Teacher Testing Standards and the New Teacher Pipeline*

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Abstract

We examine the impact of changes in teacher testing standards on the new teacher pipeline by exploiting a quasi-experimental change in the minimum passing score required for admission into teacher training programs. Using institution-level data, we find that higher testing standards sharply reduce enrollments and graduations and that the effects are concentrated in academically weaker institutions. This suggests that testing standards were set inefficiently high if the goal of entry standards is to screen out students who would not have graduated. According to our estimates, the average increase in testing standards accounts for one-fifth of recent declines in new teacher graduations and more than half of the decline in the states that saw the largest increase in entry standards.

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1 Introduction

Testing is ubiquitous. Before gaining the right to practice, prospective doctors and lawyers must pass licensing exams. Firms sometimes ask job applicants to take skills tests prior to being hired. In the context of US undergraduate programs, admissions committees with incomplete information about student ability use Scholastic Aptitude Test (SAT) or American College Test (ACT) scores to screen out applicants whom they believe would be unlikely to graduate. Regardless of the setting, the goal of an entry test is to decrease the likelihood of admitting an applicant who will not be successful (i.e., reduce type I error). However, since testing is imperfect, an increase in entry standards may also increase the likelihood of rejecting applicants who would have otherwise been successful (i.e., increase type II error).[1] An efficient increase in entry testing standards reduces type I error with little or no increase in type II error (Declercq and Verboven, 2018). In contrast, an inefficient increase in standards may either fail to remove from the pool those who would not succeed, or weed out applicants who would have succeeded. Despite the widespread use of testing, there is limited empirical evidence on its efficiency as a screen. Indeed, given that testing standards can be adjusted endogenously in response to market conditions, it is not easy to causally identify the impact of testing standards.

In this paper, we investigate the effects of testing standards with a focus on their efficiency as a screen. Our setting is the US teaching profession, one of the nation's largest occupations, and one in which state governments require potential teachers to pass a variety of tests at various stages along the new teacher pipeline, including entry into university teacher preparation programs. We take advantage of a unique quasi-experiment that provides exogenous variation in difficulty of entry testing standards for potential teachers, namely the replacement of the Educational Testing Service's (ETS) Pre-Professional Skills Test (PPST) with the Praxis Core.[2] The PPST and the Praxis Core are a series of tests that prospective teachers in many states must pass prior to admission into university teacher preparation programs. The two tests cover the same subjects (basic

[1] Additionally, in a world of imperfect information about performance on an entry test, an increase in entry standards may discourage an otherwise successful candidate from applying. See Guasch and Weiss (1981).

[2] The PPST and Praxis Core are sometimes known as the Praxis I exams.

reading, writing, and mathematics) and are similar in terms of topics, length, and structure. Under the PPST, the minimum passing scores set by each state varied widely. Because the Praxis Core was scaled differently than the PPST, new passing scores had to be set with limited information about the difficulty of the new test. To facilitate this, the ETS organized a multi-state standard-setting panel to determine recommending passing scores for the new exam, which were adopted by every state but one. Thus, replacement of the PPST with the Praxis Core simultaneously raised entry standards by a large amount in some states, a small amount in others, and even lowered them in five states. We argue that the extent to which the replacement of the PPST with the Praxis Core changed the difficulty of the entry standards in each state should be uncorrelated with factors that affected the demand and supply of teachers, given that almost every state adopted the same passing score in spite of vastly different standards under the PPST and different conditions in each state.

To investigate the efficiency of testing as a screen, we examine institution-level data on education major enrollments as well as graduations from university teacher training programs. Holding constant graduation standards, an increase in testing standards is efficient if enrollments in education programs decrease but graduations remain unchanged. This is because the new standard simply weeds out students who would have been unable to complete the program. On the other hand, if an increase in testing standards reduces both enrollments and graduations, the increase in standards is inefficient since this implies that the increase in testing standards removes candidates from the pool who would have otherwise been able to complete the program.[3]

Using institution-level data on education major enrollments and graduations from college and university teacher training programs in the 21 states plus the District of Columbia that replaced the

[3] An advantage of our setting is the fact that many education programs operate under state-mandated exit requirements as well. Specifically, in addition to entry exams, teachers must pass standardized exit exams. The key point of our efficiency argument lies in the distinct roles of entrance and exit exams. An entrance exam, in its most efficient form, aims to moderate the number of enrollments by ensuring that incoming students possess the baseline skills necessary to complete the program. In contrast, the exit exam is designed to control the number of graduates, measuring the successful attainment of the specific skills and knowledge imparted by the program. This distinctive function of entrance tests—regulating enrollments rather than graduations—sits at the heart of our argument regarding their efficiency. In essence, entrance exams should not exclude those with the potential to succeed in the program and pass the exit exams. Instead, they serve as a preliminary filter for program readiness. This is in contrast with settings where exit standards may endogenously increase with increases in entry standards, arising, for instance, if a program or state is actively trying to improve the caliber of its graduates.

PPST with the Praxis Core, we estimate the impact of the change in entry testing standards. We find that higher testing standards induce an economically significant reduction in the number of people entering teacher preparation programs. Two-way fixed effect estimates indicate that a one-standard deviation increase in testing difficulty decreases enrollment in education programs by 23 percent. Our findings also suggest that this increase in testing standards was inefficient as graduations from teacher training programs decreased by as much as enrollments. Using an event-study approach, we estimate that the increase in standards in 2013 reduced enrollments in education majors instantaneously and reduced graduations from teacher preparation programs with a lag of two years. The timing of these effects is consistent with the fact that prospective teachers typically take these entry exams during their sophomore or junior years. The fact that our pre-trends are small and statistically indistinguishable from zero increases our confidence that the change in testing standards was orthogonal to underlying trends in teacher program enrollment. We document that the impact of higher testing standards is concentrated in institutions with academically weaker students and in states with a growing demand for new teachers. Finally, we also show that the increase in testing standards led to a reduction in the number of new teacher licenses awarded by state governments.

We contribute to the literature on teacher licensing requirements. Much of this literature examines the impact of exit tests (i.e., tests taken after teacher preparation program completion but prior to certification, for instance, the Praxis II tests) on student performance (e.g., Buddin and Zamarro, 2009; Clotfelter et al., 2010; Goldhaber, 2007; Goldhaber and Hansen, 2010; Goldhaber et al., 2017; Chen et al., 2023).[4] While the evidence is mixed, many of these studies find that teachers with higher exit test scores improve students' performance in math. Overall, teacher evaluations appear to raise teacher quality by increasing attrition among low-performing teachers. To the best of our knowledge, Chung and Zou (2023) are the first to use state-level variation in licensing stringency to examine the impact of licensing requirements on the number of graduates from teacher preparation programs, a measure of the pipeline of new teachers. They find that higher exit stan-

[4] A related literature examines the impact of alternative teacher certification pathways on student achievement (Decker et al., 2012; Jacob and Lefgren, 2004; Kane et al., 2008; Sass, 2015). In most states teachers obtaining alternative certifications must pass the required exams but are exempt from the coursework that is taken in conventional teacher preparation programs.

dards arising from the adoption of edTPA (a portfolio-based teacher evaluation system that some states require for education program completion) reduce the number of graduates.

There is a small literature that examines teacher preparation entry tests (i.e., the PPST), but these papers focus on the effect of testing standards on teacher quality. Angrist and Guryan (2008) find that requiring teachers to take the PPST raises teacher wages, but has no impact on metrics of teacher input quality (e.g., teacher SAT scores). Larsen et al. (2020) incorporate the PPST exams into a broader index of licensing stringency and find that stricter licensing requirements may be effective in screening out less qualified candidates from the teaching profession (where quality is measured by the selectivity of a candidate's undergraduate institution). Shuls (2018) documents that teachers who pass the PPST did not raise student test scores relative to teachers who failed but were still permitted to teach within the state Arkansas.

Our findings also contribute to the growing literature on the consequences of occupational licensing laws on labor markets (e.g., Kleiner, 2006, 2013; Kleiner and Krueger, 2010). Much of this literature looks at the impacts of changing licensing standards on wages (e.g., Law and Marks, 2017; Gittleman et al., 2018; Kleiner and Krueger, 2013; Thornton and Timmons, 2013). Other studies analyze the impacts of licensing laws on participation and sometimes find that tougher licensing requirements reduce participation in regulated occupations (e.g., Pagliero, 2010; Barrios, 2022; Blair and Chung, 2019; Law and Marks, 2009; Law and Kim, 2005). These papers focus on testing, training and fee regulations that apply before gaining the right to practice (but after formal training has ended). In contrast we examine requirements that are imposed before formal training begins. Accordingly, our focus is on a salient requirement that affects an earlier segment of the new practitioner pipeline. While many occupational licensing regimes require prospective practitioners to pass a test or series of tests as a prerequisite for entry, the impact of testing standards is relatively under-studied, perhaps because standards can be adjusted endogenously to demand and supply conditions (Pagliero, 2013).

Finally, our findings suggest that increases in teacher testing standards may be an important but overlooked factor behind ongoing teacher shortages. Between the 2008-09 and 2018-19 academic years, graduations from traditional teacher training programs—the primary pathway into the teaching profession—declined by 35 percent nationally, with the states we analyze also experiencing large reductions in teacher preparation program graduations (Will, 2022). This has led to much soul-searching about a crisis in the teaching profession and speculation that recent teacher shortages are due to low teacher salaries, the lack of respect afforded teachers, and new challenges in the classroom, for instance, larger class sizes, evaluation processes that depend on standardized testing in the classroom, and an increasingly politicized classroom environment (Schmitt and deCourcy, 2022). Curiously, however, the role of teacher testing is neglected in these discussions. Back-of-the-envelope calculations using our estimates suggest that the increase in testing standards arising from the replacement of the PPST with the Praxis Core accounts for one-fifth of recent declines in new teacher graduations and more than half of the decline in the states where testing standards increased the most. While we remain agnostic about the impact of these changing standards on teacher quality or student achievement, our work indicates that rising standards play an economically significant role in reducing the supply of new teachers.

2 Background

All states require teachers to possess a license prior to teaching in public schools, with the licensing requirements set at the state-level. State standards may include requirements for entry into teacher preparation programs, course work requirements, student teaching hours, as well as exit exams on subject matter and pedagogy. Prior to becoming fully fledged teachers, prospective teachers typically enroll in a state-recognized teacher training program housed within an institution's education school.

A universal theme in teacher licensing is that prospective teachers must pass tests at various points along the pipeline. A subset of states requires prospective teachers to pass a series of entry tests, normally taken during their sophomore or junior year, to enter their college's teacher preparation program. Some states (e.g., California) have designed their own entry tests. Others outsource this task to the ETS, which set a series of tests called the Pre-Professional Skills Test (PPST).[5] In the spring of 2013, ETS introduced the Praxis Core Academic Skills Test as a replacement for the PPST, which was fully phased-out on September 1st of 2014. Both the PPST and Praxis Core test basic knowledge of math, reading, and writing. They each consist of three component tests which can be taken all at once or on separate occasions. In most states, prospective teachers must obtain a minimum score on each component test in order to gain entry to teacher preparation programs.[6]

According to ETS (2013), the new test was designed to align with the Common Core. Unlike the PPST, the Praxis Core is only offered as a computer-based test. While the test still assessed basic skills in the same three subject areas—reading, writing and mathematics—the questions were designed to be more focused on analyzing, assessing and evaluating various pieces of content. Additionally, the format was designed to be more interactive. There are some differences in the number of questions and the time allotted to each component. However, the overall content is remarkably similar (see Appendix Figure A1 for a comparison of the content of the tests). A comparison of the study guides provided by the ETS for both tests shows significant overlap in practice questions. For our purposes, the key difference between the two tests is that the PPST was scored from 150-190 while the Praxis Core is scored from 100-200, which required state governments to set new passing scores.

The PPST had no nationally recommended passing scores; every state set its own passing scores for each PPST component. However, when the ETS was planning for the replacement of the PPST, it convened a multi-state panel in February 2013 to establish a universal recommended passing score for the reading, writing, and mathematics components of the Praxis Core. Education agencies from 23 states, Washington D.C., and Guam sent panelists familiar with what is required of students to succeed in teacher preparation programs to recommend new passing scores. As shown in Table 1 the states that participated in the panel (Column 6) overlap heavily with our

[5]Between 2007-2010, roughly 150,000 undergraduates took each of the three the PPST exams (ETS, 2010)

[6]Many states exempt students with sufficient high scores on the ACT or SAT from having to take Praxis entry tests. However, the threshold ACT or SAT scores for this exemption are high. For instance, Maryland requires a minimum ACT composite score of 24 (74 percentile of all college-going students) or a total math and critical reading score of 1180 on the SAT whereas the minimum passing score for the Praxis Core is much lower at almost half a standard deviation below the national average of potential teachers.

sample of states (Column 5). Among the states that used the PPST, every state but one adopted the passing scores recommended by the panel.[7]

3 Data and sample

Information on which entry tests are required of prospective teachers was obtained from ETS and cross checked with state Department of Education websites. In most cases the two sources align.[8] Information about the use of the PPST and Praxis Core by state is shown in the first two columns of Table 1.

To be included in our sample, a state had to use the PPST from 2008-2012 and adopt the Praxis Core.[9] In addition, the state needed to implement the passing scores recommended by the multi-state panel for the Praxis Core and use the Praxis Core through 2019. This leaves us with a sample of 21 states plus Washington, DC.

We measure the potential teacher supply response to the change in the entry test requirement along two margins: the number of students enrolled in education majors in post-secondary institutions, and the number of graduates from teacher preparation programs. Both data series were obtained from the Integrated Postsecondary Education Data System (IPEDS), which contains detailed information about post-secondary institutions located within all 50 states plus DC.

In September 2019 Praxis changed the Core math test and recommended new passing scores. Accordingly, our experiment ends in 2019. Our enrollment analysis encompasses the years 2008 to 2018, since the 2018 entrants were the last available group covered by this experiment (the

[7]North Dakota is the only state that used the PPST but did not adopt all of the passing scores recommended by the multi-state panel. It adopted the recommended passing score for the math and reading test but chose a lower score on the writing test; as such we exclude it from the main analysis. However, as shown in Appendix Table A1, the point estimates of interest are unchanged when we include North Dakota in the sample.

[8]One exception is that the ETS reports that Tennessee requires the Praxis Core while the Tennessee Department of Education states, "Praxis Core academic tests may be required for admission to an educator preparation program but may not be required for licensure." See tn.gov (Accessed: November 27, 2023). Because of this ambiguity, we excluded Tennessee from our sample; however, our findings are robust to the inclusion of Tennessee (see Appendix Table A1).

[9]Among the states that required the PPST only Indiana failed to adopt the Praxis Core. Among the states that adopted the Praxis Core only Iowa, Kentucky, and Washington did not previously require the PPST (see Appendix Table A1).

enrollment data is biennial; thus the 2020 entrants would have faced different passing scores and a different test). Because the PPST and Praxis Core are entry exams that are typically taken in the sophomore or junior years, the effect on graduation will occur with a lag of at least one year. Our graduation analysis therefore covers the years 2009 to 2020.

In IPEDS, fall enrollment data is available at the two-digit CIP code level for even-numbered years. We measure enrollments using CIP code 13, which is a count of the number of education students at the institution-level. This is an imprecise measure of the potential teacher pipeline. While CIP code 13 includes students in teacher preparation programs, it also includes students majoring in fields like school counseling services or instructional education media design. This may introduce attenuation bias in our enrollment analysis, as the non-teacher preparation program students in CIP code 13 are unaffected by the transition from PPST to Praxis Core.

IPEDS provides annual data on the number of graduates with more granularity (at the six-digit CIP code level) than on enrollments (at the two-digit CIP code level). Accordingly, our measure of the number of graduates from teaching preparation programs at the institution-level uses these detailed statistics of program completion by major. Measuring graduations at the six-digit CIP code level allows us to focus on the sub-sample of education students who have a major that requires them to pass a teacher preparation entry exam. We follow the definition of teacher preparation programs recommended by Kraft et al. (2020) and sum the number of graduates across all teacher preparation program majors at the institution-level.[10] Unlike enrollment, data on graduations is available annually. Additionally, IPEDS graduation data reflect the academic year. For example, the data point corresponding to 2012 reports graduates from July 2011 until June 2012.

To be included in our sample an institution needed to have at least one year of enrollment data as well as at least one year of data on the number of graduates from teacher preparation programs.[11] The data set for our main results includes 507 universities across 21 states plus DC.

[10]The majors include, among others, 'Education, General', 'Bilingual, Multilingual and Multicultural Education', 'Curriculum and Instruction', 'Special Education and Teaching', 'Teacher Education and Professional Development, Specific Levels and Methods', 'Teaching English or French as a Second or Foreign Language', and 'Education, Other' but excludes categories like "Educational Administration and Supervision".

[11]There are 14 universities that have data on graduates but not enrollment. Results are robust to including these 14 universities.

Table 2 displays descriptive statistics on the number of education majors and the number of teacher preparation program graduates for the full sample and split by institution-level selectivity. We also report time-varying institution characteristics taken from IPEDS to account for changes in student demographics and institution quality that may impact enrollment or graduations. The variables include counts of full-time-first-time freshman enrollment, SAT and ACT submission rates, the 25^{th} and 75^{th} percentile scores on the SAT and ACT, the percent of students receiving Pell grants and student loans, and the value of Pell grants and student loans conditional on receipt. The average university-year in our sample has 566 students enrolled in the education major and 124 students graduating from a teacher preparation program.

4 Identification strategy

4.1 Testing standards

To construct a single index that measures the entry testing standards in a state-year, we need to confront two challenges. First, when ETS replaced the PPST with the Core, it altered the minimum and maximum scores making the comparison of old and new raw passing scores meaningless. To solve this problem, we standardized raw passing scores into z-scores for each component (reading, writing, math) of each test. For each component test, the z-scores are computed as the difference between a state's raw passing score and the national mean score for all test takers divided by the national standard deviation for that test. The data used to compute these z-scores (national mean test scores and standard deviations for each component of the PPST and Praxis Core) were collected from ETS technical manuals (ETS, 2010, 2015).[12] Second, we need to convert the three components of each test into a single Test Difficulty Index (TDI). To do this, we took the arithmetic average of the z-scores for each of the three components. Later, we explore the robustness of our results to alternative metrics of test difficulty. Finally, for each state we compute ΔTDI. ΔTDI

[12] All PPST tests were standardized using national data from the 2010 technical manual since we were unable to locate a 2012 technical manual. We used national data from the 2015 technical manual to standardize the Praxis Core.

is equal to the TDI in 2014 (the first year of full adoption of the Praxis Core) minus TDI in 2012 (when the PPST was the only entrance exam). By construction ΔTDI captures the variation in testing standards that is attributable to the fact that all states adopted the scores recommended by the multi-state panel without regard to local concerns.

Table 3 contains the data used to construct the Test Difficulty Index (TDI) for the PPST. Data on the raw passing scores for each state was taken from the ETS's *Praxis Series Passing Score by Test and State* reports and was cross checked with each state's Department of Education. The table reports the raw passing scores and the corresponding z-score for each test component. The PPST z-scores are negative for every states except Virginia, with many states having minimum passing standards more than one standard deviation below the average score earned by all test takers on one or more test component. As shown in the table, small differences in raw passing scores translate into large differences in z-scores. For instance, for the math test, Connecticut's passing score of 171 translates into a z-score of -1.01 whereas Vermont's passing score of 175 is a z-score of -0.43. Additionally, it is worth noting that states with low z-scores on one component tend to have low z-scores on all components (see, for example, Pennsylvania or Connecticut) with some exceptions (like Maryland or West Virginia).

The second to last column reports the TDI for the PPST. The test difficulty index ranges from a high of 0.10 in Virginia to a low of -1.16 in Mississippi with an average of -0.63. After the adoption of the Praxis Core, all states had an identical TDI of -0.42.[13] The final column shows ΔTDI. In five states (Louisiana, Maryland, Maine, Virginia, and Vermont) TDI decreased with the adoption of the Praxis Core. Thus teacher preparation entry test standards became easier in these states. In the remaining states entry testing standards increased following the adoption of the Praxis Core, with the magnitude of the increase in the TDI varying substantially across these states. When the PPST was in place, entry requirements were the least binding in Mississippi, Nebraska, Connecticut, and Hawaii. These four states experienced an increase in testing standards

[13]For the Praxis Core the z-scores are -0.23 in math, -0.87 in reading and writing -0.15. As a consequence, the average increase in exam difficulty was driven by the math and writing components. In a robustness check we explore the change in each subject test separately.

of at least half of a standard deviation. Figure 1 shows the Test Difficulty Index for each state year in our sample. The switch from the PPST, where each state had its own passing scores, to the Core, where all states used the same passing scores, is apparent from the figure. All states had a common TDI between 2014 and 2017. In 2018 Pennsylvania and South Carolina weakened their entry testing requirements slightly.

4.2 Enrollments

We first investigate the effect of the change in entry testing standards caused by the replacement of the PPST by the Praxis Core which occurred in 2013-14 on enrollments in education programs. To do this, we estimate the following two-way fixed-effect model:

$$Y_{u,s,t} = \beta_1 TDI_{s,t} + \alpha_{u,s} + T_t + \gamma V_{s,t} + \theta Z_{u,s,t} + \epsilon_{u,s,t} \tag{1}$$

In this regression $Y_{u,s,t}$ is the natural log of fall enrollment in the education program in university u located in state s in year t. Our variable of interest is $TDI_{s,t}$ which is the value of the test difficulty index in state s in year t.[14] Equation (1) includes a set of university fixed effects $\alpha_{u,s}$, and a set of year fixed effects T_t. As mentioned earlier, we only have enrollment data for even-numbered years. Because the Praxis Core was first available in the spring of 2013 and was fully rolled out by fall 2014, we expect enrollment to be affected without a lag. If the change in teacher testing standards is orthogonal to time-varying state-level factors that influence participation in teacher preparation programs, β_1 will be an unbiased estimate of the impact of testing standards on enrollments.

$V_{s,t}$ is a vector of time varying, state-level controls. We control for economic conditions at the state-year level, specifically the unemployment rate and median income taken from the census.

[14]As noted earlier, 20 out of the 22 jurisdictions in our sample have the same pass scores for the Praxis Core throughout the sample period (South Carolina and Pennsylvania made small adjustments to their passing scores in the last year of our sample). Equation (1) includes variation from these small changes in entry standards. However, we are concerned that the change in entry standards for South Carolina and Pennsylvania may be endogenous. As shown in Appendix Table A1, our findings on enrollments and graduations are robust to excluding this variation.

Within $V_{s,t}$ we also include a series of state-level education policy indicators (taken from Kraft et al. (2020)) that may affect teacher supply such as teacher accountability reforms, the elimination of teacher tenure, the increase in the probationary period, the weakening of unions, obtaining a federal Race to the Top grant, and adoption of Common Core standards, as well as the year edTPA was required (taken from Chung and Zou (2023)). Finally, $Z_{u,s,t}$ is a vector of time-varying institution-level controls including average 25th and 75th percentile SAT and ACT scores, whether or not the university is SAT or ACT test-optional, the percent of students receiving a federal Pell grants and student loans, the average dollar amount of federal Pell grants and student loans awarded, and total enrollment. Given that testing standards are set by states, we cluster standard errors at the state level and weight the regressions by state population.[15]

We also study the impact of the change in testing standards arising from the replacement of the PPST with the Praxis Core using an event study framework. This specification allows us to conduct a falsification test of our identifying assumption by estimating leads of the impact of the change in testing standards and examining them for evidence of pre-trends. Formally, the event-study regression equation is as follows:

$$Y_{u,s,t} = \alpha_{u,s} + T_t + \sum_{k=-2}^{k=3} \delta_k \Delta TDI_{s,t-k} + \gamma V_{s,t} + \theta Z_{u,s,t} + \epsilon_{u,s,t} \tag{2}$$

For the event study the key variable of interest is ΔTDI. Recall that ΔTDI is equal to TDI in 2014 (the first year of full adoption of the Core) minus TDI in 2012 (when the PPST was the only entrance exam). Since our enrollment data is biennial, in equation (2) we trace out the anticipatory effects for years 2008 and 2010 as well as the dynamic post treatment effects for years 2014, 2016, and 2018 (the year 2012 is standardized to zero). All other variables are defined as in equation (1). An event-study provides suggestive evidence of the key identifying assumption which is that other factors that influence enrollments in education programs are uncorrelated with ΔTDI. Given that all states adopted a common test score, we expect this assumption to hold.

[15] Alternatively we can weight the regression by university enrollment in 2010. Our main results are robust to this alternative weighting scheme.

Additionally, this framework allows us to test the assumption that the impact of the change entry standards on enrollment occurs without a lag.

4.3 Graduations

We now turn attention to the impact of testing standards on graduations from teacher preparation programs. As discussed earlier, IPEDS graduation data reflect the academic year. For instance, the data from 2015 captures all graduates from July 2014 to June 2015. While the exact timing varies by state and university, students are usually required to pass the entrance exam (i.e., the PPST or Core) by the end of their sophomore year or the beginning of their junior year. For instance, according to the guidelines for Delaware, all candidates in an undergraduate teacher education program must pass the Praxis Core Academic Skills for Educators tests in reading, writing, and mathematics after completing 60 credit hours and/or prior to admission to upper-level education courses.[16] However, others do not require it until late in their junior year or, in some cases, even their senior year (see, for instance, Mississippi State's requirements at msstate.edu).

Though the PPST was officially phased out by ETS on September 1, 2014, as shown in Table 1 some states had already transitioned to the Core by the spring of 2013.[17] In these states, students who underwent the test in spring of their sophomore year are expected to graduate in the 2014-15 academic year and should appear in the IPEDS 2015 graduation data. However, if students took the test in the spring of their freshman year, the impact on graduation numbers would only be evident in 2016. It is also worth noting that many states did not adopt the Praxis Core until the fall of 2014. As a result, we anticipate the spring of 2015 to be the first period where the effects become noticeable and for the effect of testing requirements on the number of graduates to increase over

[16]We investigated the entry requirements for several teacher preparation programs with an eye to understanding when students were required to take the PPST or the Praxis Core. Many schools require the submission of scores by the end of the sophomore year. See, for instance, the requirements at the University of Vermont, Kean University, and Eastern Kentucky State.

[17]An analysis of data from the Title II National Teacher Preparation Reports (`https://title2.ed.gov/Public/DataTools/Tables.aspx`) confirms that students were taking both the PPST and the Praxis Core in the spring of 2013. Additionally, our enrollment results, which document a significant decline in enrollment in the fall of 2014, are highly suggestive of the Praxis Core being in place in the spring of 2013.

time as more and more teacher preparation program students are exposed to this policy change.

To analyze the impact of entry standards on the number of graduates we estimate equation (1) with three modifications. First, we define our outcome variable as the natural log of the number of graduates from an institution's teacher preparation program in spring of that year. Second, all variables are measured annually instead of only in even-numbered years. Finally, to account for the fact changes in entry testing standard impact graduation with a lag, we lag TDI by one year.

To more closely examine the relationship between TDI and graduations, we estimate equation (3), which is a dynamic treatment effect model that allows us to trace the anticipatory and post-treatment effects when the outcome of interest is graduations.

$$Y_{u,s,t} = \alpha_{u,s} + T_t + \sum_{l=-3}^{l=7} \delta_l \Delta TDI_{s,t-l} + \gamma V_{s,t} + \theta Z_{u,s,t} + \epsilon_{u,s,t} \tag{3}$$

For the graduation event study, we use annual data. Recall that ΔTDI is equal to TDI in 2014 (the first year of full adoption of the Core) minus TDI in 2012 (when the PPST was the only entrance exam). As in equation (2), the leave out year is 2012. We can estimate the impact of the policy change on the size of the graduation cohorts for the years 2009 to 2011 when the changes to the entry exam could not have influenced the number of graduates as well as the graduation cohorts for the years 2013 and 2014 when the changes to the entry exam should not have influenced the number of graduates. As discussed earlier, because students take the test two to three years before graduation, we do not expect the change in testing standards–which occurred in 2013/2014–to affect graduations until 2015. An immediate effect of ΔTDI on graduations is potentially a violation of the no anticipation assumption or evidence of omitted variable bias. Additionally, we expect the effect of the change in testing standards to grow over time as more and more entrants into teaching preparation programs are held to the new standard. All other variables are the same as they were for equation (2).

5 Results

5.1 Enrollments of education majors

We begin with an analysis of the impact of changing the entry requirement for teacher preparation programs on enrollment of education majors. Our prediction is that enrollment should as TDI increases since some potential majors will be unable to meet the higher testing standard. Column 1 of Table 4 presents the results from estimating equation (1). A one-standard deviation increase in the test difficulty index is associated with a 23 percent decrease in enrollments in education majors. The average change in TDI for the states in our sample was an increase of 0.22 standard deviations. Thus the change in entry tests from the PPST to the Praxis Core resulted in a 5 percent decline ($= 0.22 \times -0.23$) in the number of education majors (see the "Average effect" row in the Table 4.) The average university in our sample has an education enrollment of 566 students This university therefore experienced a decline in education major enrollments of 29 students per year.

Figure 2 presents the event-study coefficients. Consistent with the exogeneity of the adoption of uniform passing scores, we find no evidence of pre-trends. In the years when the PPST was in place, the coefficients are indistinguishable from zero in magnitude and statistically insignificant, implying no differential trend in education enrollments between states that experienced large increases in testing standards and those in which the increase in standards was small or even negative. However, enrollments immediately decline when the PPST was replaced by the Praxis Core. In terms of magnitudes, an increase in test difficulty of one-standard deviation reduced enrollments by 22 percent in 2014, rising to 26 percent in 2016, and then falling to 16 percent in 2018.

Given our hypothesis that the higher entry testing standards are responsible for the decline in enrollment, we expect the effects to be larger in universities with academically weaker student bodies. To test this conjecture, we use the 2010 IPEDS data on SAT/ACT test scores to classify universities into more selective and less selective sub-samples. Many institutions did not report ACT or SAT scores in IPDES. We suspect that the vast majority of these schools are open enrollment and therefore impute their ACT or SAT scores to be low. We then classify as more selective any institution with 25th percentile SAT verbal or ACT verbal scores above the in-sample median. All remaining schools are classified as less selective.[18] We estimate equation (1) separately for each sub-sample. The results for less selective universities are displayed in Table 4 columns (2) while column (3) contains the estimates for more selective universities. Consistent with our hypothesis, all the impact of higher entry standards on enrollment comes from the less selective institutions. For less selective institutions, a one-standard deviation increase in test difficulty reduces the number of education majors by 57 percent. Accordingly, the 0.22 standard deviation increase in TDI experienced by the average less selective university in our sample reduces enrollments by 13 percent. In contrast, changes in entry test standards have zero impact on education major enrollments in the academically more selective institutions.

A growing body of research investigates the impact of having a same-race teacher on a wide variety of K-12 student outcomes, including test scores, disciplinary outcomes, social-emotional development ratings, the likelihood of completing high school, and the likelihood of enrolling in college (see, for instance, Morgan and Hu (2023); Lindsay and Hart (2017); Wright et al. (2017); Dee (2005, 2004). Much of the evidence finds positive effects. Given the importance of minority teachers and their limited supply, it worth investigating how the increase in entry testing standards arising from the replacement of the PPST with the Praxis Core affected enrollments of education students of different racial backgrounds.

From 2010 onward, IPEDS reports reliable enrollment data disaggregated by racial categories. To study the impact of entry testing standards on enrollments by race, we construct two mutually exclusive categories, white and non-white, and then estimate equation (1) separately for each category. As shown in columns (4) and (5) of Table 4, the coefficients on the test difficulty index are negative for both groups and statistically indistinguishable from each other.

To further explore the impact of higher entry standards on enrollments, we estimate the model separately for states with growing and shrinking school-age populations. In states with growing school-age populations, institutions may have in place weaker entry standards to increase the sup-

[18] If we exclude institutions that do not report tests and split the remaining schools according to their test scores, we continue to find that the effects on enrollments are much larger for less selective universities.

ply of potential teachers (i.e., a lower GPA requirement, or a low minimum SAT score, or not failing out students who perform poorly in their first year). In these states, a given increase in test difficulty is likely to have a relatively large impact on education major enrollment because the left tail of the quality distribution has not already been culled. Conversely, in shrinking states, the absence of pressure to produce more teachers may allow institutions' to impose stricter entry standards. Accordingly, we expect the same increase in test difficulty to have a larger impact in states where the school-age population is growing than in states with shrinking school-age populations. We classify a state as growing (shrinking) if its 5-17 year old population increased (decreased) between 2009 and 2018. Among growing states, the school-age population rose an average of 4.8 percent over this period while in shirking states the school-age population declined by 4.5 percent on average. Table 4, column (6) shows the results for shrinking states while column (7) shows the results for growing states. The coefficient estimates from this exercise are consistent with our conjecture. For growing states, a one-standard deviation increase in test difficulty reduces enrollments by 26 percent, while in growing states, the same increase reduces enrollments by a statistically insignificant 9 percent.

5.2 Graduations from teacher preparation programs

We now turn attention to our analysis of the effect of the change in testing standards on graduations from teacher preparation programs. A priori, it is possible that an increase in testing standards could reduce enrollments in education majors without affecting graduations. Higher entry standards, by eliminating the left-tail of the quality distribution, may simply remove from the pool those students who would have been unable to graduate. In this case, stricter testing standards are potentially welfare enhancing, since they weed out students who would never have completed teacher preparation programs, saving them time and money. Table 7 presents our estimates of the impact of the change in testing standards on graduations from teacher preparation programs. As shown in column (1), the increase in testing standards is associated with a large decline in graduations. The point estimate indicates that an increase in testing standards of one-standard deviation reduced graduations by 23 percent. In magnitude, the impact on graduations is exactly the same as the impact on enrollments suggesting that the increase in entry standards screened out many students who would have otherwise been able to meet exit requirements and graduate from teacher preparation programs. TDI increased by 0.22 standard deviations on average in the states in our sample. This implies a reduction of 5 percent ($= 0.22 \times -0.23$) in the number of teacher preparation program graduates (see "Average effect" row in Table 7). The average university in our sample has a graduating class of 124 student. In such an institution, graduations would have fallen from 124 to 118 students. Given that there are 507 institutions in our sample this suggests a reduction in the number of new teachers of 3,042 per year across these 22 states.

As before we divide our sample into less and more selective institutions according to their SAT or ACT scores. The results for less selective institutions are shown in column (2) of Table 7, while column (3) displays the results for more selective institutions. Consistent with our enrollment results, the effects of higher entry standards on graduations are concentrated among less-selective institutions. A one-standard deviation increase in test difficulty reduces graduations in less selective institutions by 48 percent, while for more selective institutions, graduations fall by a statistically insignificant 10 percent. The fact that an increase in entry standards reduces enrollments and graduations only among less selective institutions helps reassure us that it is the change in entry testing standards that is driving our results and not some other confounder that is changing at the same time. We also estimate the model separately for white and non-white students using data from 2012 onward due to poor reporting of graduations by racial category in the earlier years in the sample. As shown in columns (4) and (5) of Table 7, the increase in testing difficulty reduced graduations for white as well as non-white teacher preparation students. Finally, columns (6) and (7) of Table 7 report our findings when we divide the sample into states with shrinking and growing school-age populations, respectively. We find that a one-standard deviation increase in testing standards reduces graduations by 16 percent in both groups of states, but the estimate is only statistically significant for shrinking states.

Figure 3 presents the event study coefficients from equation (3). Recall that the Praxis Core was first available in the spring of 2013 and that the test is normally taken by students during their sophomore or junior years. Thus, we would not expect to see a decline in graduations until 2015. As shown in the figure, 2015 is the first year that we observe a statistically significant reduction in graduations, which increases slightly with time. A one-standard deviation increase in TDI reduces graduations by 27 percent in 2015 and peaks at 35 percent in 2020.[19] As shown by the null coefficients in the pre-period years, there is no evidence that other factors that impact graduation rates are correlated with the change in the difficulty of the testing standards.

6 Robustness tests and other implications

6.1 Alternative measures of TDI

Our first robustness check involves re-estimating our two-way fixed effect models on enrollments and graduations using alternative measures of the Test Difficulty Index (TDI). The results for enrollments are shown in panel A of Table 6, while the corresponding estimates for graduations are presented in panel B. Recall that our main measure of test difficulty is the arithmetic average of the z-scores for each of the three tests (math, reading, and writing). In columns (1) through (3) we show the results using each component's z-score as the sole determinant of TDI. For enrollments, the increase in testing standards for each component has a statistically significant and negative impact. The magnitudes are also similar regardless of which test component we use. For graduations, only math and reading are statistically significant, but again the magnitudes are similar across all test components. In some states the TDI for one component was relatively unchanged, while the TDI for another test component changed significantly. Accordingly, in column (4) we report the results where we set TDI to be equal to the z-score for the one component that saw the largest change in difficulty as a result of the switch from the PPST to the Praxis Core. Using this approach, we find a large and statistically significant effect. Reassuringly, the negative effect of entry standards on enrollments and graduations is larger when we define the change in entry

[19]See Table A2 in the appendix for the coefficients and standard errors from the event study regression.

standards using the most binding of the three tests.

Finally, in some states, a test taker who obtains a high enough composite score is not bound by the minimum score listed for individual tests by the ETS. Our baseline results do not incorporate composite score exemptions in the computation of TDI. Hawaii, Maine, New Hampshire, and Pennsylvania allow students to pass the PPST provided that their combined scores meet a minimum threshold. In addition to meeting the combined score requirement, students must obtain a minimum score on each component which differs from the one reported in the ETS's Praxis Series Score by Test and State (an alternative minimum score). For each of these states, the gap between the listed minimum and the alternative minimum score was three points. Maryland, Virginia, and Vermont allow students to pass the PPST provided that their combined score from all three test components meet a minimum threshold. These states do not, however, have official minimum scores for each component. To construct an alternative minimum passing score for these states, we subtracted three points from each of their listed minimum passing scores, since this was the gap we found for those states that had a combined score requirement as well as reported effective minimum passing score for each component. In column (5), we used the alternative minimum score for all states to account for the composite score exemptions. The results from this exercise are qualitatively similar to our preferred specification and more precisely estimated.

6.2 Placebo tests

A potential threat to our identification strategy is the possibility that state-level changes in teacher preparation program entry test standards are correlated with broader changes in college enrollments and graduations. For instance, if other determinants of college attendance like tuition or local economic conditions are correlated with the change in teacher preparation program entrance exam difficulty, then we might be misattributing the decline in teacher preparation enrollments and graduations to test difficulty.

To examine this possibility, we conduct three placebo tests that examine the relationship between the change in test difficulty and enrollments and graduations of students who are not required to take this test. The first placebo test is an event study (identical to equation 2) focusing on the enrollments of all students except education majors. If our experiment is valid, the increase in testing difficulty should not reduce enrollments of these students. However, we may see a small increase in non-education enrollments due to students substituting away from education towards other majors because the entry standard became more difficult. Figure 4A shows the coefficients from an event-study of the switch from the PPST to the Praxis Core on non-education major enrollments. While the pre-trends are noisy, the validity of our experiment is not rejected and there is some suggestive evidence that the increase in testing difficulty induced potential education majors to switch to other majors.

Our next two placebo tests examine graduations. The first is an event study (similar to equation 3) that looks at all graduations excluding those from teacher preparation programs. As shown in Figure 4B, we find no evidence that our key result concerning the fall in graduations from teacher preparation programs can be attributed to other factors that influence graduations overall and happen to be correlated with the increase in test difficulty. The second is another event study that looks at graduations of education majors who are not are subject to the entry test requirement (for instance, education administration, school counseling, and instructional media majors). This is our preferred placebo test because it focuses on a subset of students who should also be affected by state-level changes in education policy or funding but are not affected by the entry test. The results from this exercise are shown in Figure 4C, which shows no relationship between the test difficulty index and the number of graduates from other education majors.

6.3 Other outcomes: new teacher licenses and student learning

While teacher preparation programs are the primary pathway into the teaching profession, there are alternative routes to becoming a teacher. For instance, students who participate in Teach for America are eligible to teach but do not attend traditional teacher preparation programs. Thus, an important policy question is whether the reduction in teacher preparation program graduates induced by the replacement of the PPST with the Praxis Core in fact reduced the number of new teachers eligible to work. To investigate this we use state-level data on the number of new teacher licenses awarded each year from 2010 to 2019.[20] The data come from the Office of Title II of the US Department of Education, which collects information on new teacher licenses awarded each year regardless of type (i.e., traditional licenses awarded to graduates of teacher preparation program, temporary/emergency licenses, and certifications granted to graduates of alternative programs). We then estimated a model similar to the graduation event-study regression model (equation 3) at the state-year level using the log of the number of new teacher licenses as the dependent variable (excluding the university-level controls and replacing university fixed effects with state fixed effects). Figure 5 displays the results. Reassuringly, as with graduations from teacher preparation programs, there is no evidence of differential pre-trends. Additionally, the effect of increased entry testing standards on the number of newly licensed teachers is negative and increases in magnitude over time, which is consistent with the fact that there may be a lag between when students graduate from teacher preparation programs and when they meet all licensing requirements.

A key question is whether higher testing standards induced by the switch from the PPST to the Praxis Core improved teacher quality in terms of student learning. As discussed by Angrist and Guryan (2008), an increase in entry testing standards could increase or decrease student learning. On the one hand, if higher entry standards induce an improvement in the average effectiveness of the teaching pool, student learning may improve. On the other hand student learning may suffer since higher entry standards reduce teacher supply, which in turn may force school districts to hire fewer or less qualified teachers. Additionally if the production function for effective teaching is multidimensional (for instance, it may require teacher academic ability as well as classroom management skills), high testing standards may select along academic ability at the expense of classroom management, which could reduce teacher effectiveness (Dinerstein and Opper, 2022).

To investigate this question, we combine our data on teacher preparation program entry test standards with state-level data on student test scores taken from the National Assessment of Education Progress (NAEP), the longest running and most widely used nationally representative survey

[20]We are grateful to Melissa Lyon and Matthew Kraft for compiling and sharing these data (Kraft and Lyon, 2022).

of student learning in the United States. Known as the ”Nation’s Report Card”, the NAEP, among other things, assesses the reading and math skills of 4th and 8th grade students in every state in odd-numbered years. For our analysis, we make use of these test scores from the 2009 to 2019 surveys.[21] To determine whether entry testing standards affect student learning, we estimate a modified version of equation (1). In this model, the dependent variable is a measure of student performance in either the math or reading test at the state-year level. For each test, we measure performance in three ways: the average test score in the subject, the percent of students in a state who attain a basic level of understanding of the subject, and the percent of student who attain proficiency in the subject. We include state and year fixed effects as well as the state-year controls for economic conditions and education policies. Our key variable of interest is the test difficulty index, lagged by one year to account for the fact that entry standards impact teacher preparation program graduates (i.e., new teachers) with a lag.

Coefficient estimates are shown in Table 7. Panel A reports the results for 4th grade math and reading while Panel B displays the estimates for 8th grade math and reading. For the raw NAEP scores, regardless of test or grade-level, the coefficients are positive but minuscule relative to the mean raw score and not statistically significant. Our findings are similar for the other outcomes as well. Accordingly, there is little evidence that the increase in teacher testing standards affected student learning.

We should point out that our setting is not ideal for investigating the link between entry test difficulty and performance on NAEP tests. Given that the first cohort of teachers to be affected graduated in the spring of 2015 and entered the classroom that fall, only a small share of the stock of teachers were exposed to the higher entry standard. As a result our estimates are biased towards zero. While we have established that higher entry standards reduce teacher supply, the jury is still out as to whether and how teacher preparation program entry testing standards affect student learning.[22]

[21]We opted to end the analysis in 2019 since our natural experiment on entry testing standards ended in 2019. However, there are NAEP test scores for 2022. Our findings are robust to including this additional year of data.

[22]Recent evidence suggests that Covid-era waivers of teacher licensure requirements had no effect on teacher effectiveness (Backes and Goldhaber, 2023; Bacher-Hicks et al., 2023).

7 Conclusion

In this paper we investigate the impact of a quasi-experimental change in testing standards brought about by the replacement of the PPST with the Praxis Core on the new teacher pipeline. The new test simultaneously lowered testing standards in five states and raised them in other states by varying degrees. Using institution-level data from 21 states plus DC, we find that the average increase in testing standards reduced education major enrollments as well as graduations from teacher preparation programs. Our estimates indicate that an increase in test difficulty of one-standard deviation reduced education major enrollments and teacher preparation program graduations by 23 percent. These declines were only occurred in academically weaker institutions. We also find that the increase in test difficulty resulted in fewer newly licensed teachers. There is no evidence that the change in entry standards correlates with state-specific trends in education majors or graduates from teacher preparation programs.

Our findings present new evidence on the efficiency of testing as an entry screen. Holding constant graduation standards, an efficient test should only weed out candidates who are unlikely to complete the program. If the Praxis Core were an efficient replacement test for the PPST, the increase in standards should have reduced enrollments in teacher preparation programs by weeding out students who would have been unable to meet program requirements without reducing graduations from teacher preparation programs. This is not what we find. Our results therefore suggest that state governments adopted testing standards that were too stringent, under the assumption that teacher preparation programs were already graduating teachers who would have been successful in the classroom.

Finally, our estimates suggest that the replacement of the PPST with the Praxis Core, which on average raised entry standards, had an economically large impact on teacher supply, and that it accounts for a sizeable portion of the ongoing decline in graduations from teacher preparation programs in some states. Between 2012 and 2020, the number of teacher preparations program graduates fell by 27 percent in the states in our sample.[23] Our estimates suggest that the change

[23]Among the five states where testing standards were relaxed, graduations declined by 14 percent between 2012

in entry testing standards results in a 5 percent decline in graduates for the average state in our sample. The replacement of the PPST with the Praxis Core therefore accounts for almost 19 percent ($\approx 0.05 \div 0.27$) of the decline in graduates from teacher preparation programs. Four states in our sample (Hawaii, Connecticut, Nebraska, and Mississippi) each saw an increase of entry test difficulty of at least half a standard deviation, with an average increase of 0.64 standard deviations. This implies a reduction in the number of teacher preparation program graduates of almost 15 percent ($\approx 0.64 \times 0.23$) in the subset of states with the largest increase in entry standards. Between 2012-2020, the number of teacher preparation program graduates declined by 26 percent in these four states. A back-of-the-envelope calculation therefore suggests that 58 percent ($= 0.15 \div 0.26$) of this decline can be explained by the high minimum passing scores that were put in place with the adoption of the Praxis Core. Accordingly, current teacher shortages in many states may, at least in part, be an unintended consequence of the replacement of the PPST with the Praxis Core.

While we are agnostic about the effects of higher testing standards on teacher quality, we believe that our findings can explain why state-level policy makers have, in response to perceived teacher shortages, recently pushed for the lowering of Praxis passing scores, or even the wholesale elimination of entry requirements like the Praxis Core. According to a 2021 study published by the National Council on Teacher (Putman and Walsh, 2021), many states have lowered or removed academic requirements for entry into teacher preparation programs. West Virginia now permits teacher training programs to waive test requirements or to admit students based on a cohort average instead of requiring individual students to pass the test. Mississippi, where testing entry standards increased the most, reduced the pass score for the math portion of the Praxis Core by 20 points in 2019. In 2022 and 2023 respectively, Louisiana and Nebraska, eliminated the requirement for teachers to use the Praxis Core to demonstrate basic skills.[24] Whether these policy changes reverse the decline in teacher preparation program enrollments and alleviate the shortage of new teachers is a topic for future research.

and 2020 whereas, among the states where testing standards were increased, graduations fell by 29 percent.

[24]See Nicholls State University (2022) for Louisiana. For Nebraska see ne.gov (Accessed: November 29, 2023)

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8 Tables

Table 1: State Descriptive Information

State	PPST	Core Adoption Date	Adopted Pass Scores	Panel Participant	In Sample	Shrinking State
AK	yes	Fall 2014	yes	yes	yes	no
AR	yes	Fall 2013	yes	yes	yes	no
CT	yes	Fall 2014	yes	yes	yes	yes
DE	yes	Spring 2014	yes	yes	yes	no
DC	yes	Fall 2013	yes	yes	yes	yes
HI	yes	Fall 2013	yes	yes	yes	no
IN	yes					
IA				yes		
KY		Fall 2014	yes	yes		
LA	yes	Fall 2014	yes	yes	yes	yes
ME	yes	Fall 2013	yes	yes	yes	yes
MD	yes	Fall 2014	yes	yes	yes	no
MS	yes	Fall 2013	yes	yes	yes	yes
NE	yes	Fall 2014	yes	yes	yes	no
NV	yes	Fall 2013	yes		yes	no
NH	yes	Fall 2013	yes	yes	yes	yes
NJ	yes	Fall 2013	yes	yes	yes	yes
NC	yes	Fall 2013	yes	yes	yes	no
ND	yes	Fall 2014	no*	yes		
OK	yes	Fall 2014	yes			
OR	yes	Spring 2014	yes		yes	no
PA	yes	Fall 2014	yes		yes	yes
RI				yes		
SC	yes	Fall 2013	yes	yes	yes	no
TN	yes	Fall 2013**	yes	yes		
VT	yes	Fall 2013	yes	yes	yes	yes
VA	yes	Fall 2013	yes		yes	no
WA		Fall 2014	no			
WV	yes	Fall 2013	yes	yes	yes	yes
WI	yes	Fall 2014	yes	yes	yes	yes

Only that states used the PPST or Praxis Core or participated in the multi-state standard setting panel are included in this table. Shrinking states are defined as states that saw their school-age (5-17) population shrink from 2008 to 2018.

* North Dakota adopted the recommended pass score for the math and reading test but chose a lower score on the writing test.

** ETS reports that TN requires the Praxis Core while the TN Department of Ed states "Praxis Core academic tests may be required for admission to an educator preparation program, but may not be required for licensure."

Table 2: Summary Statistics

	All	More Selective	Less Selective
Panel A Outcomes:			
Education fall enrollments	566	720	398
	(769)	(762)	(74)
White education fall enrollments	390	454	195
	(527)	(556)	(401)
Non-white education fall enrollments	170	266	203
	(333)	(439)	(447)
Teacher preparation graduates	124	165	73
	(169)	(188)	(122)
White teacher preparation graduates	88	115	44
	(123)	(139)	(83)
Non-white teacher preparation graduates	29	50	29
	(70)	(99)	(63)
Panel B Time-varying Controls:			
Total freshmen enrollment	892	1259	458
	(1135)	(1379)	(545)
SAT submission rate	63.5	63.0	61.0
	(30.1)	(31.3)	(27.2)
ACT submission Rate	41.3	43.1	41.3
	(29.0)	(30.0)	(26.6)
SAT math 25th percentile score	472	494	446
	(56.8)	(56.1)	(45.3)
SAT verbal 25th percentile score	470.0	493	446
	(55)	(53.4)	(45.5)
ACT composite 25th percentile score	19.5	20.7	18.1
	(2.9)	(2.9)	(2.1)
Pell grant (dollar amount, thousands)	4232	4220	4340
	(520)	(471)	(598)
Pell grant (% student)	40.7	31.3	52.1
	(18.6)	(12.7)	(18.2)
Loan (dollar amount, thousands)	7252	7544	6993
	(1766)	(1725)	(1741)
Loan (% student)	67.3	64.2	70.5
	(18.0)	(17.0)	(18.1)
Number of universities	507	267	240

Notes: All university data comes Integrated Postsecondary Education Data System. School age population change is calculated using the American Community Survey. Less selective universities are those with scores below the median or those that did not report test scores. More selective universities are defined as those with SAT/ACT scores above the in-sample median as of 2008. The table presents mean values, with standard deviations shown in parentheses underneath.

Table 3: Descriptive Information on Testing Standards

	Pre-Professional Skills Test (PPST)							
	Math		Reading		Writing			
State	Raw Score	Z-Score	Raw Score	Z-Score	Raw Score	Z-Score	TDI	ΔTDI
AK	173	-0.72	175	-0.38	174	-0.38	-0.50	0.08
AR	171	-1.01	172	-0.93	173	-0.64	-0.86	0.44
CT	171	-1.01	172	-0.93	171	-1.15	-1.03	0.62
DC	174	-0.58	172	-0.93	171	-1.15	-0.89	0.47
DE	174	-0.58	175	-0.38	173	-0.64	-0.53	0.12
HI	173	-0.72	172	-0.93	171	-1.15	-0.94	0.52
LA	175	-0.43	176	-0.20	175	-0.13	-0.25	-0.16
MD	177	-0.14	177	-0.18	173	-0.64	-0.26	-0.15
ME	175	-0.43	176	-0.20	175	-0.13	-0.25	-0.16
MS	170	-1.30	172	-1.29	173	-0.90	-1.16	0.75
NC	173	-0.72	176	-0.20	173	-0.64	-0.52	0.11
NE	171	-1.01	170	-1.29	172	-0.90	-1.07	0.65
NH	172	-0.87	174	-0.57	172	-0.90	-0.78	0.36
NJ	174	-0.58	175	-0.38	173	-0.64	-0.53	0.12
NV	172	-0.87	174	-0.56	172	-0.90	-0.78	0.36
OR	175	-0.43	174	-0.56	171	-1.15	-0.72	0.30
PA	173	-0.73	172	-0.93	173	-0.64	-0.76	0.35
SC	172	-0.87	175	-0.38	173	-0.64	-0.63	0.21
VA	178	0.00	178	0.16	176	0.12	0.10	-0.51
VT	175	-0.43	177	-0.18	174	-0.38	-0.28	-0.14
WI	173	-0.72	175	-0.38	174	-0.38	-0.50	0.08
WV	172	-0.87	174	-0.56	172	-0.90	-0.78	0.36
Average	173.2	-0.68	174.2	-0.55	172.9	-0.68	-0.63	0.22

Notes: ”Raw Score” is the minimum score needed to pass each subject of the Pre-Professional Skills Test. Data on passing scores came from the Education Testing Service cross checked with each state’s Department of Education. The z-scores are computed as the difference between a state’s raw passing score and the national mean score for all test takers divided by the national standard deviation for that test. TDI is the simple average of the three z-scores shown in columns 3,5, and 7. ΔTDI is the change in Test Difficulty Index from the last year of the PPST to the first year of the Praxis Core.

Table 4: Education Major Enrollments

	(1) All	(2) Less Selective	(3) More Selective	(4) White	(5) Non-White	(6) Shrinking State	(7) Growing State
TDI	-0.23**	-0.57**	0.00	-0.25*	-0.19*	-0.09	-0.26*
	(0.07)	(0.16)	(0.10)	(0.06)	(0.09)	(0.22)	(0.10)
Observations	2,896	1,313	1,583	2,424	2,424	1,567	1,329
Mean enrollment	566	387	691	399	152	548	596
Num. universities	507	240	267	505	505	272	235
Average effect	-0.05	-0.13	0.00	-0.06	-0.04	-0.02	-0.06

Notes: Each column represents a separate regression. The dependent variable in each regression is the log of the number of fall education enrollments. All regressions include university fixed effects, year fixed effects, state economic controls, and university-level controls as specified in equation (1). More selective universities are defined as those with SAT/ACT scores above the in-sample median as of 2010. In contrast, less selective universities are those with scores below the median or those that did not report test scores. Columns 4 and 5 are estimated using data from 2010 onwards. Growing states are defined as states that saw their school-age (5-17) population grow from 2008 to 2018. Average effect is an estimate of the change in enrollment for the average state is in the sample (the point estimate on TDI multiplied by the average change in TDI for that sample). Robust standard errors clustered at the state level are displayed in parentheses. All regression results are weighted by state population. ** $p<0.01$, *$p<0.05$

Table 5: Teacher Preparation Program Graduates

	(1) All	(2) Less Selective	(3) More Selective	(4) White	(5) Non-White	(6) Shrinking State	(7) Growing State
TDI	-0.23**	-0.48*	-0.10	-0.26**	-0.16**	-0.16*	-0.16
	(0.07)	(0.19)	(0.05)	(0.05)	(0.06)	(0.06)	(0.09)
Observations	5,780	2,629	3,151	4,357	4,341	3,130	2,650
Mean graduates	124	72	161	90	28	121	128
Num. universities	507	240	267	503	503	272	235
Average effect	-0.05	-0.11	-0.02	-0.06	-0.04	-0.04	-0.04

Notes: Each column represents a separate regression. The dependent variable in each regression is the log of the number of teacher preparation program graduates in a university-year. All regressions include university fixed effects, year fixed effects, state economic controls, state education policy controls, and university-level controls as specified in equation (3). More selective universities are defined as those with SAT/ACT scores above the in-sample median as of 2010. In contrast, less selective universities are those with scores below the median or those that did not report test scores. Columns 4 and 5 are estimated using data from 2012 onward. Growing states are defined as states that saw their school-age (5-17) population grow from 2008 to 2018. Average effect is an estimate of the change in graduates for the average state is in the sample (the point estimate on TDI multiplied by the average change in TDI for that sample). Robust standard errors clustered at the state level are displayed in parentheses. All regression results are weighted by state population ** $p<0.01$, * $p<0.05$.

Table 6: Robustness Tests Using Alternative Measures of the Test Difficulty Index

Panel A: Education Enrollments

	(1) Math Test	(2) Reading Test	(3) Writing Test	(4) Binding Test	(5) Alternative Min Scores
TDI	-0.16*	-0.17**	-0.17**	-0.21**	-0.22**
	(0.07)	(0.04)	(0.04)	(0.05)	(0.03)
Observations	2,896	2,896	2,896	2,896	2,896
Mean enrollment	566	566	566	566	566
Number of universities	507	507	507	507	507

Panel B: Graduations

	(1) Math Test	(2) Reading Test	(3) Writing Test	(4) Binding Test	(5) Alternative Min Scores
TDI	-0.20*	-0.16*	-0.18	-0.22*	-0.29**
	(0.07)	(0.07)	(0.09)	(0.09)	(0.04)
Observations	5,780	5,780	5,780	5,780	5,780
Mean graduates	124	124	124	124	124
Number of universities	507	507	507	507	507

Notes: Each column represents a separate regression. The dependent variable in Panel A is the log of the number of fall education enrollments and in Panel B is the number of graduates from teacher preparation programs. All regressions include university fixed effects, year fixed effects, state economic controls , state education policy controls , and university-level controls as specified in equation (1). Robust standard errors clustered at the state level are displayed in parentheses. All regression results are weighted by total state population. ** $p<0.01$, * $p<0.05$,

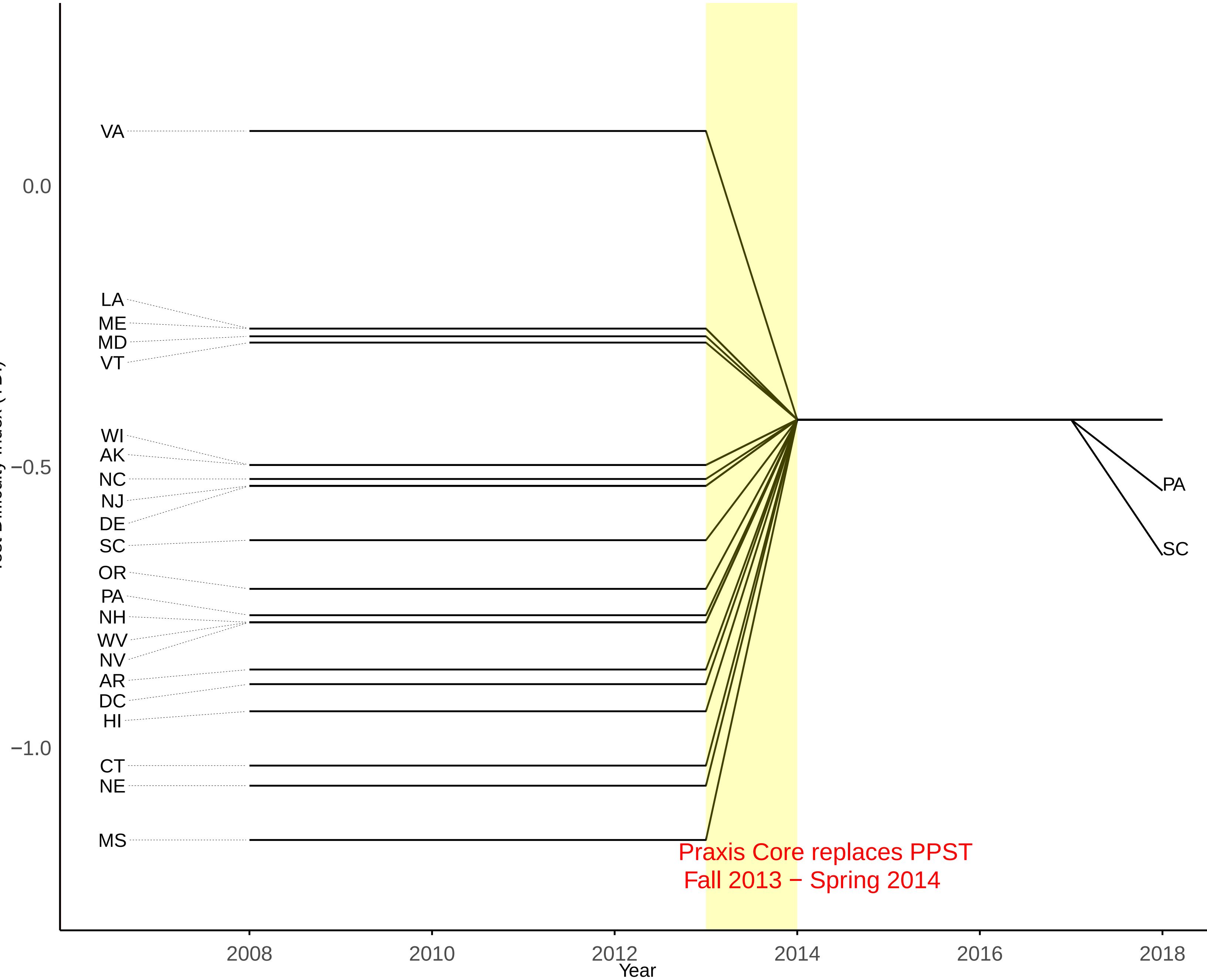
Table 7: Student Test Scores

	Math			Reading		
	(1) Raw Score	(2) Percent Basic	(3) Percent Proficient	(4) Raw Score	(5) Percent Basic	(6) Percent Proficient
(a) Panel A: 4th Grade						
Test Difficulty Index	0.37	1.34	-0.12	2.55	3.09	1.73
	(3.12)	(3.35)	(3.52)	(2.23)	(2.41)	(1.85)
Observations	132	132	132	132	132	132
Mean dependent var	241.2	82.07	41.62	222.1	68.15	35.94
(b) Panel B: 8th Grade						
Test Difficulty Index	1.48	1.81	1.48	1.26	1.57	0.07
	(2.55)	(2.70)	(2.43)	(1.19)	(1.33)	(1.24)
Observations	132	132	132	132	132	132
Mean dependent var	283.6	71.86	35.04	265.2	75.24	34.53

Notes: Each column represents a separate regression. The dependent variable in each regression is a measure of student performance on a NAEP test at the state-year level. Raw Score is the average raw score in a given state-year. Percent Basic is the percent of students who attain a basic level of understanding in the subject. Percent Proficient is the percent of student who reach proficiency in the subject. Robust standard errors clustered at the state level are displayed in parentheses. All regression results are weighted by state population and include state fixed effects, year fixed effects, state economic controls (unemployment rate and median income from census data), and state education policy controls (including teacher accountability reforms, elimination of teacher tenure, lengthening of the probationary period, weakening of teacher unions, receipt of a federal Race to the Top grant, adoption of Common Core standards, and year when edTPA was implemented). ** $p<0.01$, * $p<0.05$

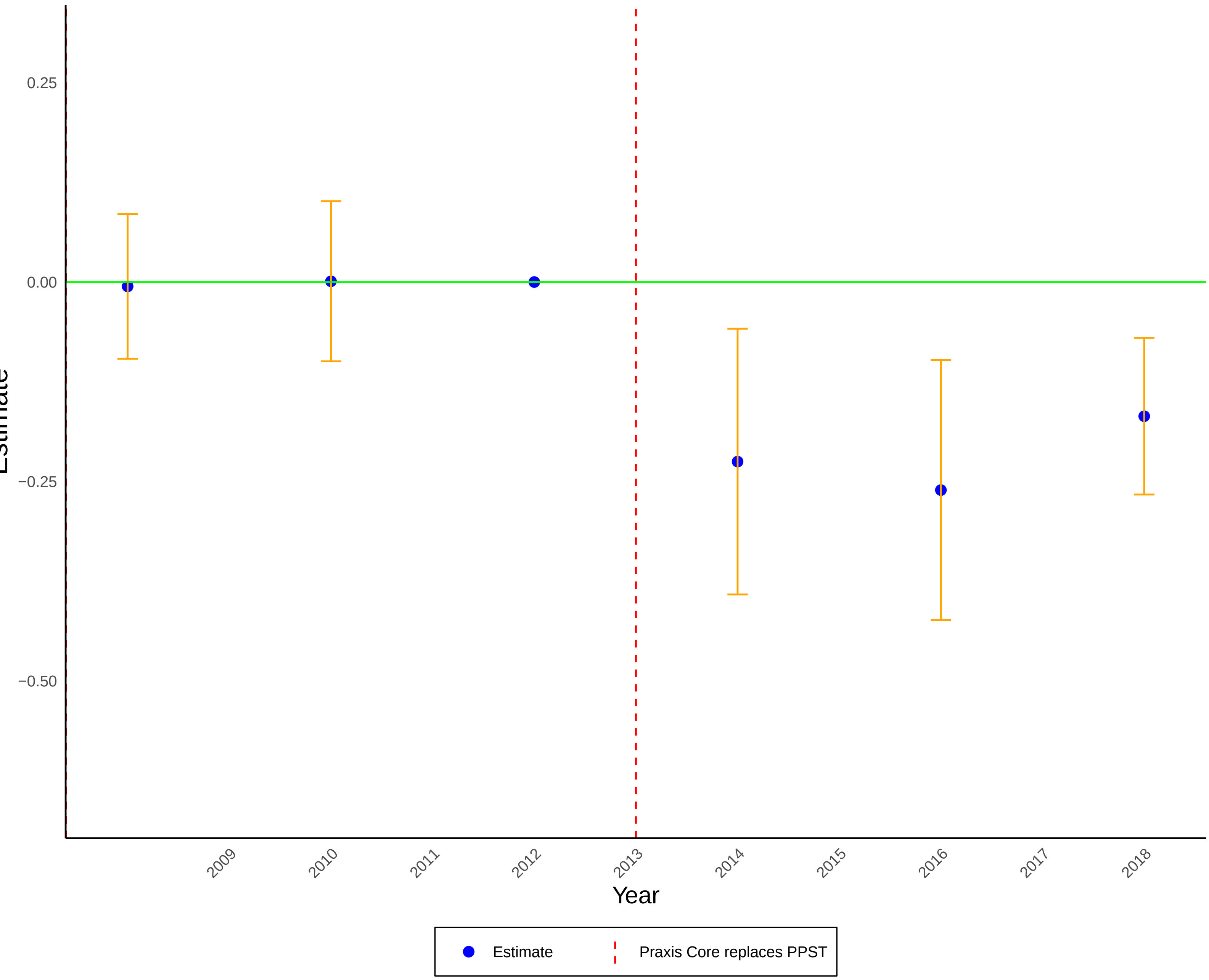
9 Figures

Figure 1: Test Difficulty Index



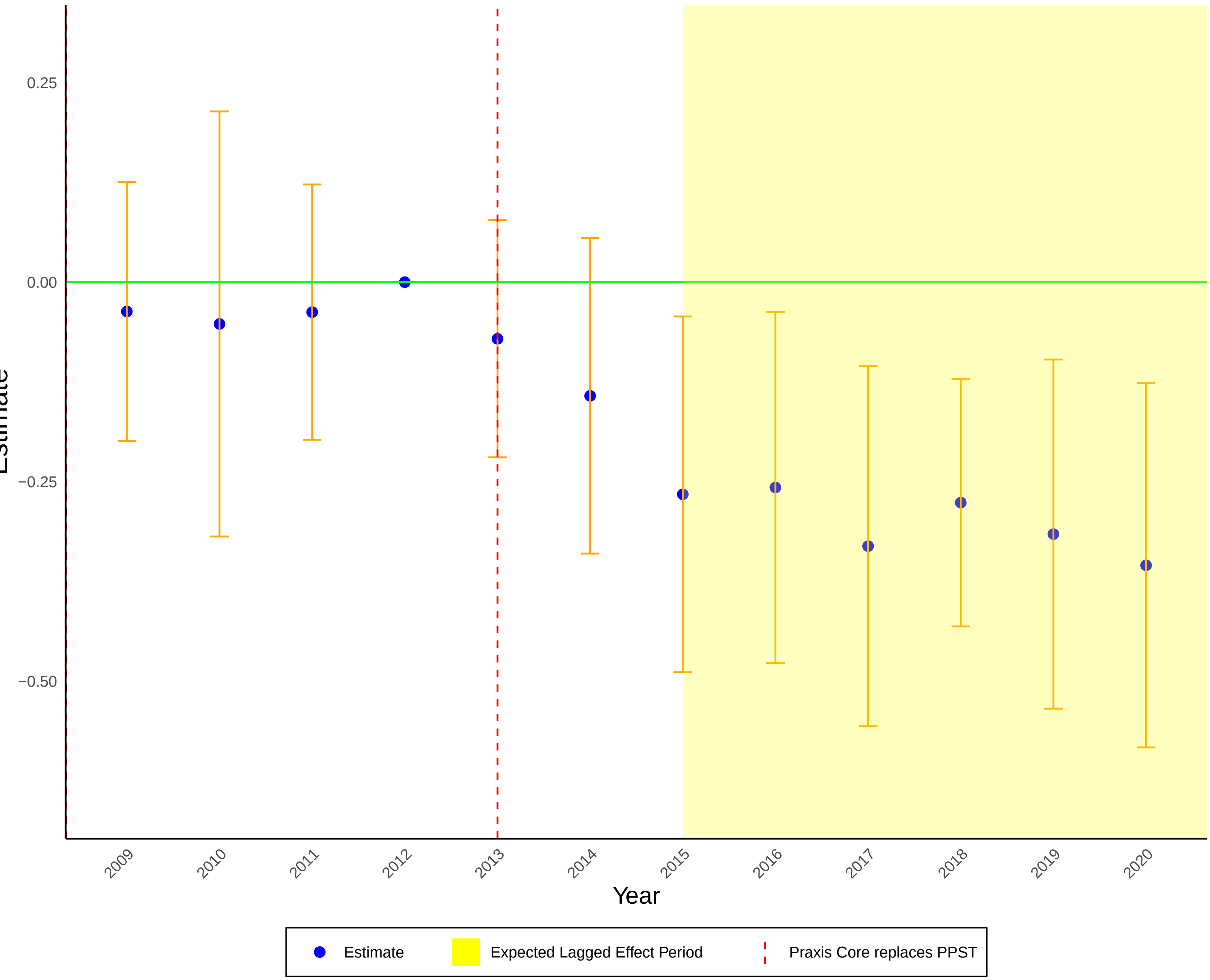
Notes: This figure shows the value the Test Difficulty Index value for each state in our sample from 2008 until 2018. The Test Difficulty Index is an equally weighted sum of the z-scores for the three components of the entry test either the Praxis Core or the PPST.

Figure 2: Education Major Enrollments Event Study



Notes: This graph depicts the estimated coefficients from Equation (2), alongside their 95% confidence intervals with log fall education major enrollments as the dependent variable.

Figure 3: Teacher Preparation Program Graduations Event Study



Notes: This graph depicts the estimated coefficients from Equation (3), alongside their 95% confidence intervals with log teacher preparation program graduates as the dependent variable.

Figure 4A: Non Education Enrollments

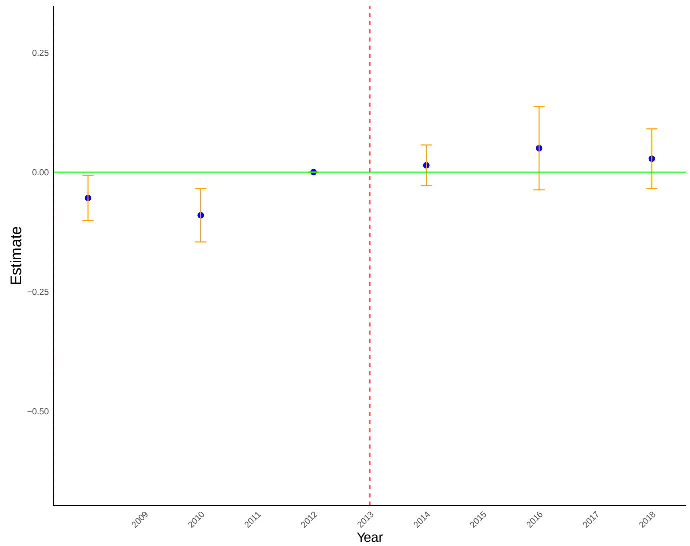


Figure 4B: Non Education Graduations

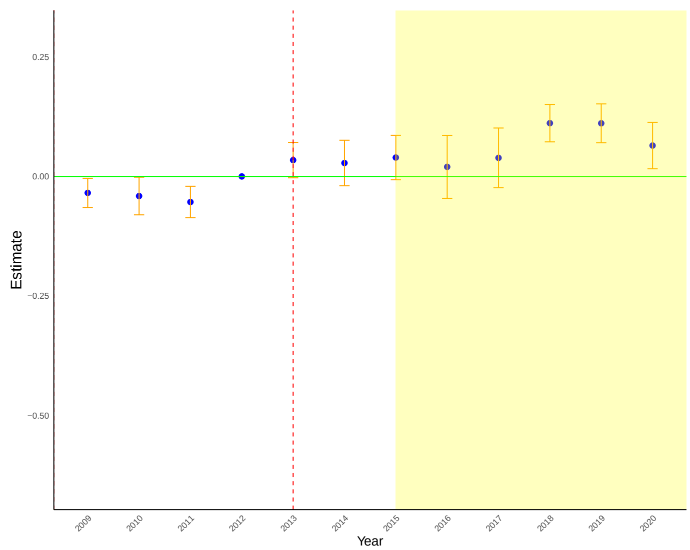
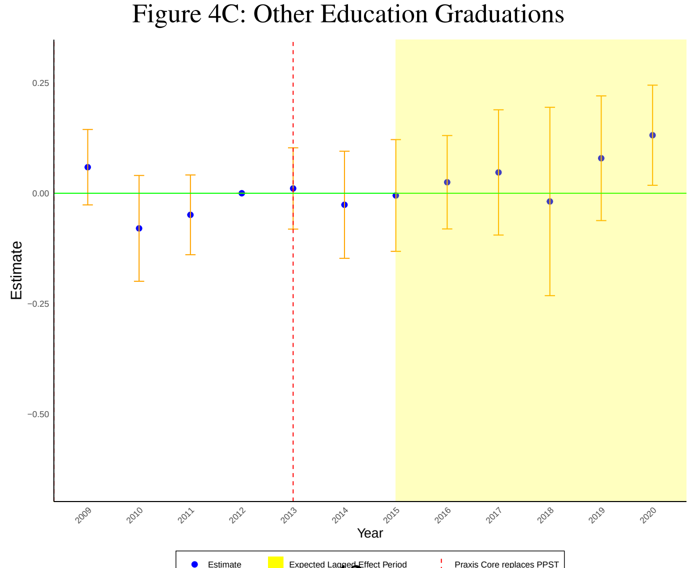
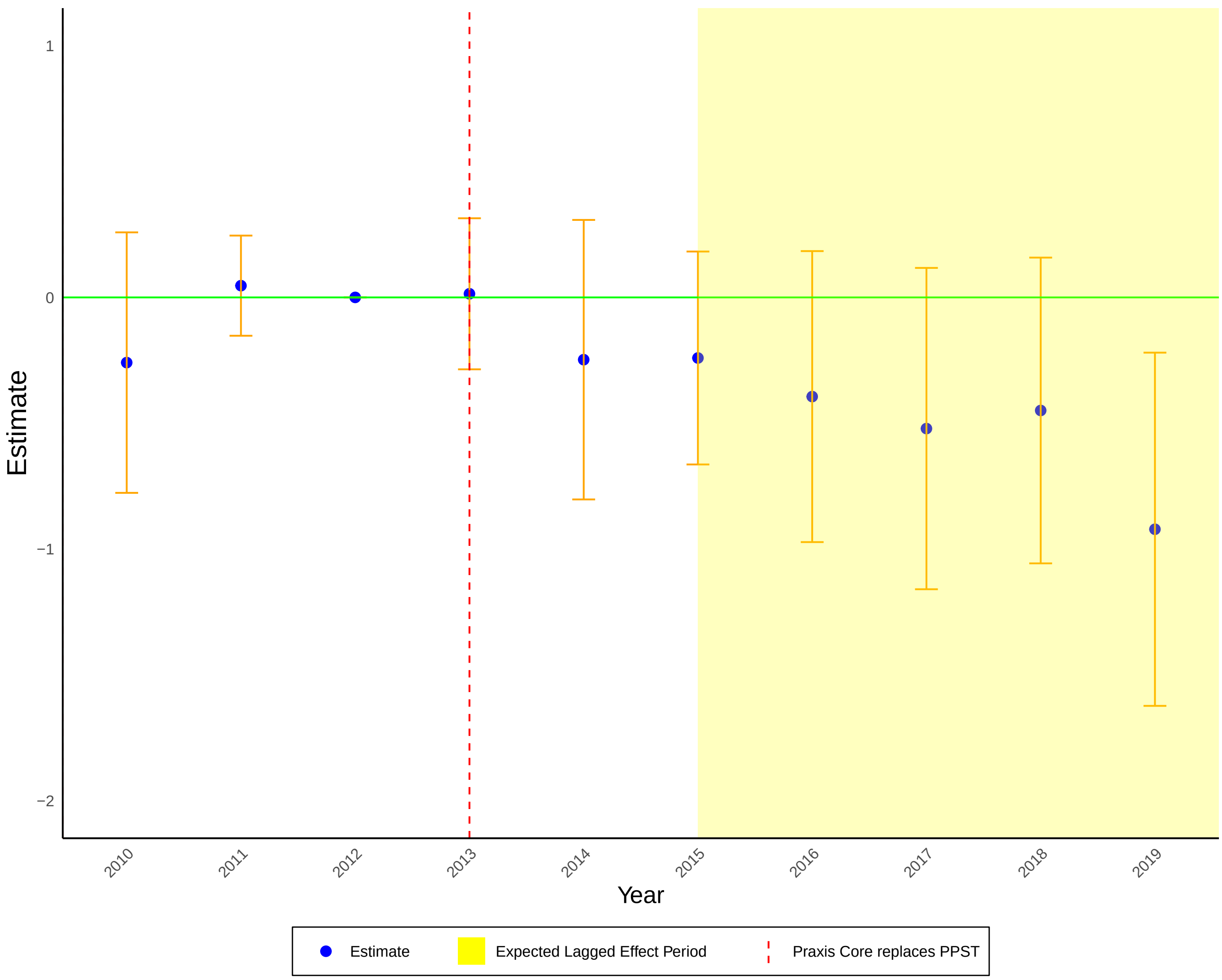


Figure 4C: Other Education Graduations



Notes: Figure 4A shows the estimated coefficients from Equation (2), while Figures 4B and 4C show the estimated coefficients from Equation (3), alongside their 95% confidence intervals.

Figure 5: New Teacher Licenses Event Study



Notes: This graph depicts the estimated coefficients from an event study where the dependent variable is log of new teacher licenses at the state-year level which includes all new teacher licenses awarded each year regardless of type. The model includes state and year fixed effects, state economic controls, and education policy controls. The regression are weighted by state population with standard errors clustered at the state. level, alongside their 95% confidence intervals.

Appendix

Appendix Figure A1

PRAXIS PPST Reading and *PRAXIS* Core Academic Skills for Educators: Reading Comparison Chart

The **Pre-Professional Skills Test in Reading** measures the ability to understand, analyze, and evaluate written texts. Varying in difficulty, the reading material is drawn from a variety of subject areas and real–life situations that educated adults are likely to encounter. Passages are drawn from both print and electronic media, such as newspapers, magazines, journals, nonfiction books, novels, online articles, and visual representations. Each passage is followed by questions that are based on its content and that relate to a variety of reading skills. All questions can be answered by using information contained within the passage; no question requires outside knowledge of the content.

The **Core Academic Skills for Educators Test in Reading** measures academic skills in Reading needed to prepare successfully for a career in education. All skills assessed have been identified as needed for college and career readiness, in alignment with the Common Core State Standards for Reading. In particular, there is an emphasis on skills that are critical to learning and achievement in teacher preparation programs. These skills include the ability to understand, analyze, and evaluate texts of different kinds. Varying in difficulty, the reading material on the test is drawn from a variety of subject areas and real-life situations that educated adults are likely to encounter. Passages are drawn from both print and electronic media, such as newspapers, magazines, journals, nonfiction books, novels, online articles, and visual representations. Each passage is followed by questions that are based on its content and that relate to reading skills. All questions can be answered by using information contained within the passage; no question requires outside knowledge of the content.

	PPST Reading (5710/0710)	**Core Reading (5712)**
Number of questions	46 multiple-choice questions (5710) 40 multiple-choice questions (0710)	56 selected-response questions
Time allotted	75 minutes (5710) 60 minutes (0710)	85 minutes
Delivery Method	Computer-delivered (5710) Paper-delivered (0710)	Computer-delivered
Content Categories	I. Literal Comprehension II. Critical and Inferential Comprehension	I. Key Ideas and Details II. Craft, Structure, and Language Skills III. Integration of Knowledge and Ideas
Types of passages	• Long passages (approx. 200 words) with 4-7 questions • Short passages (approx. 100 words) with 2 or 3 questions • Brief statements with 1 question	• Paired passages totaling approx. 200 words with 4-7 questions • Long passages (approx. 200 words) with 4-7 questions • Short passages (approx. 100 words) with 2 or 3 questions • Brief statements with 1 question
Types of questions	Single-selection multiple-choice questions	Selected-response questions, including • Single-selection multiple-choice questions • Multiple-selection multiple-choice questions • Select-in-passage questions
Scoring scale	150 - 190	100 - 200

PRAXIS PPST Writing and *PRAXIS* Core Academic Skills for Educators: Writing Comparison Chart

The **Pre-Professional Skills Test in Writing** assesses the ability to use grammar and language appropriately and the ability to communicate effectively in writing; these abilities are essential to a well-educated adult in a professional role. The multiple-choice section is designed to measure examinees' ability to use standard written English correctly and effectively. The essay section assesses examinees' ability to write effectively in a limited period of time. Experienced teachers read and evaluate each essay holistically (that is, with a single score for overall quality) under carefully controlled conditions designed to ensure fair and reliable scoring.

The **Core Academic Skills for Educators Test in Writing** measures academic skills in writing needed to prepare successfully for a career in education. All skills assessed have been identified as needed for college and career readiness, in alignment with the Common Core State Standards for Writing. The selected-response section is designed to measure examinees' ability to use standard written English correctly and effectively. The two essays assess examinees' ability to write effectively in a limited period of time. The Argumentative essay topic invites examinees to draw from personal experience, observation, or reading to support a position with specific reasons and examples. The Informative/Explanatory essay topic asks examinees to extract information from two provided sources to identify important concerns related to an issue. Experienced teachers read and evaluate each essay holistically (i.e., with a single score for overall quality) under carefully controlled conditions designed to ensure fair and reliable scoring.

	PPST Writing (5720/0720)	**Core Writing (5712)**
Number of questions	44 multiple-choice questions (5720) 40 multiple-choice questions (0720) 1 constructed-response question (both 5710 and 0710)	40 selected-response questions 2 constructed response questions
Time allotted	68 minutes (5720) – 38 minutes for the multiple-choice section and 30 minutes for the constructed-response section 60 minutes (0720) – Two 30-minute sections	100 minutes (40 minutes for the selected-response section and two 30-minute constructed-response sections)
Delivery Method	Computer-delivered (5720) Paper-delivered (0720)	Computer-delivered
Content Categories	I. Grammatical Relationships II. Structural Relationships III. Word Choice and Mechanics IV. Essay	I. Text Types, Purposes, and Production II. Language and Research Skills for Writing
Types of questions	Single-selection multiple-choice questions: • Usage • Sentence Correction Constructed-response question: • Argumentative Essay	Selected-response questions: • Usage • Sentence Correction • Revision in Context • Research Skills Constructed-response questions: • Argumentative Essay • Informative/Explanatory Essay
Scoring scale	150 - 190	100 - 200

***PRAXIS* PPST Mathematics and *PRAXIS* Core Academic Skills for Educators: Mathematics Comparison Chart**

The **Pre-Professional Skills Test in Mathematics** measures those mathematical skills and concepts that an educated adult might need. It focuses on the key concepts of mathematics and on the ability to solve problems and to reason in a quantitative context. Many of the problems require the integration of multiple skills to achieve a solution. Computation is held to a minimum, and few technical words are used. Terms such as area, perimeter, ratio, integer, factor, and prime number are used because it is assumed that these are commonly encountered in the mathematics all examinees have studied. Figures are drawn as accurately as possible and lie in a plane unless otherwise noted.

The **Core Academic Skills for Educators Test in Mathematics** measures academic skills in mathematics needed to prepare successfully for a career in education. All skills assessed have been identified as needed for college and career readiness, in alignment with the Common Core State Standards for Mathematics. Focus is on key concepts of mathematics and the ability to solve problems and to reason in a quantitative context. Many of the problems require the integration of multiple skills to achieve a solution.

In Number and Quantity, the understanding of order among integers, representation of a number in more than one way, place value, properties of whole numbers, equivalent computational procedures, ratio, proportion, and percent are emphasized. Algebra assesses the ability to handle equations and inequalities, recognition of various ways to solve a problem, relationship between verbal and symbolic expressions, and graphs. Functions questions test the knowledge of basic function definitions and the relationship between the domain and range of any given functions. Geometry assesses the understanding and application of the characteristics and properties of geometric shapes, the Pythagorean theorem, transformation, and use of symmetry to analyze mathematical situations. Knowledge of basic U.S. customary and metric systems of measurement is assumed. Statistics and Probability assesses the ability to read and interpret visual display of quantitative information, understand the correspondence between data and graph, make inferences from a given data display, determine mean, median, and mode, and assign a probability to an outcome.

	PPST Mathematics (5730/0730)	**Core Mathematics (5732)**
Number of questions	46 multiple-choice questions (5730) 40 multiple-choice questions (0730)	56 selected-response questions
Time allotted	75 minutes (5730) 60 minutes (0730)	85 minutes
Delivery Method	Computer-delivered (5730) Paper-delivered (0730)	Computer-delivered
Content Categories	I. Number and Operations II. Algebra III. Geometry and Measurement IV. Data Analysis and Probability	I. Number and Quantity II. Algebra and Functions III. Geometry IV. Statistics and Probability
Types of questions	Single-selection multiple-choice questions	Selected-response and numeric entry questions, including • Single-selection multiple-choice questions • Multiple-selection multiple-choice questions • Numeric entry questions
Calculator	Calculator not allowed	On-screen four-function calculator provided
Scoring scale	150 - 190	100 - 200

Table A1: Robustness Tests Using Alternative Samples

	(1) Main Sample	(2) Include ND	(3) Include TN	(4) Exclude PA and SC 2018
Panel A: Enrollments				
TDI	-0.23**	-0.23**	-0.25**	-0.23**
	(0.07)	(0.06)	(0.07)	(0.06)
Observations	2,892	2,963	3,123	2,765
Mean enrollments	566	566	561	580
Number of universities	507	520	550	499
Panel B: Graduations				
TDI	-0.23**	-0.23**	-0.23**	-0.22**
	(0.07)	(0.07)	(0.07)	(0.07)
Observations	5,780	5,924	6,235	5,664
Mean graduates	124	124	123	125
Number of universities	507	520	550	507

Notes: Each column represents a separate regression. The dependent variable in regressions under Panel A is the log of the number of fall education enrollments and in Panel B is the log of the number of teacher preparation program graduates. Robust standard errors clustered at the state level are displayed in parentheses. All regression results are weighted by state population. All regression results are weighted by state population and include university fixed effects, year fixed effects, state economic controls (unemployment rate and median income from census data), state education policy controls (including teacher accountability reforms, elimination of teacher tenure, lengthening of the probationary period, weakening of teacher unions, receipt of a federal Race to the Top grant, adoption of Common Core standards, and year when edTPA was implemented), and university-level controls (such as average 25th and 75th percentile SAT scores, SAT or ACT test-optional policy indicator, percentage of students receiving federal Pell grants, percentage of students receiving student loans, average dollar amount of federal Pell grants awarded, average dollar amount of student loans awarded, and total enrollment) as specified in equation (1). ** $p<0.01$, * $p<0.05$

Table A2: Event Study Coefficients

	Enrollments	Graduations
Coefficient: 2008	-0.005	-
	(0.05)	
Coefficient: 2009		-0.04
		(0.08)
Coefficient: 2010	-0.001	-0.05
	(0.05)	(0.14)
Coefficient: 2011		-0.04
		(0.08)
Leave Out Year: 2012		
Coefficient: 2013		-0.07
		(0.08)
Coefficient: 2014	-0.22**	-0.14
	(0.08)	(0.10)
Coefficient: 2015		-0.27**
		(0.11)
Coefficient: 2016	-0.26**	-0.26**
	(0.08)	(0.11)
Coefficient: 2017		-0.33**
		(0.11)
Coefficient: 2018	-0.16**	-0.28**
	(0.05)	(0.08)
Coefficient: 2019		-0.32**
		(0.11)
Coefficient: 2020		-0.35**
		(0.12)
Observations	2,896	5,784
Mean dependent variable	566	124

Notes: This table presents the event study coefficients from equation (3). The dependent variable in column (1) is the log of the number of education major fall enrollments. The dependent variable in column (2) is the log of the number of teacher preparation program graduates in a university-year. Each regression includes university and year fixed effects. Robust standard errors clustered at the state level are displayed in parentheses. Regression are weighted by state population. ** $p<0.01$, * $p<0.05$