportionate share of students who are initially at the extreme ends of the score distribution (McCaffrey, Lockwood, Koretz, and Hamilton (2003)). The FCAT-NRT, in contrast, is designed as a vertical-scale test, but suffers from the fact that it is not as well aligned with state standards. On balance, we view the FCAT-SSS as preferable to the

[23] The developmental scale score is a grade-level-specific linear transformation of the FCAT-SSS scale score. For a detailed description of how the developmental scale score is constructed, see http://www.firn.edu/doe/sas/fcat/fcatscor.htm

[24] A potential disadvantage of the accountability is that teachers may appear effective by teaching students how to take tests, a form of "teaching to the test." While there is the potential for these teachers to be judged equally effective to those who produce genuine improvements in learning, it is likely that the accountability leads all teachers to engage in teaching to the test and, if this is the case, then this should not bias the estimated *difference* in effectiveness between NBCTs and other teachers.

[25] For a detailed description of how the developmental scale score is constructed, see http://www.firn.edu/doe/sas/fcat/fcatscor.htm

FCAT-NRT for the present analysis, partly because we can and do account for test scaling issues ourselves by including grade-by-year fixed effects. However, we also carry out each estimation with both tests to determine whether the results are robust. Estimates based on scores from the FCAT-NRT exam are provided in an appendix.

Several other specific differences between the two tests are worth noting. First, discussions with officials of the Florida Department of Education indicate the FCAT-SSS generally involves more challenging content standards and higher cognitive level questions compared with the FCAT-NRT. Also, in the FCAT-SSS math test, students are graded partly on the explanations they give with their answers, not just whether their final answer is correct. We discuss the potential importance of these differences in the context of the empirical findings. In addition, there is a difference in the available data from the two exams. Use of the FCAT-NRT in all grades 3-10 began in the 1999-2000 school year while the FCAT-SSS was first administered in all grades 3-10 in the 2000-2001 school year.[26] The difference in sample periods has little influence on the results, however. Rather any observed differences in results from the two tests are due to the tests themselves.[27]

## VI. Results

### *A. Effects of NBPTS-Certified Teachers on Own Students' Performance*

Table 3 shows the estimated impact of NBCTs on student achievement, holding constant student mobility, peer characteristics and time-invariant student and school characteristics. Columns [1] and [3] contain estimates of equation (3), which includes only a single certification measure, whether the teacher is ever certified by NBPTS. This measure captures the average difference in "value added" by teachers who become NBPTS-certified by 2004 and those teachers who never obtain certification during the same period

[26] Prior to 2000-2001 the math portion of the FCAT-SSS was given to students in grades 5, 8 and 10 and the reading portion was given in grades 4, 8 and 10.

[27] All of the FCAT-NRT results reported in the appendix have been estimated using all available data for the FCAT-NRT (ie. 1999-2000 – 2003-2004). Estimates based on FCAT-NRT data, but only including observations where a student took both the FCAT-SSS and FCAT-NRT exams, are qualitatively the same as those provided in the appendix. FCAT-NRT-based results using only observations in which both exams were taken are available from the authors upon request.

(controlling for experience and advanced degrees held by teachers). In reading, we find that the teachers who achieve NBPTS certification at some point are more productive than those who are never certified, but we find no such difference in math. In the estimates with the FCAT-NRT, there are no productivity differences in either subject.

To see if the certification process itself enhances teacher effectiveness we estimate equation (4), which splits the NBPTS certification indicator into three components: the time period prior to application year, the application year, and the period during which the teacher is NBPTS certified.[28] The estimates of equation (4) are reported in columns [2] and [4]. We find that prior to application, reading teachers who later become certified boost student achievement by more than 11 scale-score points (about .03 of the standard deviation in achievement levels) compared with never-NBCTs.[29] During the application year we find no differences in the impact of NBPTS-certified teachers on student reading achievement vis-à-vis teachers who never become certified. NBCTs are more productive than never-NBPTS teachers after certification is completed, though less effective than they were prior to applying for certification. All three NBCT coefficients are insignificant in math, indicating that both before and after receiving certification, the impact of NBCTs on their students' math scores is no different than the average never-NBCT. The NBCT coefficients are all insignificant in estimates produced from FCAT-NRT scores in both subjects, except for a marginally significant and positive pre-certification advantage for NBCTs teachers in math.

As noted in the discussion of the Goldhaber and Anthony paper, cohort and certification effects are potentially intertwined in the above specification. Since we only observe early recipients of NBPTS certification after they have been certified, they tend to disproportionably influence the estimated post-NBPTS-certification effects. Similarly, cohorts who become certified later have a relatively greater influence on the estimated pre-certification effectiveness of future NBCTs. In order to disentangle the cohort effects from

[28] Like Goldhaber and Anthony, we assume that the application year is the one immediately preceding the year of certification and that the application process takes only one year. The Florida EDW does not include direct measures of the time periods of the certification process.

[29] The calculations are based on the standard deviations in test scores across all grades levels. For achievement levels, the standard deviation in test scores by grade ranges from 169-258 for math and 252-330 for reading.

the true certification effects, we separately estimate the achievement model for five cohorts of NBCTs. The results, presented in Table 4, suggest that early cohorts of teachers who became NBCTs are quite different than later cohorts and these cohort differences distort the estimated impacts of national board certification. For the 2002 and 2003 cohorts of NBCTs, where data are available pre- and post-certification, we find ever-NBCTs are significantly more effective than the average never-NBCT in three of four cases and in all instances are no more effective than never-NBCTs during the application process and beyond. In contrast, the pre-2001 cohorts are significantly more productive than never-NBCTs in both math and reading, post-certification. This suggests that the roughly 20 percent of NBCTs who achieved certification prior to 2001 may have been inherently different than later recipients. For example, if the most productive teachers embraced the NBPTS concept early then the apparent positive post-certification effects could simply be due to inherent differences in their ability as teachers. Using the FCAT-NRT as a gauge of student performance, estimated NBPTS-certification coefficients for cohort-specific subsamples, like those for the full sample, are mostly insignificant.

Prior research suggests that the contribution of NBPTS varies by specific grade (Goldhaber and Anthony (forthcoming)) as do the contributions of teacher professional development (Harris and Sass (2006a)). Thus, depending on the attributes being measured by NBPTS, the value of NBPTS certification as a signal of teacher quality may vary by grade level as well.[30] To determine if this is indeed the case, we separately estimate the student achievement model for elementary, middle and high-school students. The results, presented in Table 5, show inconsistent patterns. In elementary math, ever-NBCTs are initially less productive, but then become more productive post-certification. In middle school math, the

[30] We also considered estimating separate effects for specific NBPTS certification fields (eg. math, language arts and "generalist"). However, there is little variation in certification fields within a subject area and grade level. At the elementary level in 2003/04, 98.1 percent of students receiving instruction from an NBCT are taught by an NBCT with a generalist certification. For middle-school reading, 91.1 percent of students taught by an NBCT are taught by an NBCT with a language arts certification. For high school reading the proportion is even higher at 93.8 percent. For high school math, 92.3 percent of the students receiving instruction by an NBCT are taught by an NBCT with a mathematics certification. The only area where there is modest variation is in middle school math where 61.1 percent of students taught by an NBCT are being instructed by an NBCT certified in math. NBCTs with a generalist certification instruct another 23.0 percent and 7.5 percent are taught by NBCTs with a science certification.

opposite pattern emerges—teachers who achieve NBPTS certification are initially more productive than the average never-NBCT but then become less productive after certification. In high school math, the productivity of teachers who later become NBCTs is insignificantly different from the productivity of teachers who never obtain NBCT status. Once certification is achieved, NBCTs of high school math are more effective than the average never-NBCT, though the difference between the between the pre- and post-certification productivity of NBCTs is not statistically significant. The results are similarly inconsistent across grade levels in reading. In general we find that the effectiveness of reading teachers who become NBCTs drops during the application year and then rises to a level below their pre-application effectiveness. However, depending on the grade level, the changes over time in the effectiveness of teachers who become NBCTs is sometimes statistically significant and sometimes not. The FCAT-NRT results still tend to show no differences pre- or post-certification, except in middle and high school math where NBPTS teachers appear to become significantly less productive after receiving NBPTS certification.

One reason that post-certification productivity may appear somewhat small is that the certification process leads teachers to change their teaching practices and this leads to a temporary dip in performance as they master new ways of teaching. To explore this possibility of a delayed productivity effect, we re-estimate the achievement model, splitting the post-certification period into two components: the first year of certification (ie. the year certification is awarded) and all subsequent years. If the delayed-effect hypothesis is correct then teacher effectiveness should be relatively low the first year of certification and subsequently improve. The estimates of this specification are presented in Table 6. While the point estimates are, as predicted, almost uniformly larger two years after certification compared with the shorter term effect, none of the differences are statistically significant. This same general conclusion also holds with the FCAT-NRT.

The validity of NBPTS as a signal of productivity, or as a factor influencing productivity, may vary by student group. In Table 7 we estimate the achievement model for students of different racial, ethnic, income and prior-achievement sub-groups. In the pre-certification stage, the only certification coefficients that are statistically significant are those

for the impact of NBPTS-certified teachers on reading achievement of Black students and students receiving free or reduced price lunches. It appears that before they apply for certification, NBPTS-certified teachers boost math achievement of Black students by more than 20 scale-score points (about 0.06 of a standard deviation in achievement levels) relative to the average of teachers who never are NBPTS-certified. Similarly, they add about 25 points or 0.07 of a standard deviation to the reading scores of students receiving FRL. These differences become insignificantly different from zero during the application period and beyond, however. In the post-certification stage the only significant coefficient is for students who initially scored at the higher end of the test score distribution. This suggests that whatever changes in practice are adopted as a result of the NBPTS certification process may make them more productive with high-achieving students, but less productive with students of low-socio-economic status. In the FCAT-NRT, the only significant coefficient is a positive pre-certification effect of NBCTs on the achievement of Black students in math.

We noted earlier that NBCTs in Florida can become mentors and therefore have a formal responsibility to help other teachers. We might expect that teachers who choose to act as mentors are ones that are particularly confident in their teaching skills and are more effective than other NBCTs. Likewise, administrators may encourage the most effective NBCTs to engage in mentoring. But mentors, by definition, also have added responsibilities which, like the NBPTS application process, may take time away from their own students. Table 8 provides evidence that prior to applying for certification, NBCTs who have ever acted as mentors are actually less productive on average in teaching reading and equally productive in teaching math than those who do not later mentor. In contrast, post-certification the NBCTs who mentor are more productive in teaching both math and reading than their NBCT colleagues who do not mentor. There is no clear evidence that teachers become less effective while mentoring, though this is difficult to determine with much confidence since post-certification most teachers who are ever mentors are currently mentoring. In the FCAT-NRT results, nearly all of the mentor-related coefficients are statistically insignificant.

So far, the results suggest some noticeable differences between the estimates produced using the FCAT-SSS to measure student achievement versus those based on the FCAT-NRT. First, the post-certification effects are more positive with the FCAT-SSS in both reading and math. This may be because, as noted earlier, the FCAT-SSS focuses more on higher level cognitive skills and, in the case of math, student scores are determined partly on their explanations and written work and not only the final answer. Further, according to NBPTS, the organization's certification is focused on content standards and students' critical thinking skills.[31] Therefore, it is plausible that NBPTS certification shifts the content of teaching toward material that is better aligned with the FCAT-SSS and therefore produces larger and more precisely estimated effects. This might also explain why NBPTS teachers actually appear to be less productive after certification with the FCAT-NRT; a shift in content toward the FCAT-SSS may also mean a shift away from the content measured by the FCAT-NRT.

It is also worth noting that the effects of teacher characteristics other than NBPTS are relatively robust to changes in the test used to measure student achievement. For example, in Table 3 teacher experience appears to be a statistically significant predictor of teacher productivity with the FCAT-SSS. While not shown, the stability of effects of teacher characteristics also holds with the FCAT-NRT. This suggests that the content of the achievement test matters more when studying a small and distinctive group of teachers, such as NBPTS teachers, who are more likely to teach systematically different academic content, as opposed to broader groupings (e.g., experienced and inexperienced teachers) who may differ in productivity, but are similar on average with regard to content taught. Test content is therefore likely to be an issue mainly when studying highly focused teacher training and certification, such as NBPTS.

[31] A document on the NBPTS web site indicates that teachers receiving its certification should "develop the critical and analytical capacities of their students." The web site also lists specific content standards by subject area, suggesting a general focus on academic standards.

*B. Spillover Effects*

Based on the apparently limited differences between NBCTs and other teachers when teaching their own students, it seems unlikely that NBCTs would have measurable effects on the productivity of non-NBCTs within their schools. Table 9 tests this possibility in a model that includes variables for the number of NBCTs in a given school. To separate the direct effect of NBCTs on their own students (identified in previous tables), the sample of students is limited to those who are taught by teachers who never become NBPTS certified. Interestingly, the effectiveness of never-NBPTS-certified teachers in mathematics appears to decline with increases in the number of ever-NBPTS-certified teachers in the same school, suggesting a negative rather than positive spillover. The effect is small, however, equivalent to 0.005 of a standard deviation in student achievement.[32] A similar result is obtained when using the FCAT-NRT to measure student achievement.

Even though there do not appear to be positive spillovers from the average NBCT, there are two reasons to think that increasing the number of NBCTs who are being paid to mentor may result in greater student learning. First, as indicated earlier, in some cases NBPTS-certified mentors are more productive with their own students and may therefore be more effective in producing positive spillovers. Second, NBPTS mentors are paid to assist other teachers and therefore there is a greater likelihood of interaction with non-NBCTs. With the FCAT-SSS, we find that mentoring NBCTs have no effect on the productivity of never-NBCTs. Estimates based on the FCAT-NRT do suggest that students taught by non-NBCTs learn more in both math and in reading the greater the number of mentoring NBCTs in the school. The magnitude of these apparent positive spillovers is very small, however.[33]

[32] While small, this is a surprising result and could possibly suggest that the inclusion of student and school fixed effects do not fully address the non-random assignment of teachers to schools. Our models include school fixed effects which control for any time-invariant differences in school quality. However, if the number of NBCTs at a school is correlated with unobserved time-varying changes in school quality then the estimated spillovers could partly reflect other school-level inputs that are changing over time. For example, a new principal might boost test scores and at the same time encourage (or possibly discourage) teachers from becoming NBCTs. However, it is expected that improvements in school quality would likely be positively correlated with increases in the number of NBCTs, which would tend to bias the estimates toward finding a positive impact of the number of NBCTs at a school on the effectiveness of non-NBCTs.

[33] The positive externality from mentoring NBCTs is rather surprising given that almost none of the previous FCAT-NRT results indicate that NBCTs, whether mentors or not, are more effective in teaching reading to their own students. This anamolous finding may simply reflect some sort of omitted variable bias.

*C. Specification Checks*

The results in the previous tables utilize a specification that includes student and school fixed effects to control for time-invariant student and teacher characteristics. Table 10 examines how the estimates change if these controls are removed and/or student covariates are used in place of student fixed effects. For purposes of comparison, the estimates with both student and school fixed effects from columns [2] and [4] of Table 3 are reproduced in columns [1] and [6] of Table 10.

Across the first row, we observe that the estimated magnitudes of the pre-certification signaling effects become smaller in magnitude as more of the controls are dropped from the estimation. This pattern is most pronounced in the reading results where the magnitudes drop and all remain statistically significant. The pattern is also evidenced in the math estimates, though these coefficients are much less precisely estimated.

The magnitude of the post-certification coefficient estimates are relatively insensitive to changes in model specification, though the estimates do appear more precise when student fixed effects are replaced with time-invariant student characteristics. A similar pattern is observed in the estimates based on the FCAT-NRT. The inflated t-statistics likely reflect omitted variable bias from the non-random assignment of NBCTs to schools and students. The patterns are less clear with the application year effects where nearly all of the coefficients are insignificant, regardless of specification.

It is also worth comparing our results to the main specifications in Goldhaber and Anthony, which omit student and school fixed effects (most closely approximated by columns [4] and [9] in our Table 10). If we had estimated only these specifications, the benefits of NBPTS certification would appear larger, especially in math. The difference in results is even more pronounced in the FCAT-NRT-based results where in our preferred specifications, there are essentially no differences between ever-NBPTS and never-NBPTS teachers but where, in the Goldhaber and Anthony specifications, many of the results are positive and highly significant. It is unclear why our results are more sensitive to the use of fixed effects than theirs, or why the sensitivity depends on the achievement test. Interestingly, Goldhaber and Anthony's findings are based on North Carolina's end-of-year

exams which are criterion-referenced exams, like the FCAT-SSS. If we look only at the FCAT-SSS, the sensitivity of the results is relatively small and similar across the two studies.

Adding teacher fixed effects to the model, however, does not seem to have as much of an impact on the estimated effects of NBPTS certification as do student fixed effects. The estimated changes in teacher effectiveness during and after the NBPTS application process presented in Tables 3-10 are based on a comparison of the average effectiveness of all ever-NBCTs at different points in time, or in the case of Table 4, the average effectiveness of a particular cohort of ever-NBCTs at different times. If the student and school effects have not fully accounted for the non-random assignment of students to teachers, then a potentially better measure of the intertemporal changes in effectiveness of ever-NBCTs is to estimate the change in effectiveness of an NBCT relative to her own baseline effectiveness prior to beginning the application process. To do this we incorporate fixed effects for each teacher who is ever NBPTS certified. This comes at a cost, however. Employing fixed effects for individual NBCTs means that we can only identify changes in effectiveness for teachers who we observe during all three stages of the certification process: pre-application, application year, and post-certification. As illustrated in Table 4, this means the within-teacher changes in effectiveness are only identified for the cohorts of teachers certified in 2002 and 2003.

Estimates for the two groups where we previously found the largest differences between pre- and post-certification productivity, elementary and middle school math teachers, are presented in Table 11. For purpose of comparison, columns [1] and [3] of Table 11 contain estimates from the model without individual fixed effects for ever-NBCTs, which were previously presented in Table 5. The estimates with fixed effects for ever-NBCTs are presented in columns [2] and [4]. The fixed effects capture the baseline effectiveness of ever-NBCTs, prior to applying for NBPTS certification and thus the (Ever NBCT $\times$ Pre-Application Period) interaction is omitted in these specifications. Further, since the fixed effects capture the pre-application effectiveness of future NBCTs, the coefficients on (Ever NBCT $\times$ Application Year) and (Ever NBCT $\times$ Received Certification) represent the *changes* in effectiveness relative to the pre-application period. When teacher fixed effects are included we find no statistically significant differences between the pre-application,

application-year and post-certification productivity of NBCTs. Due to the relatively short time period of analysis these results must be interpreted with some caution. However, they do reinforce the cohort analysis presented in Table 4. Some of what appears to be intertemporal changes in the productivity of teachers who become NBCTs is likely differences in the productivity of different cohorts of NBCTs.

Finally, in Table 12 we test the sensitivity of the results to the inclusion/exclusion of other possible indicators of teacher effectiveness: teacher experience, teacher education, and whether the teacher has full state certification. The addition of state certification is important because it allows us to test whether all the information about teacher effectiveness represented by NBPTS is also captured by state certification (recall that all NBPTS teachers have to be state certified). We find that these exclusions have almost no effect on the results in either subject. The one exception is that math teachers now appear to be more effective than others post-certification. This is not surprising, given that NBPTS certification is now also capturing differences in experience, as well as the certification itself. The results are also essentially unchanged with the FCAT-NRT.

## VII. Conclusion

With its extensive process to gauge teacher practice and knowledge, combined with extra salary for those who meet the requirements, certification from NBPTS represents a departure from previous forms of teacher certification. However, our results paint a mixed picture about the value of NBPTS as a signal of teacher effectiveness.

On the surface, our results are similar to those of Goldhaber and Anthony. They find that NBCTs in North Carolina are more effective than other teachers before they start the certification process, their relative productivity falls during the certification process, and it never returns to pre-application levels. We also find some similar patterns in Florida. Both studies find some evidence that the signaling effect is larger for black students. Neither study finds any evidence that the certification process significantly improves teacher effectiveness. Finally, both studies find the post-certification efficacy of NBCTs varies with

the method used to account for student heterogeneity.

Our work contrasts with previous studies in that we possess data on a much larger number of NBCTs which allows us to estimate separate effects for sub-groups of students and teachers. Conducting separate analyses for different cohorts of NBCTs we find that positive post-certification effects exist for NBCTs who achieved certification early, but not for later cohorts. Subsequent cohorts of NBCTs tend to be better than the average never-NBCT prior to certification, but lose this advantage during the application process and never regain it. We also find that the ability of the NBPTS process to identify superior teachers varies by grade level and subject and whether we focus on the signal pre-certification or post-certification.

Our data also allow us to better account for non-random selection of students and teachers. Given the short panel of data available to Goldhaber and Anthony, they focus on models that control for student heterogeneity via observed student characteristics. We find that excluding student fixed effects, as in Goldhaber and Anthony's main specifications, makes NBPTS certification appear more beneficial. Without student fixed effects, the signaling effects becoming more precise, the productivity decline during the application year appears smaller and the measured post-certification effectiveness of NBCTs is greater.

There is some evidence of positive spillovers of NBPTS mentor teachers on other teachers, in both reading and math, but only with the FCAT-NRT student achievement test. Such positive evidence is not surprising in math where NBPTS mentors are more effective with their own students, but it is somewhat surprising in reading where such direct effects are not present. It is possible that the presence of any type of mentor induces teachers to spend more time improving their teaching. Therefore, the effects we estimate may be the effects of mentoring in general and not the effects of NBPTS mentoring per se. To our knowledge, this is the first study to present direct evidence regarding these spillover effects.

Unlike Goldhaber and Anthony, our data include two student tests and the choice of test turns out to have a significant influence on many of the results. The FCAT-NRT is more likely to yield statistically significant differences between NBPTS and other teachers (both positive and negative) in math, while the FCAT-SSS yields differences (mostly

positive) in reading. Given the differences in results between this study and Goldhaber and Anthony, and the fact that they used a high-stakes test like the FCAT-SSS, it would appear their more positive effects are partly due to the test characteristics, such as the alignment of test content with the curriculum and/or to differences in scaling procedures. Given the growing body of economic research using value-added modeling to identify the effects of all types of educational interventions, learning more about these test differences is an important avenue for future research.

Future studies will undoubtedly provide further insight into the issues raised here, using data from other states and covering longer periods of time. But, even if these results are confirmed, it is not entirely clear whether NBPTS improves overall teacher effectiveness. The pre-certification signaling effect might warrant both the identification and additional compensation of these teachers, but the possibility that the effect does not exist post-certification would be an important drawback. Also, while the extensive application process has the potential to raise the productivity of teachers, the results here provide little evidence of gains in human capital.

In addition to the potential benefits, it is important to consider the substantial costs that go into the certification—teacher time, NBPTS administration and direct financial incentives—as well as other possible means of accomplishing the same objective of increased teacher effectiveness. NBPTS certification provides a distinctive mixture of certification, preparation and merit pay, but that does not necessarily make it a more cost-effective policy compared to other options.

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**Table 1**
**Number of New NBPTS Certifications in Florida by Field and Year**

| | Before 1999 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | All Years |
|---|---|---|---|---|---|---|---|---|
| All Fields | 27 | 525 | 670 | 981 | 1,238 | 1,446 | 1,468 | 6,355 |
| Art | 9 | 25 | 21 | 38 | 47 | 55 | 42 | 237 |
| Counseling | 0 | 0 | 0 | 0 | 0 | 0 | 69 | 69 |
| ESL | 0 | 0 | 11 | 13 | 15 | 23 | 26 | 88 |
| Foreign Languages | 0 | 0 | 0 | 0 | 28 | 46 | 33 | 107 |
| General | 12 | 284 | 328 | 439 | 499 | 515 | 503 | 2,580 |
| Language Arts | 3 | 73 | 84 | 136 | 117 | 155 | 130 | 698 |
| Library/Media | 0 | 0 | 0 | 0 | 62 | 60 | 78 | 200 |
| Literacy | 0 | 0 | 0 | 0 | 0 | 0 | 46 | 46 |
| Math | 0 | 51 | 35 | 60 | 71 | 63 | 106 | 386 |
| Music | 0 | 0 | 0 | 0 | 50 | 54 | 51 | 155 |
| Physical Education | 0 | 0 | 0 | 21 | 23 | 47 | 23 | 114 |
| Science | 3 | 59 | 68 | 69 | 75 | 95 | 77 | 446 |
| Social Studies/History | 0 | 33 | 35 | 59 | 53 | 78 | 66 | 324 |
| Special Education | 0 | 0 | 61 | 116 | 151 | 199 | 162 | 689 |
| Vocational/Technical | 0 | 0 | 27 | 30 | 47 | 56 | 56 | 216 |

**Table 2**
**Sample Characteristics**
**Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2000/01-2003/04**

| | Math Sample | | Reading Sample | |
|---|---|---|---|---|
| | Never NBPTS Certified | Ever NBPTS Certified | Never NBPTS Certified | Ever NBPTS Certified |
| Number of Teachers | 30,948 | 1,256 | 33,516 | 1,517 |
| Proportion Male | 0.224 | 0.076 | 0.151 | 0.058 |
| Proportion Black | 0.175 | 0.035 | 0.165 | 0.038 |
| Proportion Hispanic | 0.088 | 0.095 | 0.091 | 0.085 |
| Proportion with Advanced Degree | 0.302 | 0.497 | 0.302 | 0.508 |
| Average Years of Experience | 9.471 | 10.349 | 9.259 | 10.069 |
| Ever NBPTS Certified in Math | | 0.256 | | |
| Ever NBPTS Certified in Language Arts | | | | 0.319 |
| Ever NBPTS Mentor | | 0.179 | | 0.184 |
| Number of Students | 1,031,471 | 81,513 | 1,067,226 | 106,218 |
| Proportion Black | 0.227 | 0.159 | 0.229 | 0.156 |
| Proportion Hispanic | 0.206 | 0.197 | 0.203 | 0.193 |
| Proportion Free/Reduced Price Lunch | 0.422 | 0.316 | 0.428 | 0.305 |
| Average Achievement Gain (High-Stakes Test) | 102.401 | 104.382 | 88.737 | 97.528 |
| Average Achievement Gain (Low-Stakes Test) | 14.514 | 14.840 | 9.671 | 9.819 |
| Proportion in Lowest Achievement Quintile | 0.099 | 0.054 | 0.132 | 0.070 |
| Proportion in Highest Achievement Quintile | 0.328 | 0.476 | 0.241 | 0.360 |

Note: Samples are restricted to students with at least two valid achievement gain scores during the period 2000/01-2003/04. Since testing occurs in grades 3-10 this limits the samples to students in grades 4-10, plus some third-grade repeaters. Achievement quintiles are based on national percentile ranking of exam score in previous year. Time-varying teacher characteristics (advanced degrees and experience) and time-varying student characteristics (free-lunch status, achievement gain, achievement quintile) are averaged over time by student and then averaged over students. Student totals represent the number of students ever exposed to a never NBPTS-certified or a never-NBPTS-certified teacher and thus do not sum to the total number of students in the sample.

**Table 3**
**Estimates of the Effects of NBPTS-Certified Teachers on Student Achievement Controlling for Individual, Peer and School Characteristics Using FCAT-SSS Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2001/02-2003/04)**

| | Math | | Reading | |
|---|---|---|---|---|
| | [1] | [2] | [3] | [4] |
| Ever NBPTS Certified | 1.8577<br>(1.32) | | 5.0365**<br>(2.41) | |
| Ever NBPTS Certified × Pre-Application Period | | 0.9866<br>(0.41) | | 11.5817***<br>(2.99) |
| Ever NBPTS Certified × Application Year | | 0.6161<br>(0.22) | | -6.0390<br>(1.50) |
| Ever NBPTS Certified × Received Certification | | 2.9126<br>(1.50) | | 6.2529**<br>(2.28) |
| 0 Years of Experience | -12.6120***<br>(8.80) | -12.6118***<br>(8.80) | -12.8027***<br>(6.08) | -12.8467***<br>(6.10) |
| 1-2 Years of Experience | -2.0180**<br>(2.29) | -2.0048**<br>(2.28) | -2.2943*<br>(1.70) | -2.3032*<br>(1.71) |
| 3-4 Years of Experience | -1.2322<br>(1.13) | -1.1912<br>(1.09) | -3.7743**<br>(2.21) | -3.7212**<br>(2.18) |
| 5-9 Years of Experience | -0.3161<br>(0.37) | -0.3152<br>(0.37) | -2.4119*<br>(1.67) | -2.3591<br>(1.64) |
| Advanced Degree | 1.1647*<br>(1.77) | 1.1504*<br>(1.74) | -4.2802***<br>(3.97) | -4.2743***<br>(3.96) |
| Student Time-Varying Char. | Yes | Yes | Yes | Yes |
| Peer Characteristics | Yes | Yes | Yes | Yes |
| Student Fixed Effects | Yes | Yes | Yes | Yes |
| School Fixed Effects | Yes | Yes | Yes | Yes |
| R-squared | 0.684 | 0. 684 | 0. 684 | 0. 684 |
| No. of Student-Year Obs. | 1,808,527 | 1,808,527 | 1,883,974 | 1,883,974 |

Note: Absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include grade-by-year dummies and a constant. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size.

**Table 4**
**Estimates of the Effects of NBPTS-Certified Teachers on Student Achievement Controlling for Individual, Peer and School Characteristics, By NBPTS Certification Cohort Using FCAT-SSS Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2000/01-2003/04)**

| | Math | | | | | Reading | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Certified Prior to 2001 | Certified in 2001 | Certified in 2002 | Certified in 2003 | Certified in 2004 | Certified Prior to 2001 | Certified in 2001 | Certified in 2002 | Certified in 2003 | Certified in 2004 |
| Ever NBPTS Certified × Pre-Application Period | | | 17.1359* | 12.3114** | -4.0683 | | | 59.9536*** | 5.7624 | 14.2119*** |
| | | | (1.82) | (2.35) | (1.35) | | | (3.27) | (0.83) | (2.66) |
| Ever NBPTS Certified × Application Year | | 9.5164 | -2.9836 | 4.2609 | -2.3648 | | 24.1919 | -7.9748 | -7.2030 | -12.1084 |
| | | (0.90) | (0.54) | (0.91) | (0.46) | | (1.49) | (0.96) | (1.19) | (1.19) |
| Ever NBPTS Certified × Received Certification | 7.3051** | -1.5517 | -3.0577 | 2.8542 | | 16.2805*** | -2.2570 | 8.0599 | -9.5050 | |
| | (2.47) | (0.37) | (0.73) | (0.38) | | (3.30) | (0.46) | (1.27) | (1.15) | |
| No. of Teachers in Cohort | 276 | 215 | 255 | 241 | 283 | 320 | 279 | 288 | 313 | 320 |
| R-squared | 0.693 | 0.695 | 0.694 | 0.694 | 0.693 | 0.699 | 0.699 | 0.699 | 0.698 | 0.699 |
| No. of Student-Year Obs. | 1,743,371 | 1,736,567 | 1,739,987 | 1,738,559 | 1,746,227 | 1,795,323 | 1,793,187 | 1,792,202 | 1,799,821 | 1,794,317 |

Note: Absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include student/school fixded effects, grade-by-year dummies and a constant. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size. Teacher experience categories and advanced degree indicator are also included.

**Table 5**
**Estimates of the Effects of NBPTS-Certified Teachers on Student Achievement Controlling for Individual, Peer and School Characteristics, By Grade Level Using FCAT-SSS Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2000/01-2003/04)**

| | Math | | | Reading | | |
|---|---|---|---|---|---|---|
| | Elementary (Grades 4-5) | Middle (Grades 6-8) | High (Grades 9-10) | Elementary (Grades 4-5) | Middle (Grades 6-8) | High (Grades 9-10) |
| Ever NBPTS Certified × Pre-Application Period | -11.4610* (1.82) | 13.6778*** (2.63) | 5.0213 (1.54) | 9.4158 (1.07) | 17.9472*** (2.80) | 8.2874 (1.45) |
| Ever NBPTS Certified × Application Year | -0.2906 (0.04) | -4.5172 (0.76) | 7.9657** (2.15) | -6.8139 (0.69) | -0.6133 (0.10) | -15.0548** (2.40) |
| Ever NBPTS-Certified × Received Certification | 8.7752** (2.03) | -7.9645* (1.71) | 7.0578*** (2.70) | 8.4184 (1.36) | 8.1014** (2.00) | 1.9124 (0.41) |
| Teacher Time-Varying Char. | Yes | Yes | Yes | Yes | Yes | Yes |
| Student Time-Varying Char. | Yes | Yes | Yes | Yes | Yes | Yes |
| Peer Characteristics | Yes | Yes | Yes | Yes | Yes | Yes |
| Student Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| School Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| R-squared | 0.665 | 0.677 | 0.684 | 0.741 | 0.656 | 0.600 |
| No. of Student-Year Obs. | 518,258 | 644,476 | 645,793 | 670,859 | 695,231 | 517,884 |

Note: Absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include grade-by-year dummies and a constant. Included time-varying teacher characteristics are a set of experience category dummies and an indicator for teachers possessing an advanced degree. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size.

**Table 6**
**Estimates of the Effects of NBPTS-Certified Teachers on Student Achievement Allowing the Effect of Receiving Certification to Vary Over Time, by Grade Level Using FCAT-SSS Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10)**

| | Math | | | Reading | | |
|---|---|---|---|---|---|---|
| | Elementary (Grades 4-5) | Middle (Grades 6-8) | High (Grades 9-10) | Elementary (Grades 4-5) | Middle (Grades 6-8) | High (Grades 9-10) |
| Ever NBPTS Certified × Pre-Application Period | -11.4212* (1.82) | 13.6751*** (2.63) | 5.0708 (1.56) | 9.4326 (1.07) | 17.9377*** (2.80) | 8.3026 (1.45) |
| Ever NBPTS Certified × Application Year | 0.1258 (0.02) | -4.5365 (0.76) | 7.7760** (2.10) | -6.8901 (0.70) | -0.6163 (0.10) | -14.8525** (2.36) |
| Ever NBPTS-Certified × First Year of Certification | 1.9949 (0.26) | -8.7526 (1.11) | 3.7045 (0.83) | 4.9186 (0.47) | 7.4570 (1.18) | 5.4694 (0.74) |
| Ever NBPTS-Certified × After First Year of Certification | 11.8746** (2.35) | -7.5321 (1.35) | 8.4663*** (2.80) | 10.1628 (1.37) | 8.4920* (1.71) | -0.3541 (0.06) |
| Teacher Time-Varying Char. | Yes | Yes | Yes | Yes | Yes | Yes |
| Student Time-Varying Char. | Yes | Yes | Yes | Yes | Yes | Yes |
| Peer Characteristics | Yes | Yes | Yes | Yes | Yes | Yes |
| Student Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| School Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| R-squared | 0.666 | 0.677 | 0.684 | 0.741 | 0.656 | 0.600 |
| No. of Student-Year Obs. | 518,258 | 644,476 | 645,793 | 670,859 | 695,231 | 517,884 |

Note: Absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include grade-by-year dummies and a constant. Included time-varying teacher characteristics are a set of experience category dummies and an indicator for teachers possessing an advanced degree. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size.

**Table 7**
**Estimates of the Effects of NBPTS-Certified Teachers on Student Achievement Controlling for Individual, Peer and School Characteristics, by Student Demographics Using FCAT-SSS Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2000/01-2003/04)**

| | Math | | | | | Reading | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Black Students | Hispanic Students | Students Receiving Free Lunch | Students w/ 1-20 NPR In Prior Year | Students w/ 81-99 NPR in Prior Year | Black Students | Hispanic Students | Students Receiving Free Lunch | Students w/ 1-20 NPR in Prior Year | Students w/ 81-99 NPR in Prior Year |
| Ever NBPTS Certified × Pre-Application Period | 3.8574 | -8.7754 | -1.4082 | -4.1822 | 1.3607 | 20.6673** | 13.9215 | 24.7983*** | 48.2266 | 10.5730 |
| | (0.50) | (1.44) | (0.21) | (0.07) | (0.37) | (1.97) | (1.58) | (2.72) | (0.89) | (1.04) |
| Ever NBPTS Certified × Application Year | -1.6620 | 1.2476 | -0.6065 | 1.8861 | 1.4855 | 2.6872 | 4.0493 | 10.2548 | -20.5129 | -3.8544 |
| | (0.20) | (0.18) | (0.08) | (0.03) | (0.37) | (0.26) | (0.46) | (1.06) | (0.35) | (0.39) |
| Ever NBPTS-Certified × Received Certification | 3.9509 | 1.8524 | 2.2617 | 24.4112 | 5.9713** | 12.4802 | 3.8784 | 8.6212 | -0.2122 | 6.7092 |
| | (0.64) | (0.41) | (0.44) | (0.47) | (2.09) | (1.59) | (0.62) | (1.30) | (0.00) | (1.00) |
| R-squared | 0.717 | 0.695 | 0.741 | 0.825 | 0.691 | 0.732 | 0.707 | 0.763 | 0.838 | 0.701 |
| No. of Student-Year Obs. | 381,482 | 375,398 | 726,241 | 144,696 | 643,462 | 396,887 | 384,394 | 764,832 | 201,524 | 495,206 |

Note: Absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include student/school fixded effects, grade-by-year dummies and a constant. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size. Teacher experience categories and advanced degree indicator are also included.

**Table 8**
**Estimates of the Effects of NBPTS-Certified Teachers who Mentor on Student Achievement Controlling for Individual, Peer and School Characteristics Using FCAT-SSS Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2000/01-2003/04)**

| | Math | | Reading | |
|---|---|---|---|---|
| | [1] | [2] | [3] | [4] |
| Ever NBPTS Certified × Pre-Application Period × Never Mentor | 1.5875<br>(0.65) | 0.0347<br>(0.01) | 12.3336***<br>(3.04) | 12.8136***<br>(2.69) |
| Ever NBPTS Certified × Application Year × Never Mentor | 1.6090<br>(0.56) | 1.7034<br>(0.51) | -7.3315*<br>(1.70) | -12.1599**<br>(2.36) |
| Ever NBPTS Certified × Received Certification × Never Mentor | -1.0571<br>(0.46) | -5.5209**<br>(2.04) | 4.8806<br>(1.46) | 4.2968<br>(1.03) |
| Ever NBPTS Certified × Pre-Application Period × Ever Mentor | -25.3523<br>(1.21) | -26.1897<br>(1.05) | -3.0441<br>(0.19) | -2.3366<br>(0.14) |
| Ever NBPTS Certified × Application Year × Ever Mentor | -16.3981*<br>(1.87) | -6.1848<br>(0.62) | 3.2045<br>(0.27) | -0.5715<br>(0.04) |
| Ever NBPTS Certified × Received Certification × Ever Mentor | 12.8500***<br>(3.73) | 9.5477<br>(1.54) | 8.6662*<br>(1.76) | 5.3187<br>(0.52) |
| Ever Mentor × Mentoring in Current Year | | 8.4984<br>(1.19) | | -1.1666<br>(0.10) |
| Teacher Time-Varying Char. | Yes | Yes | Yes | Yes |
| Student Time-Varying Char. | Yes | Yes | Yes | Yes |
| Peer Characteristics | Yes | Yes | Yes | Yes |
| Student Fixed Effects | Yes | Yes | Yes | Yes |
| School Fixed Effects | Yes | Yes | Yes | Yes |
| R-squared | 0.684 | 0.687 | 0.685 | 0.689 |
| No. of Student-Year Obs. | 1,806,726 | 1,787,942 | 1,880,030 | 1,851,691 |

Note: Absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include grade-by-year dummies and a constant. Included time-varying teacher characteristics are a set of experience category dummies and an indicator for teachers possessing an advanced degree. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size.

**Table 9**
**Estimates of the Impact of the Numbers of NBPTS-Certified Teachers and NBPTS-Certified Teachers Acting as Mentors in a School on the Effectiveness of Never-NBPTS-Certified Teachers Controlling for Individual, Peer and School Characteristics Using FCAT-SSS Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2000/01-2003/04)**

| | Math | | Reading | |
|---|---|---|---|---|
| | [1] | [2] | [3] | [4] |
| Number of Ever-NBPTS-Certified Teachers in School | -0.9009** (2.01) | | -1.1653 (1.39) | |
| Number of Ever-NBPTS-Certified Teachers in School who are Mentoring | | -0.0357 (0.04) | | -1.8938 (1.23) |
| Teacher Time-Varying Char. | Yes | Yes | Yes | Yes |
| Student Time-Varying Char. | Yes | Yes | Yes | Yes |
| Peer Characteristics | Yes | Yes | Yes | Yes |
| Student Fixed Effects | Yes | Yes | Yes | Yes |
| School Fixed Effects | Yes | Yes | Yes | Yes |
| R-squared | 0.752 | 0.756 | 0.762 | 0.765 |
| No. of Student-Year Obs. | 1,399,715 | 1,379,973 | 1,458,412 | 1,439,082 |

Note: Absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include grade-by-year dummies and a constant. Included time-varying teacher characteristics are a set of experience category dummies and an indicator for teachers possessing an advanced degree. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size. Teacher experience categories and advanced degree indicator are also included.

**Table 10**
**Estimates of the Effects of NBPTS-Certified Teachers on Student Achievement**
**With/Without Controls for Individual and School Characteristics Using FCAT-SSS Data**
**(Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2000/01-2003/04)**

| | Math | | | | | Reading | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] | [9] | [10] |
| Ever NBPTS Certified × Pre-Application Period | 0.9866 | -0.6816 | -1.7456* | -0.3138 | -0.7866 | 11.5817*** | 7.5993*** | 5.6618*** | 5.2509*** | 3.8138*** |
| | (0.41) | (0.43) | (1.93) | (0.37) | (0.92) | (2.99) | (3.26) | (4.53) | (4.42) | (3.20) |
| Ever NBPTS Certified × Application Year | 0.6161 | 1.9303 | -1.3538 | -0.0893 | -0.7772 | -6.0390 | -4.2034* | 1.4913 | 1.5366 | 0.3761 |
| | (0.22) | (1.05) | (1.35) | (0.09) | (0.79) | (1.50) | (1.67) | (1.09) | (1.16) | (0.28) |
| Ever NBPTS-Certified × Received Certification | 2.9126 | 2.8954** | 1.3143* | 1.4753** | 0.7660 | 6.2529** | 8.0417*** | 5.3108*** | 6.0237*** | 4.6180*** |
| | (1.50) | (2.33) | (1.91) | (2.30) | (1.19) | (2.28) | (4.88) | (5.76) | (7.05) | (5.39) |
| Teacher Time-Varying Char. | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Student Time-Varying Char. | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Student Time-Invariant Char. | No | No | Yes | Yes | No | No | No | Yes | Yes | No |
| Peer Characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Student Fixed Effects | Yes | Yes | No | No | No | Yes | Yes | No | No | No |
| School Fixed Effects | Yes | No | Yes | No | No | Yes | No | Yes | No | No |
| R-squared | 0.684 | 0.546 | 0.164 | 0.149 | 0.141 | 0.684 | 0.498 | 0.110 | 0.104 | 0.096 |
| No. of Student-Year Obs. | 1,808,527 | 1,808,527 | 1,808,527 | 1,808,527 | 1,808,527 | 1,883,974 | 1,883,974 | 1,883,974 | 1,883,974 | 1,883,974 |

Note: Absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include grade-by-year dummies and a constant. Time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Time-invariant student characterisitcs are: female, black, hispanic, free/reduced-price lunch, limited English proficiency, disability status. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size. Teacher experience categories and advanced degree indicator are also included.

**Table 11**
**Estimates of the Effects of NBPTS-Certified Teachers on Student Achievement Controlling for Individual, Peer and School Characteristics Plus Individual-Specific Time-Invariant Characteristics of NBPTS-Certified Teachers Using FCAT-SSS Data (Elementary and Middle School Math Classes, 2000/01-2003/04)**

| | Math – Elementary School | | Math – Middle School | |
|---|---|---|---|---|
| | [1] | [2] | [3] | [4] |
| Ever NBPTS Certified × Pre-Application Period | -11.4610* (1.82) | | 13.6778*** (2.63) | |
| Ever NBPTS Certified × Application Year | -0.2906 (0.04) | -1.5714 (0.09) | -4.5172 (0.76) | -12.1541 (1.29) |
| Ever NBPTS Certified × Received Certification | 8.7752** (2.03) | -7.3925 (0.31) | -7.9645* (1.71) | -5.5497 (0.34) |
| Teacher Time-Varying Char. | Yes | Yes | Yes | Yes |
| Student Time-Varying Char. | Yes | Yes | Yes | Yes |
| Peer Characteristics | Yes | Yes | Yes | Yes |
| Ever-NBPTS-Certified Fixed Effects | No | Yes | No | Yes |
| Student Fixed Effects | Yes | Yes | Yes | Yes |
| School Fixed Effects | Yes | Yes | Yes | Yes |
| R-squared | 0.665 | 0.669 | 0.677 | 0.678 |
| No. of Student-Year Obs. | 518,258 | 518,258 | 644,476 | 644,476 |

Note: Absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include grade-by-year dummies and a constant. Included time-varying teacher characteristics are a set of experience category dummies and an indicator for teachers possessing an advanced degree. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size.

**Table 12**

**Estimates of the Effects of NBPTS-Certified Teachers on Student Achievement Controlling for Individual, Peer and School Characteristics Plus State Licensure Status Using FCAT-SSS Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2000/01-2003/04)**

| | Math | | | Reading | | |
|---|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] | [6] |
| Ever NBPTS Certified × Pre-Application Period | 0.9866<br>(0.41) | 0.4240<br>(0.17) | 1.7812<br>(0.73) | 11.5817***<br>(2.99) | 11.5607***<br>(2.96) | 11.0801***<br>(2.87) |
| Ever NBPTS Certified × Application Year | 0.6161<br>(0.22) | 0.2043<br>(0.07) | 1.4188<br>(0.52) | -6.0390<br>(1.50) | -5.7732<br>(1.42) | -6.0749<br>(1.52) |
| Ever NBPTS Certified × Received Certification | 2.9126<br>(1.50) | 3.0152<br>(1.54) | 3.9542**<br>(2.05) | 6.2529**<br>(2.28) | 6.0699**<br>(2.19) | 5.9563**<br>(2.19) |
| Full State Licensure | | 3.4154***<br>(2.65) | | | 3.8417**<br>(2.01) | |
| 0 Years of Experience | -12.6118***<br>(8.80) | -10.3674***<br>(6.20) | | -12.8467***<br>(6.10) | -10.3197***<br>(4.19) | |
| 1-2 Years of Experience | -2.0048**<br>(2.28) | -1.1503<br>(1.19) | | -2.3032*<br>(1.71) | -1.4011<br>(0.94) | |
| 3-4 Years of Experience | -1.1912<br>(1.09) | -0.7870<br>(0.71) | | -3.7212**<br>(2.18) | -3.3594*<br>(1.94) | |
| 5-9 Years of Experience | -0.3152<br>(0.37) | -0.2858<br>(0.33) | | -2.3591<br>(1.64) | -2.3489<br>(1.61) | |
| Advanced Degree | 1.1504*<br>(1.74) | 0.9603<br>(1.44) | | -4.2743***<br>(3.96) | -4.5856***<br>(4.19) | |
| Student Time-Varying Char. | Yes | Yes | Yes | Yes | Yes | Yes |
| Peer Characteristics | Yes | Yes | Yes | Yes | Yes | Yes |
| Student Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| School Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| R-squared | 0.684 | 0.687 | 0.684 | 0.684 | 0.687 | 0.684 |
| No. of Student-Year Obs. | 1,808,527 | 1,786,784 | 1,808,527 | 1,883,974 | 1,863,892 | 1,886,667 |

Note: Absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include grade-by-year dummies and a constant. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size.

# Appendix

**Table A1**
**Estimates of the Effects of NBPTS-Certified Teachers on Student Achievement Controlling for Individual, Peer and School Characteristics Using FCAT-NRT Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2000/01-2003/04)**

| | Math | | Reading | |
|---|---|---|---|---|
| | [1] | [2] | [3] | [4] |
| Ever NBPTS Certified | -0.1174<br>(0.51) | | -0.0609<br>(0.29) | |
| Ever NBPTS Certified × Pre-Application Period | | 0.6252*<br>(1.68) | | 0.0196<br>(0.06) |
| Ever NBPTS Certified × Application Year | | -0.6996<br>(1.50) | | -0.5595<br>(1.31) |
| Ever NBPTS Certified × Received Certification | | -0.4328<br>(1.30) | | 0.0971<br>(0.33) |
| 0 Years of Experience | -2.2543***<br>(11.15) | -2.2553***<br>(11.16) | -1.0610***<br>(5.32) | -1.0633***<br>(5.33) |
| 1-2 Years of Experience | -0.4659***<br>(3.58) | -0.4744***<br>(3.65) | -0.5329***<br>(4.00) | -0.5322***<br>(4.00) |
| 3-4 Years of Experience | -0.2748<br>(1.64) | -0.2867*<br>(1.71) | -0.5302***<br>(3.08) | -0.5245***<br>(3.05) |
| 5-9 Years of Experience | -0.1903<br>(1.40) | -0.1918<br>(1.41) | -0.4610***<br>(3.16) | -0.4573***<br>(3.14) |
| Advanced Degree | 0.1936*<br>(1.86) | 0.1972*<br>(1.89) | 0.1144<br>(1.05) | 0.1125<br>(1.04) |
| Student Time-Varying Char. | Yes | Yes | Yes | Yes |
| Peer Characteristics | Yes | Yes | Yes | Yes |
| Student Fixed Effects | Yes | Yes | Yes | Yes |
| School Fixed Effects | Yes | Yes | Yes | Yes |
| R-squared | 0.598 | 0.598 | 0.627 | 0.627 |
| No. of Student-Year Obs. | 2,235,895 | 2,235,895 | 2,225,456 | 2,225,456 |

Note: absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include grade-by-year dummies and a constant. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size.

**Table A2**
**Estimates of the Effects of NBPTS-Certified Teachers on Student Achievement Controlling for Individual, Peer and School Characteristics, By NBPTS Certification Cohort Using FCAT-NRT Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2000/01-2003/04)**

| | Math | | | | | Reading | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Certified Prior to 2001 | Certified in 2001 | Certified in 2002 | Certified in 2003 | Certified in 2004 | Certified Prior to 2001 | Certified in 2001 | Certified in 2002 | Certified in 2003 | Certified in 2004 |
| Ever NBPTS Certified × Pre-Application Period | | | 1.1055 | 1.6548** | -0.2674 | | | 1.2151 | 0.6753 | -0.5301 |
| | | | (0.90) | (2.32) | (0.54) | | | (1.07) | (1.18) | (1.02) |
| Ever NBPTS Certified × Application Year | | 0.6089 | -1.8295** | 0.6906 | -1.3015 | | -1.8387* | -1.1304 | -0.0374 | -0.3298 |
| | | (0.49) | (2.21) | (0.80) | (1.22) | | (1.75) | (1.37) | (0.05) | (0.27) |
| Ever NBPTS Certified × Received Certification | -0.4057 | 0.0634 | -0.8128 | 0.6147 | | 0.0838 | -0.5500 | 0.2507 | 1.6399* | |
| | (0.83) | (0.09) | (1.07) | (0.40) | | (0.17) | (1.01) | (0.33) | (1.66) | |
| No. of Teachers in Cohort | 316 | 254 | 286 | 270 | 326 | 349 | 304 | 308 | 340 | 344 |
| R-squared | 0.611 | 0.613 | 0.612 | 0.612 | 0.611 | 0.643 | 0.643 | 0.644 | 0.642 | 0.644 |
| No. of Student-Year Obs. | 2,153,489 | 2,145,981 | 2,150,074 | 2,147,987 | 2,156,956 | 2,118,497 | 2,116,116 | 2,113,617 | 2,123,631 | 2,116,671 |

Note: absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include student/school fixded effects, grade-by-year dummies and a constant. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size. Teacher experience categories and advanced degree indicator are also included.

**Table A3**
**Estimates of the Effects of NBPTS-Certified Teachers on Student Achievement Controlling for Individual, Peer and School Characteristics, By Grade Level Using FCAT-NRT Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2000/01-2003/04)**

| | Math | | | Reading | | |
|---|---|---|---|---|---|---|
| | Elementary (Grades 4-5) | Middle (Grades 6-8) | High (Grades 9-10) | Elementary (Grades 4-5) | Middle (Grades 6-8) | High (Grades 9-10) |
| Ever NBPTS Certified × Pre-Application Period | 0.7147 (1.17) | 1.8762** (2.39) | 1.9168** (2.74) | -0.1109 (0.18) | -0.0491 (0.10) | 0.4282 (0.58) |
| Ever NBPTS Certified × Application Year | -0.9586 (1.18) | -1.0592 (1.16) | -0.6594 (0.64) | -0.6066 (0.71) | -0.0715 (0.11) | -1.5463* (1.81) |
| Ever NBPTS-Certified × Received Certification | 0.5035 (0.93) | -3.0561*** (4.07) | -1.9752*** (2.83) | -0.3431 (0.62) | 0.7247* (1.67) | -0.6641 (1.04) |
| Teacher Time-Varying Char. | Yes | Yes | Yes | Yes | Yes | Yes |
| Student Time-Varying Char. | Yes | Yes | Yes | Yes | Yes | Yes |
| Peer Characteristics | Yes | Yes | Yes | Yes | Yes | Yes |
| Student Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| School Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| R-squared | 0.587 | 0.654 | 0.690 | 0.602 | 0.576 | 0.624 |
| No. of Student-Year Obs. | 785,605 | 783,433 | 666,857 | 797,519 | 924,519 | 503,418 |

Note: absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include grade-by-year dummies and a constant. Included time-varying teacher characteristics are a set of experience category dummies and an indicator for teachers possessing an advanced degree. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size.

**Table A4**
**Estimates of the Effects of NBPTS-Certified Teachers on Student Achievement Allowing the Effect of Receiving Certification to Vary Over Time, by Grade Level Using FCAT-NRT Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10)**

| | Math | | | Reading | | |
|---|---|---|---|---|---|---|
| | Elementary (Grades 4-5) | Middle (Grades 6-8) | High (Grades 9-10) | Elementary (Grades 4-5) | Middle (Grades 6-8) | High (Grades 9-10) |
| Ever NBPTS Certified × Pre-Application Period | 0.7149<br>(1.17) | 1.8737**<br>(2.39) | 1.8773**<br>(2.27) | -0.1103<br>(0.18) | -0.0481<br>(0.09) | 0.4317<br>(0.59) |
| Ever NBPTS Certified × Application Year | -0.9642<br>(1.19) | -1.0778<br>(1.18) | -0.5153<br>(0.50) | -0.6318<br>(0.74) | -0.0684<br>(0.11) | -1.4874*<br>(1.74) |
| Ever NBPTS-Certified × First Year of Certification | 0.3133<br>(0.38) | -4.0872***<br>(3.38) | -0.0918<br>(0.08) | -1.1995<br>(1.40) | 1.2943**<br>(2.02) | 0.4160<br>(0.43) |
| Ever NBPTS-Certified × After First Year of Certification | 0.6260<br>(0.91) | -2.4786***<br>(2.66) | -2.7745***<br>(3.43) | 0.2080<br>(0.31) | 0.3034<br>(0.55) | -1.3586*<br>(1.71) |
| Teacher Time-Varying Char. | Yes | Yes | Yes | Yes | Yes | Yes |
| Student Time-Varying Char. | Yes | Yes | Yes | Yes | Yes | Yes |
| Peer Characteristics | Yes | Yes | Yes | Yes | Yes | Yes |
| Student Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| School Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| R-squared | 0.587 | 0.654 | 0.690 | 0.602 | 0.576 | 0.624 |
| No. of Student-Year Obs. | 785,605 | 783,433 | 666,857 | 797,519 | 924,519 | 503,418 |

Note: absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include grade-by-year dummies and a constant. Included time-varying teacher characteristics are a set of experience category dummies and an indicator for teachers possessing an advanced degree. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size.

**Table A5**
**Estimates of the Effects of NBPTS-Certified Teachers on Student Achievement Controlling for Individual, Peer and School Characteristics, by Student Demographics Using FCAT-NRT Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2000/01-2003/04)**

| | Math | | | | | Reading | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Black Students | Hispanic Students | Students Receiving Free Lunch | Students w/ 1-20 NPR In Prior Year | Students w/ 81-99 NPR in Prior Year | Black Students | Hispanic Students | Students Receiving Free Lunch | Students w/ 1-20 NPR in Prior Year | Students w/ 81-99 NPR in Prior Year |
| Ever NBPTS Certified × Pre-Application Period | 1.8364** | -0.6152 | 0.2661 | 1.8035 | -0.3758 | 0.6955 | 0.0953 | 0.1871 | -1.1559 | -1.3262 |
| | (2.00) | (0.71) | (0.35) | (0.67) | (0.53) | (0.83) | (0.12) | (0.26) | (0.55) | (1.59) |
| Ever NBPTS Certified × Application Year | -0.9263 | -1.3974 | -1.3384 | 0.2462 | -0.3634 | 0.3780 | 0.4173 | 0.6519 | -0.9946 | -1.1471 |
| | (0.82) | (1.32) | (1.39) | (0.07) | (0.43) | (0.35) | (0.45) | (0.70) | (0.36) | (1.23) |
| Ever NBPTS-Certified × Received Certification | -0.8624 | -0.1261 | -0.1782 | -0.3902 | -0.4017 | 0.2352 | -0.1605 | 0.2166 | 2.7980 | -0.3863 |
| | (1.04) | (0.17) | (0.26) | (0.14) | (0.68) | (0.29) | (0.24) | (0.34) | (1.37) | (0.59) |
| R-squared | 0.655 | 0.617 | 0.685 | 0.893 | 0.673 | 0.672 | 0.638 | 0.701 | 0.885 | 0.731 |
| No. of Student-Year Obs. | 475,672 | 453,909 | 924,154 | 209,363 | 767,065 | 471,743 | 447,628 | 917,941 | 264,906 | 580,408 |

Note: absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include student/school fixded effects, grade-by-year dummies and a constant. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size. Teacher experience categories and advanced degree indicator are also included.

**Table A6**
**Estimates of the Effects of NBPTS-Certified Teachers who Mentor on Student Achievement Controlling for Individual, Peer and School Characteristics Using FCAT-NRT Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2000/01-2003/04)**

| | Math | | Reading | |
|---|---|---|---|---|
| | [1] | [2] | [3] | [4] |
| Ever NBPTS Certified × Pre-Application Period × Never Mentor | 0.5505<br>(1.43) | 0.2895<br>(0.66) | 0.1370<br>(0.37) | 0.1482<br>(0.33) |
| Ever NBPTS Certified × Application Year × Never Mentor | -0.5653<br>(1.12) | -0.0913<br>(0.15) | -0.4240<br>(0.90) | -0.4923<br>(0.86) |
| Ever NBPTS Certified × Received Certification × Never Mentor | -0.9695**<br>(2.42) | -1.3047***<br>(2.80) | 0.0082<br>(0.02) | -0.0425<br>(0.09) |
| Ever NBPTS Certified × Pre-Application Period × Ever Mentor | 0.9315<br>(0.40) | 0.7828<br>(0.29) | -1.0409<br>(0.84) | -1.3652<br>(1.01) |
| Ever NBPTS Certified × Application Year × Ever Mentor | -1.4255<br>(1.12) | -2.4785<br>(1.57) | -0.9563<br>(0.88) | -1.5793<br>(1.27) |
| Ever NBPTS Certified × Received Certification × Ever Mentor | 0.9242<br>(1.54) | 2.0876*<br>(1.80) | 0.3090<br>(0.58) | 0.5200<br>(0.48) |
| Ever Mentor × Mentoring in Current Year | | -1.5350<br>(1.14) | | -0.3129<br>(0.25) |
| Teacher Time-Varying Char. | Yes | Yes | Yes | Yes |
| Student Time-Varying Char. | Yes | Yes | Yes | Yes |
| Peer Characteristics | Yes | Yes | Yes | Yes |
| Student Fixed Effects | Yes | Yes | Yes | Yes |
| School Fixed Effects | Yes | Yes | Yes | Yes |
| R-squared | 0.598 | 0.602 | 0.627 | 0.633 |
| No. of Student-Year Obs. | 2,232,204 | 2,206,973 | 2,220,198 | 2,183,912 |

Note: absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include grade-by-year dummies and a constant. Included time-varying teacher characteristics are a set of experience category dummies and an indicator for teachers possessing an advanced degree. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size.

**Table A7**
**Estimates of the Impact of the Numbers of NBPTS-Certified Teachers and NBPTS-Certified Teachers Acting as Mentors in a School on the Effectiveness of Never-NBPTS-Certified Teachers Controlling for Individual, Peer and School Characteristics Using FCAT-NRT Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2000/01-2003/04)**

| | Math | | Reading | |
|---|---|---|---|---|
| | [1] | [2] | [3] | [4] |
| Number of Ever-NBPTS-Certified Teachers in School | -0.2360*** (3.02) | | 0.0236 (0.27) | |
| Number of Ever-NBPTS-Certified Teachers in School who are Mentoring | | 0.3826** (2.57) | | 0.4032*** (2.59) |
| Teacher Time-Varying Char. | Yes | Yes | Yes | Yes |
| Student Time-Varying Char. | Yes | Yes | Yes | Yes |
| Peer Characteristics | Yes | Yes | Yes | Yes |
| Student Fixed Effects | Yes | Yes | Yes | Yes |
| School Fixed Effects | Yes | Yes | Yes | Yes |
| R-squared | 0.653 | 0.655 | 0.682 | 0.684 |
| No. of Student-Year Obs. | 1,814,557 | 1,794,421 | 1,788,743 | 1,769,582 |

Note: absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include grade-by-year dummies and a constant. Included time-varying teacher characteristics are a set of experience category dummies and an indicator for teachers possessing an advanced degree. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size. Teacher experience categories and advanced degree indicator are also included.

**Table A8**
**Estimates of the Effects of NBPTS-Certified Teachers on Student Achievement With/Without Controls for Individual and School Characteristics Using FCAT-NRT Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2000/01-2003/04)**

| | Math | | | | | Reading | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] | [9] | [10] |
| Ever NBPTS Certified × Pre-Application Period | 0.6252* | 0.4183* | 0.4445*** | 0.6547*** | 0.6283*** | 0.0196 | -0.0277 | 0.0169 | 0.0778 | -0.0575 |
| | (1.68) | (1.81) | (3.23) | (5.01) | (4.80) | (0.06) | (0.13) | (0.13) | (0.63) | (0.46) |
| Ever NBPTS Certified × Application Year | -0.6996 | 0.4401 | 0.2065 | 0.4319** | 0.3898** | -0.5595 | -0.2647 | -0.1330 | -0.0133 | -0.1200 |
| | (1.50) | (1.48) | (1.18) | (2.53) | (2.28) | (1.31) | (0.97) | (0.83) | (0.09) | (0.77) |
| Ever NBPTS-Certified × Received Certification | -0.4328 | -0.0165 | 0.2158* | 0.4774*** | 0.4269*** | 0.0971 | 0.2301 | 0.2194** | 0.1968* | 0.0575 |
| | (1.30) | (0.08) | (1.73) | (4.05) | (3.62) | (0.33) | (1.24) | (1.96) | (1.87) | (0.55) |
| Teacher Time-Varying Char. | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Student Time-Varying Char. | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Student Time-Invariant Char. | No | No | Yes | Yes | No | No | No | Yes | Yes | No |
| Peer Characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Student Fixed Effects | Yes | Yes | No | No | No | Yes | Yes | No | No | No |
| School Fixed Effects | Yes | No | Yes | No | No | Yes | No | Yes | No | No |
| R-squared | 0.598 | 0.399 | 0.090 | 0.081 | 0.078 | 0.627 | 0.439 | 0.142 | 0.138 | 0.134 |
| No. of Student-Year Obs. | 2,235,895 | 2,235,895 | 2,235,895 | 2,235,895 | 2,235,895 | 2,225,456 | 2,225,456 | 2,225,456 | 2,225,456 | 2,225,456 |

Note: absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include grade-by-year dummies and a constant. Time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Time-invariant student characterisitcs are: female, black, hispanic, free/reduced-price lunch, limited English proficiency, disability status. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size. Teacher experience categories and advanced degree indicator are also included.

**Table A9**
**Estimates of the Effects of NBPTS-Certified Teachers on Student Achievement Controlling for Individual, Peer and School Characteristics Using FCAT-NRT Data (Elementary and Middle School Math Classes, 2000/01-2003/04)**

| | Math – Elementary School | | Math – Middle School | |
|---|---|---|---|---|
| | [1] | [2] | [3] | [4] |
| Ever NBPTS Certified × Pre-Application Period | 0.7147 | | 1.8762** | |
| | (1.17) | | (2.39) | |
| Ever NBPTS Certified × Application Year | -0.9586 | -1.5863 | -1.0592 | -3.2989** |
| | (1.18) | (1.14) | (1.16) | (2.27) |
| Ever NBPTS Certified × Received Certification | 0.5035 | -0.5228 | -3.0561*** | -5.7609** |
| | (0.93) | (0.29) | (4.07) | (2.53) |
| Teacher Time-Varying Char. | Yes | Yes | Yes | Yes |
| Student Time-Varying Char. | Yes | Yes | Yes | Yes |
| Peer Characteristics | Yes | Yes | Yes | Yes |
| Ever-NBPTS-Certified Fixed Effects | No | Yes | No | Yes |
| Student Fixed Effects | Yes | Yes | Yes | Yes |
| School Fixed Effects | Yes | Yes | Yes | Yes |
| R-squared | 0.587 | 0.589 | 0.654 | 0.654 |
| No. of Student-Year Obs. | 785,605 | 785,605 | 783,433 | 783,433 |

Note: absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include grade-by-year dummies and a constant. Included time-varying teacher characteristics are a set of experience category dummies and an indicator for teachers possessing an advanced degree. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size.

**Table A10**

**Estimates of the Effects of NBPTS-Certified Teachers on Student Achievement Controling for Individual, Peer and School Characteristics Plus State Licensure Status Using FCAT-NRT Data (Self-Contained and Math or Reading/Language Arts Classes, Grades 3-10, 2000/01-2003/04)**

| | Math | | | Reading | | |
|---|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] | [6] |
| Ever NBPTS Certified × Pre-Application Period | 0.6252* (1.68) | 0.5384 (1.43) | 0.7544** (2.03) | 0.0196 (0.06) | 0.0404 (0.12) | 0.0336 (0.10) |
| Ever NBPTS Certified × Application Year | -0.6996 (1.50) | -0.7496 (1.60) | _0.5576 (1.20) | -0.5595 (1.31) | -0.4579 (1.06) | -0.5016 (1.18) |
| Ever NBPTS Certified × Received Certification | -0.4328 (1.30) | -0.4090 (1.22) | -0.2369 (0.71) | 0.0971 (0.33) | 0.1302 (0.44) | 0.2109 (0.71) |
| Full State Licensure | | 0.7234*** (3.87) | | | -0.1690 (0.89) | |
| 0 Years of Experience | -2.2553*** (11.16) | -1.8269*** (7.77) | | -1.0633*** (5.33) | -1.1307*** (4.79) | |
| 1-2 Years of Experience | -0.4744*** (3.65) | -0.3001** (2.12) | | -0.5322*** (4.00) | -0.5591*** (3.87) | |
| 3-4 Years of Experience | -0.2867* (1.71) | -0.2051 (1.20) | | -0.5245*** (3.05) | -0.5273 (3.01) | |
| 5-9 Years of Experience | -0.1918 (1.41) | -0.1788 (1.30) | | -0.4573*** (3.14) | -0.4612*** (3.13) | |
| Advanced Degree | 0.1972* (1.89) | 0.1957* (1.85) | | 0.1125 (1.04) | 0.1187 (1.08) | |
| Student Time-Varying Char. | Yes | Yes | Yes | Yes | Yes | Yes |
| Peer Characteristics | Yes | Yes | Yes | Yes | Yes | Yes |
| Student Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| School Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| R-squared | 0.598 | 0.601 | 0.598 | 0.627 | 0.630 | 0.627 |
| No. of Student-Year Obs. | 2,235,895 | 2,210,408 | 2,235,895 | 2,225,456 | 2,201,179 | 2,225,456 |

Note: absolute values of robust t-ratios appear in parentheses. * indicates statistical significance at .10 level, **indicates significance at the .05 level and *** indicates significance at the .01 level in a two-tailed test. All models include grade-by-year dummies and a constant. Included time-varying student characteristics are: number of schools attended in current year, "structural" move from another school, "non-structural" move from another school. Included peer characteristics are: proportion female, proportion black, proportion undergoing "structural" move, mean age and class size.