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The Effects of Economic Conditions on the Labor Market for Teachers

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Prior research has found that economic downturns have positive effects on new teacher quality, but has not been able to determine the extent to which this relationship arises from a supply response (increased quantity or positive selection of teaching candidates) vs. a demand response (selection in hiring enabled by falling demand). In this paper, I use longitudinal data on students and teachers in Massachusetts to describe the effects of higher unemployment rates on both supply and demand for teachers. I show that students who graduate from college when unemployment rates are higher are more likely to take a teacher certification test, and that this effect is stronger among students who were higher achieving while in high school. On the demand side of the market, higher unemployment reduces new teacher hiring and the overall number of teachers employed, but I find no evidence that schools differentially employ higher achieving teaching candidates during economic downturns. While I cannot definitively rule out changes in demand-side selection, I show that much of the positive relationship between unemployment rates and teacher quality can be explained by positively selected supply. My results suggest that economic incentives impact both the quantity and the quality of new teaching candidates, with implications for attracting and retaining high-quality teachers outside of economic downturns.

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The Effects of Economic Conditions on the Labor Market for Teachers

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Abstract

Prior research has found that economic downturns have positive effects on new teacher quality, but has not been able to determine the extent to which this relationship arises from a supply response (increased quantity or positive selection of teaching candidates) vs. a demand response (selection in hiring enabled by falling demand). In this paper, I use longitudinal data on students and teachers in Massachusetts to describe the effects of higher unemployment rates on both supply and demand for teachers. I show that students who graduate from college when unemployment rates are higher are more likely to take a teacher certification test, and that this effect is driven by students who were higher achieving while in high school. On the demand side of the market, higher unemployment reduces new teacher hiring and the overall number of teachers employed, but I find no evidence that schools differentially employ higher achieving teaching candidates during economic downturns. While I cannot definitively rule out changes in demand-side selection, I show that much of the positive relationship between unemployment rates and teacher quality can be explained by positively selected supply. My results suggest that economic incentives impact both the quantity and the quality of new teaching candidates, with implications for attracting and retaining high-quality teachers outside of economic downturns.

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1 Introduction

Teacher shortages are a perennial policy concern in the United States. Local variation in the extent of shortages, combined with low quality data, can make it difficult to characterize teacher shortages nationally, and researchers disagree on the exact nature and extent of teacher shortages (Edwards et al., 2022; Fortin & Fawcett, 2022; García et al., 2022; Bleiberg & Kraft, 2023). National statistics show, however, that teacher preparation enrollment and new teacher certifications have been falling in recent decades (NCES, 2022). As of 2022, about 200,000 teaching positions nationally were either unfilled or held by teachers who were not fully certified (Nguyen et al., 2022). Within- and between-district differences in the extent of shortages also tend to reinforce existing inequalities: teacher shortages are concentrated in disadvantaged schools (Cowan et al., 2016). The COVID-19 pandemic has exacerbated concerns of a national crisis in teaching. Although rates of teacher turnover remained relatively flat in the early years of the pandemic, teacher retention in several states fell sharply entering the 2022-23 school year (Barnum, 2023).

While concerns over falling teacher supply and retention are not new, relatively little is known about how students make decisions about entering teaching. Existing research suggests that teacher pay plays an important role in driving supply and quality, both overall and specifically at hard-to-staff schools (Steele et al., 2010; Clotfelter et al., 2008; Dizon-Ross et al., 2019; Fullard & Zuccollo, 2021). Outside options also affect supply and disparities in supply across subject areas: women's expanding access to the workforce between 1960 and 1990 corresponded to a reduction in the likelihood of entering teaching among women with stronger academic credentials (Bacolod, 2007), and evidence suggests that high-performing teachers can receive higher wage returns to their skills outside the classroom, potentially contributing to such teachers being more likely to leave the profession (Podgursky et al., 2004; Chingos & West, 2012). Non-wage benefits such as tenure protections and defined-benefit pensions likely also play a role in driving teacher supply. Teachers tend to be risk-averse (Bowen et al., 2015; Lang & Palacios, 2019), and the removal of these non-wage benefits between 2011 and 2016 caused declines in both teacher preparation completion and teacher licensure (Kraft et al., 2020).

One consistent fact in the teacher labor markets literature is that teacher quality is countercyclical. Evidence shows that economic downturns can reduce unfilled positions (Falch et al., 2009) and that teachers hired during downturns tend to have stronger academic credentials and higher value-added (Nagler et al., 2020; Fraenkel, 2022). This relationship could be driven by either supply or demand factors: on the one hand, teaching may become more appealing during economic downturns, driving an overall increase in supply and supply-side selection of teaching candidates. On the other hand, shrinking school budgets during downturns may reduce hiring and thereby enable schools to be more selective, increasing teacher quality even absent any supply-side response.

Understanding which of these two mechanisms dominates is crucial to deriving policy implications from the relationship between economic conditions and teacher supply and quality. In particular, if the effect operates primarily on the supply side (by increasing the number of teaching candidates and improving candidate quality), then uncovering the mechanisms behind this effect can inform policy to attract and retain teachers outside of downturns. Prior research on this topic has found inconclusive results. Studies find positive, negative, and neutral effects of economic conditions experienced in college on interest in education or teaching (Ersoy, 2020; Blom et al., 2021; Deneault, 2023). Little research has studied the demand side of the market, although Griffith (2020) shows that the number of new teaching positions fell during the Great Recession, and Fullard (2021) suggests that demand-side constraints during downturns may act to increase diversity among teaching candidates. The question of how teacher supply and demand interact to affect teacher quality during economic downturns therefore remains unanswered, particularly as it pertains to downturns at the end of college, when many students are making career decisions.

In this paper, I use longitudinal data on students in Massachusetts in combination with teacher personnel data to describe how economic downturns at career start affect both supply and demand in the market for teachers. I observe students beginning during their K-12 education and follow them through higher education and into the teacher pipeline. For teaching candidates who attended Massachusetts public schools as students during my sample period, I therefore observe not only their certification test performance and performance in the classroom, but also their test scores while in high school and information about their college attendance and field of study. The richness of my data enables me to ask how higher unemployment rates at career start affect both overall entry into teaching and selection into teaching based on prior measures of graduates' academic achievement.

To do this, I use a fixed-effects design to measure the effects of higher unemployment rates around students' college graduation on the likelihood that students enter the teacher pipeline, as measured by taking a certification test, and assess how the effect of higher unemployment differs depending on students' test scores in high school. I find that students who graduate college into a recession are more likely to take the teacher certification test. The effect is stronger for students with higher state test scores and persists for up to three years after college graduation.

I next ask how higher unemployment affects demand for teachers, using teacher turnover and new hiring rates as proxies for demand. I show that while overall teacher turnover rates are unaffected by higher unemployment, new hiring fell during the Great Recession and took several years to recover. This drop in demand means that higher unemployment has an overall negative effect on the likelihood that any college graduate actually enters the classroom as a teacher soon after college graduation. This negative effect fades out more quickly for students with higher state test scores.

Finally, I ask how the relationship between teaching candidates' test scores and their likelihood of eventual hire responds to economic downturns to ask whether demand-side selection is affected by higher unemployment. I find that among certification test-takers, both high school test scores and certification test scores are positively associated with getting a teaching position. If anything, higher unemployment *weakens* this relationship, suggesting that teacher hiring during economic downturns may favor candidates with lower test scores as compared to hiring outside of downturns. The point estimate is small in magnitude, however, and I cannot rule out selection on other (unobservable) measures of preservice teacher quality.

Consistent with prior literature, I show that teachers who graduated from college during the Great Recession have higher preservice test scores and higher value-added than their peers. My results suggest that positive selection of new teaching candidates during economic downturns plays an important role in generating this countercyclical relationship between economic conditions and teacher quality. This result should be encouraging to policymakers, as it implies that it may be possible to increase novice teacher quality by determining what makes teaching more appealing during economic downturns and using policy to replicate those factors when economic conditions are good.

The remainder of this paper proceeds as follows. Section 2 describes the data. Section 3 gives context for the Massachusetts teacher certification process and time trends in my sample. Section 4 describes the empirical strategy. Section 5 summarizes the results. Section 6 discusses my findings and some additional effects of unemployment on the labor market for teachers, and Section 7 concludes.

2 Data

2.1 Administrative Data

This project relies primarily on administrative data provided by the Massachusetts Department of Elementary and Secondary Education (MA DESE). The MA DESE data contains information on students who were ever enrolled in K-12 public schools between the 2002-03 school year and the 2019-20 school year, and on teaching candidates and teachers who either took a certification test or received a license between 2003 and 2023, or were employed in the public schools between the 2007-08 and the 2022-23 school years. The state generates a unique identifier for each student and each teaching candidate in the data, but does not create a crosswalk between the two. Instead, I identify former students in the teacher data using a fuzzy match based on names and birthdates.

2.1.1 Student Data

Most student information is contained in the Student Information Management System (SIMS). The SIMS data contains annual enrollment and demographic information for all traditional public and public charter school students in Massachusetts, including where students enrolled, their race and gender, and indicators for immigration status, eligibility for free/reduced price lunch, limited English proficiency, and receipt of special education services.[1] In addition to enrollment data for K-12 public school students, I observe students' scores on state standardized tests in grades 3-10 and SAT scores for students who took the exam between 2007 and 2019.

Student higher education data comes from the National Student Clearinghouse (NSC) via MA DESE. Overall, 95% of students in the analysis sample match to a record in the

[1] A complete list of the variables contained in the SIMS data can be found on the MA DESE website here: https://www.doe.mass.edu/infoservices/data/sims/.

NSC, and 65% of students have at least one postsecondary enrollment record. For any student who is matched to an enrollment record in the NSC, the NSC reports the school where the student was enrolled, the level of the program in which they were enrolled (two-year, four-year, or post-baccalaureate), and a graduation date, degree field, and degree level if they graduated. For about 35% of students, the NSC also reports one or more fields associated with enrollment regardless of whether a degree was earned. The NSC data are reported at the term level, such that a student who attended a four-year college on a semester schedule, graduated in four years, and never pursued an additional degree would appear eight times in the data.

2.1.2 Teacher Data

In addition to the student data, I use three datasets covering teaching candidates and teachers in the state. The Massachusetts Tests for Educator Licensure (MTEL) data, provided by the Pearson testing company, contains demographic information for each prospective teacher who took any MTEL tests, as well as the date, score, and result (pass/fail) of each test they took. The Educator Licensure and Recruitment system (ELAR), maintained by the state, contains the issue and expiration dates of any licenses a teacher received, as well as the type of license (temporary, provisional, initial, or professional) and the licensure field and grade level. Both the MTEL and the ELAR data span the years of 2003-2023. Finally, the Education Personnel Information Management System (EPIMS), also maintained by the state, identifies whether teaching candidates were placed in schools, where they were placed, and what their position was in each year from 2007-08 through 2022-23.

All three teacher datasets contain teachers' full names and birthdates, as well as a unique identifier for merging teaching candidates and teachers across the three datasets. In theory, students can be matched to any one or two of the teacher datasets without being matched to all three. In practice, it is very rare for anyone to appear as a teacher without also appearing in the MTEL data, but more common for teachers to appear in the MTEL or EPIMS data without receiving a license.

2.2 Economic Data

My primary measure of economic conditions is annual unemployment at the county level, drawn from the Bureau of Labor Statistics Local Area Unemployment Statistics (LAUS). In robustness checks, I test the sensitivity of my results to using the labor force participation rate and the employment/population ratio, both of which are calculated using the LAUS in combination with county-level population estimates from the Census Bureau.

2.3 Summary Statistics

My analysis sample consists of K-12 public and charter school students in the high school graduating classes of 2005 through 2013.[2] Table 1 contains summary statistics for this sample. Students in the sample are 70% White, 15% Hispanic or Latino, 9% Black, and 5% Asian.[3] About 71% of students in the sample earned a high school degree, and just under 50% ever enrolled at a four-year college prior to 2020. These shares are slightly lower than current graduation and college-going rates in the state, but match MA DESE's posted estimates for the time period covered by my sample. 29% of students in my sample (across all races) earned a four-year college degree by 2020.

Overall, 2.1% of students in this sample took the state's required teacher certification test within nine years of graduating from high school,[4] representing 7.1% of four-

[2] I observe implausibly low shares of students becoming teachers prior to 2005. I cut off the sample with the high school graduating class of 2013 because most students take at least 5-6 years after graduating high school to become a teacher, making the classes of 2014 onward more likely to have their teacher entry behavior affected by the COVID-19 pandemic than earlier cohorts.

[3] As of the 2022-23 school year, only about 54% of Massachusetts K-12 public school students were White.

[4] See Section 3 for a description of the teacher certification process.

year college enrollees and 9.6% of four-year degree holders. About 2.5% of four-year degree holders from the high school classes of 2005-2013 became teachers in Massachusetts public schools within six years of graduating from high school, and an additional 2.6% became teachers between 7-9 years following their high school graduation. Alumni of Massachusetts public schools make up about 58% of Massachusetts teachers in an age-matched sample.

3 Context

Novice teachers in Massachusetts are generally eligible to earn either a provisional or an initial license. To earn either type of license, a teaching candidate must have a bachelor's degree (in any field) and pass the Massachusetts Tests for Educator Licensure (MTEL) Communications and Literacy Skills Test (CLST), as well as one or more grade- and field-specific subject tests.[5] Both types of license are valid for five years of employment, but an initial license, which may be extended one time (valid for a total of ten years), additionally requires teachers to complete a teacher preparation program and earn a credential for Sheltered English Immersion. Over 60% of teachers in my sample started teaching under an initial license, although there is significant variation by race in novice teachers' licensure status (Rucinski, 2023).

Students typically take the CLST at least one year after graduating high school, as shown in Figure 1. Of the 10.3% of college graduates in the classes of 2005-2013 who took the CLST by spring 2023, 93% did so within nine years of graduating high school. Overall, just over half of CLST takers in my sample took the exam within four years following high school graduation (i.e., by the time they would have graduated from college if they completed a four-year degree on time). If they fail the test, teaching candidates may retake

[5]From June 2020 through November 2023, novice teachers could also earn an emergency license, which for most fields required a bachelor's degree but had no certification testing requirement.

it as many times as they would like until they pass. In this sample, 72% of candidates pass the test on the first attempt, and retaking rates are high: 84% of candidates who fail on the first attempt retake the test, and the overall pass rate on any attempt is 91%.

Panels A and B of Figure 2 show the share of Massachusetts college graduates in the classes of 2005-2013 who took the CLST or became a teacher within nine years of their high school graduation year, while Panel C shows county-level trends in unemployment. As shown in the figure, there is substantial between-county variation in both unemployment rates and teacher entry, motivating the use of county fixed effects in my analysis (as described in the next section). There is, however, some variation within counties over time. Rates of CLST taking are highest in the high school class of 2005 and decline for about four years thereafter, leveling out from the high school class of 2009 through the class of 2013. All counties experienced a sharp increase in unemployment between 2007-2009, followed by a relatively slow recovery between 2009-2013 and a steeper recovery from 2013-2018.

4 Methods

4.1 Teacher Supply

To assess the relationship between economic conditions and entry into teaching, I run the following regression:

$$Y_{ihct} = \alpha_c + \beta Unemployment_{hc} + \gamma \mathbf{X}_i + \varepsilon_{ihct} \tag{1}$$

where Y_{icht} is an indicator equal to 1 if student i who was in the high school graduating class h in county c took the CLST or became a teacher in Massachusetts public schools within t years following their college graduation; α_c is a county fixed effect, $Unemployment_{hc}$ is a county- and cohort-specific measure of average unemployment around a cohort's expected college graduation year, and X_i is a vector of individual controls for gender, race, and low income status.[6] My preferred specification restricts to college graduates for precision, but results are robust to including the full sample of high school graduates.

In this specification, β measures the relationship between teacher entry and within-county changes in economic conditions over time. County fixed effects account for relatively stable characteristics of counties, such as demographics and income, that may be correlated with between-county differences in teacher entry, but do not account for time trends that are common to all counties. As a result, my observed effects reflect both local fluctuations in economic conditions and statewide shocks. Because Massachusetts is a small state and counties experienced similar trends in unemployment during the Great Recession (see Figure 2), students may respond to statewide conditions as much as to local conditions. On the other hand, many students do return to their home counties to teach, making the unemployment rate in their home county potentially more relevant than it might be for other careers. In practice, results are similar regardless of whether I use a county- or state-level measure of unemployment.

4.2 Teacher Demand

Demand for teachers is difficult to measure directly. Current job postings may appear online, but are not a precise measure of demand since districts often post single listings for openings in multiple grades and subjects, and past openings—even in the recent past—are not directly observable at all. To proxy for teacher demand, I measure how teacher turnover changes in response to economic conditions. Specifically, I run the following

[6] I define a student as low income if they were eligible for free or reduced-price lunch during a majority of the years that I observe them in the data.

regression:

$$Retained_{ict} = \alpha_c + \beta Unemployment_{ct} + \varepsilon_{ict} \tag{2}$$

where Y_{ict} is an indicator for whether teacher i employed in county c in the spring of year t returns to teaching in any Massachusetts public school in the fall of year t, α_c is a county fixed effect, and $Unemployment_{ct}$ is the annual unemployment rate in county c and year t.[7] As with the analysis in the previous section, effects observed in this regression may arise from both local and statewide changes in unemployment, both of which are likely to be important determinants of voluntary or involuntary changes in teacher turnover.

I run the regression separately in bins of teacher experience to allow the effects of economic conditions on teacher retention to vary by experience. The variance in effects could come from both the teacher side and the school/district side: on the one hand, teachers at different levels may have different beliefs about their outside options, and thus respond differently to economic downturns (or upturns). On the district side, incentives to retain individual teachers are likely to be correlated with experience through its relationship with pay. Importantly, variation by teacher experience in the effects of economic conditions has implications for teacher demand, again due to the relationship between pay and experience: if older teachers are more (less) likely to depart during economic downturns, this will raise (lower) teacher demand relative to a case where younger teachers are more (less) likely to depart.

4.3 Selection

I assess selection in the supply response to economic downturns using students' scores in 10th grade on the math and reading components of the state test, the Massachusetts

[7] I do not include demographic controls. Because over 90% of teachers in Massachusetts are White and about 80% are female, including demographic controls has essentially no effect on the point estimates.

Comprehensive Assessment System (MCAS). The 10th-grade MCAS is required for high school graduation.[8] To do this analysis, I simply run regression 1 separately for students who scored above/below the median on their first take of the 10th-grade MCAS.

As well as exploring supply-side selection, I test for one (limited) measure of demand side selection using the following regression:

$$Teach_{ihc} = \alpha_c + \beta_1 Score_i + \beta_2 Treatment_{hc} + \beta_3 Score_i \times Treatment_{hc} + \varepsilon_{ihc} \tag{3}$$

In this regression, restricted to CLST takers, $Teach_{ihc}$ is a binary indicator equal to 1 if a student becomes a teacher within a set number of years following their college graduation. β_1 measures how the likelihood of becoming employed as a teacher changes with a candidate's test score (on either the MCAS or the CLST), while β_3 measures how this relationship changes in response to unemployment rates. Because neither MCAS nor CLST scores are actually visible to schools[9], this can be thought of as a test for selection based on correlates of MCAS or CLST performance that are unobservable in administrative data, but that schools may observe and use to select teachers, such as greater subject matter expertise or more advanced college coursework.[10]

Finally, I assess total selection into teaching as a result of economic downturns using the following regression:

$$Y_{ihc} = \alpha_c + \beta Unemployment_{hc} + \gamma X_i + \varepsilon_{ict} \tag{4}$$

[8] I find similar results using SAT scores, and focus on MCAS scores because they are available for all cohorts in my analysis, while SAT scores are available only for the classes of 2007 onward.

[9] CLST scores are typically not even available to candidates themselves unless they have failed the test.

[10] Even so, this test for selection is limited in two major ways. First, schools may differentially select teaching candidates during downturns using measures of teacher quality that are both unobservable in the data and only weakly correlated with MCAS or CLST scores. Second, a non-zero β_3 could indicate either that schools select candidates differently during downturns, or that candidates at different points on the achievement distribution differentially change their willingness to become teachers in response to changing unemployment.

I show results separately for students who became teachers within two or five years of college graduation. I test for selection on three different measures: 10th-grade MCAS scores, CLST scores, and teacher value-added. In this regression, a positive (negative) β would indicate that teachers who experienced higher unemployment as students have higher (lower) prior test scores or value-added as teachers. This overall relationship between unemployment and teachers' academic credentials or value-added encompasses any supply-side heterogeneity in the response to unemployment in combination with any changes in demand-side selection behavior.

I describe the construction of the value-added sample and calculation of value-added scores in Appendix B. While teacher value-added is likely a more reliable measure of teacher quality than teachers' prior test scores, it is available for fewer than 10% of teachers in my full sample. In Appendix Table A3, I show that both MCAS and CLST scores are positively correlated with teacher value-added, especially in math. This motivates testing for selection on test scores for teachers for whom value-added is not available.

5 Results

5.1 Teacher Supply

I find that higher unemployment at the time that students graduate from college has a large positive effect on the likelihood that they take the CLST just before or soon after their graduation, as shown in Panel A of Figure 3. Students who graduate from college when the average unemployment rate is 1 percentage point higher are 0.16 percentage points more likely to take the CLST during their junior or senior year of college, and 0.46 percentage points more likely to have taken the test by the third year following their college graduation, after which the effect levels out.

Panel B of Figure 3 further examines this teacher supply effect by illustrating the effects of higher unemployment on the likelihood that students take any of the additional tests required to be certified as a teacher in general elementary teaching, elementary/middle school STEM subjects, high school STEM subjects, or humanities. While it appears that much of the increased interest in teaching during economic downturns may arise from students in the humanities, there are small positive effects on high school STEM certification tests: a one percentage point increase in average unemployment at college graduation is associated with a 0.07 percentage point increase in the likelihood that a college graduate will have taken a high school STEM certification test by their third year following graduation, a 10% increase over the baseline rate. This effect is larger in percentage terms than the effects on humanities or general elementary subject tests of 6% and 4%, respectively.

Because the oldest cohort I observe would have graduated from college around the peak of the Great Recession in 2009, there is some concern that these effects capture a general downward trend in interest in teaching. Three pieces of evidence, however, support a real effect of economic conditions. First, as shown in the figure and mentioned above, the positive effect of higher unemployment on CLST taking levels out around three years following students' expected college graduation. This fade-out would be unexpected from a cohort effect, but makes sense if the effects are a reflection of students responding to economic conditions in their early career years.

Second, and related, Figure 1 shows when students in different cohorts took the CLST relative to their college graduation. If my results reflected an overall downward trend in interest in teaching, we would expect later cohorts to be less likely to take the CLST at every point. Instead, the likelihood of taking the CLST is similar across all cohorts during the college years, and only starts to diverge around the time of college graduation. The fact that significant between-cohort differences in CLST taking arise only around college graduation is inconsistent with a secular downward trend in interest in teaching.

Finally, Figure A1 illustrates the total number of CLST takers around college graduation age who took the test each year, including test takers who did not attend Massachusetts public schools. While the figure does show a decline over time, it also illustrates that this trend was not only halted, but actually reversed during the Great Recession. Although I do not observe enough student cohorts to incorporate this pre-period into my fixed effects analysis, assuming that test-taking trends for Massachusetts public school students followed the overall trend, it is likely that my results would be robust to including earlier cohorts.

Panel C of Figure 3 shows that the positive effects of unemployment on CLST taking do not translate into positive effects on actual teacher entry. Instead, a one percentage point increase in unemployment is associated with a 0.09 percentage point decline in the likelihood that a college graduate will enter a public school teaching position in the fall immediately following (on time) college graduation. While the effect of unemployment on teaching turns positive after two years (shown in Table 2), the point estimate (0.03) is much smaller than the initial negative effect, resulting in a negative effect on cumulative teaching starts that persists until 4-5 years after college graduation.

If much of the increase in teacher supply occurs in non-shortage areas, as suggested by Panel B of Figure 3, then we might not expect to see a corresponding increase in the likelihood of employment. Absent any demand-side factors, however, rising supply should not actually *reduce* the share of college graduates who find employment as teachers. The observed negative employment effect therefore motivates exploring the demand side of the market in the following section.

5.2 Teacher Demand

Since I cannot observe teacher demand directly, I proxy for demand using retention of existing teachers. With relatively stable enrollment, higher rates of teacher retention should correspond to lower demand for new teachers. Figure 4, Panel A shows the effects of increases in county-level unemployment on the likelihood that a teacher employed in a given county in the spring will return to public school teaching (anywhere in Massachusetts) in the fall, with teachers grouped by their years of experience.[11] In Massachusetts, teachers are eligible for tenure at the end of their third year of teaching.

The figure shows that there is heterogeneity by experience in the effects of unemployment on retention, although the estimates are noisy. Teachers in the pre-tenure years see a small (and imprecisely estimated) reduction of 0.27 percentage points in the likelihood of returning to teaching when annual unemployment is one percentage point higher, compared to an average retention rate of 77%. Teachers near the margin of retirement at 21-25 years of experience have the largest estimated impact of unemployment on retention, with a point estimate of -0.65 percentage points. Although the effect is statistically significant, the standard error is large and the effect remains practically small: on average, 91% of teachers with 21-25 years of experience are retained each year. A 0.65 percentage point reduction in this retention rate represents a change of less than 1%.

The heterogeneous effects illustrated in Panel A of Figure 4 add up to a small negative effect on retention across all experience groups—0.2 percentage points compared to an average overall retention rate of about 81%—as shown in the figure and in Table 4. The effects of economic downturns likely vary widely across schools and districts, and these results would suggest that on average, economic downturns do not meaningfully impact teacher turnover. Still, the figure provides two pieces of evidence that schools experi-

[11] I include the school year ending in the spring in experience calculations, so the least experience I can assign to an existing teacher is one year.

ence budget constraints with rising unemployment. First, the negative effect on retention for teachers without tenure is consistent with layoff policies that target less experienced teachers.[12] Second, the negative retention effect for highly experienced teachers is consistent with schools encouraging these more expensive teachers to retire during economic downturns.

To further explore the possibility of budget constraints, I illustrate an alternative measure of demand: new hiring. Panel B of Figure 4 plots the number of classroom teachers hired in Massachusetts public schools in each year from 2004 through 2019. Because my teacher personnel data begins in 2007, I observe teachers who were hired prior to 2007 only if they remained in teaching at least through the fall of 2007. As a result, there is a steep upward slope in the number of new hires observed from 2004 to 2007. Rather than leveling off after 2007, however, the number of new hires falls precipitously in the fall of 2008, from 9,502 to 7,940. It then makes a slow recovery, never again reaching its 2007 peak.[13] This pattern in new hiring at the state level is consistent with schools facing budget constraints during the Great Recession that limited their hiring (even more so because teacher turnover was unchanged), and helps to explain why students who graduated from college at this time were less likely to become teachers despite being more likely to enter the teacher pipeline.

5.3 Selection

Among college graduates, entry into the teacher pipeline declines with student achievement while in high school, as shown in Figure 5.[14] Test scores are a limited measure

[12]Given the teacher supply effects of unemployment documented in the previous section, it seems reasonable to expect that less experienced teachers would also have stronger preferences to remain in teaching if possible when unemployment is high, which could push the overall effect towards zero.

[13]Although not shown, the trend is the same when adjusted for statewide public school enrollment.

[14]Among high school graduates, the relationship is inverse U-shaped for both MCAS and SAT scores, shown in Figures A4 and A5.

of potential teacher quality, but attracting higher achieving students into teaching is frequently cited as a policy goal. Furthermore, Table A3 shows that both MCAS and CLST scores do predict teacher value-added. To what extent can economic downturns change the relationship between academic credentials and teacher entry?

Figure 6 replicates Figure 3, separating students with below median and above median composite MCAS scores.[15] Panel A shows that both above- and below-median students become more likely to take the CLST in response to economic downturns. Although the point estimates are similar for both groups, Panel A of Figure A6 shows that on average, above-median students are 15% less likely to have taken the CLST by five years following their college graduation. Thus, while the point estimates in Panel A represent roughly a 7.6% increase in the likelihood that below-median students take the CLST within five years, they amount to a 10.3% increase in the likelihood that above-median students take the test within the same time frame. A one percentage point increase in average unemployment at college graduation is associated with a 0.7 percentile point increase in 10th-grade MCAS scores among CLST takers who took the test within five years of college graduation (over a mean of 45.9).

Panel B of Figure 6 shows heterogeneity in the effect of higher unemployment at college graduation on actual teacher entry. As was the case in the full sample, both above- and below-median students see negative effects on teacher entry in the fall immediately following college graduation. For lower achieving students, the effect never becomes positive as it did in the full sample. Instead, as shown in Table 5, the unemployment effect on teacher entry in years 1-5 is small and statistically insignificant, resulting in a persistent overall negative effect on teacher entry for these students.

Higher achieving students, on the other hand, experience negative effects of unem-

[15] Figure A7 shows the same results using SAT scores. Patterns of heterogeneity look similar regardless of which scores are used, but SAT scores are available for fewer cohorts, generating noisier results.

ployment on teacher entry only in the year that they graduate from college, and start to experience statistically significant *positive* effects starting just two years following graduation. Overall, for students who scored above the median on their 10th-grade MCAS, a one percentage point increase in unemployment at college graduation increases the likelihood that they will enter teaching within five years following their college graduation by 0.17 percentage points, a 4% increase over the baseline for these students.

It is possible that this positive effect on teacher entry for higher achieving students arises from the positive effect of unemployment on CLST taking: if higher achieving students are more likely to appear among teaching candidates when unemployment is higher, they may be mechanically more likely to enter teaching. It is also possible, however, that the effect arises from demand-side selection enabled by reduced demand for new teachers during the Great Recession. I test for demand-side selection by asking how the unemployment rate affects the relationship between prior achievement and the likelihood of employment for teaching candidates (i.e., CLST takers).[16] Table 6 shows how the likelihood of becoming employed as a teacher is related to MCAS/CLST scores, unemployment rates, and the interaction between the two for students who took the CLST between one year before and five years after graduating from college.

Overall, both MCAS and CLST scores are positively correlated with the likelihood of employment. As shown and discussed previously, higher unemployment has a negative effect on employment probability. The interaction term in both regressions is negative, suggesting that if anything, higher unemployment weakens the positive relationship between test scores and employment probability. The effects are also imprecisely estimated, however: for an outcome of teaching within two years following graduation, I cannot rule out that a one percentage point increase in unemployment reduces the MCAS advantage in hiring by anywhere from only 1.3% to 6.5%. For teaching within five years, I cannot

[16] See Section 4.3 for more discussion of the interpretation and limitations of this approach.

rule out an *increase* of 3% in the MCAS hiring advantage.

Overall, these results neither support nor firmly reject a change in demand-side selection during economic downturns, although they fail to provide even suggestive evidence that schools are taking advantage of declining demand and rising supply to hire teachers with stronger academic credentials (to the extent that observable academic credentials are correlated with MCAS and CLST scores). While not conclusive—I also cannot rule out changes in demand-side selection on other dimensions—my results are consistent with James et al. (2023), who find that eventual hire quality is unrelated to the number of applicants to teaching positions in Boston.

Table 7 shows the total relationship between unemployment at college graduation and eventual teachers' test scores, while Table 8 shows the relationship between unemployment at college graduation and value-added for the subsample of homegrown teachers with value-added scores.[17] Overall, a one percentage point increase in average unemployment is associated with a 0.03 (0.02) standard deviation in 10th-grade MCAS (CLST) scores (p = 0.01) for teachers hired within nine years of high school graduation. These effects are similar to the effects on math value-added shown in Table 8, which are slightly larger, but not statistically significant. As a point of comparison, Nagler et al. (2020) find that teachers in Florida who started their careers during a recession had math value-added that was 0.1 standard deviations higher than their peers'. Given that students in my sample who graduated college into the peak recession years of 2009-2013 experienced average unemployment rates about 2.5 percentage points higher than those who graduated during the recovery in 2014-2017, my results are remarkably similar.

On the other hand, in contrast to prior work, I find that a one percentage point increase in unemployment at college graduation is associated with a 0.09 standard deviation increase (p = 0.040) in value-added in ELA for teachers hired within nine years of

[17] Appendix B contains more information about how this subsample was constructed.

high school graduation. While not very precise, this is considerably larger than the increase in ELA value-added of 0.05 standard deviations estimated by Nagler et al. (2020) even without multiplying by the total increase in unemployment experienced by students who graduated at the height of the Great Recession. As shown in Table A3, value-added in ELA is only weakly correlated with prior test scores. The larger positive effects of unemployment on ELA value-added may therefore arise from supply- or demand-side selection along other unobservable dimensions. Especially given the small sample size, however, it is difficult to know what to make of this result.

6 Discussion

Prior research consistently finds that negative economic shocks at the time of entry are associated with higher teacher quality, but has been unable to distinguish between the various mechanisms that might drive this relationship. My results show that supply-side factors play an important role in the relationship between economic conditions and the quality of teaching candidates. Students who graduate from college during periods of higher unemployment are more likely to take a teacher certification test, and the effect is stronger (in percentage terms) for higher-achieving students. In part, this finding points to the importance of certification processes in shaping teacher supply: in Massachusetts, any college graduate is eligible to earn a teaching license if they pass the required certification test(s) for their licensure area, regardless of whether they majored in education or completed an official licensure program. This generates flexibility that may not exist in other settings for college graduates to respond to labor market conditions at their career start.[18]

On the demand side, the evidence is less clear. Higher unemployment does not mean-

[18] As described in Section 3, teachers do need to complete some additional requirements if they wish to remain in the classroom beyond the five years allowed by a provisional license.

ingfully affect teacher turnover, but it does substantially reduce hiring of new teachers. In theory, this reduced hiring could generate a positive selection effect if schools were able to raise their threshold for teaching candidates in response. I find no evidence of changing selection on the demand side: the relationship between candidates' test scores and their likelihood of finding a job is unaffected by unemployment rates. My results are imprecisely estimated, however, and I cannot rule out changes in selection on other dimensions unobservable in my data, but more available to schools during the hiring process.

Of further interest to policymakers is what drives the supply side effect, both the overall increase in interest in teaching and in particular the positive selection. Understanding what makes teaching more appealing during economic downturns could inform policy to attract higher quality teachers outside of bad economic times. The hiring effects I observe, coupled with the fact that economic downturns reduce students' entry into the classroom in the short term, rule out one possible pathway: that students are responding to a greater availability of teaching positions relative to other jobs when unemployment is high. Instead, the supply and selection effects are likely driven by a change in the appeal of teaching as a profession.

While my results suggest that making teaching more appealing relative to other professions could increase teacher supply and quality overall, as mentioned in Section 1, teacher shortages are not evenly distributed across subjects or schools. Do economic downturns also address shortages in hard-to-staff areas? Using data on subject-specific licensure tests, I show that while higher unemployment has positive effects on certification test-taking in multiple subjects, it has the largest effect in percentage terms on high school STEM subjects, which are typically more difficult to staff than younger grades or humanities subjects. In Table A4, I present further evidence that economic downturns may not only increase teacher supply overall, but also help to address school-specific challenges in staffing. The table shows the relationship between school demographics and novice teachers' MCAS and CLST scores. I show that schools with a higher share of Black and Hispanic students (relative to White students) typically receive novice teachers with lower prior test scores, but that higher unemployment contributes to closing this gap. These findings suggest that economic incentives to enter teaching can help address shortage areas even absent any specific targeting.

Finally, in Figure A8, I illustrate the effects of unemployment at career start on teacher retention. We might expect that teachers who are induced to enter the classroom by higher unemployment might be less attached to the profession, and therefore might be more likely to leave. The figure shows, however, that higher unemployment at career start has essentially no impact on early career teacher retention (if anything, it has a small positive effect on retention between the first and second year of teaching). Although the length of my panel makes it difficult to explore effects on long-term retention, the figure provides suggestive evidence that the positive effects of economic downturns on teacher selection result in a persistent increase in teacher quality, as these higher-performing teachers remain in the classroom at similar rates to their peers.

7 Conclusion

Economic downturns could make teaching more appealing in multiple ways. Especially in highly unionized states, teacher pay is likely more robust to economic conditions than pay in other professions. This would raise the relative pay of teachers during downturns and potentially attract more graduates to the profession. It is also possible that observing high layoff rates or falling value of retirement funds could make the non-pecuniary benefits of teaching, such as tenure and pensions, more salient to students who are choosing a career.

Without more information on students' outside options and how negative economic shocks impact their entry into careers other than teaching, it is difficult to say which of these effects dominates. While unemployment rates and teachers' relative pay are positively correlated, over the length of my panel,[19] a one percentage point increase in annual unemployment at the county level predicts less than a 1 percentile point improvement in teacher salaries in the county-level wage distribution. A recession causing a 2-3 percentage point increase in unemployment, however, could have larger effects on the relative pay of teachers. My results could also indicate that teacher supply may respond meaningfully to even small changes in compensation.

Although I cannot disentangle the different mechanisms that may make teaching more appealing during downturns, my results suggest that students respond to economic incentives when deciding whether to enter teaching, and that their responses affect not only overall teacher supply, but also supply and quality in hard-to-staff schools and subjects. This finding highlights the potential for policies that make teaching more economically attractive to address current teacher shortages.

[19] The earliest year included in this analysis is 2008, the projected junior year of college for students in the high school class of 2005. The latest year is 2018, five years following high school graduation for the class of 2013.

References

Bacolod, M. P. (2007). Do Alternative Opportunities Matter? The Role of Female Labor Markets in the Decline of Teacher Quality. *Review of Economics and Statistics*, *89*(4), 737–751.

Barnum, M. (2023). Teacher turnover hits new highs across the U.S. *USA Today*. Retrieved from https://www.usatoday.com/story/news/education/2023/03/06/more-teachers-quittingthan-usual-driven-stress-politics-data-shows/11390639002

Bleiberg, J. F., & Kraft, M. A. (2023). What happened to the K–12 education labor market during COVID? The acute need for better data systems. *Education Finance and Policy*, *18*(1), 156–172.

Blom, E., Cadena, B. C., & Keys, B. J. (2021). Investment over the business cycle: Insights from college major choice. *Journal of Labor Economics*, *39*(4), 1043–1082.

Bowen, D. H., Buck, S., Deck, C., Mills, J. N., & Shuls, J. V. (2015). Risky business: An analysis of teacher risk preferences. *Education Economics*, *23*(4), 470–480.

Chetty, R., Friedman, J. N., & Rockoff, J. E. (2014). Measuring the impacts of teachers i: Evaluating bias in teacher value-added estimates. *American Economic Review*, *104*(9), 2593–2632.

Chingos, M. M., & West, M. R. (2012). Do More Effective Teachers Earn More Outside the Classroom? *Education Finance and Policy*, *7*(1), 8–43.

Clotfelter, C., Glennie, E., Ladd, H., & Vigdor, J. (2008). Would higher salaries keep teachers in high-poverty schools? Evidence from a policy intervention in North Carolina. *Journal of Public Economics*, *92*(5-6), 1352–1370.

Cowan, J., Goldhaber, D., Hayes, K., & Theobald, R. (2016). Missing elements in the discussion of teacher shortages. *Educational Researcher*, *45*(8), 460–462.

Deneault, C. (2023). Local Labor Markets and Selection into the Teaching Profession.

Dizon-Ross, E., Loeb, S., Penner, E., & Rochmes, J. (2019). Stress in boom times: Understanding teachers' economic anxiety in a high-cost urban district. *AERA Open*, *5*(4).

Edwards, D. S., Kraft, M. A., Christian, A., & Candelaria, C. A. (2022). *Teacher Shortages: A Unifying Framework for Understanding and Predicting Vacancies* (Ed Working Papers No. 22-684). Annenberg Institute at Brown University.

Ersoy, F. Y. (2020). The effects of the Great Recession on college majors. *Economics of Education Review*, *77*, 102018.

Falch, T., Johansen, K., & Strøm, B. (2009). Teacher shortages and the business cycle. *Labour Economics*, *16*(6), 648–658.

Fortin, J., & Fawcett, E. (2022). How bad is the teacher shortage? Depends on where you live. *The New York Times*.

Fraenkel, R. C. (2022). Local labor markets and job match quality: Teachers. *Labour Economics*, *78*, 102240.

Fullard, J. (2021). *Bad Economy, Good Teachers? The countercyclicality of enrolment Into Initial Teacher Training Programmes in the UK* (Working Paper Series No. 2021-06). Institute for Social and Economic Research, University of Essex.

Fullard, J., & Zuccollo, J. (2021). *Local pay and teacher retention in England* (Tech. Rep.). Education Policy Institute.

García, E., Kraft, M. A., & Schwartz, H. L. (2022). Are we at a crisis point with the public teacher workforce? Education scholars share their perspectives. *Brookings Institution*.

Griffith, M. (2020). The impact of the COVID-19 recession on teaching positions. *Learning Policy Institute*.

James, J., Kraft, M. A., & Papay, J. P. (2023). Local supply, temporal dynamics, and unrealized potential in teacher hiring. *Journal of Policy Analysis and Management*.

Kraft, M. A., Brunner, E. J., Dougherty, S. M., & Schwegman, D. J. (2020). Teacher accountability reforms and the supply and quality of new teachers. *Journal of Public Economics*, *188*, 104212.

Lang, K., & Palacios, M. D. (2019). The determinants of teachers' occupational choice. Retrieved from https://www.dropbox.com/s/r0dntxibz1qb1se/Lang%26Palacios-Teachers.pdf?dl=0

Nagler, M., Piopiunik, M., & West, M. R. (2020). Weak Markets, Strong Teachers: Recession at Career Start and Teacher Effectiveness. *Journal of Labor Economics*, *38*(2), 453–500.

NCES. (2022). *Number and percentage distribution of persons who were enrolled in and who completed a teacher preparation program, by program type: Academic years 2012-13 through 2019-20.* Retrieved from https://nces.ed.gov/programs/digest/d22/tables/dt22_209.02.asp?current=yes

Nguyen, T. D., Lam, C. B., & Bruno, P. (2022). Is there a national teacher shortage? a systematic examination of reports of teacher shortages in the united states. *Annenberg Institute at Brown University*.

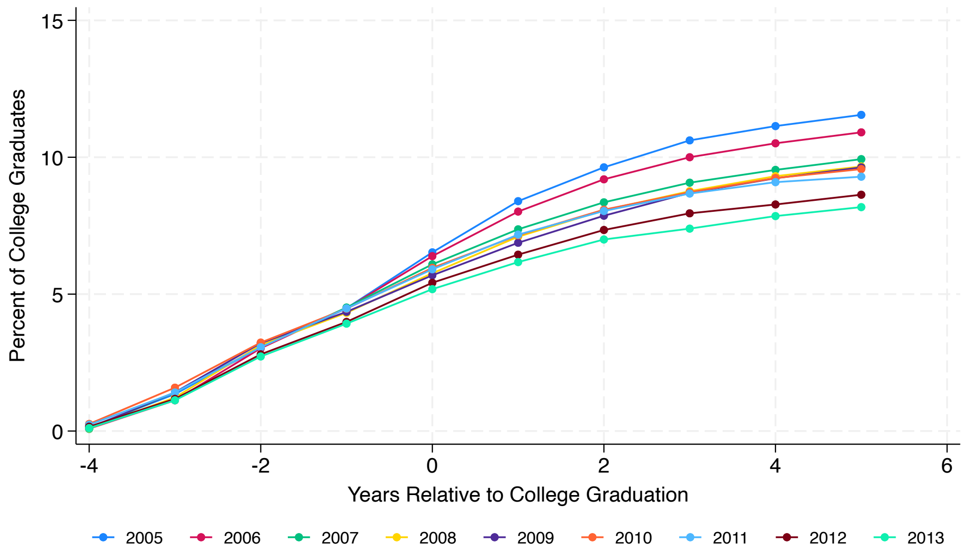
Podgursky, M., Monroe, R., & Watson, D. (2004, October). The academic quality of public school teachers: an analysis of entry and exit behavior. *Economics of Education Review*, *23*(5), 507–518.

Rucinski, M. (2023). *Who becomes a teacher? Racial diversity in the K-12 to teacher pipeline* (Policy Brief). Rappaport Institute for Greater Boston.

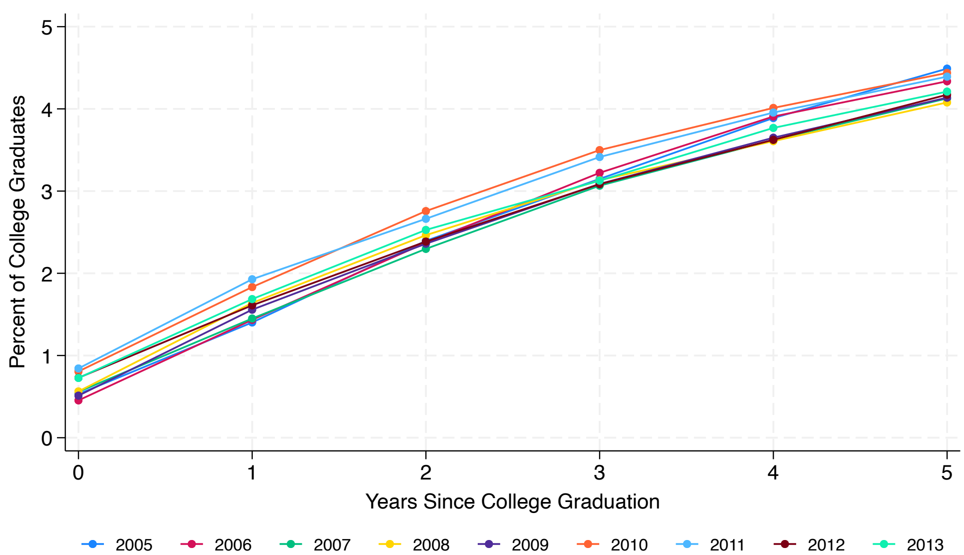
Steele, J. L., Murnane, R. J., & Willett, J. B. (2010). Do financial incentives help low-performing schools attract and keep academically talented teachers? Evidence from California. *Journal of Policy Analysis and Management*, *29*(3), 451–478.

Figure 1: Timing of CLST Taking and Teacher Entry

(a) CLST Taking



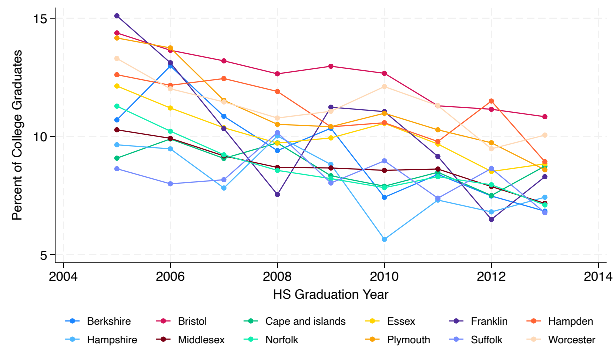
(b) Teacher Entry



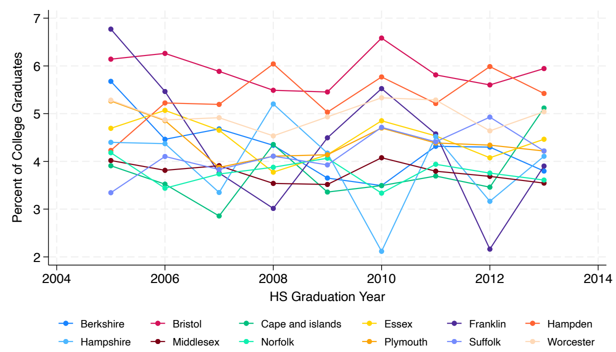
Notes: Panel A illustrates the cumulative share of four-year college graduates in the classes of 2005-2013 who took the CLST for the first time between their (projected) freshman year of college and five years post (projected on-time) college graduation. Panel B illustrates the cumulative share of college graduates who entered teaching 0-5 years following college graduation. Overall, over 90% of students I observe taking the CLST do so within nine (five) years of graduating from high school (college), and 81% of students I observe becoming a teacher do so within five years of their projected college graduation year.

Figure 2: Time Trends by County

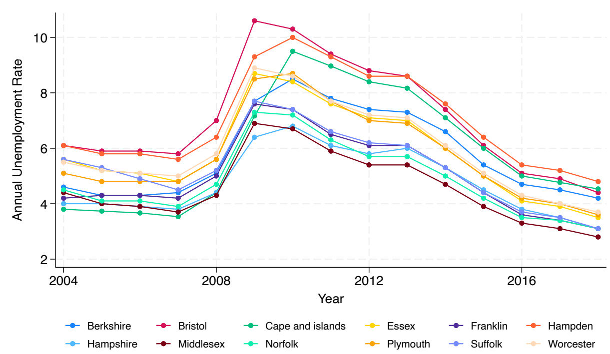
(a) Took CLST within 9 Years



(b) Taught within 9 Years



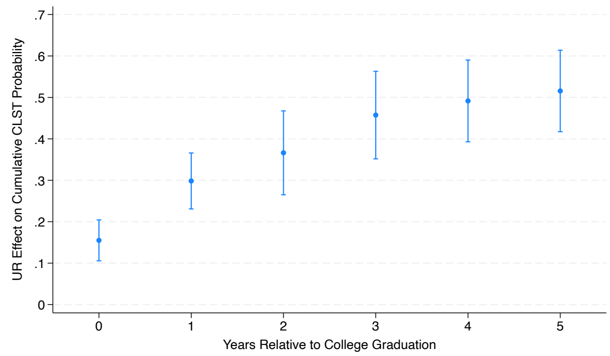
(c) Unemployment Rate



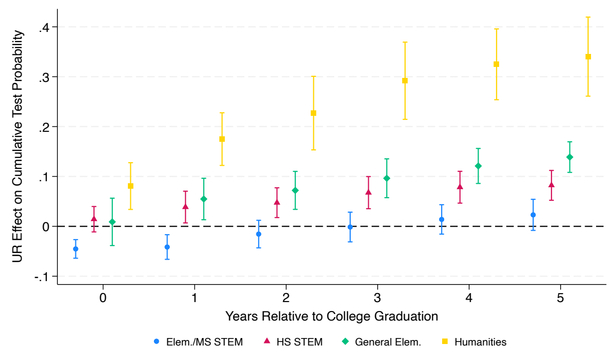
Notes: Panels A and B show time trends by county in the share of students who took the CLST/became a teacher within six/nine years of high school graduation. Panels C and D show time trends in annual county-level unemployment and the county-level teacher wage percentile. The Cape and islands group includes the counties of Barnstable, Nantucket, and Dukes.

Figure 3: Effects of Unemployment on Teacher Supply

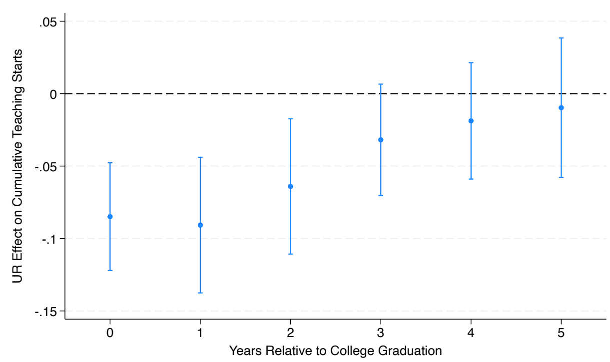
(a) CLST Taking



(b) Subject Test Taking



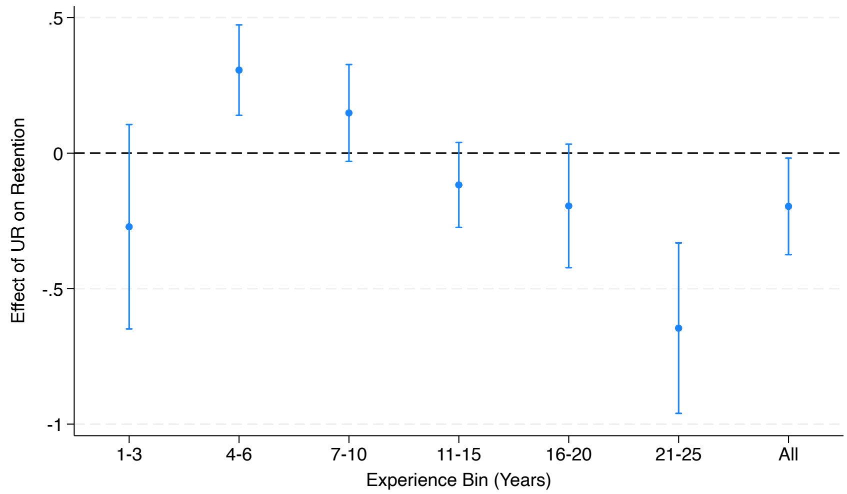
(c) Teaching Starts



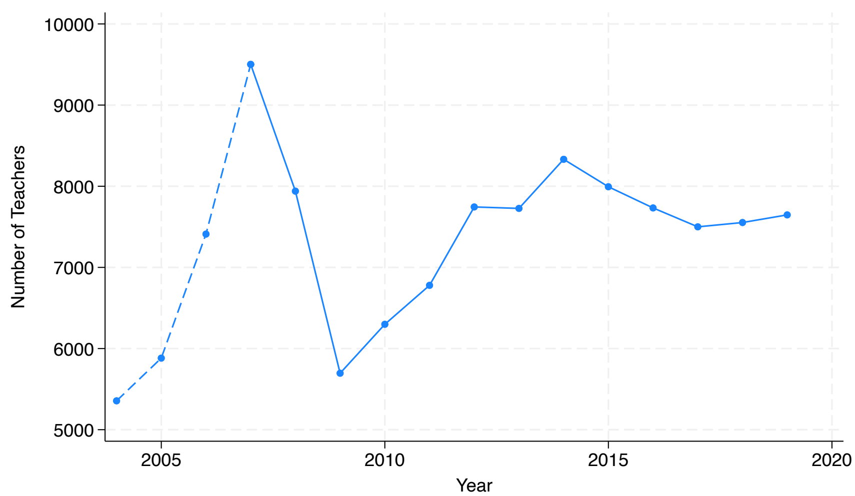
Notes: Panel A illustrates the effect of the average county-level unemployment rate over over years 3, 4, and 5 after a student graduates from high school (i.e., their projected junior and senior years of college and one year following four-year college graduation) on the cumulative likelihood of taking the CLST for the first time 0-5 years following college graduation. The point estimate for year 0 includes year -1 (junior year of college). Panel B illustrates the effect of this same unemployment rate on the cumulative likelihood of taking MTEL subject tests in four different categories (elementary/middle school STEM subjects, high school STEM subjects, general elementary, or humanities subjects), and Panel C illustrates the effect on the cumulative likelihood of starting a public school teaching position in Massachusetts. All y-axes are scaled from 0 to 100. All regressions are restricted to students in the high school classes of 2005-2013 who earned a four-year college degree and include controls for race, gender, and low-income status, as well as county fixed effects. Standard errors are clustered at the county level.

Figure 4: Teacher Demand

(a) Teacher Retention



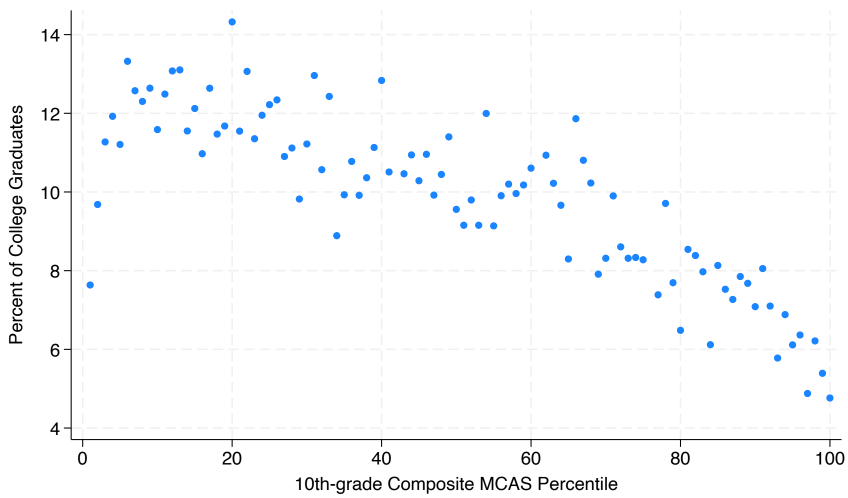
(b) New Hires



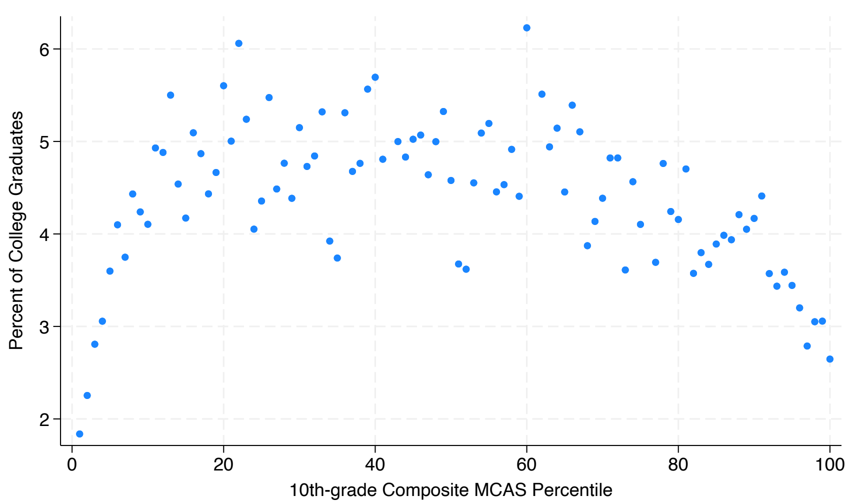
Notes: Panel A is a coefficient plot illustrating the effect of annual unemployment at the county level in a given year on the likelihood that a teacher in a given experience bin in the spring of that year will return as a teacher (in any Massachusetts public school) in the fall. The y-axis is scaled from 0 to 100. The sample includes all main classroom teachers. The regression includes county fixed effects. Standard errors are clustered at the county level. Panel B plots the number of new teachers hired each year. The personnel data begins in 2007, so I observe a hiring date for teachers hired before 2007 only if they were still teaching as of fall 2007.

Figure 5: MCAS Scores and Teacher Entry

(a) CLST in 9 Years



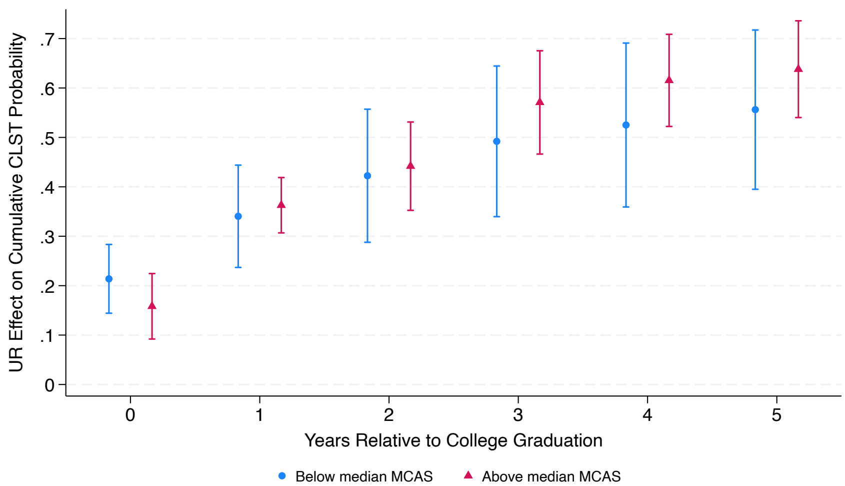
(b) Teach in 9 Years



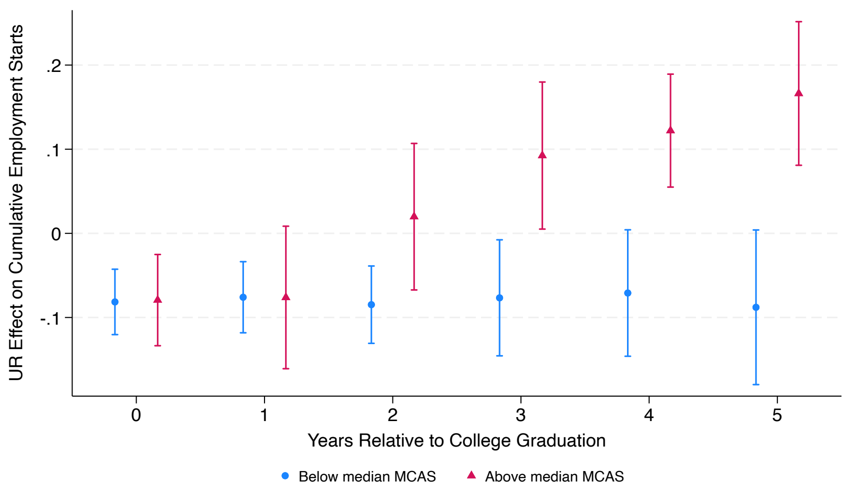
Notes: Panels A and B respectively plot the share of college graduates who took the CLST and became a teacher within nine years of their high school graduation year against their 10th-grade composite (math and reading) MCAS percentile. MCAS percentiles are constructed within years and within the sample of college graduates. The y-axis in both panels is scaled from 0 to 100.

Figure 6: Supply-Side Selection

(a) CLST Taking



(b) Teacher Entry



Notes: Panel A illustrates the effect of the average county-level unemployment rate over over years 3, 4, and 5 after a student graduates from high school (i.e., their projected junior and senior years of college and one year following four-year college graduation) on the cumulative likelihood of taking the CLST 0-5 years following college graduation separately for students who scored above/below the median on their first attempt of the 10th-grade MCAS. The point estimate for year 0 includes year -1 (junior year of college). Panel B illustrates the effect of this same unemployment rate on the cumulative likelihood of starting a public school teaching position in Massachusetts 0-5 years following college graduation. All regressions are restricted to students in the high school classes of 2005-2013 who earned a four-year college degree and include controls for race, gender, and low-income status, as well as county fixed effects. Standard errors are clustered at the county level. MCAS percentiles are constructed within years and within the sample of college graduates. The y-axis in all panels is scaled 0-100.

Table 1: Summary Statistics

	All students (1)	HS Graduates (2)	4-yr Enrollees (3)	4-yr Graduates (4)
Count	819507.0	578736.0	404893.0	235635.0
White	69.1	74.6	78.8	83.4
Black	9.2	7.7	6.8	4.3
Hispanic/Latino	15.1	11.1	7.3	4.6
Asian	4.9	4.9	5.6	6.3
Other/multiple	1.7	1.6	1.5	1.4
Low income	30.9	25.1	16.6	11.2
4-year degree	28.8	38.9	58.2	100.0
Took CLST	3.6	4.9	7.1	9.6
Became teacher	1.9	2.5	3.7	5.1

Notes: Summary statistics for students eligible to graduate from MA public schools between 2005 and 2013. In the data, students can be identified as any combination of White, Black, Asian, American Indian or Alaska Native, and Native Hawaiian or Other Pacific Islander, and are separately identified as Hispanic or Latino. The Hispanic or Latino group in the table includes all students identified as Hispanic or Latino, regardless of which other racial group(s) they were identified with, and is constructed to be mutually exclusive with the other groups. I identify students as low income if they were eligible for free or reduced-price lunch in the majority of years that they appear in the data. The last two rows show the percentage of students who took the CLST or became a teacher within nine years of their high school graduation year.

Table 2: Effects of Unemployment on Teacher Supply

	Panel A: Yearly CLST Taking					
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
	(1)	(2)	(3)	(4)	(5)	(6)
3-yr avg. UR (PS)	0.155***	0.143***	0.068***	0.091***	0.034***	0.024***
	(0.023)	(0.016)	(0.020)	(0.006)	(0.007)	(0.005)
Observations	222961	222961	222961	222961	222961	222961

	Panel B: Yearly Teaching Starts					
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
	(1)	(2)	(3)	(4)	(5)	(6)
3-yr avg. UR (PS)	-0.085***	-0.006	0.027**	0.032***	0.013	0.009
	(0.017)	(0.009)	(0.010)	(0.009)	(0.013)	(0.007)
Observations	222961	222961	222961	222961	222961	222961

Notes: The table shows the effect of higher unemployment on first-time CLST taking and teaching starts in years 0-5 following a student's projected college graduation year. The effect on CLST taking in year 0 includes taking the test in year -1 (junior year of college). Unemployment is the county-level average unemployment over years 3, 4, and 5 following a student's high school graduation year (i.e., a 3-year average centered on their projected senior year of college). All outcomes are scaled from 0 to 100. The sample is restricted to students in the high school graduating classes of 2005-2013. All columns include county fixed effects and controls for student race, gender, and low income status. Robust standard errors clustered at the county level are in parentheses (* p<.10 ** p<.05 *** p<.01).

Table 3: Effects of Unemployment on Subject Test Taking

	Panel A: Elementary/Middle School STEM					
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
	(1)	(2)	(3)	(4)	(5)	(6)
3-yr avg. UR	-0.010**	0.004	0.026***	0.014***	0.015***	0.009**
	(0.005)	(0.005)	(0.004)	(0.004)	(0.003)	(0.003)
Observations	222961	222961	222961	222961	222961	222961
	Panel B: High School STEM					
	(1)	(2)	(3)	(4)	(5)	(6)
3-yr avg. UR	0.013*	0.024***	0.009**	0.020***	0.011***	0.004
	(0.007)	(0.005)	(0.004)	(0.004)	(0.002)	(0.002)
Observations	222961	222961	222961	222961	222961	222961
	Panel C: General Elementary					
	(1)	(2)	(3)	(4)	(5)	(6)
3-yr avg. UR	0.010	0.046***	0.017**	0.024**	0.025***	0.018**
	(0.013)	(0.009)	(0.007)	(0.010)	(0.004)	(0.006)
Observations	222961	222961	222961	222961	222961	222961
	Panel D: Humanities					
	(1)	(2)	(3)	(4)	(5)	(6)
3-yr avg. UR	0.055***	0.094***	0.052***	0.065***	0.033***	0.015*
	(0.013)	(0.009)	(0.017)	(0.015)	(0.008)	(0.008)
Observations	222961	222961	222961	222961	222961	222961

Notes: The table shows the effect of higher unemployment on first-time subject test taking in elementary/middle school STEM subjects, high school STEM subjects, general elementary, and humanities subjects in years 0-5 following a student's projected college graduation year. The effect on CLST taking in year 0 includes taking the test in year -1 (junior year of college). Unemployment is the county-level average unemployment over years 3, 4, and 5 following a student's high school graduation year (i.e., a 3-year average centered on their projected senior year of college). All outcomes are scaled from 0 to 100. The sample is restricted to students in the high school graduating classes of 2005-2013 who earned a four-year degree. Within this sample, rates of subject test-taking between one year prior to college graduation and five years after college graduation were 0.8% for both elementary/middle STEM subjects and high school STEM subjects, 2.7% for general elementary, and 4.7% for humanities subjects. All columns include county fixed effects and controls for student race, gender, and low income status. Robust standard errors clustered at the county level are in parentheses (* p<.10 ** p<.05 *** p<.01).

Table 4: Effects of Local Unemployment on Retention by Years of Experience

	1-3 (1)	4-6 (2)	7-10 (3)	11-15 (4)	16-20 (5)	21-25 (6)	All (7)
Annual UR	-0.272	0.306***	0.148*	-0.117	-0.195*	-0.646***	-0.197**
	(0.174)	(0.077)	(0.083)	(0.073)	(0.105)	(0.146)	(0.082)
Observations	150667	117399	128669	120622	76006	44899	638262

Notes: The treatment variable is annual unemployment at the county level for the year when retention is measured. The outcome equals 1 if a teacher in Massachusetts public schools in the spring of a given year returned in the fall of that year. Experience includes the spring school year, so a teacher finishing their first year is counted as having one year of experience. The sample includes main classroom teachers in Massachusetts public schools from the 2007-08 school year through the 2019-20 school year (the last observation of retention is from spring 2019 to fall 2019). All regressions include county fixed effects. Robust standard errors clustered at the county level are in parentheses (* $p<.10$ ** $p<.05$ *** $p<.01$).

Table 5: Heterogeneity in Effects of Unemployment on Teacher Supply

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
	(1)	(2)	(3)	(4)	(5)	(6)
		Panel A: Yearly CLST Taking, below median MCAS				
3-yr avg. UR	0.128***	0.127***	0.082**	0.070***	0.033**	0.031***
	(0.023)	(0.029)	(0.027)	(0.020)	(0.012)	(0.007)
Observations	106926	106926	106926	106926	106926	106926
		Panel B: Yearly CLST Taking, above median MCAS				
3-yr avg. UR	0.137***	0.205***	0.079***	0.129***	0.045***	0.023**
	(0.019)	(0.013)	(0.022)	(0.015)	(0.012)	(0.010)
Observations	105098	105098	105098	105098	105098	105098
		Panel C: Yearly Teaching Starts, below median MCAS				
3-yr avg. UR	-0.081***	0.006	-0.009	0.008	0.006	-0.017
	(0.018)	(0.016)	(0.019)	(0.019)	(0.012)	(0.017)
Observations	106926	106926	106926	106926	106926	106926
		Panel D: Yearly Teaching Starts, above median MCAS				
3-yr avg. UR	-0.079***	0.003	0.096***	0.073***	0.030	0.044***
	(0.025)	(0.017)	(0.011)	(0.009)	(0.019)	(0.014)
Observations	105098	105098	105098	105098	105098	105098

Notes: The table shows the effect of higher unemployment on first-time CLST taking and teaching starts in years 0-5 following a student's projected college graduation year, separately for students who had composite (math and reading) 10th-grade MCAS scores above/below the median on their first take of the exam. The effect on CLST taking in year 0 includes taking the test in year -1 (junior year of college). Unemployment is the county-level average unemployment over years 3, 4, and 5 following a student's high school graduation year (i.e., a 3-year average centered on their projected senior year of college). All outcomes are scaled from 0 to 100. The sample is restricted to students in the high school graduating classes of 2005-2013 who earned a four-year college degree. The median MCAS score is determined within years and within the sample of college graduates. All columns include county fixed effects and controls for student race, gender, and low income status. Robust standard errors clustered at the county level are in parentheses (* p<.10 ** p<.05 *** p<.01).

Table 6: Demand-Side Selection

	Composite MCAS		Composite CLST	
	Teach in 2	Teach in 5	Teach in 2	Teach in 5
	(1)	(2)	(3)	(4)
Test Score (std.)	9.965***	9.091***	7.852***	7.753***
	(0.711)	(1.038)	(1.133)	(1.032)
3-yr avg. UR	-2.293***	-2.564***	-2.806***	-2.523***
	(0.333)	(0.281)	(0.238)	(0.240)
3-yr avg. UR x Test Score (std.)	-0.391***	-0.111	-0.371*	-0.106
	(0.129)	(0.195)	(0.184)	(0.211)
Observations	14560	14560	19053	19053

Notes: The table shows the relationship between unemployment rates, test scores, and teacher entry within two/five years of college graduation for students who took the CLST between 3-9 years following high school graduation. The unemployment variable is the county-level unemployment over years 3, 4, and 5 following a student's high school graduation year (i.e., their projected junior and senior years of college and one year following college graduation). The test score variable in columns 1 and 2 is a student's standardized composite 10th-grade MCAS percentile, constructed within cohorts after restricting to the sample of college graduates. The test score variable in columns 3 and 4 is a candidate's first standardized composite (reading and writing) CLST score, constructed within CLST test years. The sample is restricted to students in the high school classes of 2005-2013 who earned a four-year college degree. All columns include county fixed effects and controls for student race, gender, and low income status. Robust standard errors clustered at the county level are in parentheses (* p<.10 ** p<.05 *** p<.01).

Table 7: Total Selection

	Composite MCAS		Composite CLST	
	Teach in 2	Teach in 5	Teach in 2	Teach in 5
	(1)	(2)	(3)	(4)
3-yr avg. UR	0.024***	0.032***	0.022**	0.021**
	(0.005)	(0.007)	(0.009)	(0.008)
Observations	5536	9469	6832	11562

Notes: The table shows the relationship between unemployment rates and test scores for students who entered teaching within two/five years of college graduation. The unemployment variable is the county-level unemployment over years 3, 4, and 5 following a student's high school graduation year (i.e., their projected junior and senior years of college and one year following college graduation). The outcome in columns 1 and 2 is standardized composite 10th-grade (math and reading) MCAS score. Scores are standardized within cohorts after restricting to the sample of college graduates. The test score variable in columns 3 and 4 is a candidate's first standardized composite (reading and writing) CLST score, constructed within CLST test years. The sample is restricted to students in the high school classes of 2005-2013 who earned a four-year college degree. All columns include county fixed effects and controls for student race, gender, and low income status. Robust standard errors clustered at the county level are in parentheses (* p<.10 ** p<.05 *** p<.01).

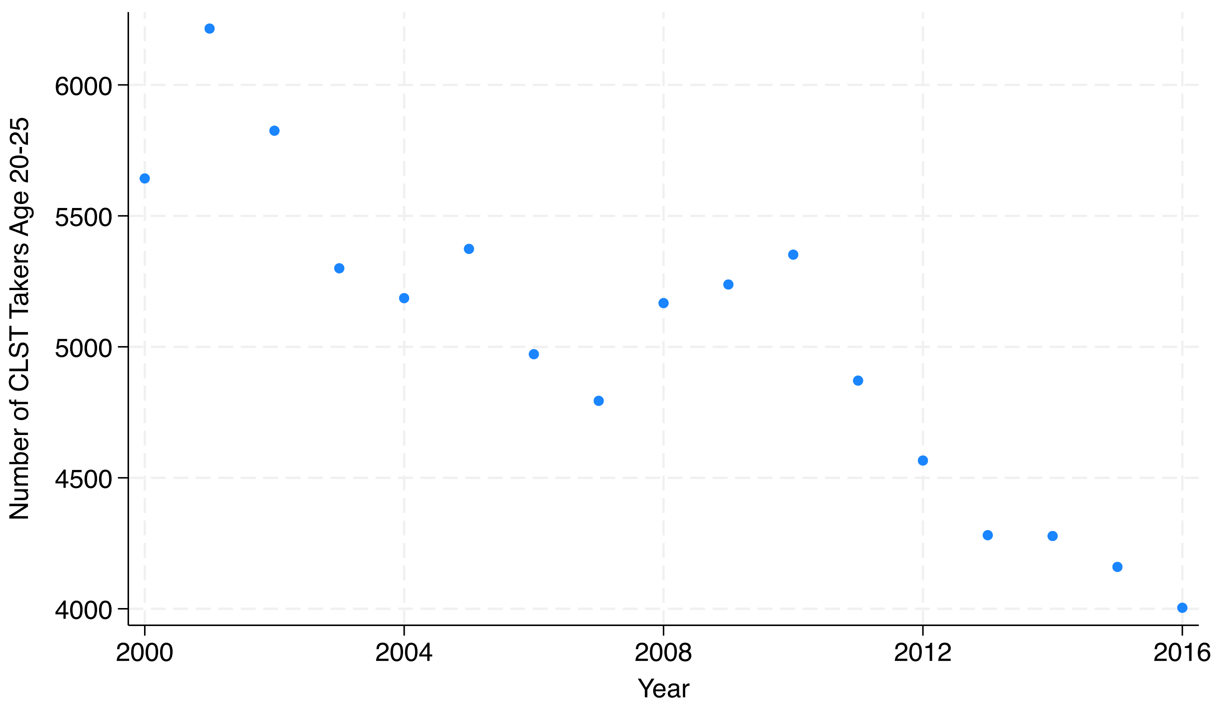
Table 8: Total Selection: Teacher Value-Added

	Math VA		ELA VA	
	Teach in 2	Teach in 5	Teach in 2	Teach in 5
	(1)	(2)	(3)	(4)
3-yr avg. UR	0.047	0.031	0.092**	0.086*
	(0.038)	(0.032)	(0.033)	(0.040)
Observations	434	604	496	707

Notes: The table shows the relationship between unemployment rates and value-added for alumni of Massachusetts public schools who entered teaching within two/five years of college graduation. The unemployment variable is the county-level unemployment over years 3, 4, and 5 following a student's high school graduation year (i.e., their projected junior and senior years of college and one year following college graduation). The outcome in columns 1 and 2 is a teacher's first observed value-added score in math, standardized within grades and school years. The outcome in columns 3 and 4 is a teacher's first observed value-added score in ELA, standardized within grades and school years. The sample is restricted to students in the high school classes of 2005-2013. Value-added scores are only available for a small subset of teachers, as described in more detail in Appendix Section B. All columns include county fixed effects and controls for student race, gender, and low income status. Robust standard errors clustered at the county level are in parentheses (* $p<.10$ ** $p<.05$ *** $p<.01$).

A Additional Tables and Figures

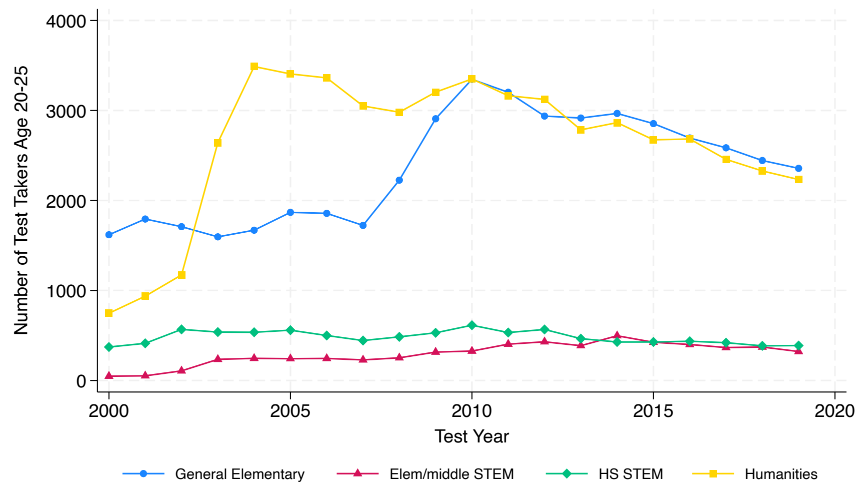
Figure A1: First-Time CLST Taking by Year



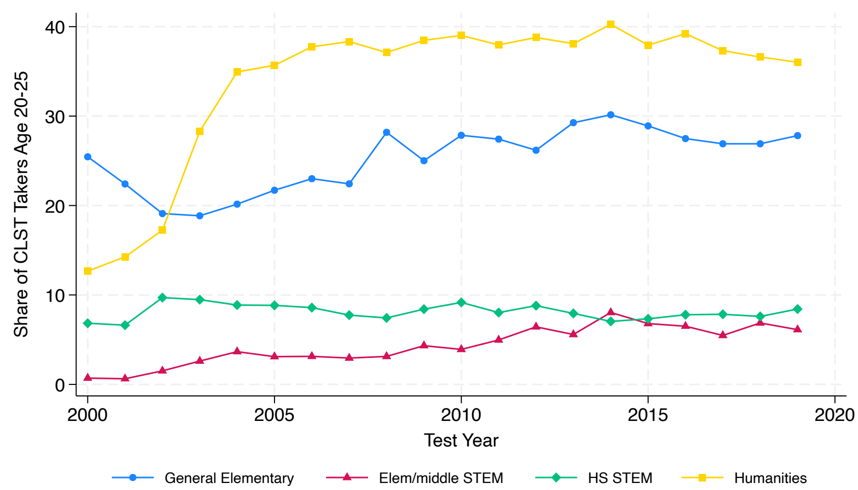
Notes: The figure shows the total number of CLST takers around college graduation age, including test takers who did not attend Massachusetts K-12 public schools, by year.

Figure A2: Subject Test Taking by Year

(a) Number of Test Takers



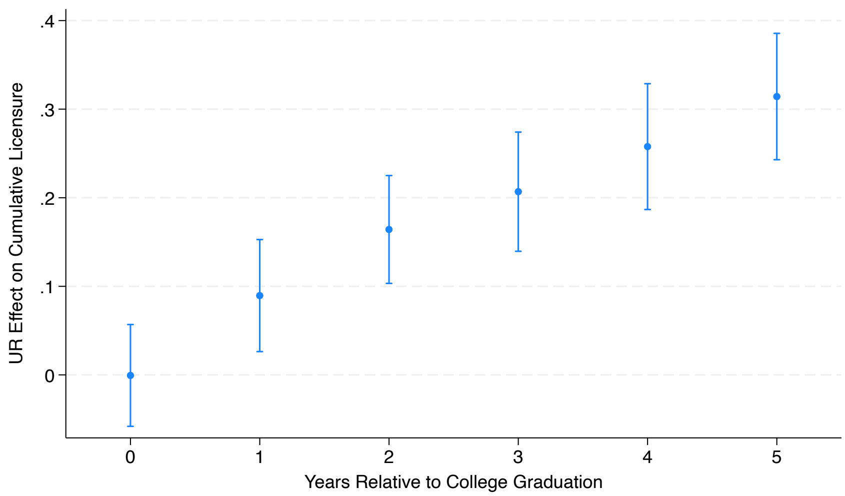
(b) Share of CLST Takers



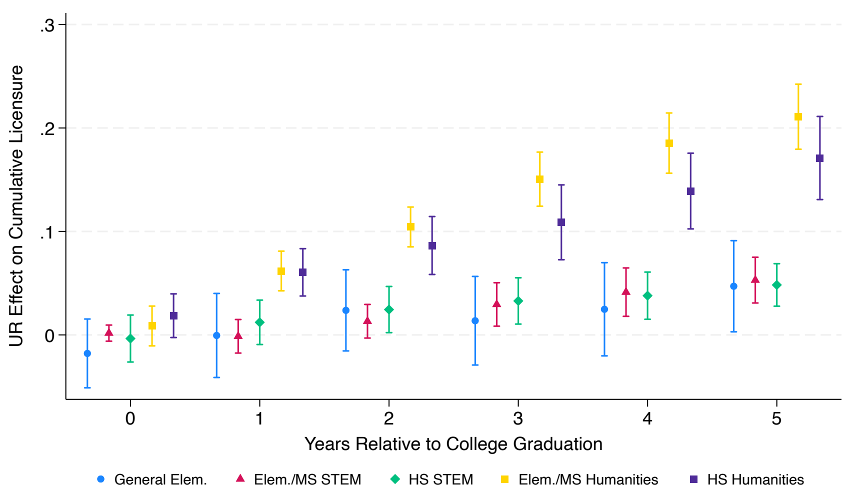
Notes: Panel A plots the number of test takers around college graduation age who took a subject test each year in general elementary, elementary/middle school STEM, high school STEM, or humanities subjects. Panel B plots the *share* of CLST takers in the same age range who took tests in different subject areas. Both figures include all test takers, not just those who attended MA K-12 public schools. Test takers can take multiple subject tests, and these outcomes are not mutually exclusive.

Figure A3: Effects of Unemployment on Teacher Licensure

(a) Any License



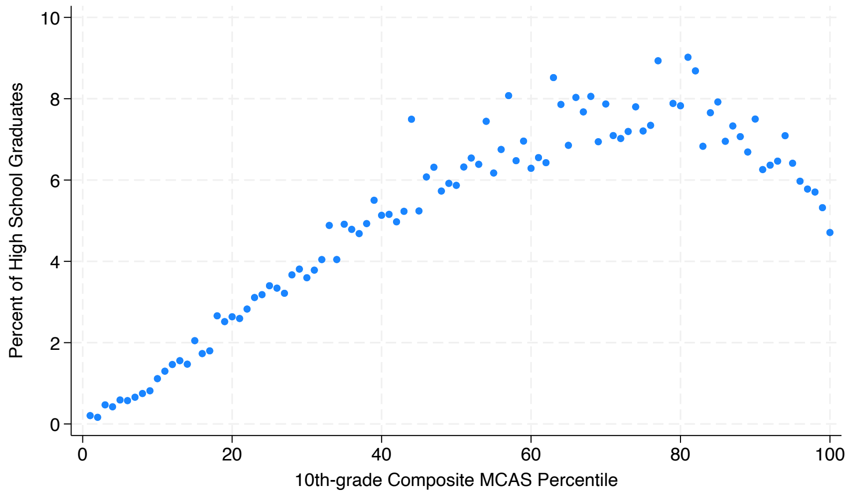
(b) Licensure by Subject



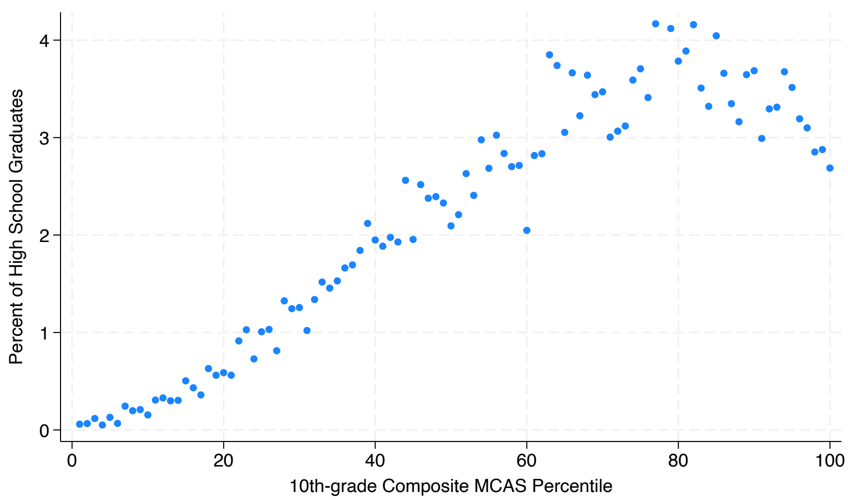
Notes: Panel A illustrates the effect of the average county-level unemployment rate over over years 3, 4, and 5 after a student graduates from high school (i.e., their projected junior and senior years of college and one year following four-year college graduation) on the cumulative likelihood of earning any teaching license for the first time 0-5 years following college graduation. Panel B illustrates the effect of this same unemployment rate on first-time licensure by subject. Licensure outcomes in Panel B are not mutually exclusive. All y-axes are scaled from 0 to 100. All regressions are restricted to students in the high school classes of 2005-2013 who earned a four-year college degree and include controls for race, gender, and low-income status, as well as county fixed effects. Standard errors are clustered at the county level.

Figure A4: MCAS Scores and Teacher Entry (HS Graduates)

(a) CLST in 9 Years



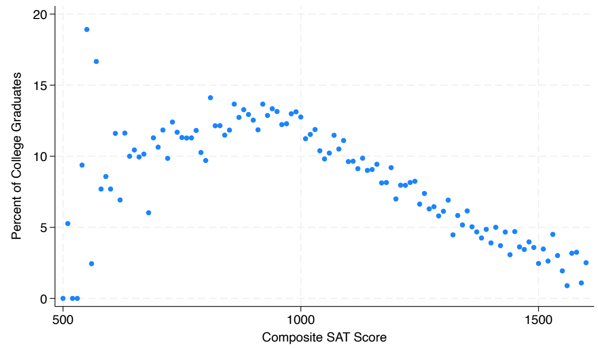
(b) Teach in 9 Years



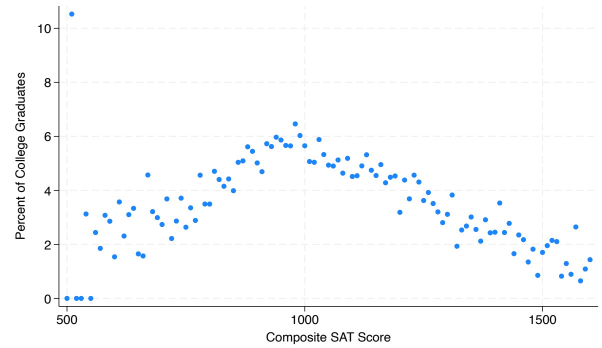
Notes: Panels A and B respectively plot the share of high school graduates who took the CLST and became a teacher within nine years of their high school graduation year against their 10th-grade composite (math and reading) MCAS percentile. MCAS percentiles are constructed within years and within the sample of high school graduates. The y-axis in both panels is scaled from 0 to 100.

Figure A5: SAT Scores and Teacher Entry

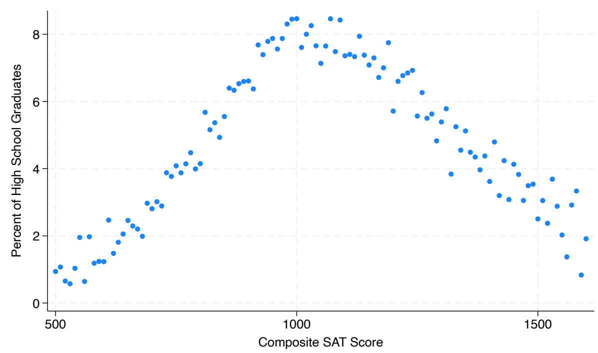
(a) CLST in 9 Years



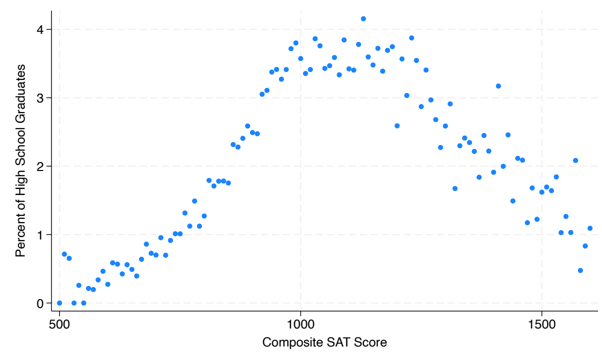
(b) Teach in 9 Years



(c) CLST in 9 Years (HS Grads)



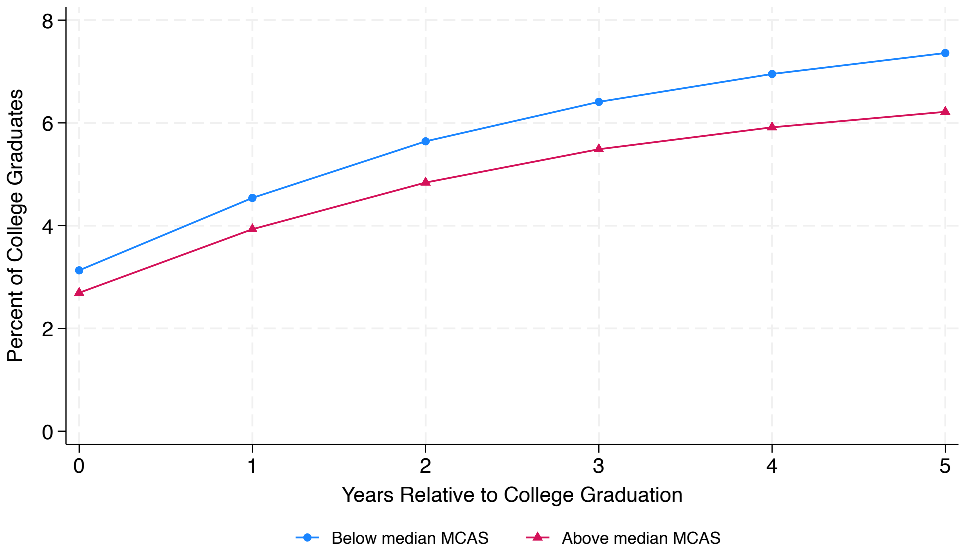
(d) Teach in 9 Years (HS Grads)



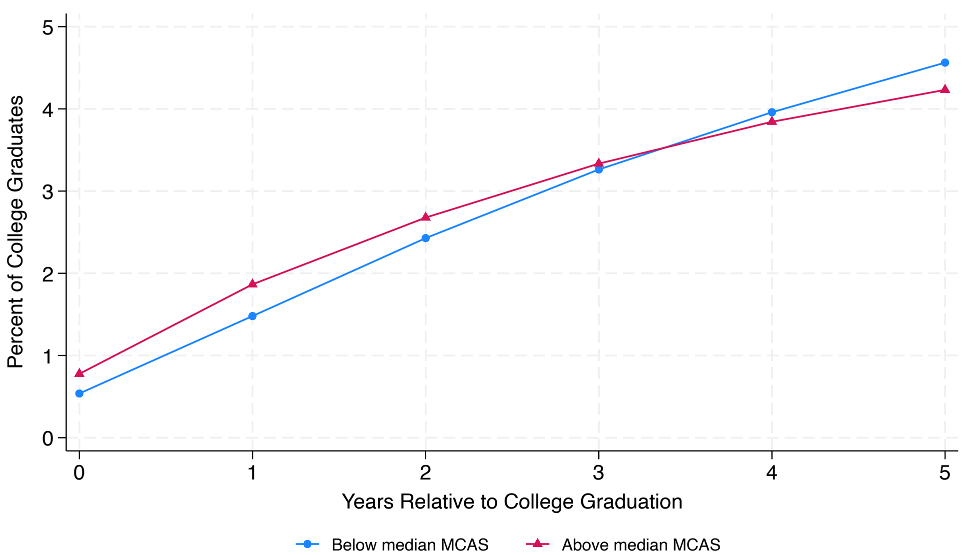
Notes: Panels A and B respectively plot the share of college graduates who took the CLST and became a teacher within nine years of their high school graduation year against their composite (math and reading) SAT scores. Panels C and D are the equivalent for high school graduates. The sample is restricted to students in the high school graduating classes of 2007-2013 (SAT scores are not available for earlier cohorts). The median composite SAT score among all SAT test-takers is 1050. The y-axis in both panels is scaled from 0 to 100.

Figure A6: Heterogeneity in CLST Taking and Teacher Entry

(a) CLST Taking



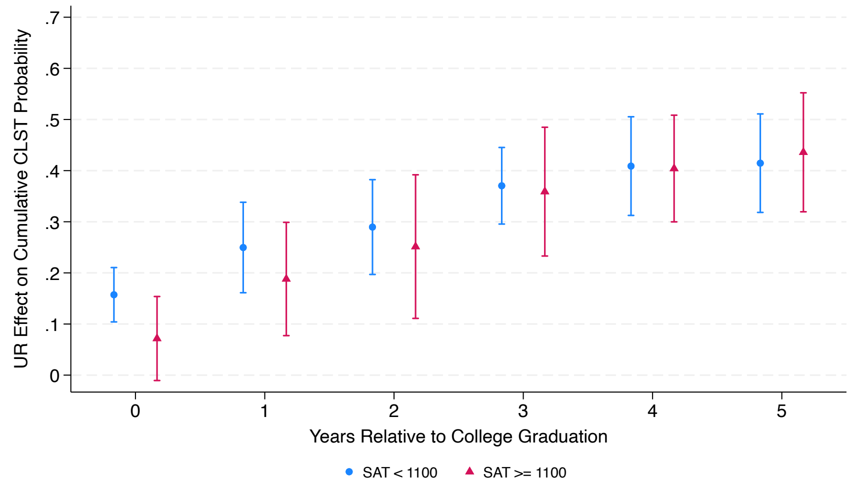
(b) Teacher Entry



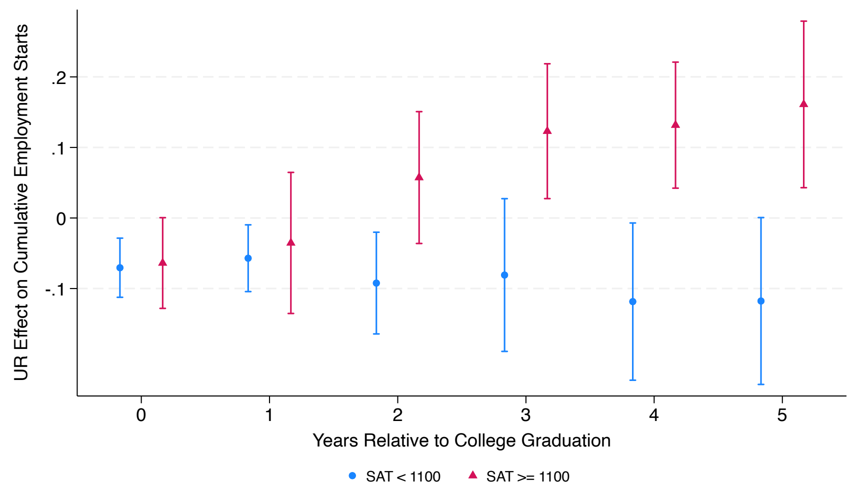
Notes: Panel A illustrates the cumulative share of four-year college graduates in the classes of 2005-2013 who took the CLST for the first time between 0-5 years following their (projected) college graduation, with students separated according to whether they scored above/below the median on their first take of the 10th-grade MCAS. The share of college graduates in year 0 includes students who took the test during their (projected) junior year of college. Panel B illustrates the cumulative share of college graduates who entered teaching 0-5 years following college graduation, separately by MCAS performance.

Figure A7: Supply-Side Selection (SAT)

(a) CLST Taking

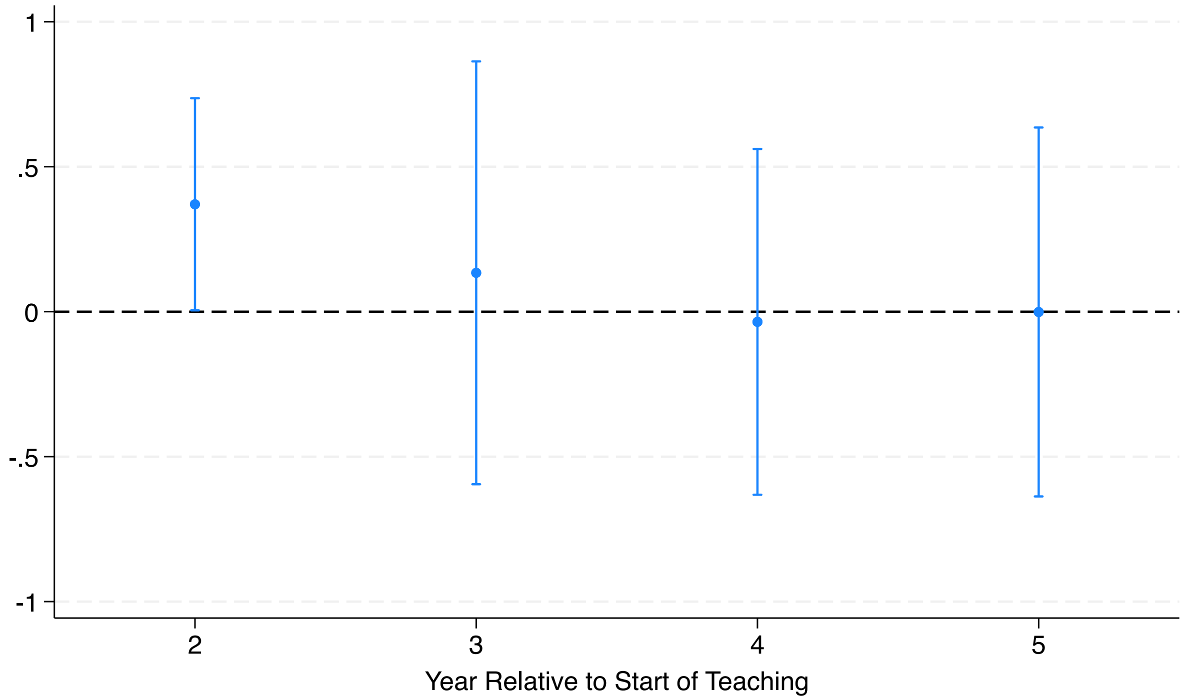


(b) Teacher Entry



Notes: Panel A illustrates the effect of the average county-level unemployment rate over over years 3, 4, and 5 after a student graduates from high school on the cumulative likelihood of taking the CLST 0-5 years following college graduation separately for students who had a maximum composite (math and reading) SAT score above/below a score of 1100 (the median among college graduates). The point estimate for year 0 includes year -1 (junior year of college). Panel B illustrates the effect of this same unemployment rate on the cumulative likelihood of starting a public school teaching position in Massachusetts 0-5 years following college graduation. All regressions are restricted to students in the high school classes of 2007-2013 who earned a four-year college degree and include controls for race, gender, and low-income status, as well as county fixed effects. Standard errors are clustered at the county level. The y-axis in all panels is scaled 0-100.

Figure A8: Unemployment and Teacher Retention



Notes: The figure illustrates, for students who entered teaching within six years of graduating from high school, the effect of the average county-level unemployment rate over years 3, 4, and 5 following their high school graduation year on the likelihood that they continued to teach for 2-5 years (i.e., an additional 1-4 years after their first year). The outcome is scaled from 0 to 100. All regressions are restricted to students in the high school classes of 2005-2013 and include controls for race, gender, and low-income status, as well as county fixed effects. Standard errors are clustered at the county level.

Table A1: Alternative Measures of Economic Conditions and Teacher Supply

	Year 0 (1)	Year 1 (2)	Year 2 (3)	Year 3 (4)	Year 4 (5)	Year 5 (6)
Panel A: Yearly CLST Taking vs. LFP Rate						
3-yr avg. LFP	-0.024	-0.084	-0.051	-0.074	-0.029	-0.014
	(0.076)	(0.053)	(0.032)	(0.047)	(0.039)	(0.021)
Observations	222961	222961	222961	222961	222961	222961
Panel B: Yearly CLST Taking vs. Emp/Pop Ratio						
3-yr avg. EPop	-0.122***	-0.130***	-0.065***	-0.089***	-0.033**	-0.022**
	(0.032)	(0.022)	(0.020)	(0.014)	(0.015)	(0.009)
Observations	222961	222961	222961	222961	222961	222961
Panel C: Yearly Teaching Starts vs. LFP						
3-yr avg. LFP	0.056*	-0.011	0.003	-0.051**	0.054**	0.001
	(0.027)	(0.028)	(0.026)	(0.018)	(0.023)	(0.014)
Observations	222961	222961	222961	222961	222961	222961
Panel D: Yearly Teaching Starts vs. Emp/Pop Ratio						
3-yr avg. EPop	0.078***	0.001	-0.019	-0.038***	0.006	-0.006
	(0.017)	(0.012)	(0.013)	(0.010)	(0.016)	(0.005)
Observations	222961	222961	222961	222961	222961	222961

Notes: The table replicates Table 2 using the county-level labor force participation rate and employment/population ratio averaged over years 3, 4, and 5 following a student's high school graduation year. All outcomes are scaled from 0 to 100. The sample is restricted to students in the high school graduating classes of 2005-2013 who earned a four-year degree. All columns include county fixed effects and controls for student race, gender, and low income status. Robust standard errors clustered at the county level are in parentheses (* p<.10 ** p<.05 *** p<.01).

Table A2: Teacher Supply (Alternative Years of Unemployment)

	Panel A: Yearly CLST Taking					
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
	(1)	(2)	(3)	(4)	(5)	(6)
College avg. UR	0.010	0.069**	0.030	0.081***	0.041**	0.015
	(0.029)	(0.029)	(0.025)	(0.017)	(0.019)	(0.014)
Observations	222961	222961	222961	222961	222961	222961
Junior/senior avg. UR	0.140***	0.130***	0.061***	0.084***	0.034***	0.022***
	(0.023)	(0.015)	(0.020)	(0.007)	(0.008)	(0.006)
Observations	222961	222961	222961	222961	222961	222961
Senior/+1 avg. UR	0.154***	0.143***	0.068***	0.089***	0.031***	0.023***
	(0.022)	(0.014)	(0.019)	(0.006)	(0.007)	(0.004)
Observations	222961	222961	222961	222961	222961	222961
	Panel B: Yearly Teaching Starts					
College avg. UR	-0.074***	0.028*	-0.001	0.025*	-0.041**	-0.005
	(0.023)	(0.015)	(0.016)	(0.013)	(0.016)	(0.009)
Observations	222961	222961	222961	222961	222961	222961
Junior/senior avg. UR	-0.081***	-0.000	0.022*	0.034***	0.007	0.004
	(0.016)	(0.010)	(0.010)	(0.009)	(0.014)	(0.006)
Observations	222961	222961	222961	222961	222961	222961
Senior/+1 avg. UR	-0.079***	-0.011	0.029***	0.027***	0.019*	0.013*
	(0.016)	(0.009)	(0.009)	(0.008)	(0.010)	(0.007)
Observations	222961	222961	222961	222961	222961	222961

Notes: The table replicates Table 2 using unemployment averaged over alternative years. The college average unemployment rate is averaged over years 1-4 following a student's high school graduation (i.e., it includes the projected college graduation year, but not the high school graduation year). All outcomes are scaled from 0 to 100. The sample is restricted to students in the high school graduating classes of 2005-2013 who earned a four-year degree. All columns include county fixed effects and controls for student race, gender, and low income status. Robust standard errors clustered at the county level are in parentheses (* p<.10 ** p<.05 *** p<.01).

Table A3: Teacher Value-Added vs. Prior Test Scores

	Math VA (1)	ELA VA (2)
Panel A: TVA vs. MCAS		
MCAS Score (std.)	0.118**	0.003
	(0.047)	(0.046)
Observations	639	745
Panel B: TVA vs. SAT		
SAT Score (std.)	0.155***	-0.009
	(0.055)	(0.054)
Observations	407	472
Panel C: TVA vs. CLST		
CLST Score (std.)	0.157***	0.022
	(0.048)	(0.044)
Observations	603	711

Notes: The table shows the relationship between teachers' first observed value-added scores in math and ELA and teachers' MCAS, SAT, and CLST scores. In Panels A and B, teachers' value-added in math is regressed on their math scores on the MCAS/SAT, and their value-added in ELA is regressed on their ELA/reading scores on the MCAS/SAT. In Panel C, teacher value-added in both subjects is regressed on teachers' composite CLST scores (combining their reading and writing subscores). Value-added is standardized within year and grade. MCAS and SAT scores are standardized within cohort. CLST scores are standardized within test year. All regressions are restricted to students in the high school graduating classes of 2005-2013 and include controls for race and gender. Robust standard errors are in parentheses (* p<.10 ** p<.05 *** p<.01).

Table A4: Teacher Test Scores and School Characteristics

	Composite MCAS		Composite CLST	
	Teach in 2	Teach in 5	Teach in 2	Teach in 5
	(1)	(2)	(3)	(4)
UR	0.021	0.012	0.087***	0.075***
	(0.028)	(0.024)	(0.027)	(0.022)
% Black + Hispanic	-0.835***	-0.470*	-0.769***	-0.566***
	(0.278)	(0.245)	(0.245)	(0.204)
% Asian	0.970	1.687**	1.281*	0.881
	(0.759)	(0.698)	(0.772)	(0.676)
UR x % Black + Hispanic	0.183***	0.100**	0.177***	0.120***
	(0.053)	(0.041)	(0.047)	(0.035)
UR x % Asian	-0.044	-0.207*	-0.158	-0.095
	(0.128)	(0.111)	(0.132)	(0.107)
Observations	3033	5264	3350	6025

Notes: The table shows the relationship between teacher test scores and student demographics at the school where they were first employed, and how this relationship changes with unemployment rates. The sample is restricted to teachers who were students in the Massachusetts high school graduating classes of 2005-2013 and who took the CLST between 3-9 years following high school graduation. Student demographic shares are on a scale of 0-1, and the share of White students is the omitted category. The unemployment rate is measured at the state level and averaged over years 3, 4, and 5 following a student's high school graduation year. The test score variable in columns 1 and 2 is a student's standardized composite 10th-grade MCAS percentile, constructed within cohorts after restricting to the sample of college graduates. The test score variable in columns 3 and 4 is a candidate's first standardized composite (reading and writing) CLST score, constructed within CLST test years. All columns include controls for teacher race. Robust standard errors clustered at the school level are in parentheses (* p<.10 ** p<.05 *** p<.01).

B Teacher Value-Added

I am restricted to calculating value-added for teachers who teach math or ELA in grades 4-8 (because students are tested in these subjects in grades 3-8, and value-added calculations require at least one year of prior test scores). I am able to link students to teachers using course data beginning in the 2010-11 school year, and ending in the 2019-20 school year. Because students were not tested in the spring of 2020 due to the COVID-19 pandemic, this means that I can calculate value-added for teachers who taught between 2010-11 and 2018-19—a limited subset of all teachers I observe in the personnel data, which spans 2007-08 to 2022-23.

To restrict each course to only one assigned teacher, I first drop non-teaching course staff, and then drop all courses with more than one teacher assigned (after dropping non-teaching staff, only 3% of class sections are associated with more than one teacher). Calculating value-added also requires that each student be associated with only one teacher in a given grade and subject. To meet this restriction, I first keep full-year courses only. I then drop non-core courses for students who have a core course in a given year. After making these sample restrictions, I drop all remaining students who are assigned to multiple teachers within a subject and grade.

To calculate value-added scores, I use the `vam` package in Stata written by Michael Stepner, which follows the methodology in Chetty et al. (2014). I define a teacher's "class" in a given year as all the students they taught within a given grade and subject. In the value-added model, I include controls for student race and gender, as well as indicators for a student's low-income, special education, and English learner status in each year. I also control for a cubic function of a student's prior year test score, and I control linearly for teacher experience.

Overall, 2.1% of students in my analysis sample who ever became teachers have value-added scores in both ELA and math. 3.1% have value-added only in ELA, and 2.4% have value-added only in math. These rates are very similar to my full sample of teachers, in which 2.7% of teachers have value-added in both subjects, 3.2% have value-added only in ELA, and 3% have value-added only in math.