Washington State Institute for Public Policy
110 Fifth Avenue SE, Suite 214 • PO Box 40999 • Olympia, WA 98504 • 360.664.9800 • www.wsipp.wa.gov

December 2018

An Evaluation of National Board-Certified Teachers in Washington and Review of Financial Incentives in Other States

The 2017 Washington State Legislature directed the Washington State Institute for Public Policy (WSIPP) to "update its previous meta-analysis on the effect of the national board for professional teaching standards certification on student outcomes."[1] The legislature also directed WSIPP to examine whether National Board Certification improves teacher retention in Washington, if an additional compensation program incentivizes National Board-Certified Teachers (NBCTs) to work in high-poverty schools, and to identify other states with similar incentive programs. This report presents findings for each aspect of the assignment.

Section I provides background information on National Board Certification. Section II reviews states with financial incentive programs for National Board-certified educators similar to Washington's program. Section III describes the methods and results of an updated meta-analysis of Board Certification and student outcomes. Section IV describes the methods we used to evaluate teacher retention and the effect of Washington's Challenging Schools Bonus (CSB) program on teachers working in high-poverty schools. Section V presents these results, and Section VI summarizes all key findings.

Summary

National Board Certification is a voluntary and nationally recognized teaching credential. Some states provide additional benefits and financial incentives to Board-certified educators. In Washington, most Board-certified educators receive a financial incentive of about $5,000 per year. Individuals working in high-poverty schools can receive an additional $5,000 per year through the state's Challenging Schools Bonus (CSB) program. Through a 50-state review, we identified nine other states with financial incentive programs similar to Washington's CSB program.

The 2017 Washington Legislature directed WSIPP to study several aspects of Board Certification. We found that, on average, exposure to a National Board-Certified Teacher (NBCT) increases student test scores and attendance. Evidence suggests that Board Certification identifies effective teachers, but the process of earning certification does not make teachers more effective.

We also found that NBCTs are no more likely than similar teachers without Board Certification to remain in Washington's public education system, to remain in teaching positions, or to transfer into leadership positions.

Finally, we found that the creation of the CSB program had a small increase on the percentage of teachers with Board Certification working in high-poverty schools.

Suggested citation: Cramer, J., Hansen, J., & Bitney, K. (2018). *An evaluation of National Board-Certified Teachers in Washington and review of financial incentives in other states*. (Document Number 18-12-2201). Olympia: Washington State Institute for Public Policy.

[1] Substitute Senate Bill 5883, Chapter 1, Laws of 2017.

I. Background

The National Board for Professional Teaching Standards (NBPTS) certificate (referred to as Board Certification in this report) is a voluntary and nationally recognized teaching credential. Teachers may pursue Board Certification to build their teaching skills, improve classroom learning, advance in the teaching profession, and/or receive higher compensation.

Board Certification is administered by the National Board for Professional Teaching Standards (referred to as the National Board in this report).[2] The National Board was created in 1987 with the mission to "advance the quality of teaching and learning" by creating and maintaining national standards for what effective teachers "should know and be able to do" and to certify teachers who meet these standards.[3]

Teachers and school counselors with a bachelor's degree, valid state teaching or counseling license, and at least three years of teaching or counseling experience are eligible to apply for Board Certification.[4] See Exhibit 1 for more details about the certification process.

The certification process can take anywhere from one to five years. Candidates have up to three years to initially complete the four required components plus an additional two years to retake components if needed.[5] The four required components consist of three portfolio entries and one computer-based assessment.

The portfolio entries include samples of student work and require candidates to demonstrate their instructional decisions; interactions with students; ability to assess student performance; and collaboration with colleagues, parents, and the broader community. The computer-based assessment includes three sections that evaluate candidates' knowledge and teaching practices within a chosen certification field.

Legislative Assignment

. . . for the Washington institute for public policy to update its previous meta-analysis on the effect of the national board for professional teaching standards certification on student outcomes by December 15th, 2018. The institute shall also report on the following:

a) Does the certification improve teacher retention in Washington state?;

b) Has the additional bonus provided under RCW 28A.405.415 to certificated instructional staff who have attained national board certification to work in high poverty schools acted as an incentive for such teachers to actually work in high poverty schools?; and

c) Have other states provided similar incentives to achieve a more equitable distribution of staff with national board certification?

Substitute Senate Bill 5883, Chapter 1, Laws of 2017.

[2] NBPTS website.
[3] Ibid.
[4] Guide to National Board Certification. (2018). Prepared by Pearson for the NBPTS.
[5] Ibid.

The cost of Board Certification depends on how quickly a candidate successfully completes all four components and whether or not they retake components. At a minimum, candidates pay $1,975. This includes a non-refundable $75 fee per year[6] and an additional $475 fee per component. Candidates who retake portfolio entries are required to pay an additional $475 per portfolio submission. Candidates who retake the computer-based assessment pay $125 for each of the three assessment sections.[7]

There are 25 certificate fields that candidates can choose to pursue. These fields cover 16 subject areas (e.g., generalist, math, English Language Arts, music) and several developmental stages (e.g., early childhood, young adulthood).[8]

Once certified, the credential is valid for five years. Individuals can renew certification every five years and typically begin the renewal process during the fourth year of their certificate.[9] The renewal process is less intensive than the certification process. Individuals submit one component that demonstrates how their teaching practices continue to meet certification standards.[10] In 2018-19, the cost to renew a certificate was $1,250.

Exhibit 1

The National Board Certification Process

Eligibility: Teachers and school counselors with a valid bachelor's degree, at least three years of teaching or counseling experience, and a valid state teaching or school counseling license are eligible to apply for the certification process.

Length of certification: One to five years. Candidates must submit all four components within the first three years and have an additional two years to retake components.

Four component requirements:

- Component 1 (Content Knowledge): computer-based assessment of candidates' knowledge and teaching practices in chosen certification field.
- Component 2 (Differentiation in Instruction): portfolio includes samples of student work showing growth over time, and a candidate's written analysis of growth and instructional decisions.
- Component 3 (Teaching Practice and Learning Environment): portfolio includes video of teacher-student interactions and candidate's written analysis of interactions.
- Component 4 (Effective and Reflective Practitioner): portfolio includes resources to assess student learning and candidate's plan for increasing student learning. Must include examples of how candidate collaborates with colleagues, parents, and broader community.

Cost: $75 non-refundable annual fee plus $475 per component. Candidate pays between $125-$475 depending on type and number of retakes.

Certification fields: 25 certification fields including generalist or subject-specific certificates based on developmental levels.

[6] The $75 fee is charged each year a candidate is in the certification process. Guide to National Board Certification (2018).
[7] Ibid.
[8] Choosing the Right Certificate: Information by certificate area (2017). Prepared by Pearson for the NBPTS.
[9] Before 2017, National Board Certification was valid for ten years, with the opportunity to renew. Individuals renewing certification between 2017 and 2020 have a valid certificate for ten years, until 2027 through 2030 respectively. Individuals certified in 2017 or later have a valid certificate for five years.
[10] 2018-19 Renewal Guide to National Board Certification (2018). Prepared by Pearson for NBPTS.

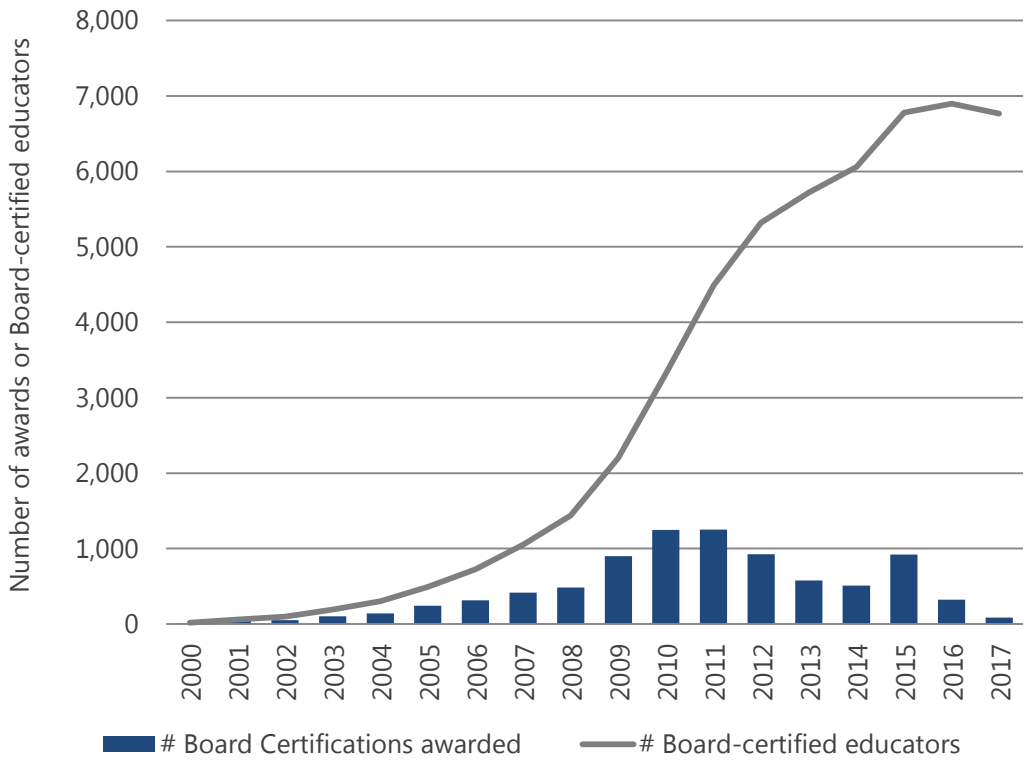
National Board Certification in Washington State

Washington ranks third in the nation for the total number of educators ever certified.[11] As of 2017, a total of 10,004 educators have achieved certification in Washington.[12] The annual number of certified educators has increased over time. Almost 7,000 employed educators held National Board Certification in 2017, compared to just 20 in 2000 (see Exhibit 2). The number of certificates awarded each year has also grown from 15 awards in 2000 to 1,251 in 2011 (see Exhibit 2).

We observe fewer awards issued in later years. This is because, in 2014, the National Board restructured the certification process to make it more accessible to teachers. Changes were implemented over several years and candidates who began the process in 2014 were unable to certify until 2017 at the earliest.[13]

Exhibit 2

Number of National Board Certificates Awarded and National Board-Certified Educators by Year



[11] North Carolina ranked 1st, with 21,445 NBCTs and Florida 2nd with 13,552 NBCTs. NBPTS website.

[12] Retrieved from NBPTS website.

[13] NBPTS. (2014). *Guide to National Board Certification for candidates beginning the process in 2014-15*.

In 2017, 6,767 educators actively held Board Certification in Washington. Most of these individuals (83%) were teachers (i.e., NBCTs) and formed about 9% of the state's public school teacher workforce.[14] The remaining Board-certified educators worked in specialist or supportive positions like school counselors and library specialists (12%), and 5% held administrative positions like elementary principals and district administrators.

Many states, including Washington, have created programs to support Board candidates and Board-certified educators. Some states provide candidates financial support to pursue certification; others recognize the credential as fulfilling requirements for state teaching license; some states provide compensation above and beyond base salaries for all Board-certified educators; and other states provide financial incentives for individuals that work in high-need schools.

Candidates pursuing certification in Washington can apply to receive a loan through the Office of Superintendent of Public Instruction (OSPI) worth $1,425.[15] This loan covers the cost of three of the four required components. Candidates must pay for the fourth component themselves. Some districts also provide candidates with varying levels of support like tuition reimbursements, stipends, time off, or equipment rentals to assist teachers with compiling portfolio entries.[16]

Teachers in Washington can use their National Board Certification to transfer their first level teaching license, called the residency certificate, to the state's advanced license, the professional certificate. A teacher can also use their Board Certification to renew their professional certificate for five years or for the duration of the Board Certification, whichever is longer. A continuing certificate may also be renewed with a valid National Board Certificate. Teachers must submit proof of valid certification, a fee, and an application to OSPI to fulfill renewal and professional certification requirements. Additionally, out-of-state teachers who move to Washington to teach can use valid Board Certification to meet professional certification standards.[17]

Washington is one of 25 states that offers compensation to Board-certified educators.[18] We discuss the types of financial incentives provided by these 25 states in detail in Section II of this report.

Since 2000, Washington has provided a base bonus to teachers and certificated instructional staff working in public K–12 schools.[19] In 1999, the legislature established a 15% salary increase[20] but fixed the bonus for all Board-certified educators at an annual $3,500 in the following year.[21] In 2007, the legislature increased the base bonus to an annual $5,000, which has been adjusted for inflation over time.[22] Teachers and certain certificated instructional staff receive 60% of the base bonus for the

[14] There were 5,614 NBCTs/64,435 total certificated teachers in Washington in 2017. OSPI's school apportionment and financial services site.
[15] OSPI's site on National Board Certification. and WAC 392-140-976.
[16] District-provided support during 2017-18 school year.
[17] OSPI's site on National Board Certification.
[18] WSIPP review of 50 states and the District of Columbia.
[19] WAC 392-140-972.
[20] Engrossed Substitute Senate Bill 5180, Chapter 309, Laws of 1999.
[21] Engrossed House Bill 2487, Chapter 1, Laws of 2000.
[22] Substitute House Bill 1128, Chapter 522, Laws of 2007.

school year in which they attain Board Certification and the full amount in subsequent years if they hold a valid Board Certificate for the entire school year and report a full-time workload (FTE) greater than zero.[23] During the 2018-19 school year, Board-certified educators received $5,397.[24]

Also in 2007, the legislature created an additional incentive for Board-certified educators working in high-poverty schools, called the Challenging Schools Bonus (CSB). The objective of the CSB program and similarly structured programs in other states is to encourage teachers considered to be effective to work in high-need schools with the goal of increasing student achievement in those schools. Washington is one of nine states that provides incentives to Board-certified educators in high-need schools.[25]

Board-certified educators working in high-poverty schools in Washington can receive up to $5,000 per year on top of their base bonus.[26] Individuals receive 60% of the bonus for the first school year and a prorated amount in subsequent years based on their FTE.[27]

In 2007-08, the first school year of the CSB program, eligible high-poverty schools were those with 70% or more students eligible for the federal free-or reduced-priced lunch (FRPL) program. Due to the disproportionate number of eligible elementary schools in the first year, the legislature changed eligibility the next year to increase the number of middle and high schools eligible for the bonus. Currently, eligible elementary schools have 70% or more students eligible for FRPL, middle schools have 60% or more eligible students, and high schools have 50% or more eligible students.[28]

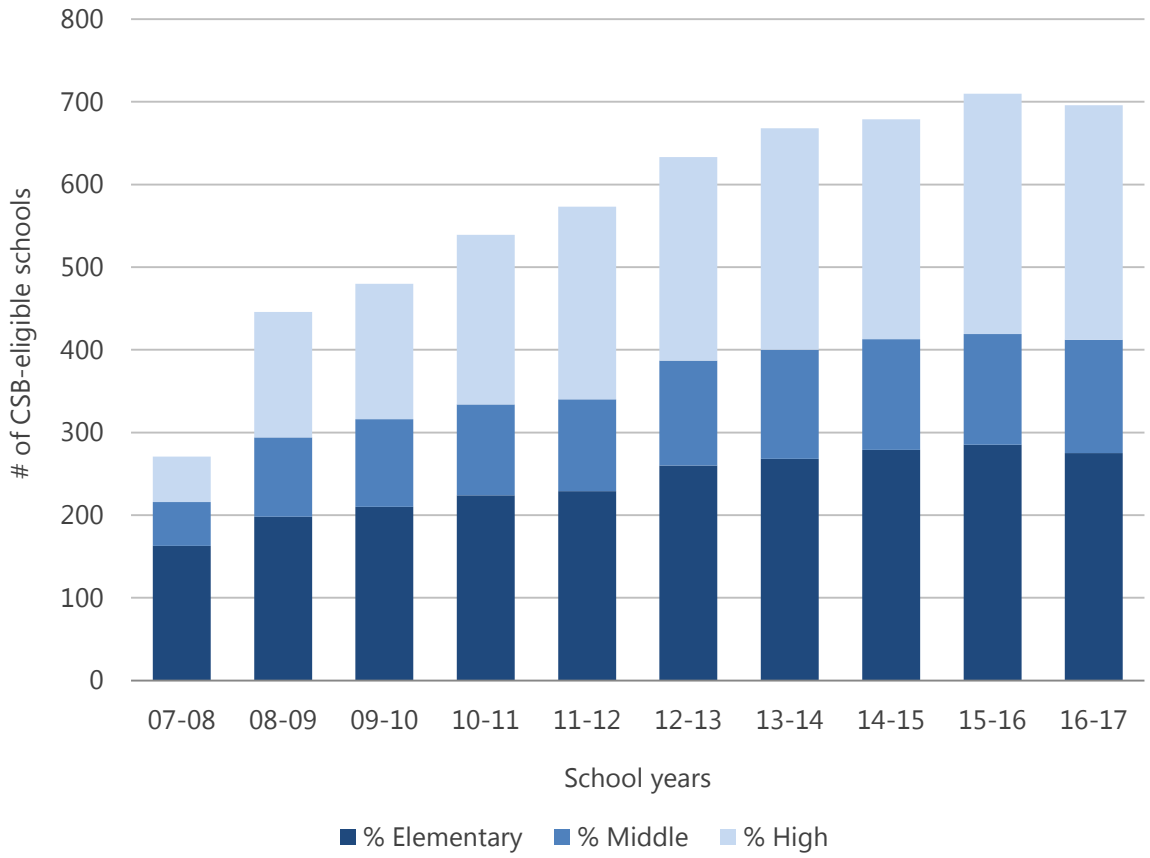
The change in CSB eligibility increased the number of eligible schools. During the 2007-08 school year, just 284 schools met eligibility standards. In the following year, 446 schools met the new eligibility standards, an increase of almost 60% (see Exhibit 3).

The increase in the number of eligible CSB schools caused by the change in eligibility criteria also increased the number of Board-certified educators potentially eligible to receive the bonus. These educators either were already in schools that became newly eligible, or they had more options to move from ineligible to eligible schools after the policy change. We explore this in more detail in Section V.

[23] OSPI's site on National Board Certification and WAC 392-140-173.
[24] $5,397 reflects the base bonus with inflationary adjustments. Engrossed Substitute Senate Bill 6032, Chapter 299, Laws of 2018.
[25] WSIPP review of 50 states and the District of Columbia.
[26] The Challenging Schools Bonus has not been adjusted for inflation since enacted in 2007. OSPI's site on National Board Certification and WAC 392-140-173.
[27] WAC 392-140-173.
[28] Schools must also have 30 or more students enrolled or be the largest school in the district serving elementary, middle, or high school student. WAC 392-140-173.

Exhibit 3

Number of CSB-eligible Schools by School Year and Distribution of Eligible Schools by Level



II. Financial Incentives in Other States

In this section, we address part (c) of the legislative assignment to examine whether "other states [provide similar incentives as Washington's Challenging Schools Bonus program] in order to achieve a more equitable distribution of staff with National Board Certification" [across districts and schools].[29]

Research indicates that high-performing teachers are more likely to work in more advantaged schools than in high-poverty schools and schools with low student achievement rates.[30] Across the country, states have implemented various incentive programs to improve the distribution of what are seen as high-quality teachers across schools in order to support student achievement in low-performing schools.

To conduct this review, we researched Board Certification policies in all 50 states and the District of Columbia. We used resources from the National Board's website, searched statues in individual states, and referred to education agency websites in individual states.

While we focused on Board-certified teachers in our previous analyses, this review took a broader focus on Board-certified educators, not just teachers.

In our review, we identified 25 states that provide financial incentives for Board-certified educators (Exhibit 4). Nine of these states provide Board-certified educators working in high-need schools an annual bonus and one state provides fee support for Board candidates in high-need schools (Exhibit 5).

Some states provide either a base bonus or a high-need bonus, while other states provide both. Colorado, Hawaii, Mississippi, and Washington offer Board-certified staff both a base bonus and additional compensation if they work in high-need schools. Arkansas, Maryland, Montana, Utah, and Wisconsin provide Board-certified staff either a base bonus or a high-need bonus, depending on eligibility.

Two states, Maryland and Montana, have structured their high-need bonus programs as matching programs. For example, Maryland provides an annual one-to-one match with school districts for Board-certified educators in schools with "comprehensive needs," as defined by a school's receipt of federal Title 1 funds and academic performance.[31]

Most states provide additional compensation for the life of the Board Certificate. In other words, if a certificate expires, individuals no longer receive either the base bonus or high-need schools bonus. However, Arkansas restricts incentive payouts to a specific period based on school

[29] Substitute Senate Bill 5883, Chapter 1, Laws of 2017.
[30] Clotfelter, C., Ladd, H., Vigdor, J. (2010). *Teacher mobility, school segregation, and pay-based policies to level the playing field.* National Center for Analysis of Longitudinal Data in Education Research; Goldhaber, D., Gross, B., Player, D. (2010). *Teacher career paths, teacher quality, and persistence in the classroom: Are schools keeping their best?* National Center for Analysis of Longitudinal Data in Education Research.

[31] Correspondence between Maryland State Superintendent of Schools to members of the State Board of Education.

and district status. Board-certified educators in Arkansas who work in designated high-poverty schools, but not high-poverty districts, receive $5,000 per year for a maximum of five years. Board-certified educators working in high-poverty schools within high-poverty districts receive $10,000 per year for a maximum of ten years, regardless of how many times they renew their certificate.[32]

We identified one state, Illinois, which does not provide compensation but instead offers first-time National Board candidates up to $1,900 to cover the cost of application if they work in high-need schools.[33]

Eligible Bonus Recipients

Like Washington, most states extend bonus compensation to education staff with National Board Certification, not only teachers. Thus, most states provide school counselors, librarians, and non-administrative staff compensation if they work in designated high-need schools. Arkansas and Colorado also provide compensation to Board-certified faculty in leadership positions like school principals. In Washington, Board-certified individuals in positions like principals, superintendents, and school and district administrators are not eligible for either the base bonus or Challenging Schools Bonus.[34]

Hawaii, Utah, and Wisconsin provide financial incentives to Board-certified teachers only.

Defining "High-Need" Schools

The definition of high-need varies across states. Washington is unique in its tiered structure of eligible "high-poverty" schools. Recall that Board-certified educators are eligible to receive the Challenging Schools Bonus if they work in elementary schools with 70% or more students eligible for FRPL, in middle schools with 60% or more students eligible for FRPL, or in high schools with 50% or more students eligible for FRPL. Arkansas, Illinois, Montana, Utah, Maryland, and Wisconsin also use FRPL to define high-need schools and districts but do not tier eligibility by school level. Colorado, Hawaii, Illinois, Maryland, and Montana use multiple indicators to define high-need schools. For example, Hawaii provides additional compensation for Board-certified teachers working in schools with high turnover rates and schools with low academic performance.[35] Montana provides its bonus to individuals working in schools with 40% or more students eligible for FRPL or schools with educator shortages, which are often schools in rural areas.[36]

Unsurprisingly, states with robust incentive programs have a higher number of Board-certified educators. For example, Board-certified educators working in high-need schools in Washington, Mississippi, and Arkansas can receive $10,000 per year through a base and high-need bonus programs. These states have a large cumulative number of certified educators

[32] Arkansas Department of Education's website on National Board Certified teachers.
[33] Illinois State Board of Education informational handout regarding candidate fee subsidy.
[34] Principals and vice principals with National Board Certification received bonuses until the 2010-2011 school year. OSPI's website on National Board Certification and WAC 392-140-972.
[35] Hawaii State Department of Education. *Frequently asked questions*.
[36] SB 115, 20-4-134 MCA.

(10,004 in Washington, 4,040 in Mississippi, and 3,100 in Arkansas see Exhibit 4), which also comprise a larger proportion of their teacher populations.[37] For a general sense of scale, there are currently about 64,000 total classroom teachers in Washington, 32,000 in Mississippi, and 33,000 in Arkansas.

States with relatively smaller incentive programs, like Utah and Montana, have had fewer individuals ever certify (271 in Utah and 173 in Montana), which comprise a small proportion of each state's teacher population (i.e., 29,000 teachers in Utah and 10,500 in Montana).

Maryland and Hawaii are two exceptions. Maryland has a relatively small base and high-need bonus programs, but more than 3,000 educators have certified in the state. There are currently around 60,000 classroom teachers in Maryland. Alternatively, Hawaii has one of the largest base and high-need bonus programs identified but relatively few (628) individuals have ever certified. There are approximately 11,000 teachers in Hawaii.

[37] Number of Board-certified educators ever certified in each state based on self-reported data from NBPTS website.

Exhibit 4

States That Offer Base Bonuses and High-Need Incentives for National Board-Certified Educators

State	# ever certified in state	Base bonus amount/year	High-need bonus amount/year	Total potential bonus amount/year
North Carolina	21,438	12% salary increase		Depends on individual salaries
Washington	**10,004**	**$5,397**	**$5,000**	**$10,397**
South Carolina	9,042	$5,000		$5,000
Mississippi	4,040	$6,000	$4,000	$10,000
Kentucky	3,606	$2,000		$2,000
Arkansas	3,100	$2,500-$5,000	$5,000-$10,000	$10,000
Oklahoma	3,086	$5,000		$5,000
Maryland	3,063	$1,000	$2,000	$2,000
Alabama	2,531	$5,000		$5,000
Wisconsin	1,256	$2,500	$5,000	$5,000
New Mexico	1,150	$6,000		$6,000
Colorado	1,025	$1,600	$3,200	$4,800
West Virginia	943	$3,500		$3,500
Nevada	752	5% salary increase		Depends on individual salaries
Iowa	732	$2,500		$2,500
Wyoming	692	$4,000		$4,000
Hawaii	628	$5,000	$5,000	$10,000
Kansas	433	$1,000		$1,000
Idaho	388	$2,000		$2,000
Maine	346	$3,000		$3,000
Virginia	301	$2,500		$2,500
Utah	271	$750	$1,500	$1,500
Montana	173	$1,000	$2,000	$2,000
South Dakota	111	$2,000		$2,000
North Dakota	42	$1,000		$1,000

Exhibit 5

States with Incentive Programs for National Board-Certified Educators Working in High-Need Schools

State	Description of high-need bonus	Provided in addition to base bonus?	Eligible recipient	How states define "high-need"
Arkansas	**Bonus program:** $5,000/year for five years if in a high-poverty school but not high-poverty district; $10,000/year for ten years if in high-poverty school in a high-poverty district	No	Teachers, counselors, librarians, principals, assistant principals, instructional facilitators, and higher education NBCTs	High-poverty schools and districts defined by > 70% FRPL
Colorado	**Bonus program:** $3,200/year	Yes	Teachers, counselors, and principals; application process required	Schools assigned "turnaround" or "priority improvement" plans by the Colorado State Board of Education based on school performance indicators
Hawaii	**Bonus program:** $5,000/year	Yes	Teachers	Schools with high turnover rates, considered "hard-to-fill," or in a "priority, focus, or superintendent's zone" based on school performance indicators
Illinois	**Fee support:** State provides $1,900 to cover application fees for candidates in high-need schools	N/A	First-time candidates who are teachers or counselors; application process required	Schools with ≥ 50% FRPL or are not meeting academic performance standards
Maryland	**Bonus match program:** State provides 1:1 match with districts up to $2,000/year	No	Teachers and non-administrative school employees	"Comprehensive needs school" are Title I and low-performing schools
Mississippi	**Bonus program:** $4,000/ year	Yes	Teachers, nurses, and counselors	Schools located in 13 districts
Montana	**Bonus match program:** $1,000/year base amount + 2:1 district match up to $2,000 max	No	Teachers, librarians, and counselors, but not administrators	School is in a high-poverty district (> 40% FRPL) or school experiencing high educator shortage
Utah	**Bonus program:** $1,500/year	No	STEM teachers; application process required	Federal Title I served schools
Washington	**Bonus program:** $5,000/year	Yes	Teachers, counselors, librarians, other certificated specialists, but not administrators	Elementary schools with ≥70% FRPL; Middle schools with ≥ 60% FRPL; High schools with ≥ 50% FRPL
Wisconsin	**Bonus program:** $5,000/year	No	Teachers rated "effective" or "highly effective"	High-poverty school defined by > 60% FRPL

III. Updated Meta-Analysis

In this section, we report the results of our assignment to "update [a] previous meta-analysis on the effect of the national board for professional teaching standards certification on student outcomes."[38]

WSIPP's Approach

The main objective of WSIPP's meta-analysis approach is to identify what works, on average, and what does not. For each program under consideration (Board Certification in this case), we first gather all of the research literature and consider all available studies, regardless of their findings. That is, we do not "cherry pick" studies to include in our analysis.

Next, we vet and include only rigorous studies. We require those study authors reasonably attempt to demonstrate causality using appropriate statistical techniques.[39] Studies that do not meet our minimum standards are excluded from the analysis.

Finally, we use a formal set of statistical procedures to calculate an average effect size for each outcome. The overall evidence may indicate that a program worked (i.e., had a desirable effect on outcomes), caused harm (i.e., had an undesirable effect on outcomes), or had no detectable effect one way or the other.

These standardized procedures support the rigor of our analysis and allow program effects to be compared on an "apples-to-apples" basis. For more information on WSIPP's approach to meta-analysis see our Technical Documentation.[40] For our meta-analytic results, see Exhibit 6 and Exhibit 7, as well as Appendix I.

Previous Results

Our previous meta-analysis was conducted in 2012.[41] At that time, we found 12 rigorous evaluations measuring the effect of exposure to a National Board-certified teacher (NBCT) on students' standardized test scores. We estimated that on average, students taught by an NBCT had slightly but reliably higher reading and math test scores than students taught by teachers without Board Certification.

Although effects were estimated across a variety of standardized tests, the magnitude of the average effect of having an NBCT was about 0.031 standard deviation units. This means that if a test has a mean score of 100 points and a standard deviation[42] of 15 points, the average effect is equivalent to a 0.46 point increase on that test.[43]

After updating our 2012 analysis, we found similar effects on student test scores and were able to examine additional student

[38] Substitute Senate Bill 5883, Chapter 1, Laws of 2017.
[39] For example, studies must include both treatment and comparison groups with an intent-to-treat analysis or include econometric methods like difference-in-differences to approximate a randomized controlled experiment when it is not feasible.
[40] Washington State Institute for Public Policy. (December 2017). *Benefit-cost technical documentation*. Olympia, WA: Author.
[41] Pennucci, A. (2012). *Teacher compensation and training policies: Impacts on student outcomes*. (Doc. No. 12-05-2201). Olympia: Washington State Institute for Public Policy.
[42] A statistical measure that quantifies the amount of variation around a set of data points.
[43] 0.031*15 = 0.46 point increase on test.

outcomes. For this update, we also estimated effects for students in elementary school separately from effects for students in middle and high schools[44] and explored several mechanisms for why NBCTs may influence student outcomes.

Updated Results

In our updated meta-analysis, we included 14 rigorous evaluations reporting the effect of students exposed to an NBCT compared to students exposed to a teacher without Board Certification.[45] Based on how students were exposed to NBCTs in the studies, we estimated separate effects for elementary school students and students in middle or high school.

Results in Elementary Schools

We found 11 rigorous studies examining NBCTs in elementary schools. Studies reported effects on reading and math test scores, attendance, and suspensions. We estimated that on average, exposure to an NBCT in elementary school slightly increased student test scores and attendance. We found no effect on suspension rates. See Exhibit 6 for full meta-analytic results.

Results in Middle and High Schools

We found eight rigorous studies examining NBCTs in middle and high schools. We separate these findings from our meta-analysis focused on NBCTs in elementary because these eight studies focused on NBCTs as math or English Language Arts (ELA) instructors specifically in middle schools or high schools whereas our meta-analysis in elementary focused on general exposure to NBCTs. Similar to our results in elementary schools, we found that on average, exposure to an NBCT in math or ELA courses in middle or high school slightly increased student test scores. See Exhibit 6 for meta-analytic results.

Secondary Meta-Analyses

We conducted secondary meta-analyses to disaggregate the effects described above to explore two theories that may explain why NBCTs impact student outcomes.

We focused one meta-analysis on estimating the "human capital effect" and a second meta-analysis estimating the "signaling effect" of National Board Certification.

In the context of this report, the human capital effect estimates whether the National Board Certification process itself increases teacher effectiveness by improving the knowledge, experience, and skills of teachers—also called their "human capital." We examined the following question:

- Among teachers who receive Board Certification, did the process itself improve their teaching ability?

Studies in this analysis estimate teachers' effects on student outcomes before and after the teachers receive Board Certification. The studies control for factors like teacher experience and ability. Once these factors are controlled for, the authors of the studies can determine whether teachers performed better (increased student test scores more) after the certification process than they would have had they not gone through it.

[44] Effects on test scores for elementary and secondary school students were pooled together in our 2012 analysis.
[45] Comparison group teachers in included studies were teachers who had never been National Board Certified or were not National Board Certified at the time they were studied.

The "signaling effect" estimates whether Board Certification is an indicator of an effective teacher. Perhaps NBCTs are better able to distinguish themselves as high-quality teachers and therefore, students taught by NBCTs are taught by effective teachers. In other words, perhaps the Board Certification process does not improve teacher effectiveness but identifies already effective teachers. In this meta-analysis, we examined the following question:

- Does National Board Certification distinguish effective teachers from average teachers?

Studies included in this analysis estimate differences in teacher performance between NBCTs and similar teachers without Board Certification. The studies control for factors like teacher experience and the human capital effect of certification. Once the authors of these studies have controlled for these alternative explanations of differences in teacher performance, they can measure how much of the difference between NBCTs and comparable teachers is due to unquantifiable characteristics like "ability." The signaling effect is the extent to which teachers with high ability, or other unquantifiable characteristics, can be distinguished from others by Board Certification alone.

Evidence from our secondary analyses suggests that Board Certification identifies effective teachers ("signaling effect"). Therefore, increases in student test scores and attendance are due to exposure to these high-quality teachers. We found no evidence that the certification process itself improves teacher performance. In other words, teachers who go through the certification process are, on average, equally as effective after certification as they would have been had they not entered the process.

It's important to note that Board Certification is not the only signal of teacher effectiveness. Other research, including previous WSIPP analyses, identify teacher experience, graduate degrees, and subject-specific graduate degrees as other potential signals of teacher effectiveness (as measured by student test scores).[46]

See Exhibit 7 for results of our secondary meta-analyses.

[46] Pennucci (2012).

Exhibit 6

Primary Meta-Analytic Results: Effects of Exposure to National Board-Certified Teachers in Elementary and Secondary Grades

Intervention	Outcome	Average age	# of effect sizes	# in treatment	Effect size	Standard error	P-value
NBCT in elementary school	Test scores	10	17	405,357	0.021	0.005	0.001
	Attendance	10	4	20,605	0.045	0.021	0.030
	Suspensions	10	4	20,605	0.001	0.001	0.489
NBCT in middle or high school	Test scores	13	10	284,613	0.031	0.006	0.001

Exhibit 7

Secondary Meta-Analytic Results: Signaling and Human Capital Effects of National Board Certification

Intervention	Estimated effect	Outcome	Average age	# of effect sizes	# in treatment	Effect size	Standard error	P-value
NBCT in elementary school	Signaling	Test scores	10	4	185,107	0.030	0.012	0.012
NBCT in middle or high school	Signaling	Test scores	14	3	81,865	0.024	0.008	0.003
NBCT in elementary school	Human capital	Test scores	10	5	225,758	0.004	0.009	0.657
NBCT in middle or high school	Human capital	Test scores	14	5	164,527	-0.005	0.017	0.761

IV. Evaluation Methodology

In this section, we summarize the methods used to examine retention among NBCTs and non-NBCTs in Washington and the Challenging Schools Bonus (CSB) program's impact on the percentage of NBCTs working in high-poverty schools.

Teacher Retention

WSIPP was directed in part (a) of the legislative assignment to examine if National Board Certification "[improves] teacher retention in Washington State."[47] We carried out this request by examining the following research questions:

Compared to otherwise similar teachers, do Board-certified teachers:

- Remain employed in the public education system at a higher rate?
- Remain employed as public school teachers at a higher rate?
- Transition from teaching to leadership positions at a higher rate?

Analysis Methods

From a statistical standpoint, the ideal way to evaluate the impact of Board Certification on retention rates would be to utilize a randomized controlled trial, the "gold standard" approach to estimating treatment effects.[48] Random assignment allows the researcher to estimate the effect of a program by comparing average outcomes between treatment (NBCTs) and comparison (non-NBCTs) groups. This is because apart from the Board Certification status, one can assume there are no other differences in characteristics between the treatment and comparison group participants, on average, at the beginning of the experiment. Therefore, any differences in outcomes between the two groups after random assignment can be attributed to Board-certified status alone, rather than to other observed or unobserved group characteristics.

However, it is not possible to randomly assign Board Certification to some teachers and not to others. In reality, teachers who choose to pursue Board Certification may differ systematically from teachers who choose not to pursue certification in ways that may influence their employment outcomes. This is called "selection bias." For example, teachers who intend to teach only for a few years are probably less inclined to pursue Board Certification because they do not plan to continue teaching long enough to complete a potentially intensive certification process.

To address the issue of selection bias, we used a statistical technique called "Coarsened Exact Matching" (CEM), which allowed us to compare outcomes for NBCTs to the outcomes for a matched comparison group of non-NBCTs. The effect of Board Certification was then estimated by comparing two groups of teachers who were nearly identical in terms of observable characteristics except for Board Certification.[49]

[47] Substitute Senate Bill 5883, Chapter 1, Laws of 2017.

[48] Austin, P.C. (2011). An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivariate Behavioral Research, 46*(3).

[49] Iacus, S., King, G., & Porro, G. (2011). Causal inference without balance checking: Coarsened exact matching. *Political Analysis*, 20, 1-24

CEM can reduce selection bias insofar as one can observe teacher characteristics that are related to both the treatment (i.e., Board Certification) and the outcome of interest (i.e., retention).[50] However, this method may not eliminate all selection bias. We can only match groups on observable characteristics and not all teacher characteristics related to both Board Certification and retention may be known or available to analyze in our data. For example, we could not match NBCTs and non-NBCTs on their teacher licensure score (an observable characteristic) because we could not access this data. Also, we were unable to control for unobserved characteristics like teacher motivation. Both licensure scores and motivation are factors that may be correlated with a teacher's decision to pursue Board Certification and remain in the education profession.

In our retention analysis, treatment and comparison group participants included the following:

- *Treatment Group:* individuals who began teaching in Washington's public education system between 2002 and 2007 and who received Board Certification between 2006 and 2013.[51] Treatment group participants are referred to in this section as NBCTs.[52]
- *Comparison Group:* individuals who began teaching in Washington's public education system between 2002 and 2007 and did not receive Board Certification between 2006 and 2013. Teachers who were Board candidates but did not certify between 2006 and 2013 were potential members of the comparison group. Comparison group participants are referred to as non-NBCTs.

Once we created treatment and comparison groups matched on pre-Board Certification characteristics including employment experience, teacher demographics, and school and district characteristics, we conducted a survival analysis of this matched sample. Survival analysis is considered an effective method to use when the outcome of interest is the time until the occurrence of a particular event.

In our survival analysis, our main outcome of interest was the retention rate of NBCTs and similar non-NBCTs over time, estimated in three ways:

- The percentage of NBCTs and non-NBCTs that remained in Washington's public education system after entering.
- The percentage of NBCTs and non-NBCTs that remained working as classroom teachers after entering the public education system.
- The percentage of NBCTs and non-NBCTs that ever transitioned from public school teaching positions to leadership positions between 2002 and 2016.

See Appendix II for full methodology details of our retention analysis.

[50] More precisely, only characteristics that are conditionally related to both the outcome and treatment lead to selection bias.

[51] We restrict between 2006 and 2013 because the National Board implemented changes to the certification process beginning in 2014, which reduced the number of individuals that certifying in Washington between 2014 and 2017.

[52] Beginning teachers are those new to Washington's public education system but could have taught in other states. Individuals are required to have at least three years of teaching experience (from anywhere, not just Washington) before they apply for Board Certification. Therefore, 2004 was the earliest year in our analysis period that beginning teachers could have received certification.

Challenging Schools Bonus

Part (b) of the legislative assignment directed WSIPP to examine if the Challenging Schools Bonus (CSB) program, created in 2007, incentivized NBCTs to work in high-poverty schools.[53] We carried out this request by examining the following research question:

- Did the CSB program increase the percentage of teachers working in high-poverty schools with National Board Certification?

Analysis Methods

Again, for our analysis of the CSB program, we could not employ a randomized controlled trial because the CSB is not randomly assigned to schools. NBCTs in qualifying high-poverty schools receive the CSB based on a school's percentage of students eligible for the federal free-or-reduced-priced lunch (FRPL) program.

Further, we could not simply compare the percentage of NBCTs in high-poverty schools before and after the policy change. This type of pre-post design could be biased because it would not control for pre-existing trends and policies that occurred at the same time as the CSB program and similarly influenced both treatment and comparison schools.

To isolate the effect of the CSB program, we employed a statistical method called difference-in-differences (DID), which compares the change over time for a treatment group relative to the change over time for a comparison group.[54] In the context of this evaluation, we compared the change in the percentage of teachers with Board Certification working in high-poverty schools before and after the CSB program was created, compared to the change in the percentage of NBCTs working in low-poverty schools over the same period.

In our DID analysis, treatment and comparison group participants include the following:

- *Treatment Group:* Washington public schools defined by the CSB program as *high poverty* and therefore eligible for the CSB.
- *Comparison Group:* Washington public schools defined by the CSB program as *low poverty* and therefore ineligible for the CSB.

The main outcome of interest was the percentage of teachers working in CSB-eligible and -ineligible schools that were Board certified.

Exhibit 8 describes a hypothetical scenario and does not reflect the actual data in our analysis. Instead, it illustrates the concept of how a DID analysis can estimate the CSB program's effect on the percentage of NBCTs working in high-poverty schools.

The blue trend line represents the percentage of teachers working in CSB-eligible schools that were Board certified (treatment group) before and after the CSB program was implemented. The red trend line represents the percentage of teachers working in CSB-ineligible schools that were Board certified (comparison group) over the same period.

[53] Substitute Senate Bill 5883, Chapter 1, Laws of 2017.
[54] Murnane, R., & Willett, J.B. (2011). Methods matter: *Improving causal inference in educational and social science research.* Oxford University Press. New York, NY.

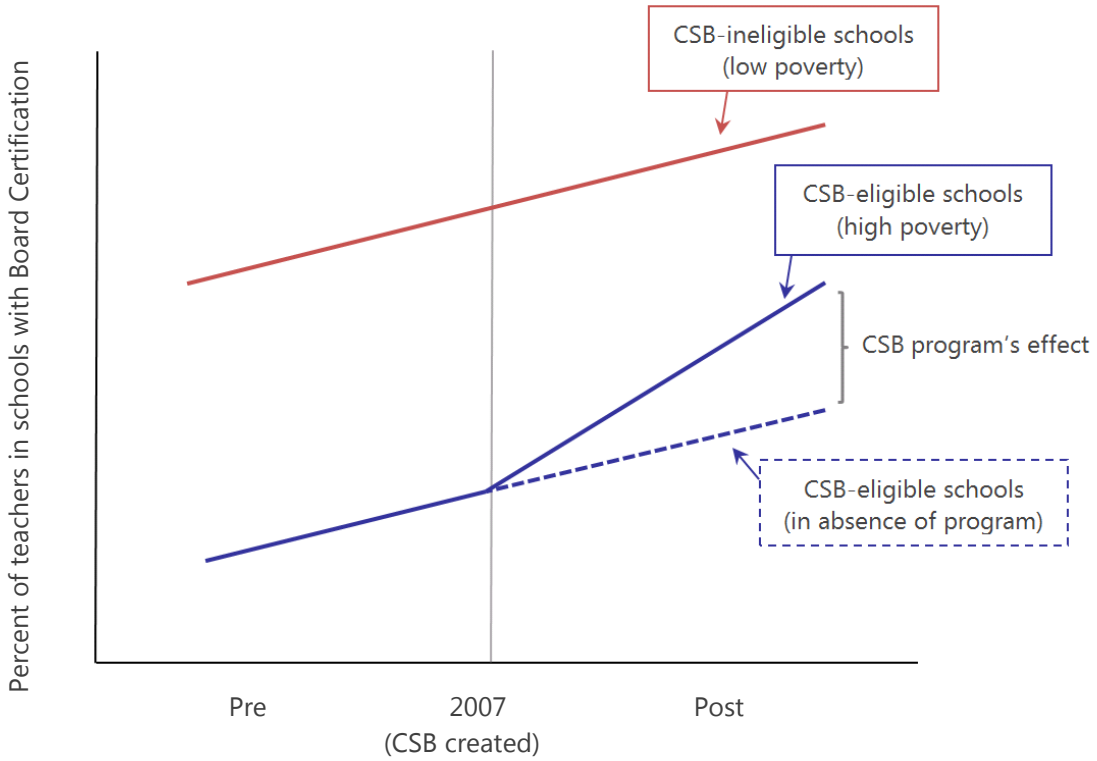
The blue dashed trend line illustrates the main assumption of our DID approach. That is, we assume that the change in the percentage of NBCTs working in CSB-eligible schools over time would be the same as the change in the percentage of NBCTs working in CSB-ineligible schools if the CSB program were not implemented. If this assumption holds, then our DID analysis eliminates observed and unobserved factors that occurred at the same time as the program and similarly affected both CSB-eligible and -ineligible schools.

For example, the number of NBCTs had been increasing prior to 2007 in both eligible and ineligible schools. Without DID, one might attribute the increase of NBCTs in high-poverty schools to the CSB program's effect, when really it was just a general trend. The use of DID can help prevent this type of error. However, if other programs influenced more (or fewer) NBCTs to work in high-poverty schools than in low-poverty schools, then this assumption would not hold and our estimate of the program effect would be biased.

The CSB program's effect estimated in our DID model is the change in the percentage of teachers who are Board certified working in CSB-eligible schools before and after CSB was created, minus the change in the percentage of teachers who are Board certified working in CSB-ineligible schools over the same period.

Exhibit 8

DID Estimate of the CSB Program's Effect on the Percentage of NBCTs Working in CSB-Eligible Schools over Time, Compared to the Percentage in CSB-Ineligible Schools



Secondary Analysis Methods

We conducted secondary analyses to further explore the CSB program's effect. For these analyses, we deconstructed the overall effect that we estimated in our primary analysis into five individual parts. In other words, we conducted individual DID analyses to estimate how much of the CSB program's effect was due to an increase in Board Certification among teachers already in high-poverty schools before the program, and how much was due to other factors like NBCTs transferring from low- to high-poverty schools or increased retention.

See Appendix III for full methodology details of our CSB program evaluation.

Data

For our retention and CSB analyses, we obtained educator-level employment data from OSPI's S-275 personnel data files and school- and district-level data from OSPI Report Card data files. OSPI also provided us with Board-related bonus information for individuals and CSB eligibility information for schools. We linked OSPI- provided data with Board-provided data, which included information about individuals that applied to and became Board certified by a school, district, and year in Washington.[55]

[55] NBPTS states that *authors of this publication are not employed by or affiliated with National Board for Professional Teaching Standards, and any opinions or conclusions set forth herein are those of the authors and not NBPTS*.

V. Evaluation Findings

In this section, we summarize results from our teacher retention analysis and evaluation of the CSB program.

Retention Among National Board-Certified Teachers

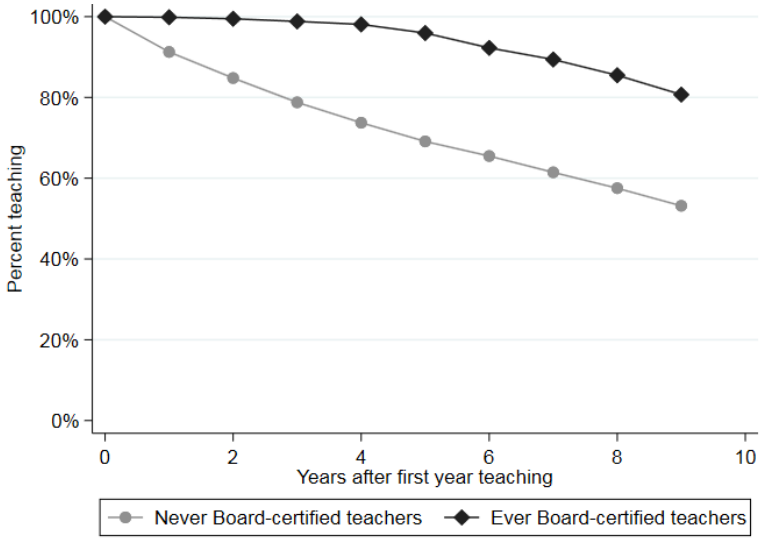
Prior to creating our matched treatment and comparison groups, we examined the difference between NBCTs and all other public school teachers in Washington during their first year of teaching.

NBCTs were more likely to have a master's degree, be female, and identify as White. They also tended to work in slightly larger schools than non-NBCTs and tended to work in slightly lower-poverty schools. NBCTs were also more experienced than non-NBCTs, on average. This disparity was unsurprising, given the requirement that teachers cannot pursue Board Certification without first teaching for at least three years. See Exhibits A8 and A12 in Appendix II.

Looking beyond teacher characteristics in their first year and before matching, NBCTs exited the public education system at a lower rate than non-NBCTs. For example, about 80% of NBCTs remained in Washington's public education system at least nine years after entering, compared to about 53% of non-NBCTs (Exhibit 9). Again, note that NBCT retention rates are higher than non-NBCT retention rates for the first three years (before matching) because individuals are required to teach for at least three years before they can apply for Board Certification.

Exhibit 9

Probability of Remaining in Washington's Public Education System (Before Matching)



Note:
Cumulative retention among NBCTs and all WA teachers (first year teachers entering system between 2002-2007).

Retention in Public Education System

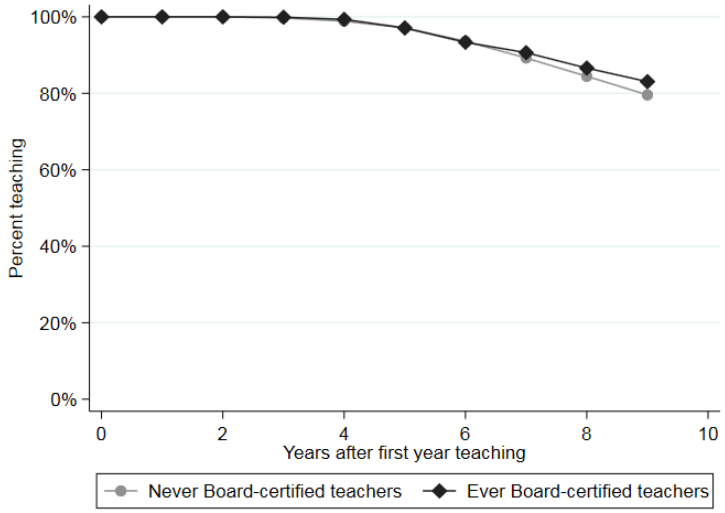
After matching, NBCTs and non-NBCTs were balanced in terms of their prior employment characteristics, teacher demographics, and school and district factors. We then conducted survival analyses on our matched sample. See Exhibits A8 and A12 in Appendix II.

More so than most characteristics, years of previous work experience tended to predict Board Certification and subsequent retention.[56] This is unsurprising given that the Board Certification process requires several years of teaching experience before applying.

Because we exactly matched NBCTs and non-NBCTs on their previous employment experience and because all NBCTs are required to have at least three years of experience, we observe in Exhibit 10 that 100% of NBCTs and non-NBCTs remained in the public education system three years after entering the system. The probability of remaining in the system starts to decrease beginning in the fourth year and continues to decrease in subsequent years. Overall, about 80% of both NBCTs and non-NBCTs remained in Washington's public education system for at least nine years after entering. While we observe a slightly higher retention rate among NBCTs than non-NBCTs in the ninth year, this difference was not statistically different from zero. See Exhibit A9 and A11 in Appendix II for full results.

Exhibit 10

Probability of Remaining in Washington's Public Education System (After Matching)



Note:
Cumulative retention among NBCTs and similar non-NBCTs (first year teachers entering system between 2002-2007).

[56] We identified years of work experience in OSPI's S-275 personnel data. This includes total education-related work experience in and outside of Washington's public education system.

Further, we cannot say for certain where individuals go after they leave Washington's public education system. Other research has stated that teachers may leave for various reasons including retirement, moving out of state, and moving into the private education system.[57] However, we cannot comment on where teachers go because we could not track individuals beyond OSPI's S-275 data files. It's also important to note that our retention findings are specific to teachers who entered Washington's public education system between 2002 and 2007. Additionally, our findings are specific to individuals that certified under the Board's older certification process and do not reflect retention rates that may occur under the newer certification process implemented in 2014.

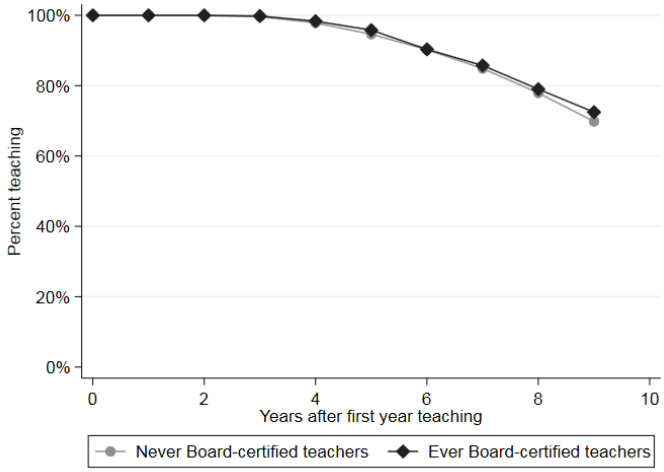
We further examined retention in the public education system by school level. We observed that NBCTs in elementary and middle schools were slightly less likely to remain in the public education system than non-NBCTs but more likely to remain at the high school level. However, while we observed differences between NBCTs and non-NBCTs across school levels, the differences were not statistically different from zero. Full results are displayed in Exhibit A10 in Appendix II.

Retention in Teaching Positions

We found similar trends between groups when analyzing retention within the teaching position. After matching, about 70% of NBCTs and non-NBCTs remained in teaching positions at least nine years after entering Washington's public education system (Exhibit 11). Again, we observe slightly higher retention rates among NBCTs than non-NBCTs in later years, but these differences were not statistically significant. Full results are displayed in Exhibit A13 in Appendix II.

Exhibit 11

Probability of Remaining in Teaching Positions (After Matching)



Note:
Cumulative retention among NBCTs and similar non-NBCTs (first year teachers entering system between 2002-2007).

[57] Education Research & Data Center. (2011). *Who leaves teaching and where do they go?*

Again, upon further examination of retention in teaching positions by school levels, we did not find differences that were statistically different from zero.

Transfer into Leadership Positions

Finally, we estimated the probability of NBCTs and non-NBCTs transferring from teaching positions to leadership positions between 2002 and 2016. In this analysis, we defined leadership positions as district superintendents, assistant superintendents, district administrators, school principals, and school vice principals.[58] Our definition does not include leadership roles that may occur within teaching positions like coaching and mentoring other teachers. This is because we were unable to identify these specific roles in OSPI's S-275 personnel data files.

We found that NBCTs and non-NBCTs transitioned from teaching to leadership positions at similar rates. About 7% of NBCTs and non-NBCTs ever transitioned from teaching to leadership positions between 2002 and 2016. Upon further examination of transfer rates by school levels, we did not find differences that were statistically different from zero.

Full results are displayed in Exhibit A14 in Appendix II.

Growth of NBCTs in High-Poverty Schools

Before summarizing findings for our analysis examining the CSB program's impact on the percentage of teachers in high-poverty schools with Board Certification, we describe the differences between CSB-eligible and ineligible schools (our treatment and comparison groups) before and after the CSB program was implemented in 2007.

Before 2007, schools that would become CSB-eligible in the future had somewhat smaller student enrollment than future ineligible schools and had larger populations of minority students, students eligible for FRPL, students in special education, and English language learners. Future CSB schools also had slightly smaller populations of teachers with master's degrees, fewer overall teachers, and slightly fewer NBCTs than future ineligible schools. See Exhibit A16 in Appendix III.

As mentioned earlier, CSB program eligibility changed after the first year. The legislature changed eligibility criteria in order to improve the distribution of eligibility across all school levels. As a result, there was a 60% increase in the number of eligible schools between 2007-08 and 2008-09 school years, which increased the number of NBCTs potentially eligible to receive the CSB. Through our DID approach, we control for these trends and other policy effects that may have similarly influenced teachers' employment decisions in high-and low-poverty schools at the same time as the CSB program.

Prior to 2007, the percentage of teachers in high-poverty schools with Board Certification was lower than the percentage of NBCTs in low-poverty schools. About a year after the program was implemented, the percentage of NCBTs in high-poverty schools increased and surpassed the percentage in low-poverty schools, a trend that continued until 2015 (Exhibit 12). After 2015, the percentage of teachers with l Board Certification in both low- and high-poverty schools decreased. By 2017, the percentage was the same in low- and high-poverty schools. We cannot say for

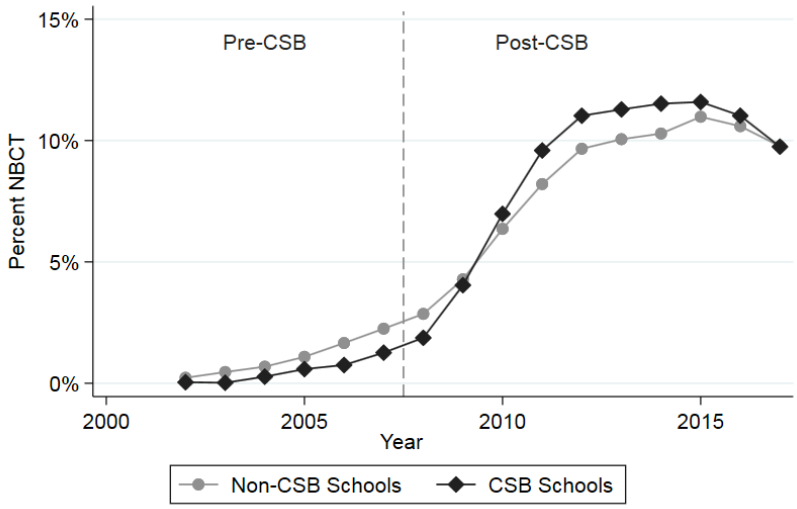
[58] Defined in OSPI S-275 personnel data as duty roots 31-34 to duty roots 11-13, or 21-24.

certain whether or not the CSB program caused declining trends in later years. In part, the decline in later years may be due to changes that the Board made to the certification process in 2014.[59] These changes limited the number of awards issued between 2014 and 2017 and, therefore, the overall number of certified individuals in the state.

Overall, we estimated that the creation of the CSB program increased the percentage of teachers with Board Certification in high-poverty schools by 1.2 percentage points. This means that for a school with 100 teachers, the effect would be one additional high-quality teacher. Full results are displayed in Exhibit A17 in Appendix III.

Exhibit 12

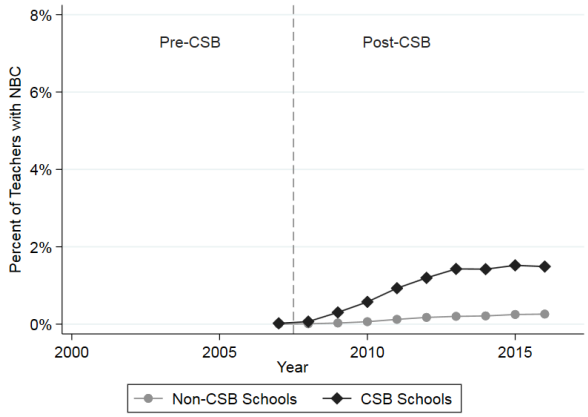
The Percentage of Teachers with Board Certification in Low- and High-Poverty Schools by Year



[59] NBPTS. (2014).

Exhibit 13

The Percentage of Teachers Transferring Between Low-and High-Poverty Schools and Receiving Board Certification



Note:
Non-NBCTs in 2006, NBCTs after 2007, transferred between CSB eligible and ineligible schools after 2007.

Growth of NBCTs Within Schools and Transfers Between Schools

We conducted secondary analyses to explore how much of the CSB program's effect in our primary analysis (i.e., the 1.2 percentage point increase) was due to the growth of NBCTs within high-poverty schools versus the transfer of NBCTs into high-poverty schools.

We conducted five separate analyses (referred to as analyses a, b, c, etc.) to estimate what proportion of the CSB program's effect was due to:

a) An increase in teachers located in high-poverty schools before 2007 who became Board certified after 2007.
b) An increase in retention among NBCTs in high-poverty schools compared to retention among NBCTs in low-poverty schools.
c) An increase in non-NBCTs transferring into high-poverty schools and receiving Board Certification after 2007.
d) An increase in NBCTs transferring into high-poverty schools after 2007.
e) An increase in newly hired teachers in high-poverty schools after 2007 that initially or later became Board certified.

Below, we report statistically significant results from analyses c, d, and e. We report non-significant results from analyses a and b in Appendix III.

Teachers Transferring into High-Poverty Schools and Receiving Board Certification (Analysis c)

We observed a greater percentage of teachers that were not Board certified before 2007 who moved into high-poverty schools and became certified after 2007, compared to low-poverty schools. Half of the CSB program's effect was due to this growth (Exhibit 13).

NBCT Transfers into High-Poverty Schools (Analysis d)

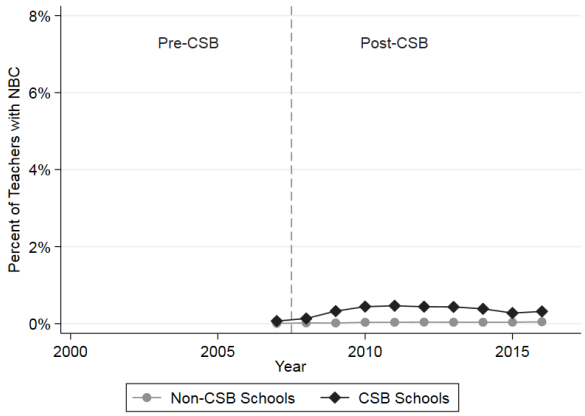
A larger percentage of NBCTs transferred to high-poverty schools after 2007 than into low-poverty schools (Exhibit 14). The effect we estimated was small and not a major driver of the CSB program's effect.

Newly Hired Teachers Who Later Received Board Certification (Analysis e)

Additionally, we found that a greater percentage of newly hired teachers in high-poverty schools later became Board certified after 2007, compared to low-poverty schools (Exhibit 15). This comprised one-third of the CSB program's effect.

Exhibit 14

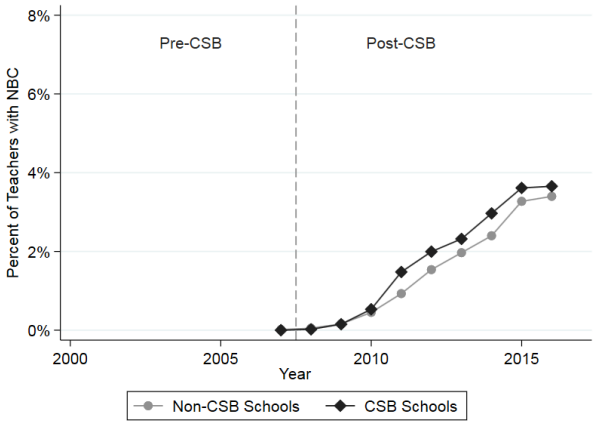
The Percentage of NBCTs Transferring Between Low-and High-Poverty Schools



Note:
NBCTs in 2006, transferred between CSB-eligible and -ineligible schools after 2007.

Exhibit 15

The Percentage of Newly Hired Teachers in Schools that Later Received Board Certification



Note:
Non-teacher in 2006, newly hired teacher in CSB-eligible and -ineligible schools after 2007 and NBCT.

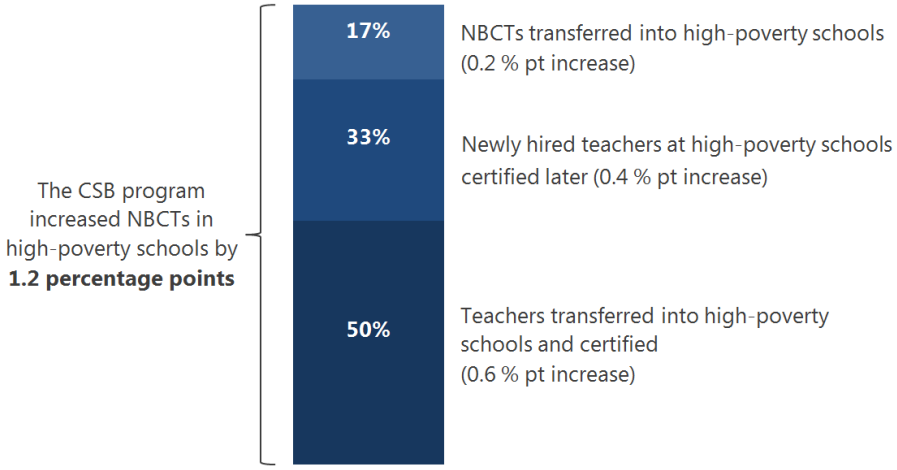
We considered how these types of growth may have influenced teacher effectiveness in high-poverty schools. Our meta-analytic and teacher retention results suggest that Board Certification identifies effective teachers; the certification process does not make teachers more effective; and NBCTs are no more likely to remain in Washington's public education system or in teaching positions than similar non-NBCTs. These findings suggest that incentivizing teachers to pursue Board Certification would not increase the overall teacher effectiveness in high-poverty schools. However, the increased migration of NBCTs from low- to high-poverty schools (analysis d) and the increased retention of NBCTs in high-poverty schools (analysis b), relative to low-poverty schools, would increase overall teacher effectiveness in high-poverty schools.

We expect that the small effect from NBCTs who moved into high-poverty schools (analysis d) increased overall teacher effectiveness in those schools. The larger effects that we estimated due to teachers moving into high-poverty schools (analysis c) and due to newly hired teachers that became Board certified (analysis e) may or may not have increased teacher effectiveness in those schools. We cannot say for certain because we cannot determine whether teachers that moved into high-poverty schools and *later* became Board certified were (1) more effective teachers than those who would have been hired absent the CSB or (2) equally effective teachers that became more likely to certify as a result of the CSB program's creation.

We can only conclude that the CSB program increased the percentage of teachers working in high-poverty schools with Board Certification by 0.2 to 1.2 percentage points. Exhibit 16 shows how each type of growth accounts for the CSB program's overall effect.

Exhibit 16

The Percentage of the CSB Program's Effect Explained by NBCT Growth Within Schools Versus NBCT Transfers Between Schools



VI. Summary

National Board Certification is a voluntary and nationally recognized teaching credential. Some states, including Washington, provide additional benefits and financial incentives to Board-certified educators. In Washington, most Board-certified educators receive a financial incentive of about $5,000 per year. Individuals working in high-poverty schools can receive an additional $5,000 per year through the state's Challenging Schools Bonus (CSB) program.

In our 50-state review, we identified nine states with financial incentive programs similar to Washington's CSB program that aim to distribute Board-certified educators more equitably across schools and districts. Similar to Washington, Colorado, Hawaii, and Mississippi offer a base bonus to Board-certified educators and an additional bonus if they work in high-need schools. Also similar to Washington, most identified states extend compensation to certified educational staff, not only teachers.

Washington is unique in the way that it defines "high-need" schools for its CSB program, using a tiered structure based on free-or reduced-priced-lunch program eligibility by elementary, middle, and high school levels. Arkansas, Illinois, Montana, Utah, Maryland, and Wisconsin also use FRPL to define "high-need" schools, but eligibility is fixed across school type.

Overall, we observed that states with robust incentive programs have had a higher number of Board-certified educators over time than states with more limited programs or no incentives at all.

In our updated meta-analysis, we found that, on average, students exposed to an NBCT have higher test scores and attendance than students exposed to similar teachers without certification. The NBCT process reliably identifies highly effective teachers. However, through additional analyses, we found that these effects are not due to the certification process. NBCTs are not more effective after completing the certification than they were before. Teachers who complete the Board Certification process were already effective educators before they entered the process.

In our retention analysis, we found that NBCTs were about as likely as similar teachers without Board Certification to remain in Washington's public education system, in teaching positions, or transfer into leadership positions over time.

While we observed a slightly higher retention rate among NBCTs in public education, our estimates are not sufficiently precise to conclude that the effect of certification is statistically different from zero. In other words, there may truly be no difference in retention rates between NBCTs and similar non-NBCTs. That said, there could also be a small but true difference between NBCT and non-NBCT groups. Our inability to rule out the possibility of a small increase in retention for NBCTs is a noteworthy limitation of our analysis. Research suggests that even a relatively

small difference in retention rates among high-quality teachers could have a substantial impact on students' lifetime earnings.[60]

In our evaluation of the CSB program, we found that its creation in 2007 increased the percentage of teachers with Board Certification in high-poverty schools by 1.2 percentage points on average between 2008 and 2016. We found that most of the program's effect was due to teachers that transferred into high-poverty schools and became Board certified after 2007 as well as newly hired teachers that were already or later became Board certified.

Our meta-analytic and teacher retention results suggest that incentivizing teachers to pursue Board Certification might not increase the overall composition of teacher effectiveness in high-poverty schools. Rather, it seems that only the increased migration of NBCTs from low- to high-poverty schools or the increased retention of NBCTs in high-poverty schools would improve the overall teacher effectiveness in high-poverty schools. A small amount of the CSB program's effect was due to the transfer of NBCTs from low-to high-poverty schools after 2007, which we expect would have a small but positive impact on teacher effectiveness in high-poverty schools. However, we could not conclude whether or not the other margins of growth that comprised the CSB program's effect increased teacher effectiveness in high-poverty schools.

It is an important caveat to note that financial incentives alone, like the CSB program, are probably not enough to encourage teachers to move into high-poverty schools. Other factors like school leadership, culture, resources, and collegiality also contribute to teachers' decisions about where to work. Further, research indicates that it is expensive to change where teachers choose to teach, inducing teachers to move from low- to high-poverty schools for example. Our CSB program effect of 1.2 percentage points is consistent with these findings.[61]

Further, while our findings suggest that creating a new financial incentive program for NBCTs may not create more effective teachers or attract more effective teachers, we cannot comment on what would happen to Washington's teacher workforce if the base bonus and/or CSB programs were eliminated.

[60] Raj, C., Friedman, J., & Rockoff, J. (2011). *The long-term impacts of teachers: teacher value-added and student outcomes in adulthood*. National Bureau of Economic Research.

[61] Protik, A., Glazerman, S., Bruch, J., & Teh, B. (2015). Staffing a low-performing school: Behavioral responses to selective teacher transfer incentives. *Association for Education Finance and Policy, 10*(4), 573-610 and Cowan and Goldhaber (2015).

Appendices

An Evaluation of National Board-Certified Teachers in Washington and Review of Financial Incentives in Other States

I: Meta-Analytic Methods and Results....33

II: Teacher Retention Analysis Methods and Results....40

III: Challenging Schools Bonus (CSB) Analysis Methods and Results

- CSB Program Evaluation: Methods and Limitations (Primary Analysis)....54
- CSB Program Evaluation: Results (Primary Analysis)....57
- CSB Program Evaluation: Methods and Limitations (Secondary Analyses)....59
- CSB Program Evaluation: Results (Secondary Analyses)....63

I. Meta-Analytic Methods and Results

Meta-Analytic Results

Exhibit A1 shows results from our primary meta-analysis of the effect of exposure to an NBCT in elementary grades. This meta-analysis included 11 rigorous evaluations and reported standardized test score, attendance, and suspension outcomes. We found that on average, exposure to an NBCT in elementary grades increased student test scores by 0.021 standard deviation units and attendance by 0.045 standard deviation units. However, exposure did not affect suspension rates. Exhibit A2 is a forest plot illustrating the 17 estimated test score effect sizes in this meta-analysis.

Exhibit A1

Meta-Analytic Results: Effects of Student Exposure to NBCTs in Elementary Grades

Outcome	Average age	# of effect sizes	# in treatment	Effect size	Standard error	P-value
Test scores	10	17	405,357	0.021	0.005	0.001**
Attendance	10	4	20,605	0.045	0.021	0.030*
Suspensions	10	4	20,605	0.001	0.001	0.489

Note:
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Exhibit A2

Meta-Analytic Results: Forest Plot of Standardized Test Score Effect Sizes (Student Exposure to NBCTs in Elementary Grades)

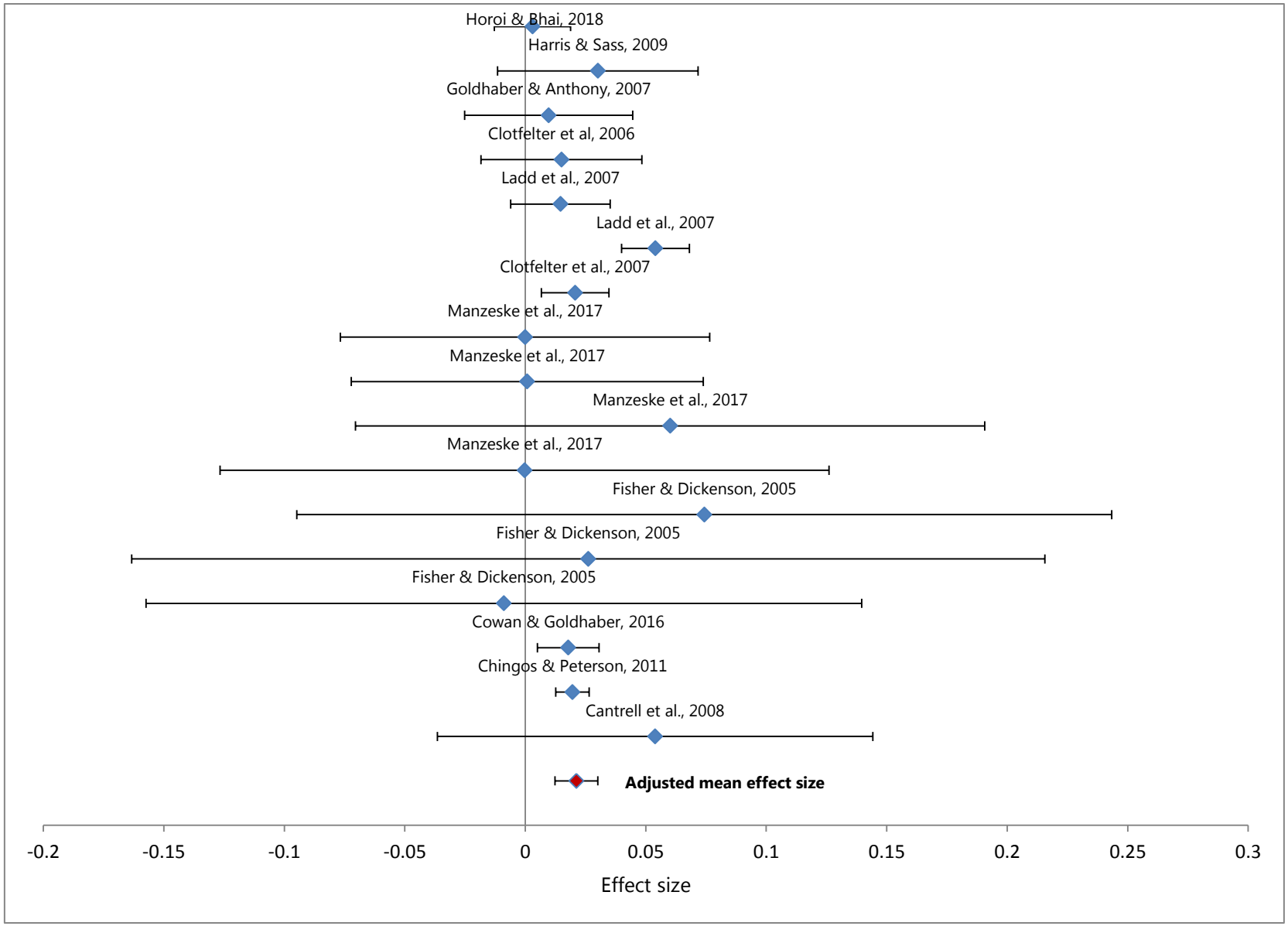


Exhibit A3 shows results from our primary meta-analysis of the effect of exposure to an NBCT who teaches math or English Language Arts (ELA) in middle or high school grades. This meta-analysis included eight rigorous evaluations and reported standardized test score outcomes. We found that on average, exposure to an NBCT who teaches math or ELA in middle or high school increased student test scores by 0.031 standard deviation units. Exhibit A4 is a forest plot illustrating the ten estimated test score effect sizes in this meta-analysis.

Exhibit A3

Meta-Analytic Results: Effects of Student Exposure to Math or ELA NBCTs in Middle or High School Grades

Outcome	Average age	# of effect sizes	# in treatment	Effect size	Standard error	P-value
Test scores	13	10	284,613	0.031	0.006	0.001**

Note:

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Exhibit A4

Meta-Analytic Results: Forest Plot of Standardized Test Score Effect Sizes (Student Exposure to Math or English Language Arts NBCTs in Middle or High School Grades)

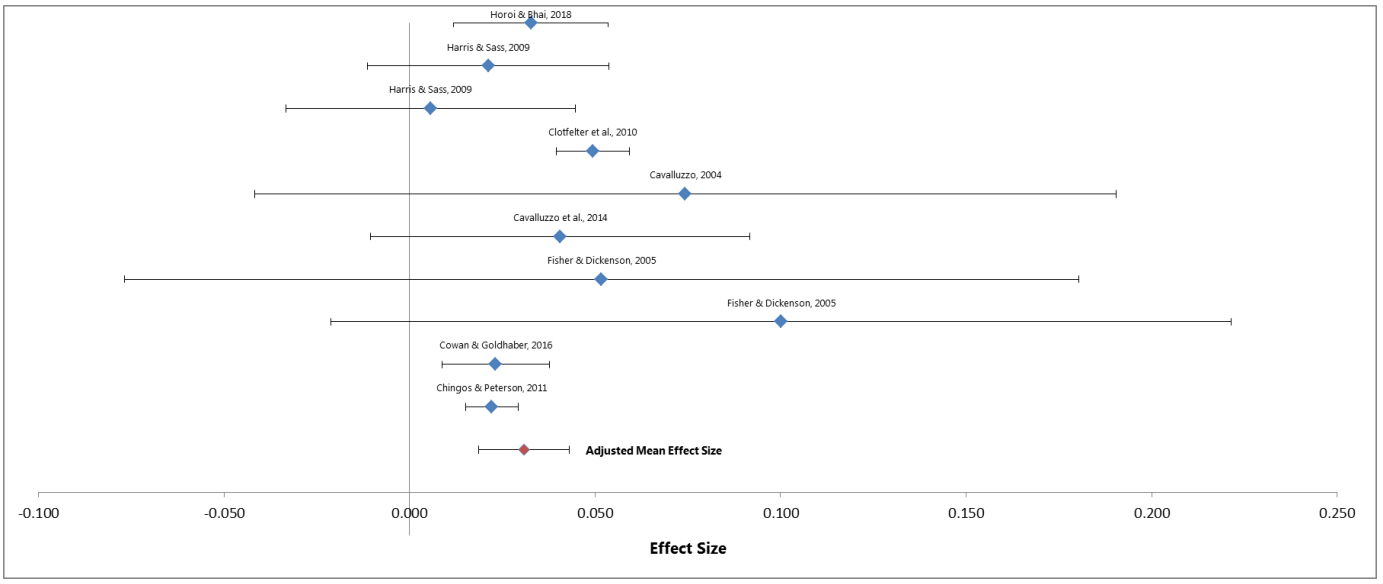


Exhibit A5 shows results from secondary meta-analyses focused on the signaling effect of Board Certification. We conducted two separate analyses based on grade levels. The meta-analysis of elementary included three rigorous evaluations and the meta-analysis of middle and high school included two rigorous evaluations. Standardized test scores were the main outcome in both analyses. Studies estimate differences in teacher performance between NBCTs and similar teachers who are not certified. The studies control for factors like teacher experience and the human capital effect of Board Certification in order to measure how much of the difference between NBCTs and comparable teachers is due to unquantifiable characteristics like "ability." In both elementary and secondary grade levels our analysis suggests that Board Certification identifies effective teachers and, therefore, increases in test scores are due to student exposure to an effective teacher regardless of certification.

Exhibit A5

Meta-Analytic Results: Signaling Effect of National Board Certification

Intervention	Estimated effect	Outcome	Average age	# of effect sizes	# in treatment	Effect size	Standard error	P-value
NBCT in elementary school	Signaling	Test scores	10	4	185,107	0.030	0.012	0.012*
NBCT in middle or high school	Signaling	Test scores	14	3	81,865	0.024	0.008	0.003**

Note:
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Exhibit A6 shows results from our meta-analyses on the human capital effect of Board Certification. The meta-analysis of elementary included four rigorous evaluations and the analysis of middle and high school also included four rigorous evaluations. Test scores were the main reported outcome. Studies included in this analysis estimate teacher effects on student test scores before and after receiving Board Certification. The studies control for factors like teacher experience and ability, directly or through the use of "fixed effects" models to determine whether teachers performed better after the certification process than they would had they not gone through it.

In both elementary and secondary grade levels, we estimate that the Board Certification process does not make teachers more effective than they already were before the process.

Exhibit A6

Meta-Analytic Results: Human Capital Effect of National Board Certification

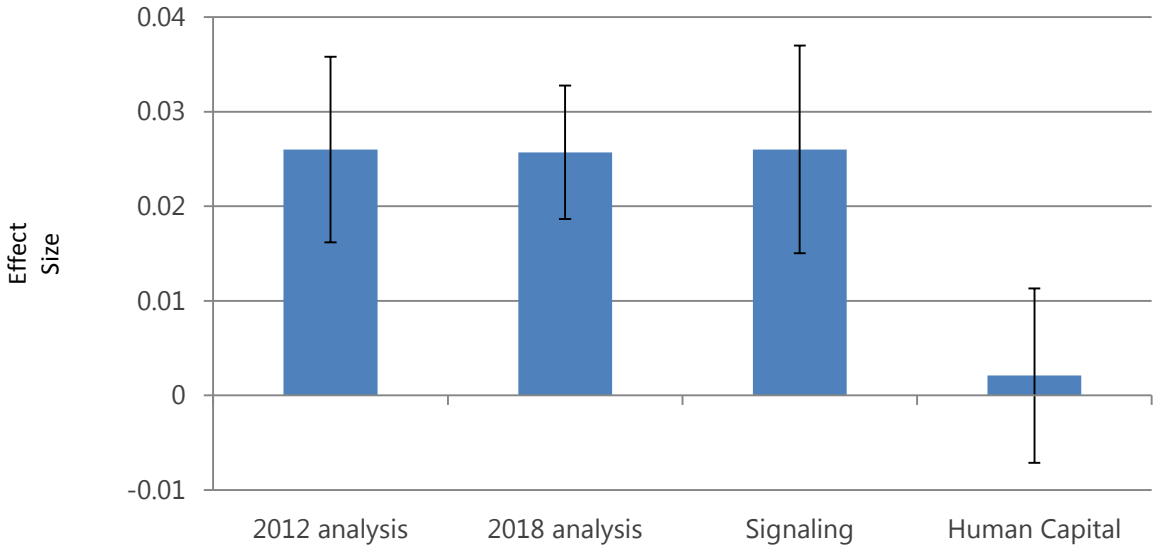
Intervention	Estimated effect	Outcome	Average age	# of effect sizes	# in treatment	Effect size	Standard error	P-value
NBCT in elementary school	Human capital	Test scores	10	5	225,758	0.004	0.009	0.657
NBCT in middle or high school	Human capital	Test scores	14	5	164,527	-0.005	0.017	0.761

Note:
$p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Exhibit A7 compares meta-analytic test score results from our 2012 analysis, our current primary analysis, and our secondary analysis on signaling and human capital effects of Board Certification. Note that the effect on test scores estimated in our current analysis is similar to results from our 2012 analysis. The signaling effect of Board Certification explains most of the effect on test scores due to student exposure to effective teachers.

Exhibit A7

Meta-Analytic Results: Comparison of Disaggregated Effects on Test Scores



Note:
95% confidence intervals reported.

Study Citations

National Board-Certified Teachers in Elementary Schools (Primary Analysis)

Cantrell, S., Fullerton, J., Kane, T.J., & Staiger, D.O. (2008). *National board certification and teacher effectiveness: Evidence from a random assignment experiment* (Working Paper No. 14608). Cambridge: National Bureau of Economic Research.

Chingos, M.M., & Peterson, P.E. (2011). It's easier to pick a good teacher than to train one: Familiar and new results on the correlates of teacher effectiveness. *Economics of Education Review, 30*(3), 449-465.

Clotfelter, C.T., Ladd, H.F., & Vigdor, J.L. (2006). Teacher-student matching and the assessment of teacher effectiveness. *The Journal of Human Resources, 41*(4), 778-820.

Clotfelter, C.T., Ladd, H.F., & Vigdor, J.L. (2007). Teacher credentials and student achievement: Longitudinal analysis with student fixed effects. *Economics of Education Review, 26*(6), 673-682.

Goldhaber, D., & Anthony, E. (2007). Can teacher quality be effectively assessed? National board certification as a signal of effective teaching. *The Review of Economics and Statistics, 89*(1), 134-150.

Cowan, J., & Goldhaber, D. (2016). National Board Certification and Teacher Effectiveness: Evidence from Washington State. *Journal of Research on Educational Effectiveness, 9(*3), 233-258.

Fisher, S., & Dickenson, T. (2005). *A study of the relationship between the national board certification status of teachers and students' achievement: Technical report*. Columbia, SC: South Carolina Dept. of Education.

Harris, D.N., & Sass, T.R. (2009). The effects of NBPTS-certified teachers on student achievement. *Journal of Policy Analysis and Management, 28*(1), 55-80.

Horoi, I., & Bhai, M. (2018). New evidence on national board certification as a signal of teacher quality. *Economic Inquiry, 56(*2), 1185-1201.

Ladd, H.F., Sass, T.R., & Harris, D.N. (2007). *The impact of national board certified teachers on student achievement in Florida and North Carolina: A summary of the evidence*. Prepared for the National Academies Committee on the evaluation of the impact of teacher certification by NBPTS. Unpublished manuscript.

Manzeske, D., Park, S.J., Liu, F., Borman, T., Gnedko-Berry, N., West, B., & Deng, E. (2017). *Effects of National Board Certified Teachers teachers on student achievement and behavioral outcomes: Studies conducted in two states.* Working Paper. American Institutes for Research.

National Board-Certified Teachers in Middle and High Schools (Primary Analysis)

Cavalluzzo, L.C. (2004). *Is national board certification an effective signal of teacher quality?* Alexandria, VA: The CNA Corporation.

Cavalluzzo, L., Barrow, L., Henderson, S., Mokher, C., Geraghty, T., & Sartain, L. (2014). *From large urban to small rural schools: An empirical study of national board certification and teaching effectiveness*. CNA Analysis and Solutions.

Chingos, M.M., & Peterson, P.E. (2011). It's easier to pick a good teacher than to train one: Familiar and new results on the correlates of teacher effectiveness. *Economics of Education Review, 30*(3), 449-465.

Clotfelter, C.T., Ladd, H.F., & Vigdor, J.L. (2010). Teacher credentials and student achievement in high school: A cross-subject analysis with student fixed effects. *Journal of Human Resources, 45*(3), 655-681.

Cowan, J., & Goldhaber, D. (2016). National Board Certification and Teacher Effectiveness: Evidence from Washington State. *Journal of Research on Educational Effectiveness, 9(*3), 233-258.

Fisher, S., & Dickenson, T. (2005). *A study of the relationship between the national board certification status of teachers and students' achievement: Technical report*. Columbia, SC: South Carolina Dept. of Education.

Harris, D.N., & Sass, T.R. (2009). The effects of NBPTS-certified teachers on student achievement. *Journal of Policy Analysis and Management, 28*(1), 55-80.

Horoi, I., & Bhai, M. (2018). New evidence on national board certification as a signal of teacher quality. *Economic Inquiry, 56(*2), 1185-1201.

Signaling Effect of National Board Certification (Secondary Analysis)

Clotfelter, C.T., Ladd, H.F., & Vigdor, J.L. (2007). Teacher credentials and student achievement: Longitudinal analysis with student fixed effects. *Economics of Education Review, 26*(6), 673-682.

Harris, D.N., & Sass, T.R. (2009). The effects of NBPTS-certified teachers on student achievement. *Journal of Policy Analysis and Management, 28*(1), 55-80.

Ladd, H.F., Sass, T.R., & Harris, D.N. (2007). *The impact of national board certified teachers on student achievement in Florida and North Carolina: A summary of the evidence*. Prepared for the National Academies Committee on the evaluation of the impact of teacher certification by NBPTS. Unpublished manuscript.

Human Capital Effect of National Board Certification (Secondary Analysis)

Cavalluzzo, L., Barrow, L., Henderson, S., Mokher, C., Geraghty, T., & Sartain, L. (2014). *From large urban to small rural schools: An empirical study of national board certification and teaching effectiveness*. CNA Analysis and Solutions.

Chingos, M.M., & Peterson, P.E. (2011). It's easier to pick a good teacher than to train one: Familiar and new results on the correlates of teacher effectiveness. *Economics of Education Review, 30*(3), 449-465.

Clotfelter, C.T., Ladd, H.F., & Vigdor, J.L. (2007). Teacher credentials and student achievement: Longitudinal analysis with student fixed effects. *Economics of Education Review, 26*(6), 673-682.

Harris, D.N., & Sass, T.R. (2009). The effects of NBPTS-certified teachers on student achievement. *Journal of Policy Analysis and Management, 28*(1), 55-80.

Ladd, H.F., Sass, T.R., & Harris, D.N. (2007). *The impact of national board certified teachers on student achievement in Florida and North Carolina: A summary of the evidence*. Prepared for the National Academies Committee on the evaluation of the impact of teacher certification by NBPTS. Unpublished manuscript.

II. Teacher Retention Analysis Methods and Results

Teacher Retention Evaluation: Methods and Limitations

The 2017 Washington State Legislature directed WSIPP to report on the question: does "the [National Board Certification improves] teacher retention in Washington State?" Based on consultation with non-partisan legislative staff, staff members at OSPI and NBPTS, and the research literature we have operationalized this request as follows:

Research Questions

(1) Compared to otherwise similar teachers, do National Board-Certified Teachers:

- *a. Remain employed in public education in Washington at a higher rate?*
- *b. Remain employed as public school teachers in Washington at a higher rate?*
- *c. Transition to leadership positions in Washington at a higher rate?*

Definitions

Public School Teachers: We defined public school teachers using OSPI's S-275 personnel data. For our analyses, teachers included elementary teachers, secondary teachers, and other teachers in the S-275 defined by duty roots 31-34 and assigned a full-time equivalent (FTE) workload of 0.5 or higher.[62]

Public School Leadership Positions: We defined public school leadership positions in Washington as individuals assigned to positions like principals and superintendent staff positions in the S-275 data, which are defined by duty roots 11-13 and 21-24 and an FTE workload of 0.5 or higher.[63]

Treatment Group: For our analysis of teacher retention, the treatment group was Washington State public school teachers who entered the public school system between 2002 and 2007 and completed Board Certification between 2006 and 2013.

Comparison Group: Our comparison group was Washington State public school teachers who entered the public school system between 2002 and 2007 and did not complete Board Certification between 2006 and 2013. Teachers who were Board candidates but did not successfully certify were potential members of the comparison group.

Retention for this analysis was defined in the following ways:

- We considered a teacher as *leaving* Washington's public education system if we observed them leaving OSPI's S-275 personnel dataset permanently during our period of analysis (2002 to 2016). (Research Question 1.a);
- We considered an individual as *remaining* in their teaching position if we observed them as assigned duty roots 31-34 for the entire period of analysis (2002 to 2016). (Research Question 1.b); and
- We consider a teacher *transitioning* into a leadership position if we observed them switching from teaching assignments (duty roots 31 – 34) to leadership assignments (duty roots 11-13, and 21-24) during our period of analysis (2002 to 2016). (Research Question 1.c).

[62] OSPI. *Duty Code Definitions.*
[63] Ibid.

Empirical Methods

Our empirical objective was to estimate the effect of Board Certification on teacher retention in Washington State's public school system. We were unable to randomly assign Board Certification to some teachers and not to other teachers. Therefore, the credibility of our estimate depends on our ability to identify a suitable comparison group that approximates the covariate balance between groups found in a randomly assigned experiment—that is, a group of teachers whose retention rates we expect to be similar to NBCTs (on average) in the absence of certification.

We used a Coarsened Exact Matching (CEM) algorithm to identify a comparison group of teachers who were similar to NBCTs prior to receiving National Board Certification.[64] The rationale for this approach is that comparing teachers with similar observed characteristics will allow one to estimate the independent effect of Board Certification. For example, matching each NBCT to a demographically identical non-NBCT would eliminate potential confounding effects resulting from male or female teachers being more or less likely to earn certification and more or less likely to remain employed as public school teachers from year to year. Additionally, minimizing observed differences tends to minimize unobserved differences that are correlated with observed differences. If one can account for all observed and unobserved differences between NBCTs and non-NBCTs that are correlated with *both* Board participation *and* retention outcomes, then the effect of Board Certification can be estimated without bias. In other words, the necessary assumption for estimating the causal effect of Board Certification on teacher retention is "no omitted variable bias."

Conditional on the observed characteristics of teachers, our empirical strategy assumes that completion of Board Certification approximates random assignment. This assumption is also referred to as "selection on observables"[65] or "conditional independence."[66] The CEM algorithm is only helpful in estimating the effect of Board Certification on retention insofar as the teacher characteristics that predict *both* certification and retention are: (1) observed in our data or (2) correlated with a teacher characteristic observed in our data.

Similar to other matching methods, the goal of CEM is to select (and/or re-weight) sample observations to reduce model dependence—that is, decisions made by the researcher. Analysis has found that CEM outperformed the most commonly used matching methods along many important dimensions.[67] Ideally with CEM, for each NBCT a comparison teacher would be selected who was demographically identical to the NBCT, graduated from the same college as the NBCT, taught at the same initial school for the same number of years as the NBCT, and had identical personal and professional aspirations as the NBCT. The only difference between the two teachers would be that one earned Board Certification, and the other did not. In our analysis, a perfect match did not exist for every NBCT in every possible model specification. When a perfect match did not exist, the CEM algorithm selected "closest" matches using an algorithm that minimizes dissimilarity between NBCTs and non-NBCTs by iteratively coarsening variables and re-selecting comparison group teachers. Teachers in the comparison group who were not matched to an NBCT were omitted from the analysis.

If the selection on observables assumption holds, CEM allows one to estimate the sample average treatment effect on the treated (SATT), which is a weighted average of differences in outcomes between treated teachers (i.e., NBCTs) and comparison teachers (i.e., non-NBCTs):

[64] Iacus et al. (2011).
[65] Goldberger, A. (1972). Structural equation methods in the social sciences. *Econometrica*. *40*(6), 979-1001.
[66] Angrist, J.D., & Pischke, J. (2009). *Mostly harmless econometrics: An empiricist's companion*. Princeton University Press.
[67] King, G., Nielsen, R., Coberley, C., Pope, J., & Wells, A. (2011) Comparative effectiveness of matching methods for causal inference.

$$SATT = \frac{1}{n_T}\sum_{i \in T} NB_i, \quad (1)$$

where *NB* is the effect of National Board Certification on retention, *T* denotes the NBCTs, and n_T is the number of NBCTs. If the sample was a random draw from the population, then the SATT estimate would be the population average treatment effect on the treated (PATT). With exactly balanced data, additional covariates would be unnecessary to include. When matching on categorical teacher characteristics with many possible values, such as school district, NBCTs without a match were excluded, and the estimate became *local SATT*, which is SATT estimated over a subset of NBCTs.

Once we selected a comparison group that matched NBCTs to similar non-NBCTs with respect to previous public school work experience, demographics, school and district characteristics, we estimated SATT or local SATT with survival analysis. Using a person-by-year dataset, we fit logistic regression models of the following form:

$$\log\left(\frac{P\left(EMPLOYED_{ij} = 1 \,\middle|\, NB_i\right)}{1 - P\left(EMPLOYED_{ij} = 1 \,\middle|\, NB_i\right)}\right) = \alpha + \gamma(NB_i) + X_i\delta + \omega_j, \quad (2)$$

Notes:
NB_i = indicator for (ever) earning National Board Certification
γ = the difference in the log-odds of a given retention outcome attributable to National Board Certification
$EMPLOYED_{ij}$ = binary indicator for whether educator *i* was employed in a given position of interest (i.e. Washington's public school system, a teaching position, or leadership position) in year *j*.
ω_j = school year fixed effects
$X_i\,\delta$ = vector of time-invariant covariates and associated regression coefficient, such as the educator's first year observed teaching in Washington's public education system.

We fit logistic regression models with controls to confirm that the coefficient of interest was robust to potential idiosyncratic imbalance on observable coefficients introduced during coarsening.

It is important to note that the National Board implemented changes to the certification process in 2014. Changes included reducing the number of components candidates were required to complete, reducing the cost of certification, and allowing candidates a three-year submission period and two-year retake period, rather than a one-year submission period and two-year retake period as in prior years. Components were rolled out over the subsequent two years, so individuals who began the process in 2014 did not have access to all components and therefore could not certify until 2017 at the earliest. Because of these changes, the number of certifications declined in 2015 and 2016 but began to increase again starting in 2017. We restricted our analysis period to include candidates that received certification between 2004 and 2013 before these changes were implemented.[68]

[68] NBPTS. (2014).

Data

Educator-level employment data from 1996-2017 were obtained from the Office of the Superintendent of Public Instruction's (OSPI) S-275 personnel data files. Each year of data was a separate file that contained a snapshot of public school educator and administrator characteristics for a particular school year. We tracked individual teachers over time using their unique teacher certification number. To identify Board-certified teachers, we combined S-275 data with individual-level data provided by the National Board for Professional Teaching Standards. This data included information on when teachers applied for candidacy and earned their certificates. OSPI also provided us with educator-level bonus information and school-level eligibility for the Challenging Schools Bonus. We also incorporated school-level demographics from OSPI's report card data files.

Limitations

As previously discussed, CEM will reduce model dependence, but it cannot rule out omitted variable bias. A measure that is omitted from the matching that is both correlated with Board Certification and retention will bias estimates of the Board Certification effect. For example, due to data limitations, we were unable to match NBCTs and non-NBCTs on their teacher licensure test scores, a variable that may be correlated with a teacher's decision to become Board Certified and remain in the profession in Washington. Further, our retention findings are specific to teachers who entered Washington's public education system between 2002 and 2007 and cannot be generalized to Washington's broader teaching population.

Teacher Retention Evaluation: Results

Retention of NBCTs and non-NBCTs in Washington's Public Education System

We conducted survival analysis on two samples: Board-certified educators in various positions in the public education system and Board-certified educators specifically in teaching positions. Exhibit A8 presents the characteristics our sample of NBCTs and non-NBCTs in various positions (not just teaching positions) before and after we matched groups.

The unmatched columns in Exhibits A8 do not include the entire population of non-NBCTs and NBCTs in Washington. Before matching, samples in Exhibits A8 include teachers who entered Washington's public education system between 2002 and 2007 (non-NBCT sample = 6,442) and did or did not receive Board Certification between 2006 and 2013 (NBCT sample = 1,358). In Exhibits A8, our matched sample reflects NBCTs and non-NBCTs matched on prior employment characteristics, teacher demographics, and school and district characteristics. After matching, our sample was reduced to 382 non-NBCTs and 382 NBCTs.

Note that we also matched NBCTs and non-NBCTs on a combination of other characteristics. For example, model 2 in Exhibits A9 shows our sample of NBCTs and non-NBCTs matched on prior employment experience and teacher characteristics but not on the district or school characteristics. We conducted survival analyses on different matched samples, which may be more or less representative of NBCTs in Washington (depending on matching characteristics), but our overall retention results were robust across all 5 models, including our smallest matched sample of 382 NBCTs and 382 non-NBCTs**.**

Exhibit A8

Descriptive Characteristics of NBCTs and Non-NBCTs in Any Position (Before and After Matching)

Variable	Unmatched		Matched	
	Non-NBCT	NBCT	Non-NBCT	NBCT
% highest degree is an MA	0.379	0.504	0.437	0.437
% highest degree is a BA	0.613	0.488	0.563	0.563
% female	0.719	0.767	0.801	0.801
% African American	0.020	0.007	0.000	0.000
% Asian	0.040	0.041	0.003	0.003
% Hispanic	0.034	0.035	0.003	0.003
School enrollment (year 1)	790.8	836.8	824	774.2
% FRPL in school (year 1)	0.377	0.366	0.332	0.324
% teaching in WA (year 5)	0.628	0.896	0.935	0.950
% employment gap (year 5)	0.097	0.076	0.039	0.037
% exit (year 5)	0.236	0.010	0.000	0.000
% teaching in WA (year 7)	0.591	0.858	0.859	0.898
% employment gap (year 7)	0.080	0.065	0.050	0.026
% exit (year 7)	0.300	0.056	0.058	0.050
% teaching in WA (year 9)	0.567	0.816	0.804	0.814
% employment gap (year 9)	0.055	0.058	0.037	0.037
% exit (year 9)	0.356	0.100	0.128	0.113
% ever in leadership role	0.061	0.077	0.071	0.076
% Board Certification candidate (w/in three years)	0.029	0.473	0.029	0.563
% Board Certification candidate (w/in five years)	0.044	0.642	0.039	0.749
% Board Certification candidate (w/in four years)	0.057	0.768	0.042	0.856
% ever Board Certification candidate	0.081	0.974	0.092	0.982
% NBCT (w/in three years)	0.000	0.002	0.000	0.000
% NBCT (w/in four years)	0.000	0.180	0.000	0.259
% NBCT (w/in five years)	0.000	0.421	0.000	0.539
% NBCT (w/in ten years)	0.000	0.925	0.000	0.987
% NBCT ever	0	1	0	1
% ever receive Board Certification bonus	0	0.929	0	1
Average bonus received in 2007	-	$3,500	-	$3,500
Average bonus received in 2009	-	$6,815.70	-	$6,786.10
% in CSB-eligible school (2007)	0.111	0.113	0.057	0.062
% in CSB-eligible school (2008)	0.112	0.117	0.069	0.073
% in CSB-eligible school (2009)	0.109	0.117	0.057	0.062
% in CSB-eligible school (2010)	0.106	0.113	0.063	0.055
% in CSB-eligible school (2011)	0.102	0.100	0.058	0.053
% in CSB-eligible school (2012)	0.101	0.097	0.057	0.048
% in CSB-eligible school (2013)	0.093	0.093	0.053	0.047

% in CSB-eligible school (2014)	0.088	0.084	0.055	0.043
% in CSB-eligible school (2015)	0.082	0.077	0.048	0.028
# of observations	6,442	1,358	382	382

In Exhibit A9 and A13, we report regression results of each model. We conducted this survival analysis on matched individuals in various education-related positions, not teaching positions specifically. Model 1 is our baseline model, which illustrates survival analysis regression results on a sample of non-NBCT and NBCTs exactly matched on prior years of employment. Model 2 reports results on a sample of non-NBCTs and NBCTs matched on prior employment and teacher characteristics like age, race, sex, and education level. Model 3 reports results on a sample of non-NBCTs and NBCTs matched on prior employment and district characteristics including the district in which an individual was employed during their first year in the public education system and whether or not they worked in a CSB-eligible school during their first year in the system. Model 4 reports results on a sample of non-NBCTs and NBCTs matched on prior employment history and school characteristics like percentage FRPL and percentage of students in special education in the school where the individual worked during their first year. Model 5 reports results on a sample of non-NBCTs and NBCTs matched on all characteristics and is our preferred specification. We found that NBCTs were no more likely than NBCTs to remain in Washington's public education system and any observed differences were not statistically significant. Results were similar across all models.

Exhibit A9

Logistic Regression Estimates of National Board Certification Effect on Retention in WA's Public Education System (Among First-Year Teachers in 2001-2007)

Variable	Model 1 Baseline	2 Teacher characteristics	3 District characteristics	4 School characteristics	5 All
National Board	0.114	0.184	0.168^{+}	0.121	-0.021
	(0.088)	(0.143)	(0.1)	(0.113)	(0.190)
Matched variables					
Employment history	X	X	X	X	X
First year of employment	X	X	X	X	X
Demographics		X			X
Highest degree (year 1)		X			X
School level (year 1)		X			X
Years of experience		X			X
Assigned FTE		X			X
Certificate type		X			X
District employed (year 1)			X		X
School CSB eligible (year 1)			X	X	X
School characteristics (year 1)				X	
Regression covariates					
Year indicators	X	X	X	X	X
Year 1 indicators	X	X	X	X	X
Demographics	X	X	X	X	X
Highest degree (year 1)	X	X	X	X	X
School level (year 1)	X	X	X	X	X
School CSB eligible (year 1)	X	X	X	X	X
School characteristics (year 1)	X	X	X	X	X
NBCTs	858	478	858	561	335
Baseline (p)	0.976	0.976	0.976	0.976	0.976

Notes:

Heteroskedasticity robust standard errors clustered by district in parentheses. The omitted (baseline) ethnicity category is Asian. The baseline estimate is the log-odds of the outcome of interest for the relevant sample estimated without any controls.

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Exhibit A10 reports logistic regression results of our survival analysis on matched NBCTs and non-NBCTs and their retention in Washington's public education system between 2002 and 2016 disaggregated by elementary, middle, and high school levels. Columns 1-6 illustrate regression results based on the characteristics on which NBCTs and non-NBCTs were matched and pre-treatment controls. We observed that NBCTs were no more likely than similar non-NBCTs to remain in the public education system in elementary, middle, or high school levels and that any observed differences were not statistically significant.

Exhibit A10

Logistic Regression Estimates of National Board Certification Effect on Retention in WA's Public Education System (Among First-Year Teachers in 2001-2007):
Heterogeneity in Effects by School Level (Elementary, Middle, and High School)

Variable	Elementary		Middle school		High school	
	(1)	(2)	(3)	(4)	(5)	(6)
National Board	0.204	-0.113	0.100	-0.137	0.567^{+}	0.547
	(0.158)	(0.232)	(0.419)	(0.480)	(0.315)	(0.450)
Matched variables						
Employment history	X	X	X	X	X	X
First year of employment	X	X	X	X	X	X
Demographics	X	X	X	X	X	X
Highest degree (year 1)	X	X	X	X	X	X
School level (year 1)	X	X	X	X	X	X
Years of experience	X	X	X	X	X	X
Assigned FTE	X	X	X	X	X	X
Certificate type	X	X	X	X	X	X
District employed (year 1)		X		X		X
School CSB eligible (year 1)		X		X		X
School characteristics (year 1)						
Regression covariates						
Year (continuous)	X	X	X	X	X	X
Year 1 (continuous)	X	X	X	X	X	X
Demographics	X	X	X	X	X	X
Highest degree (year 1)	X	X	X	X	X	X
School level (year 1)						
School CSB eligible (year 1)	X	X	X	X	X	X
School characteristics (year 1)	X	X	X	X	X	X
NBCTs	234	179	118	72	126	84
Baseline (p)	0.971	0.972	0.984	0.982	0.978	0.978

Notes:
Heteroskedasticity robust standard errors clustered by district in parentheses.
The omitted (baseline) ethnicity category is Asian.
The baseline estimate is the log-odds of the outcome of interest for the relevant sample estimated without any controls.
$+ p < 0.10$, $* p < 0.05$, $** p < 0.01$, $*** p < 0.001$

Exhibit A11 includes OLS regression results of our survival analysis on matched NBCTs and non-NBCTs and their retention in Washington's public education system between 2002 and 2016. Columns 1-4 illustrate regression results based on the characteristics on which we matched NBCTs and non-NBCTs and pre-treatment controls. We observed that NBCTs were no more likely than similar non-NBCTs to remain in the public education system and that any observed differences were not statistically significant.

Exhibit A11

OLS Regression Estimates of National Board Certification Effect on Retention in WA's Public Education System (Among First-Year Teachers in 2002-2007)

Variable	No covariates (1)	Covariates included (2)	No covariates (3)	Covariates included (4)
National Board	0.046	0.056	-0.021	-0.029
	(0.186)	(0.199)	(0.147)	(0.154)
Matched variables				
Employment history	X	X	X	X
First year of employment	X	X	X	X
Demographics			X	X
Highest degree (year 1)			X	X
School level (year 1)	X	X	X	X
Years of experience	X	X	X	X
Assigned FTE	X	X	X	X
Certificate type	X	X	X	X
District employed (year 1)	X	X	X	X
School CSB eligible (year 1)			X	X
School characteristics (year 1)				
Regression covariates				
Year indicators		X		X
Year 1 indicators		X		X
Middle school teacher		0.326*		0.332
		(0.152)		(0.296)
High school teacher		0.071		0.164
		(0.145)		(0.346)
School CSB eligible (year 1)		-0.296+		-0.075
		(0.170)		(0.242)
School CSB target eligible (year 1)		-0.534*		-0.143
		(0.261)		(0.433)
Teacher is male		0.270*		0.279
		(0.124)		(0.279)
Teacher is African American		-0.200		
		(0.476)		
Teacher is Hispanic		-0.398		0.815
		(0.378)		-1.969
Teacher is American Indian/Alaska Native		-1.081+		

		(0.643)		
Teacher is White		-0.412		0.111
		(0.309)		(1.211)
Teacher's age		-0.052**		-0.052**
		(0.016)		(0.016)
Teacher has master's degree (year 1)		-0.776**		-0.776**
		(0.252)		(0.252)
School % FRPL (year 1)		0.014**		0.019**
		(0.005)		(0.007)
School % special education (year 1)		-0.023		-0.030**
		(0.014)		(0.011)
School % African American (year 1)		-0.033***		-0.016
		(0.007)		(0.013)
School % Hispanic (year 1)		-0.002		-0.020*
		(0.004)		(0.010)
School % two or more races (year 1)		0.005		0.001
		(0.004)		(0.010)
Constant	11.67***	11.80***	11.93***	11.85***
	(0.285)	(0.432)	(0.446)	(1.115)
N	13,528	10,917	1,626	1,490
NBCTs	958	773	396	345

Notes:
Heteroskedasticity robust standard errors clustered by district in parentheses.
The omitted (baseline) ethnicity category is Asian.
The baseline estimate is the log-odds of the outcome of interest for the relevant sample estimated without any controls.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Retention of NBCTs and Non-NBCTs in Teaching Positions

We conducted survival analysis on two samples, Board-certified educators in various positions in the public education system and Board-certified educators specifically in teaching positions. Exhibit A12 shows our sample in teaching positions only, before and after we matched groups.

The unmatched columns in A12 include individuals in teaching positions specifically who entered Washington's public education system between 2002 and 2007 (non-NBCT sample = 6,483) and did or did not receive Board Certification between 2006 and 2013 (NBCT sample = 1,361). The matched sample reflects NBCTs and non-NBCTs matched on prior employment characteristics, teacher demographics, and school and district characteristics. After matching, our sample was reduced to 388 non-NBCTs and 388 NBCTs.

We matched NBCTs and non-NBCTs on a combination of other characteristics. We conducted survival analyses on different matched samples, which may be more or less representative of NBCTs in Washington (depending on matching characteristics), but our overall retention results were robust across all five models, including our smallest matched sample of 388 NBCTs and 388 non-NBCTs.

Exhibit A12

Descriptive Characteristics of NBCTs and Non-NBCTs in Teaching Positions Only (Before and After Matching)

Variable	Unmatched		Matched	
	Non-NBCT	NBCT	Non-NBCT	NBCT
% highest degree is an MA	0.379	0.503	0.420	0.420
% highest degree is a BA	0.613	0.489	0.580	0.580
% female	0.719	0.767	0.820	0.820
% African American	0.020	0.008	0.000	0.000
% Asian	0.040	0.043	0.003	0.003
% Hispanic	0.034	0.035	0.005	0.005
School enrollment (year 1)	790.9	836.2	795.4	765
% FRPL in school (year 1)	0.377	0.365	0.334	0.332
% teaching in WA (year 5)	0.571	0.849	0.876	0.920
% employment gap (year 5)	0.116	0.101	0.070	0.059
% exit (year 5)	0.265	0.029	0.005	0.005
% teaching in WA (year 7)	0.524	0.787	0.817	0.835
% employment gap (year 7)	0.096	0.092	0.049	0.046
% exit (year 7)	0.346	0.090	0.077	0.075
% teaching in WA (year 9)	0.494	0.723	0.732	0.745
% employment gap (year 9)	0.065	0.074	0.044	0.046
% exit (year 9)	0.414	0.162	0.173	0.162
% ever in leadership role	0.061	0.076	0.072	0.070
% Board Certification candidate (w/in three years)	0.029	0.472	0.031	0.559
% Board Certification candidate (w/in five years)	0.0447	0.642	0.0438	0.755
% Board Certification candidate (w/in four years)	0.0588	0.771	0.0466	0.858
% ever Board Certification candidate	0.0813	0.974	0.0928	0.977
% NBCT (w/in three years)	0.000	0.0022	0.000	0.000
% NBCT (w/in four years)	0.000	0.180	0.000	0.263
% NBCT (w/in five years)	0.000	0.420	0.000	0.539
% NBCT (w/in ten years)	0.000	0.925	0.000	0.987
% NBCT ever	0	1	0	1
% ever receive Board Certification bonus	0.000	0.901	0.000	0.992
Average bonus received in 2007	-	$3,500	-	$3,500
Average bonus received in 2009	-	$6,860	-	$6,803
% in CSB-eligible school (2007)	0.111	0.116	0.049	0.067
% in CSB-eligible school (2008)	0.110	0.120	0.064	0.085
% in CSB-eligible school (2009)	0.112	0.118	0.055	0.074
% in CSB-eligible school (2010)	0.106	0.114	0.054	0.070
% in CSB-eligible school (2011)	0.102	0.105	0.053	0.070
% in CSB-eligible school (2012)	0.102	0.099	0.058	0.064
% in CSB-eligible school (2013)	0.096	0.091	0.053	0.064
% in CSB-eligible school (2014)	0.089	0.079	0.047	0.059
% in CSB-eligible school (2015)	0.084	0.077	0.039	0.044
# of observations	6,483	1,361	388	388

In Exhibit A13, we report regression results for each model. We conducted this survival analysis on matched individuals specifically in teaching positions. Model 1 is our baseline model, which illustrates survival analysis on a sample of non-NBCT and NBCTs exactly matched on prior years of employment. Model 2 reports results on a sample of non-NBCTs and NBCTs matched on prior employment and teacher characteristics. Model 3 reports results on a sample of non-NBCTs and NBCTs matched of prior employment and district characteristics. Model 4 reports results on a sample of non-NBCTs and NBCTs matched on prior employment history and school characteristics. Model 5 reports results on a sample of non-NBCTs and NBCTs matched on all characteristics. We found that NBCTs were no more likely than non-NBCTs to remain in teaching positions and any observed differences were not statistically significant. Additionally, Results were similar across all matched samples.

Exhibit A13

Logistic Regression Estimates of National Board Certification Effect on Retention in Teaching Position (Among First-Year Teachers in 2002-2007)

Variable	Model 1 Baseline	2 Teacher characteristics	3 District characteristics	4 School characteristics	5 All
National Board	0.021	-0.007	-0.055	0.040	-0.074
	(0.097)	(0.135)	(0.091)	(0.114)	(0.128)
Matched variables					
Employment history	X	X	X	X	X
First year of employment	X	X	X	X	X
Demographics		X			X
Highest degree (year 1)		X			X
School level (year 1)		X			X
Years of experience		X			X
Assigned FTE		X			X
Certificate type		X			X
District employed (year 1)			X		X
School CSB eligible (year 1)			X	X	X
School characteristics (year 1)				X	
Regression covariates					
Year indicators	X	X	X	X	X
Year 1 indicators		X	X	X	X
Demographics	X	X	X	X	X
Highest degree (year 1)	X	X	X	X	X
School level (year 1)	X	X	X	X	X
School CSB eligible (year 1)	X	X	X	X	X
School characteristics (year 1)	X	X	X	X	X
NBCTs	821	472	821	515	341
Baseline (*p*)	0.965	0.965	0.966	0.965	0.963

Notes:
Heteroskedasticity robust standard errors clustered by district in parentheses.
The omitted (baseline) ethnicity category is Asian.
The baseline estimate is the log-odds of the outcome of interest for the relevant sample estimated without any controls.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Transfer into Leadership Positions

Exhibit A14 includes logistic regression results of our analysis examining the probability of matched NBCTs and non-NBCTs transferring from teaching to leadership positions at any point between 2002 and 2016. Columns 1-4 illustrate regression results based on the characteristics we matched NBCTs and non-NBCTs on and pre-treatment controls. We observed similar transfer rates between NBCTs and non-NBCTs and any observed differences were not statistically significant.

Exhibit A14

Logistic Regression Estimates of National Board Certification Effect on Ever Working in Leadership Positions from 2002 to 2016 (Among First-Year Teachers in 2002-2007)

Variable	Model 1 No covariates	2 Covariates included	3 No covariates	4 Covariates included
National Board	0.121	0.151	0.033	0.227
	(0.125)	(0.154)	(0.236)	(0.296)
Matched variables				
Employment history	X	X	X	X
First year of employment	X	X	X	X
Demographics			X	X
Highest degree (year 1)			X	X
School level (year 1)	X	X	X	X
Years of experience	X	X	X	X
Assigned FTE	X	X	X	X
Certificate type	X	X	X	X
District employed (year 1)	X	X	X	X
School CSB eligible (year 1)			X	X
School characteristics (year 1)				
Regression covariates				
Year indicators		X		X
Year 1 indicators		X		X
Demographics		X		X
Highest degree (year 1)		X		X
School level (year 1)		X		X
School CSB eligible (year 1)		X		X
School characteristics (year 1)		X		X
NBCTs	958	773	396	345
Baseline (p)	0.072	0.072	0.067	0.067

Notes:

Heteroskedasticity robust standard errors clustered by district in parentheses.

The omitted (baseline) ethnicity category is Asian.

The baseline estimate is the log-odds of the outcome of interest for the relevant sample estimated without any controls.

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Exhibit A15 includes logistic regression results of our analysis examining the probability of matched NBCTs and non-NBCTs transferring from teaching to leadership positions at any point between 2002 and 2016, disaggregated across the elementary, middle, and high school levels. Columns 1-6 illustrate regression results based on the characteristics on which we matched NBCTs and non-NBCTs and pre-treatment controls. NBCTs were no more likely than non-NBCTs to transfer into leadership positions in elementary, middle, or high school grades, and any observed differences were not statistically significant.

Exhibit A15

Logistic Regression Estimates of National Board Certification Effect on Ever Working in Leadership Positions from 2002 to 2016 (Among First-Year Teachers in 2002-2007): Heterogeneity in Effects by School Level (Elementary, Middle, and High School)

Variable	Elementary		Middle school		High school	
	(1)	(2)	(3)	(4)	(5)	(6)
National Board	0.295	0.588	0.300	-0.627	-0.048	0.434
	(0.281)	(0.462)	(0.355)	(0.730)	(0.249)	(0.621)
Matched variables						
Employment history	X	X	X	X	X	X
First year of employment	X	X	X	X	X	X
Demographics		X		X		X
Highest degree (year 1)		X		X		X
School level (year 1)	X	X	X	X	X	X
Years of experience	X	X	X	X	X	X
Assigned FTE	X	X	X	X	X	X
Certificate type	X	X	X	X	X	X
District employed (year 1)	X	X	X	X	X	X
School CSB eligible (year 1)		X		X		X
School characteristics (year 1)						
Regression covariates						
Year (continuous)	X	X	X	X	X	X
Year 1 (continuous)	X	X	X	X	X	X
Demographics	X	X	X	X	X	X
Highest degree (year 1)	X	X	X	X	X	X
School level (year 1)						
School CSB eligible (year 1)	X	X	X	X	X	X
School characteristics (year 1)	X	X	X	X	X	X
NBCTs	322	165	227	72	217	80
Baseline (*p*)	0.054	0.042	0.081	0.107	0.093	0.090

Notes:
Heteroskedasticity robust standard errors clustered by district in parentheses.
The omitted (baseline) ethnicity category is Asian.
The baseline estimate is the log-odds of the outcome of interest for the relevant sample estimated without any controls.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

III. Challenging Schools Bonus Analysis Methods and Results

Challenging Schools Bonus Program Evaluation: Methods and Limitations (Primary Analysis)

The Washington State Legislature also directed WSIPP to examine the question: has the Challenging Schools Bonus (CSB) "acted as an incentive for teachers to actually work in high-poverty schools?" We operationalized this request as follows:

Research Question

(1) Did the CSB program increase the percentage of teachers with National Board Certification that work in high-poverty schools?

Definitions

Financial Incentives for National Board-Certified Educators in Washington: Board-certified educators in Washington have received a base bonus since the 1999-00 school year. Initially, the Washington State Legislature established a 15% salary increase for certified educators,[69] and then fixed the bonus at $3,500 per year in 2000.[70] In 2007, the legislature increased the base bonus from $3,500 to $5,000 per year.[71] The legislature also created an additional incentive called the Challenging Schools Bonus (CSB),[72] which provided Board-certified educators working in qualifying high-poverty schools up to $5,000 per year on top of their base bonuses. The objective of the CSB was to increase the number of NBCTs in high-poverty schools.

Treatment Group: Schools in the treated group were those classified as ever being CSB-eligible schools (i.e., high-poverty schools). While true CSB eligibility varies for individual schools by year, we assigned a fixed eligibility indicator to schools using tiered eligibility criteria established in 2008[73] and pre-treatment data measured in 2006.[74]

Comparison Group: Schools in the comparison group were classified as CSB-ineligible schools (i.e., low-poverty schools) using 2008 eligibility criteria and pre-treatment data measured in 2006.

Empirical Method

We used a difference-in-differences (DID) approach to estimate the effect of the CSB program on the percentage of teachers with Board Certification working in high-poverty schools. Simply comparing the percentage of NBCTs in high-poverty schools before and after the CSB policy might not isolate the effect of the program and would potentially confound its effect with trends and policies that occurred at the same time and also influenced where NBCTs worked. For example, the number of teachers with Board Certification across all schools had been increasing steadily before 2007. A pre-post design would confound this trend along with the CSB program's true effect. Our DID approach estimated the post-policy *differential* increase (or decrease) in the percentage of teachers in high-poverty schools with Board

[69] Engrossed Substitute Senate Bill 5180, Chapter 309, Laws of 1999.
[70] Engrossed House Bill 2487, Chapter 1, Laws of 2000.
[71] Substitute House Bill 1128, Chapter 522, Laws of 2007.
[72] Ibid.
[73] Eligible schools in 2008 and later were schools with more than 30 enrolled students, elementary schools with 70% or more students eligible for FRPL, middle schools with 60% or more students eligible for FRPL, and high schools with 50% or more students eligible for FRPL.
[74] We used eligibility criteria based on pre-treatment data (FRPL and enrollment) measured in 2006 since schools were unable to manipulate their eligibility assignment at this point.

Certification, relative to any increase (or decrease) observed in the percentage of NBCTs in low-poverty schools.

Before 2007, NBCTs were underrepresented in high-poverty schools. The bonus may have acted as an incentive for teachers in high-poverty schools to pursue Board Certification—or for NBCTs in low-poverty schools to transfer to high-poverty schools. Our DID approach assumed that trends in the percentage of NBCTs in low-poverty and high-poverty schools would have been parallel absent the creation of the CSB. If the parallel trends assumption is valid, then a change in the difference in the percentage of NBCTs between low- and high-poverty schools coinciding with the start of the program is the unbiased effect of the CSB. Using Ordinary Least Squares regression, we estimated the following model:

$$PCT\_NB_{jk} = \alpha + \beta_1(HIGH_j) + \beta_2(POST_j) + \beta_3(HIGH_j \times POST_j) + X_{jk}\beta + \gamma_j + \omega_k + \epsilon_{jk}, \quad (3)$$

PCT_NB_{jk} = percentage of a schools' (*j*) teaching staff with National Board Certification in year *k*.
$HIGH_j$ = indicator that a school (*j*) was high-poverty and therefore CSB eligible.
$POST_j$ = indicator that school (*j*) present in 2007 and later (after the CSB program was created).
X_{jk} = vector of observed time-varying control variables.
γ_j = school fixed effects
ω_k = year fixed effects
ϵ_{jk} = error term

In equation 3, the coefficient on *HIGHxPOST* is our parameter of interest. It quantifies the change in the percentage of teachers in eligible schools that were Board-certified before and after the program's implementation minus the change in the percentage of NBCTs in ineligible schools over the same period. The vector X_{jk}includes school-level characteristics including student enrollment; race and ethnic makeup; the percentage of students in special education, in the Transitional Bilingual Instructional Program, and eligible for free-or reduced-priced lunch; teachers with master's degrees, and the average number of teachers and NBCTs. Additionally, the inclusion of school and year fixed effects isolates changes in *PCT_NB* within schools over time.

It is important to note that while a school's classification as high-poverty ($HIGH_j$) does not vary over time in equation (3), in reality, it can vary over time. We fixed eligibility for each school (*j*) by construction in order to estimate the program's intent-to-treat effect (ITT), which we believe is a less biased estimate of the program's effect.

In reality, school eligibility can vary over time as the percentage of a school's students eligible for FRPL changes from year to year. For example, a school defined as CSB eligible, and therefore high-poverty, in 2007 may not have been CSB eligible in 2008 (and vice-versa). It is possible that an indirect effect of implementing the CSB program incentivized schools to try to influence their high-poverty classification in 2008 and after. If this is true, the *PCT_NB* difference between high-poverty and low-poverty schools could increase (or decrease) separately from any underlying change in teacher staffing patterns and introduce bias to our estimated program effect.

Eligibility assignment during the CSB program's first year (2007) was based on FRPL and enrollment data collected in 2006. Because data before the program's implementation was used to determine eligibility in 2007, schools were unable to manipulate their eligibility status in the first year. We use this pre-treatment data and 2008 eligibility criteria (FRPL tiered by school level) to assign eligibility ($HIGH_j$) to schools observed in our data in 2007 and fix this assignment across all years (before and after the CSB program). By estimating the program's ITT effect, we can isolate the CSB's targeted mechanisms: (1) inducing more

teachers already employed in high-poverty schools to earn Board Certification and (2) inducing teachers with Board Certification—or who intended to earn certification—to teach in high-poverty schools.[75]

The DID estimator could be upward biased by the beginning of other policies that differentially made teaching more attractive for NBCTs after 2007. The ITT effect that we estimated is likely attenuated compared to the Average Treatment Effect on the Treated (ATT) that we would have estimated if we had used true CSB eligibility, which varied over time. In our ITT estimate, program effects on staffing within schools that were not high poverty in 2007, but were high poverty in 2008 and beyond are not captured. To some extent, the issue is definitional. If one defines the CSB effect of interest such that it includes a broader set of mechanisms, then the ITT will tend to be attenuated (biased toward zero) in comparison. A reason we preferred to estimate the ITT in this context is that estimates of the ATT would only be unbiased under implausible assumptions. The ITT can be estimated under weaker assumptions.

Parallel Trends Test

Our DID approach assumes that trends in the percentage of NBCTs in low-poverty and high-poverty schools would have been parallel absent the creation of the CSB. Other programs that directly or indirectly led to more NBCTs working in high-poverty schools (relative to low-poverty schools) would violate this assumption.

We cannot prove that outcome trends would be parallel in the absence of the CSB program because we cannot observe what would have happened if the program was not implemented. Instead, we conducted a test to determine if outcome trends moved in parallel before the program was created in 2007. We then extrapolate these findings to a counterfactual setting after the program was created. Similarly, if trends in low-and high-poverty schools diverge before the CSB program was implemented, then other factors may have existed that caused these groups to differ in ways that could be unrelated to the CSB program's implementation. In that case, our estimated effect may not reflect the true program effect.

We conducted a test for parallel trends by comparing the trend in the percentage of teachers with Board Certification in CSB-eligible and -ineligible schools prior to the program's implementation. We ran a regression model including interactions between our treatment variable and pre-period time dummies. We observed a significant difference between the two groups in 2003 (p-value < 0.05), indicating differing trends in this year. However, we observed non-significant differences in 2004, 2005, and 2006, which suggests that trends between the two groups were parallel in the years immediately leading up to the creation of the CSB program. We assume that this trend would have persisted into pre-treatment years in the absence of the program.

Data

Educator-level employment data from 1996-2017 were obtained from the Office of the Superintendent of Public Instruction's (OSPI) S-275 data files. Each year of data was a separate file that contained a snapshot of public school educator and administrator characteristics for a particular school year. We tracked individual teachers over time using their unique teacher certification number. To identify Board-certified teachers, we combined S-275 data with individual-level data provided by the National Board for Professional Teaching Standards. This data included information on when teachers applied for candidacy

[75] To illustrate the value of our approach, consider the possibility that the recession led many more schools to become high-poverty schools in the post-CSB period. In this case, simply by changing the poverty labels of schools, the high/low-poverty gap in *NB_PCT* could be significantly reduced without changing the underlying distribution of Board-certified teachers across schools. That is, the estimated effect of the policy could be large even if no new teachers in high-poverty schools earned Board Certification, no new Board-certified teachers were hired from out of state into high-poverty schools, and no Board-certified teachers from low-poverty schools changed where they were teaching at all.

and earned their certificates. OSPI also provided us with educator-level bonus information and school-level eligibility for the Challenging Schools Bonus. We also incorporated school-level demographics from OSPI's report card data files.

CSB Program Evaluation: Results (Primary Analysis)

Exhibit A16 depicts the average characteristics of CSB-eligible and -ineligible schools before and after the CSB program was created in 2007. Eligible schools in the pre-period are those that would have been eligible in the post-period, based on our fixed definition of eligibility.

Exhibit A16

Descriptive Characteristics of CSB-Eligible and CSB-Ineligible Schools, Before and After Program Implementation (WSIPP-Designed Eligibility Criteria)

School-level characteristics	Eligible	Ineligible	Eligible	Ineligible
Enrollment (average)	465	553	469	552
% female	48%	48%	48%	48%
% African American	9%	5%	7%	5%
% Asian	1%	1%	5%	7%
% Hispanic	36%	9%	45%	14%
% American Indian/Alaska Native	9%	3%	8%	2%
% White	38%	75%	30%	65%
% other race/ethnicity	6%	6%	10%	14%
% FRPL	73%	34%	80%	41%
% Special Education	13%	12%	14%	14%
% English language learners	20%	5%	23%	7%
% teachers w/ master's degree	56%	58%	61%	66%
# teachers (average)	20	23	21	24
# NBCTs (average)	0.1	0.2	1.9	1.9
# of observations	1,333	8,339	2,278	14,397

Exhibit A17 illustrates our regression results from a difference-in-differences approach. The creation of the CSB program differentially increased the percentage of teachers in high-poverty (CSB-eligible) schools with Board Certification by 1.2 percentage points, relative to low-poverty (CSB ineligible) schools. Models 1 and 2 illustrate results with and without school-level covariates. Results are similar across models and robust to the inclusion of school-level and time-varying covariates.

Exhibit A17

Difference-in-Differences Analysis Results

Variable	Model 1			Model 2		
	Coefficient	SE	Sig.	Coefficient	SE	Sig.
CSB eligible x post	1.25	(0.512)	*	1.15	(0.398)	**
2002	-1.82	(0.125)	***			
2003	-1.57	(0.127)	***			
2004	-1.43	(0.117)	***	-0.40	(0.099)	***
2005	-1.04	(0.105)	***	-0.40	(0.086)	***
2006	-0.51	(0.089)	***			
2008	0.38	(0.125)	**	0.27	(0.132)	*
2009	1.64	(0.156)	***	0.77	(0.142)	***
2010	3.61	(0.208)	***	1.51	(0.174)	***
2011	5.25	(0.237)	***	1.93	(0.218)	***
2012	6.52	(0.255)	***	2.41	(0.248)	***
2013	6.84	(0.250)	***	2.40	(0.256)	***
2014	7.10	(0.253)	***	2.40	(0.269)	***
2015	7.48	(0.259)	***	2.40	(0.290)	***
2016	7.25	(0.260)	***	2.18	(0.298)	***
2017	6.61	(0.263)	***	1.94	(0.304)	***
Enrollment				0.002	(0.001)	
% female				0.003	(0.022)	
% African American				0.004	(0.020)	
% Asian				-0.04	(0.013)	**
% Hispanic				0.002	(0.023)	
% American Indian/Alaska Native				-0.02	(0.030)	
% White				0.04	(0.017)	*
% other race/ethnicity				0.03	(0.017)	
% FRPL				-0.01	(0.008)	
% Special Education				0.04	(0.018)	*
% English language learners				0.06	(0.011)	***
% teachers w/master's degree				0.01	(0.006)	
# teachers (average)				-0.24	(0.020)	***
# NBCTs (average)				2.54	(0.093)	***
constant	1.93	(0.126)	***	0.93	(1.985)	
# of schools	1,764			1,547		
# of observations	26,347			19,427		

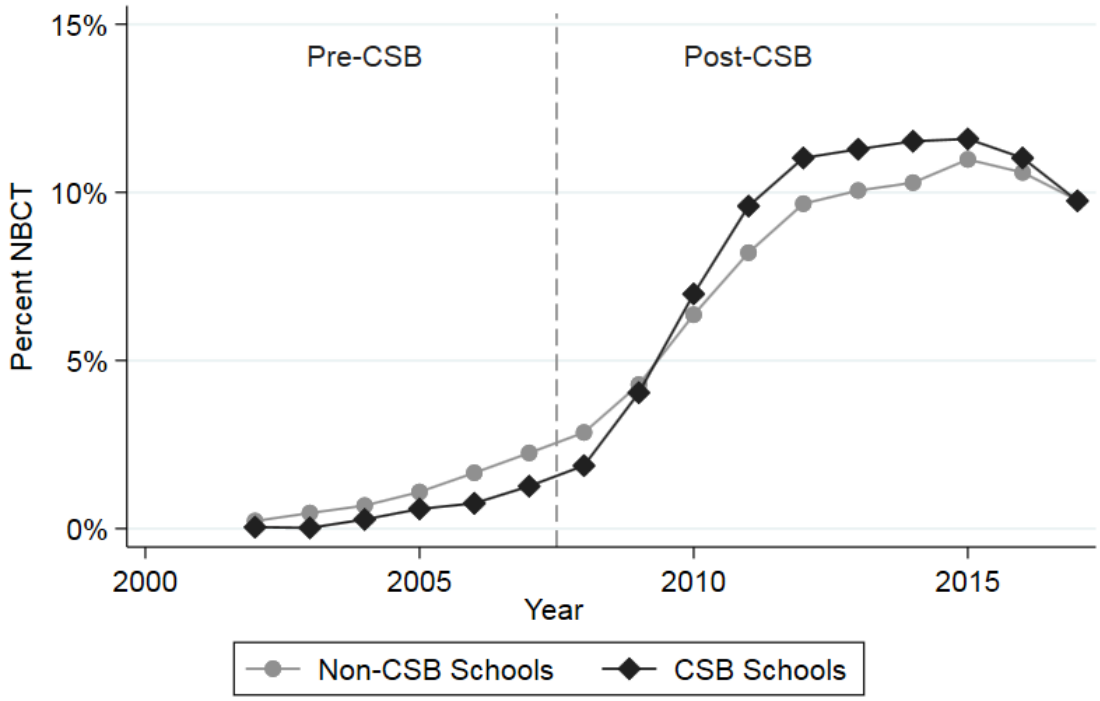
Notes:

Heteroscedasticity robust standard errors clustered by school in parentheses.

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Exhibit A18

Percentage of Teachers with Board Certification in Low- and High-Poverty Schools by Year



CSB Program Evaluation: Methods and Limitations (Secondary Analysis)

The increase in NBCTs in CSB schools is clear, but our previous analysis did not show whether the increase was reflective of a change in the *quality* of teachers in CSB schools due to the migration of NBCTs from low- to high-poverty schools or because of the *identification* of effective teachers in CSB schools due to an increase in teachers becoming certified that were already in high-poverty schools. This distinction follows from the signaling/human capital distinction in our meta-analytic results. The meta-analyses indicated that the Board Certification process did not make teachers more effective; the process identified teachers who were already more effective. Consequently, in order for the CSB program to improve teacher quality in CSB schools, it must affect *where* or *whether* NBCTs choose to teach, and not simply whether effective teachers certify.

Research Question 2b

(2) To what extent is the growth in NBCTs in CSB-eligible schools attributable to an increase in National Board Certification among teachers who were already teaching in eligible schools?

To address this secondary research question, we deconstructed the overall growth in NBCTs into its component parts. Exhibit A19 illustrates this deconstruction and the potential margins for growth. The categories in Exhibit A19 are mutually exclusive and collectively exhaustive. Every teacher in every year fell into one of five categories:

1) Non-CSB and non-NBCT (teaching more than half-time)
2) Non-CSB and NBCT (teaching more than half-time)
3) CSB and non-NBCT (teaching more than half-time)

4) CSB and NBCT (teaching more than half-time)
5) Not teaching more than half-time in the WA public school system

Comparing teacher status at any two points in time, every teacher falls into one of 25 possible categories. Exhibit A19 illustrates two time points—2006 and 2012—for demonstration, but one could compare transitions from any two years. We use the matrix in Exhibit A19 to categorize all teachers ever tracked in OSPI's S-275 personnel data files. The categories listed above correspond to the column and row numbers. For our analysis, we are most interested in column (4), shown in green.

For example, a non-NBCT who was working in a non-CSB school in 2006 falls into category (1). In 2012, if the same teacher completed Board Certification and switched into a CSB school, they would be in category (4). In Exhibit A19, we categorized this transition as cell 14 (read from left to right as row 1, column 4).

Exhibit A19

Potential Within-and Between-School Transfers Among Teachers from 2006 to 2012

		2012				
		Non-CSB, non-NBCT (1)	**Non-CSB, NBCT (2)**	**CSB, non-NBCT (3)**	**CSB NBCT (4)**	**Non-teacher (5)**
2006	**Non-CSB, non-NBCT (1)**	(11)	(12)	(13)	Certify & transfer-in (14)	(15)
	Non-CSB, NBCT (2)	(21)	(22)	(23)	Already NBCT transfer-in (24)	(25)
	CSB, non-NBCT (3)	(31)	(32)	(33)	Certify & no transfer (34)	(35)
	CSB NBCT (4)	(41)	(42)	(43)	Already NBCT retained (44)	(45)
	Non-teacher (5)	(51)	(52)	(53)	Already NBCT new teacher (54)	(55)

Aggregating Individual Teacher Classifications by CSB-Eligible and -Ineligible Schools

We also aggregated the results for each school type (i.e., CSB-eligible and -ineligible). Continuing with the same matrix as before, some cells have zero teachers. All CSB teachers in 2012 fall into a cell in column (3) or column (4) in Exhibit A20. All non-CSB teachers in 2012 fall into column (1) or column (2) in Exhibit A21. For CSB teachers in 2012 (Exhibit A19), none will be non-teachers, and none will be currently also teaching at a non-CSB school. By construction, teachers could only be assigned to one school per year using our definition of "teacher," which requires greater than 0.5 FTE).

Exhibit A20

CSB Percentage of Teachers by Cell in 2012

		2012				
		Non-CSB, non-NBCT (1)	Non-CSB, NBCT (2)	CSB, non-NBCT (3)	CSB NBCT (4)	Non-teacher (5)
2006	Non-CSB, non-NBCT (1)	0%	0%	Non-NBCT transfer-in %	New cert transfer-in %	0%
	Non-CSB, NBCT (2)	0%	0%	Cert expire transfer-in %	NBCT transfer-in %	0%
	CSB, non-NBCT (3)	0%	0%	Non-NBCT retained %	New cert retained %	0%
	CSB NBCT (4)	0%	0%	Cert expire retained %	NBCT retained %	0%
	Non-teacher (5)	0%	0%	Non-NBCT new hire %	NBCT new hire %	0%

Exhibit A21

Non-CSB Percentage of Teachers by Cell in 2012

		2012				
		Non-CSB, non-NBCT (1)	Non-CSB, NBCT (2)	CSB, non-NBCT (3)	CSB NBCT (4)	Non-teacher (5)
2006	Non-CSB, non-NBCT (1)	Non-NBCT retained %	New cert retained %	0%	0%	0%
	Non-CSB, NBCT (2)	Cert expire retained %	NBCT retained %	0%	0%	0%
	CSB, non-NBCT (3)	Non-NBCT transfer-in %	New cert transfer-In %	0%	0%	0%
	CSB NBCT (4)	Cert expire transfer-in %	NBCT transfer-In %	0%	0%	0%
	Non-teacher (5)	Non-NBCT New hire %	NBCT New hire %	0%	0%	0%

Each shaded cell in Exhibit A20 has an analogous cell in Exhibit A21. For example, cell 24 in Exhibit A20 captures the percentage of a school's teaching staff in 2012 that was "NBCT transfer-in." These are NBCTs who taught at non-CSB schools in 2006, remained NBCTs as of 2012, and switched from a non-CSB school to a CSB school as of 2012.[76] The analogous cell in Exhibit A21 is 42. These are NBCTs that transferred from CSBs to non-CSBs.

Comparing the percentage of teachers in cell 24 for CSB schools to the percentage of teachers in cell 42 for non-CSB schools is how we began to deconstruct the overall change in the percentage of NBCTs in CSB schools into its component parts. The comparisons of interest are (Exhibit A22):

Exhibit A22

Estimated Margins-of-Growth in Deconstructed Analyses

Margin of interest	Non-CSB cell	CSB cell	Does differential growth after 2007 indicate a real change in the distribution of effective teachers?
Non-NBCTs induced to certify	12	34	**No.** This growth is within schools. It is simply the identification of teachers who were already effective.
Retention of NBCTs	22	44	**Yes.** If the CSB program differentially increases retention of NBCTs in CSB schools, then, all else equal, CSB schools would have more highly effective teachers than they would have in the absence of the program.
Non-NBCT transfers and completes certification process	32	14	**Unclear.** Because highly effective teachers have a greater incentive to certify at CSB schools, we cannot disentangle whether more effective teachers were differentially induced to transfer or equally effective teachers responded to the differential incentive for certifying.
NBCT transfers	42	24	**Yes.** For teachers who were NBCTs before the differential incentives for certification began, a change in transfer rates between CSB and non-CSB schools is indicative of a change in the distribution of highly effective teachers between CSB and non-CSB schools.
Newly hired teacher is NBCT	52	54	**Unclear.** If the newly hired teacher was certified before hiring, then yes. Otherwise, because highly effective teachers have a greater incentive to certify at CSB schools, we cannot disentangle whether equally effective teachers were differentially induced to certify or if more effective teachers began their careers at CSB schools.

Recall that in our previous DID regression, we essentially used the *sum* of the cells in column (2) as the dependent variable for non-CSB schools and the sum of the cells in column (4) as the dependent variable for CSB schools. The underlying logic of proceeding cell by cell is the same. Rather than comparing the change between non-CSB and CSB schools in the sum of many cells, we conducted DID one cell at a time. Using the same definitions and assumptions as before, we estimate the following model using OLS regression:

$$PCT\_CELL_{jk} = \alpha + \beta_1(HIGH_j) + \beta_2(POST_{jk}) + \beta_3(HIGH_j x POST_{jk}) + X_{jk}\beta + \gamma_j + \omega_k + \epsilon_{jk}, \quad (4)$$

[76] Where "switched" is determined using only the two time points. A teacher who switched from non-CSB to CSB after 2006 but switched back to non-CSB before 2012 would not be classified as switching.

PCT_CELL_{jk} = the percentage of a school's *(j)* teaching staff belonging to a given cell in year *k*. Cell numbers for non-CSB and CSB schools are different, but we use a cell that corresponds to an analogous percent.

Final Categories and Rules for Assigning Teachers to Categories

Using 2006 as our fixed pre-program baseline year, we compared changes in the composition of the teaching patterns in CSB and non-CSB schools over time. In the exhibits below, 2007 reflects information from the 2006/2007 transition matrix, 2008 reflects information from the 2007/2008 transition matrix and so on.

Our preferred approach was to assign teachers to categories using a modified version of the transition matrix in Exhibit A19. The categories for the post-2006 period are the same, but we make a few adjustments for the baseline year 2006. First, we include teachers who taught in Washington before 2006 in the 2006 baseline group. An NBCT who taught in a non-CSB in 2005, did not teach at all in 2006, and taught in a non-CSB in 2007 would be classified as a "2006 NBCT non-CSB." Essentially, we redefined 2006 as teacher status in 2006 *or* the most recent year of teaching prior to 2006, for teachers who did not teach in 2006. Consequently, non-teachers in 2006 are teachers who never taught in Washington between 1996 and 2006. Second, we classified National Board Candidates in 2006 or before as NBCTs. The assumption underlying this decision is that teachers who were candidates before 2007 and later certified would have become NBCTs even in the absence of the CSB program. If the decision to certify preceded the CSB policy, we do not have to be concerned about the CSB program differentially inducing highly effective teachers to certify.

CSB Program Evaluation: Results (Secondary Analysis)

Non-NBCTs Induced to Complete Certification Process

Exhibit A23 shows results of our difference-in-differences analysis examining the percentage of teachers who were non-NBCT in 2006, NBCT in the year indicated, and did not switch between CSB and non-CSB. The increases in CSB and non-CSB schools were similar overall, but somewhat higher for CSB schools from 2009-2012. The regression estimate of the overall DID was 0.2 percentage points, which was not statistically significant. We conclude that inducing teachers to become NBCTs was a strong driver of the overall growth in NBCTs across Washington State, but it was not a key driver of the differential NBCT growth in CSB-eligible schools.

Exhibit A23

Regression Results from DID Analysis: Non-NBCTs in 2006 Remained in CSB-Eligible and Ineligible Schools and Certified after 2007

Variable	Coefficient	SE
CSB eligible x post	0.002	(0.003)
2008	0.001	(0.000)
2009	0.011	(0.001)
2010	0.028	(0.001)
2011	0.041	(0.002)
2012	0.047	(0.002)
2013	0.048	(0.002)
2014	0.047	(0.002)
2015	0.047	(0.002)
2016	0.044	(0.002)
Constant	0.000	(0.001)
# of schools	2,340	
# of observations	20,731	

Notes:
Heteroscedasticity robust standard errors clustered by school in parentheses.
$+ p < 0.10$, $^{*} p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$

Retention of NBCTs

Exhibit A24 shows that the percentage of NBCTs in 2006 that were retained was similar at CSB and non-CSB schools. An increase in retention among NBCTs in high-poverty schools, relative to NBCTs in low-poverty schools, would indicate an increase in the overall composition of teacher effectiveness in high-poverty schools. However, we found that NBCTs remained working in CSB-eligible and ineligible schools at similar rates before and after the CSB program was created. The regression estimate was -0.2 percentage points, which was not statistically significant (see Exhibit A25). These retention results were not a driver of the CSB program's effect on NBCTs in high-poverty schools.

Exhibit A24

Probability of NBCTs Remaining in CSB-Eligible and Ineligible Schools Over Time

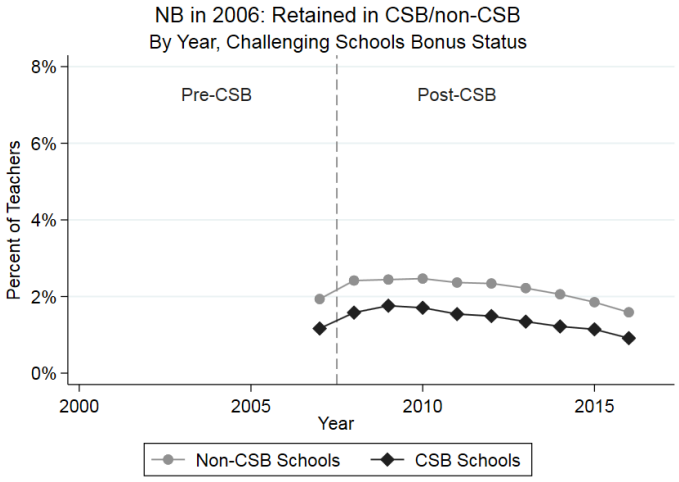


Exhibit A25

Regression Results from DID Analysis: NBCT Retention in CSB-Eligible and Ineligible Schools

Variable	Coefficient	SE
CSB eligible x post	-0.002	(0.002)
2008	0.004	(0.001)
2009	0.004	(0.001)
2010	0.004	(0.001)
2011	0.003	(0.001)
2012	0.003	(0.001)
2013	0.002	(0.001)
2014	0.000	(0.001)
2015	-0.002	(0.001)
2016	-0.004	(0.001)
Constant	0.018	(0.001)
# of schools	2,340	
# of observations	20,731	

Notes:
Heteroscedasticity robust standard errors clustered by school in parentheses.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Non-NBCT Transfers and Completes Certification Process

Exhibit A26 shows results of our difference-in-differences analysis on teachers who were non-NBCT in 2006, switched between CSB and non-CSB, and became NBCTs *after* 2006. The regression estimate was 0.6 percentage points, which was statistically significant ($p < .001$). This margin was a substantial driver of the increase in the percentage of NBCTs in CSB schools. It is important to note that this margin *may* capture more effective teachers choosing to teach in CSB schools, but we cannot rule out the role of equally effective teachers being differentially induced to certify.

Essentially, this analysis cannot distinguish between two phenomena:

a) Highly effective non-NBCTs become more likely to transfer to CSB schools, but whether they certify is not differentially affected by the CSB policy, and
b) Highly effective non-NBCTs are no more likely to transfer to CSB schools, but whether they certify is differentially affected by the CSB policy.

If (a) occurred, the result would be an increase in the percentage of highly effective teachers at CSB schools. If (b) occurred, the result would not be an increase in the percentage of highly effective teachers at CSB schools. In reality, *both* (a) and (b) could be true to some extent. Furthermore, it's possible that highly effective teachers became more likely to transfer *and* became more likely to certify once they transferred. It is not strictly an either/or story. However, the DID estimate cannot distinguish between (a) and (b). We can say with confidence that about half of the increase in the percentage of NBCTs in CSB schools compared to non-CSB schools was attributable to non-NBCTs transferring and certifying, but we cannot conclude whether that change represents an increase in overall teacher effectiveness at CSB schools.

Exhibit A26

Regression Results from DID Analysis: Non-NBCTs in 2006, Transfer into CSB-Eligible and Ineligible Schools After 2007 and Certify.

Variable	Coefficient	SE
CSB eligible x post	0.006***	(0.001)
2008	-0.001	(0.000)
2009	0.000	(0.000)
2010	0.000	(0.000)
2011	0.001	(0.000)
2012	0.002	(0.000)
2013	0.002	(0.000)
2014	0.002	(0.000)
2015	0.003	(0.000)
2016	0.003	(0.000)
Constant	0.000	(0.000)
# of schools	2,340	
# of observations	20,731	

Notes:
Heteroscedasticity robust standard errors clustered by school in parentheses.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

NBCT Transfers

Exhibit A27 shows results from our difference-in-differences analysis on teachers who were NBCTs in 2006 and had switched between teaching in a CSB and non-CSB school. We found that the percentage of NBCTs that transferred into CSB-eligible schools was higher than in CSB-ineligible schools. The regression estimate was 0.2 percentage points, which was statistically significant, but not large. This movement of NBCTs into high-poverty schools should increase teacher effectiveness in CSB-eligible schools. The effect we estimated was small and statistically different, but it was not the major driver of the CSB program's effect.

Exhibit A27

Regression Results from DID Analysis: NBCTs in 2006
Transfer Between CSB-Eligible and Ineligible Schools after 2007

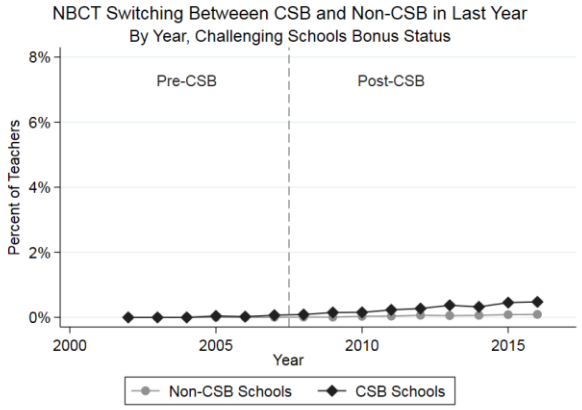
Variable	Coefficient	SE
CSB eligible x post	0.002*	(0.001)
2008	0.000	(0.000)
2009	0.000	(0.000)
2010	0.000	(0.000)
2011	0.000	(0.000)
2012	0.000	(0.000)
2013	0.000	(0.000)
2014	0.000	(0.000)
2015	0.000	(0.000)
2016	0.000	(0.000)
Constant	0.000	(0.000)
# of schools	2,340	
# of observations	20,731	

Notes:
Heteroscedasticity robust standard errors clustered by school in parentheses.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note that the approach above does not capture NBCT transfers among teachers who completed their certification after 2006. A fundamentally different approach (Exhibit A28, below) uses teacher NBCT status in the previous year (i.e., a shifting baseline year). In this approach, we conditioned on a variable that could be affected by the existence of the CSB program (teacher NBCT status in years after 2007). Nevertheless, given that the program differentially increased certification in CSB schools, if one held everything else constant and simply increased the NBCT rates at CSB schools, conditioning on NBCT status would tend to underestimate the differential effect. The regression estimate of 0.2 percentage points was statistically significant, which we consider a downward biased estimate of the effect of interest. Overall, we conclude that the program increased the annual rate of NBCT transfer from non-CSB to CSB schools by at least 0.2 percentage points. Note that using an annual rate also potentially underestimates the effect in another way; NBCTs who transfer likely remain for more than one year, which is not captured in the annual rate.

Exhibit A28

Probability of NBCTs Transferring Between CSB-Eligible and CSB-Ineligible Schools over Time



Newly Hired Teacher is NBCT

Exhibit A29 shows results from our analysis on teachers who were or later became NBCTs, were never employed in public education in Washington before 2006, and were hired at CSB schools after 2007. The regression estimate was 0.4 percentage points, statistically significant at the 10% level. It is noteworthy that the increase in NBCTs occurred several years after 2006, which suggests that Exhibit A29 and A30 is capturing the effect of new non-NBCTs being hired at CSB schools, teaching for several years, and *then* certifying. It does not appear to be driven by already-NBCTs from outside the Washington State teacher labor market being hired.

Exhibit A29

Regression Results from DID Analysis: Not a Public School Teacher in Washington in 2006, Hired at CSB-Eligible and Ineligible Schools After 2007 and Certify

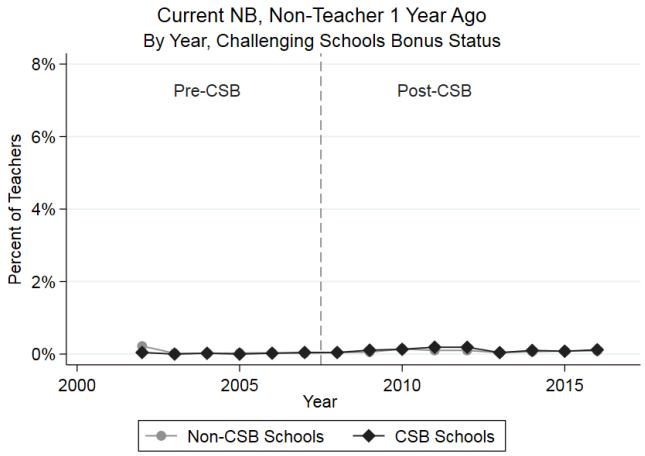
Variable	Coefficient	SE
CSB eligible x post	0.004*	(0.002)
2008	0.000	(0.000)
2009	0.001	(0.000)
2010	0.003	(0.000)
2011	0.008	(0.001)
2012	0.013	(0.000)
2013	0.016	(0.001)
2014	0.021	(0.001)
2015	0.028	(0.001)
2016	0.029	(0.001)
Constant	0.000	(0.000)
# of schools	2,340	
# of observations	20,731	

Notes:
Heteroscedasticity robust standard errors clustered by school in parentheses.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A more detailed analysis of whether new-to-WA NBCTs began differentially choosing to work at CSB schools uses NBCT status in the previous year as the baseline. In this case, the regression estimate was 0.04 percentage points, which was not statistically significant. Again, the effect on the percentage of teachers who are NBCTs in CSB schools is likely greater than 0.04 percentage points if NBCTs tend to remain for more than one year. The coefficient of 0.04 is the effect of the CSB program in the percentage of teachers who were brand new to the Washington State public education workforce and already NBCTs in CSB schools. In combination, though, it does not appear that differential hiring of already NBCTs who were previously not teaching in Washington was a substantial contributor to the growth of NBCTs in CSB schools.

Exhibit A30

Probability of Newly Hired Teachers at CSB-Eligible and CSB-Ineligible Schools Over Time Who Were or Later Became Board Certified



Acknowledgements

The authors would like to thank the staff at the Office of Superintendent for Public Instruction and the National Board for Professional Teaching Standards for providing the data and background information needed to conduct analyses in this report. We would also like to thank our WSIPP colleagues for their helpful comments and guidance on our research designs and analyses.

For further information, contact: Julia Cramer
Name at 360.664.9073, julia.cramer@wsipp.wa.gov

Document No. 18-12-2201