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*Do Master's Degrees Matter?
Advanced Degrees, Career
Paths, and the Effectiveness of
Teachers*

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Abstract

This study uses detailed administrative data on teachers and students from the state of North Carolina to revisit the empirical evidence on master's degrees, with attention to teachers at the middle and high school levels. It provides descriptive information on which types of teachers obtain master's degrees, for which subjects, at which institutions, and during what phase of their career. The study estimates returns to master's degrees using teacher fixed effects to control for time-invariant characteristics of teachers, thus separating the effects of teacher decisions to get an advanced degree from the effects of having one. Even with this careful attention to selection bias, we confirm the findings of prior studies showing that teachers with master's degrees are no more effective than those without. The only consistently positive effect of attaining a master's degree emerging from this study relates not to student test scores but rather to lower student absentee rates in middle school.

1. Introduction

The typical salary schedule for teachers in most states and local districts provides for additional pay for years of experience and advanced degrees. Although many teachers start their teaching careers with a master's degree, many more obtain a master's degree once they have entered the profession. For these teachers, getting an advanced degree is a way to invest in the knowledge and skills that might improve their teaching or open up other career opportunities in education. Importantly, however, it is also a way to increase their salaries. For any starting basic salary, the opportunity to achieve a rise in salary by getting a master's degree raises the expected value of entering the teaching profession, and, all other factors held constant, may induce more people to become teachers. In addition, in the case of master's degrees that develop skills unique to education, once a teacher has a master's degree the greater is the incentive for her to remain in the profession in order to reap the financial benefits of the degree. Keeping good teachers in the profession is desirable given that the returns to experience continue far beyond the first few years of teaching (Papay and Kraft forthcoming; Harris and Sass 2011; Ladd and Sorensen 2014; Wiswall 2013).

Despite the observation that a salary supplement for a master's degree may affect the quality of the teacher labor force through its effects on teachers' entry and exit decisions, much of the policy discussion and research surrounding them focuses on a narrower question, namely whether there is a clear link between having a master's degree and higher student outcomes. Among the many empirical papers that explore this relationship, most demonstrate that teachers with masters' degrees are, on average, no more likely to raise student test scores than those without master's degrees, all other factors held constant. Moreover, other researchers argue that measurable credentials, even those that are associated on average with higher student outcomes, are not very useful for policy because they explain only a small proportion of the variation in overall teacher quality as measured more directly by

so-called “teacher effects” (Goldhaber 2015). Given this evidence, one might think that it makes little sense to examine further the extent to which teachers with master’s degrees make greater contributions to student outcomes than those without.

Yet that is the purpose of this study. In particular we use detailed administrative data on teachers and students from the state of North Carolina for the years 2006-2013 to revisit the empirical evidence on master’s degree, with attention to teachers at the middle and high school levels. We do so for four reasons that we spell out in more detail in subsequent sections. The first is that compensation for master’s degrees is a current policy issue in North Carolina. In particular, the Legislature recently eliminated the 10 percent salary bump for master’s degree and it did so partly with reference to prior studies, including some co-authored by one of the present authors, that showed no link between having a master’s degree and student test scores. Second, the majority of the existing studies focus on teachers at the elementary level where master’s degrees could potentially be less useful than at the higher levels that we focus on here. Third, despite the fact that some of the prior studies take appropriate account of the nonrandom sorting of students to teachers, many of them, including the earlier North Carolina studies, do not fully account for the fact that teachers choose whether to get a master’s degree, which introduces a potential selection bias. And fourth, the existing studies are limited in that they focus on student test scores alone to the exclusion of other student outcomes of potential interest.

This paper contributes to the literature in part by providing descriptive information on which types of teachers obtain master’s degrees, with attention to whether they earn a master’s degree before or after they start teaching. We had hoped a second contribution would come from our careful attention to the selection biases that may arise because some teachers are more likely to obtain master’s degrees than others. By using teacher fixed effects to control for time-invariant characteristics of teachers, we are able to separate the effects of teacher decisions from the effects of having a

master's degree. As we show below, however, this statistical refinement does not alter the earlier findings that master's degrees make teachers no more effective than those without master's degrees in raising student test scores. Indeed, the only consistent positive effect of having a master's degree that emerges from this study relates not to student test scores but rather to lower student absentee rates in middle school.

Thus, we conclude that salary supplements for teachers cannot be justified on the grounds that teachers with master's degrees are on average more effective at raising test scores than other teachers. Of course, teachers contribute to student outcomes in other ways as well. By documenting that master's degrees appear to lead to lower student absences, this study provides some initial—but at best limited—evidence that middle school teachers with master's degrees may be more effective than other teachers on average in developing other skills that may be important for future life success (Jackson 2012). Moreover, our finding that the most common master's degree earned after entry into the profession is in school administration, rather than in a specific subject area, reminds us that master's degrees may serve purposes other than to make teachers more effective in the classroom.

Unfortunately, we are not able to shed any new empirical light on the broader issue mentioned in the first paragraph, namely the extent to which salary bumps for master's degrees affects the supply of teachers and their commitment to the profession. It seems safe to conclude however, that removing the salary supplement for master's degrees could have undesirable effects on the quality of the teacher labor force unless there are other compensating changes, such as modifications in the level and structure of the state salary schedule or in the financial incentives teachers are given to make other investments in their capacity to succeed either in the classroom or eventually in school administration.

1.1 North Carolina policy context.

The state government in North Carolina plays a larger role in education finance and teacher policy than in many other states. One manifestation of that is a statewide salary schedule for teachers.

In 2013, the NC state legislature made some dramatic changes in policies that affected teachers. It abolished teacher tenure (called teacher career status in NC), removed the cap on class sizes, and reduced funding for support services. In addition, citing evidence that master's degrees do not raise student test scores, the Legislature eliminated the supplement for master's degrees. Starting in the summer of 2015, teachers who successfully complete a master's (or doctorate degree) are no longer be eligible for the 10 percent salary supplement that had long been provided for teachers with advanced degrees.

Perhaps not surprisingly, a survey of 634 practicing educators in North Carolina educators administered in 2013 indicated that 88 percent of them thought this last change would have a negative or strongly negative impact on the quality of public education in North Carolina (Imig and Smith, 2013, Table 1). The mechanisms through which that outcome would occur, however, were not specified. One possibility consistent with other responses, is that the respondents may have taken for granted that master's degrees make teachers more effective and that by reducing the financial incentive to get a masters', the elimination of the salary supplement would lead to fewer master's degrees. Another possibility is that regardless of their views about the productivity of a master's degree, some respondents might have expected the elimination of this way to raise one's salary would induce more teachers to leave the profession. Consistent with this view is the further finding that 3 out of 4 of the respondents indicated that the package of policy changes would make them less likely to continue working as a teacher or administrator in the state (Imig and Smith, 2013, Table 3).

These changes followed several years in which salaries of North Carolina teachers had been declining relative to those in other states. From being close to the national average in year 2000, average salaries in this state had fallen to 48th in the country (NCES 2005, Table 77; NCES 2013, Table 211.60). Some of that relative decline can be attributed to the fact that North Carolina was harder hit than many other states by the 2008 recession, but the failure of the Republican Legislature to raise

teacher salaries after the recession can also be attributed to the higher priority it placed on reducing state taxes than on supporting teachers.

A comparison of salary supplements for master's degrees across all states based on the national Schools and Staffing Survey of 2003-2004 indicated that the financial burden of those supplements was far lower in North Carolina than in most states (Roza and Miller, 2009). According to that study, 32 percent of North Carolina's teachers had master's degrees (or above), far below the 48 percent for the country as a whole. Given its salary supplement, North Carolina spent 1.09 % of its total education budget on the master's supplement, well below the 2.92 percentage for the country. This relatively low North Carolina percentage meant that the state could save far less by eliminating the salary supplement for master's degrees than would be the case in other states, but perhaps could do so with less public outcry.

Before turning to the central purpose of this paper, namely the analysis of the relationship between master's degrees and student outcomes, we examine the patterns of obtaining master's degrees among middle and high school teachers in North Carolina.

2. Master's degrees: trends and patterns.

Figure 1 depicts a slight downward trend in the proportion of all middle school and high school teachers with master's degrees.¹ The top line shows that the overall proportion fell from about 48 percent down to about 42 percent, with the largest decline during the 2006 to 2008 period. Of the overall proportion, about three quarters are for master's degrees that teachers earned after they had started teaching, with a far smaller proportion of degrees earned prior to teaching.

¹ This sample is defined technically as any teacher observed during the 2006-2013 time period who teaches at a middle or high school. Schools are classified as middle schools if their lowest grade is between 4th and 7th grade and their highest grade is between 4th and 9th grade. Schools are classified as high schools if their low grade is between 7th through 12th grades and their highest grade is 12th grade. The teacher sample is restricted further during the later analysis to only include teachers matched to students with 6th through 8th grade end of grade or 9th through 12th grade end of course test scores between 2006 and 2013.

The patterns we describe in figures 2 and 3 start with the 41,287 middle and high school teachers we observe in the 2012-2013 school year, the final year of our data. Of these teachers, 17,322 (42 percent) had a master's degree in that year. Only a quarter of these master's degrees were earned before the teacher started teaching, with the other three quarters earned at some point during the teacher's career. Figure 2 illustrates the timing of these post-entry master's degrees. Although a few teachers obtained their master's degrees while they were still probationary teachers, the most common time for teachers to earn a post entry master's degree was 4-6 years into their teaching career, which is right after they earned career status. The clustering of master's degrees around that time suggests that many teachers who invest in master's degrees are planning to make teaching their career. The figure also shows that some teachers continue to earn master's degrees late into their careers.²

Figure 3 (parts a to f) explores how the probability of having a master's degree differs across groups of teachers. All the bar graphs are structured in the same way. The height of the bar indicates the probability that teachers of that type have a master's degree. The bottom part of the bar indicates the proportion who earned the degree prior to entering the profession and the top part, the proportion who earned it after they entered.

Interesting differences emerge by gender (3a) and race (3b). Despite the fact that male and female teachers are equally likely to have a pre-entry master's degree, female teachers are about six percentage points more likely than their male counterparts to have a master's because of their far higher propensity to obtain a post-entry degree. In terms of race, black teachers are four percentage points more likely than white teachers and a full 10 percentage points more likely than Hispanic teachers to have a master's. The difference comes from the far higher propensity for black teachers to earn a post-entry degree than either of the other groups. We draw attention here to the higher

² Literature on relationship of master's degrees to retention still to be explored. See the 2006 review by Guarina, Santibanez, and Daley and the references to Kirby et al (1999), Ingersoll and Alsalam (1997) and Adams (1997), but these studies may now be dated and refer mainly to the departure patterns of teachers who enter with a master's degree.

prevalence of post-entry degrees for females and blacks because our empirical analysis below focuses primarily on post-entry rather than pre-entry master's degrees.

The first bar in Figure 3c shows that more than half of the teachers who are National Board certified (which is a designation available only for teachers with more than 5 years of experience) have master's degrees. This high proportion is not surprising given that teachers who go through the rigorous process of becoming certified by the National Board of Professional Teaching Standards may well be motivated to invest in themselves in other ways such as by getting a master's degree. Across the four listed licensure categories, the one potentially surprising finding is that teachers with an elementary school teaching license are somewhat more likely than those with a different type of teaching license to have a master's degree. We remind the reader that despite their elementary school license, these teachers are teaching in a middle schools or high schools. One possible explanation is that some of them may have chosen to invest in an advanced degree to move from the elementary level to the middle school level. Yet, as shown in figure 3d, master's degrees in general are no more common at higher levels of schooling than at lower levels. Specifically, the proportions of teachers with master's degrees are no higher for those teaching in high school than those in middle school.

The final two parts of figure 3 categorize teachers by characteristics that are often associated with student test scores, with credentials that generally lead to higher scores on the right of each part. Figure 3e shows differences by the competitiveness of a teacher's undergraduate institution, as measured by Barron's. Although teachers who went to very competitive colleges are far more likely to start teaching with a master's degree, their propensity to earn a master's once they have started teaching is no higher than that of graduates from less competitiveness colleges. Or stated the other way around, teachers from less competitive colleges are just as likely to invest in a master's degree once they start teaching as those from a very competitive college. Figure 3f, which depicts how the propensity to have a master's degree differs across teachers with different average test scores on the teacher

licensure exam, generates a similar conclusion. We normalized each Praxis score by the year it was taken to have a mean of 0 and a standard deviation of 1 and then averaged the normalized scores across the tests taken by an individual teacher. The figure divides teachers into those that who have average Praxis scores below -0.5 standard deviations, those with scores around the average, and those with scores more than 0.5 standard deviations above the average. The figure shows that the teachers with higher ability as measured by their Praxis scores were far more likely than other teachers to earn a master's degree before they started teaching but were no more likely than others to do so once they started teaching.

The distinction between pre and post master's degrees is important for our modeling effort below because our preferred models identify the effects of master's degree based on teachers who switch into that status during their teaching career. Emerging from figure 3 is that while teachers with particularly strong credentials (e.g. those with high licensure test scores or who graduated from a competitive college) are far more likely to have earned a master's degree prior to entering teaching, they are no more likely than other groups of teachers to earn a master's degree after they start teaching. Other than the teachers with National Board certification, the main groups that are overrepresented among those earning degrees once they enter the profession are female teachers and black teachers.

We end this descriptive picture with a summary of the types of master's degrees earned by subject taught and institution type. For this analysis (and also the estimated models below) we restrict the sample to teachers of math and reading in grades 6-8 and teachers of tested subjects such as English 1, algebra, biology, and chemistry at the high school level. We restrict the set of teachers in this way so that we can connect student outcomes to specific teachers. The overall sample includes about 45,000 teachers for each of the years 2006-2013. Table 1, which is based on the information for all the teachers

matched to the student sample in 2013, reports the most common master's degrees earned by subject taught by the teacher. Panel a refers to pre-entry degrees and panel b to post-entry degrees.

Turning first to middle school teachers of math and English Language Arts (ELA), we find that the most common pre-entry degrees are in school administration, the subjects of math or reading, and elementary education. At the post-entry level, math and reading (including language arts) degrees now top the list but school administration and elementary education degrees remain common. At the high school level, the most common degrees at the pre-entry level are, as would be expected, in the field in which the teacher is teaching. At the post-entry level however, degrees in school administration reemerge among the most common degrees. While such degrees may be socially valuable, it is hard to make the case that they are likely to make a teacher more effective in raising student test scores.

Notable differences in the type of degree-granting institution also exist between teachers earning their degrees prior to or post-entry, with the latter group more likely to earn a degree from a private or for-profit institution. While about 99 percent of the high school teachers who enter teaching with a master's degree earned that degree at a public institution, among those who earned their degrees later, approximately 15 percent earned them at for-profit or private institutions (5 and 10 percent of teachers, respectively). For middle school teachers, the patterns are even clearer. Only two percent of pre-entry master's degrees are from for-profit or private institutions, whereas nearly twenty percent of post-entry degrees are earned from for-profit or private institutions (8 and 11 percent of teachers). These institutional differences could potentially translate into differences in teacher effectiveness.

3. Modeling the effects of master's degrees

The standard approach to determining how master's degrees affect student outcomes is to estimate a model of the following form:

$$Y_{ijgt} = f(T_j, TV_{jt}, X_{it}, XV_{it}, Z_v, \delta_{gt})$$

where Y_{ijgt} is an outcome variable such as student test scores (or absences) for the i th student taught by teacher j in grade g in year t . The vector T_j refers to time invariant characteristics of teachers such as their race, ethnicity, gender, licensure test scores or whether they enter teaching with a master's degree, and TV_{jt} to time-varying characteristics such as their years of teaching experience, or whether they earn a master's degree after they start teaching. The vector X_i refers to time invariant student characteristics, and XV_{it} to time varying student characteristics such as whether the student has changed schools, and importantly, lagged values of the outcome variable. The vector Z_t refers to other determinants of student outcomes that could be confounded with the teacher variables, such as the characteristics of schools or classrooms, and δ_{gt} represents grade-by-year fixed effects.

As is well documented in the literature, the major statistical problem that arises in estimating such models is that students are not randomly assigned to teachers. Hence, researchers need to find ways to assure that the estimated effects of the teacher variables are not confounded by the types of students they teach. One solution is to include a large number of observable student characteristics in the X vector and a variety of school or classroom variables in the Z vector (see for example, Clotfelter, Ladd and Vigdor 2006). An alternative approach, but one that can be pursued only if there are multiple outcome measures for each student, is to replace the time invariant student characteristics with student fixed effects (e.g. Betts et al. 2003; Clotfelter, Ladd and Vigdor 2007; and Hanushek et al. 2005). This approach in effect controls statistically not only for the measurable characteristics of students but also for those that are unobservable. An alternative strategy is to use some form of natural experiment or random assignment.

Harris and Sass (2011) include 11 studies of the effects of master's degrees in their broader review of the effects of a variety of forms of teacher training on student achievement.³ All of these studies are carefully executed in that either they include student fixed effects or they use something close to random assignment. Of interest, is that the vast majority of the estimated effects of master's degrees are zero, with only a few statistically significant positive estimates and a few negative estimates. Moreover, the new estimates by Harris and Sass based on Florida data for all three levels of schooling provide no evidence of positive effects of master's degrees. Other studies not included in the Harris and Sass review include Budding and Zamarro's 2009 study of elementary schools in San Diego, and Chingos and Peterson (2011)' study of 4th through 8th graders in Florida. Consistent with the Harris and Sass conclusions, these other studies also find either negative or no effects of master's degrees.

Two points are worth making about these prior studies. First, the vast majority of them focus on teachers at the elementary level. In their survey of estimates, for example, Harris and Sass refer to 13 estimates for teachers of elementary school students, far more than the 3 estimates they provide for middle school teachers and the 3 for high school teachers. Although Harris and Sass themselves focus on all three levels, their student outcome measures for high school students are reading and math test scores rather than the more specialized subject specific courses that teachers typically teach at the high school level. Hence there is room for further research on the role of master's degrees for teachers at the higher levels of schooling.

Second, only a few of the studies explicitly recognize that teachers choose whether or not to obtain a master's degree. The concern is that various unobservable characteristics related to the effectiveness of a teacher may be correlated with having a master's degree. If the less effective teachers were the ones more likely to have a master's degree, the estimated coefficient on the master's degree indicator variable would be biased downward. It would be biased upward if the more effective

³ Betts et al. 2003; Clotfelter, Ladd and Vigdor 2006; 2007; 2010; Dee 2004; Ding and Lehrer 2005; Hanushek et al. 2005; Jepsen 2005; Nye et al. 2004; Rivkin et al. 2005; and Rockoff 2004.

teachers were the ones more likely to have a master's degree. A few of the studies adjust for this possibility by including teacher fixed effects in the models (e.g. Buddin and Zamarro 2009 include teacher fixed effects for elementary school teachers; Chingos and Peterson 2011 include teacher fixed effects for reading and math teachers in grades 4-8 and Harris and Sass 2011 do so for math teachers in elementary school), but many, including the North Carolina studies by Clotfelter, Ladd and Vigdor, do not. By including teacher fixed effects, the researcher in effect controls for all the time-invariant characteristics of teachers, both those that are measurable and those that cannot be observed.

In the models we present below, we make a serious effort to control not only for the nonrandom sorting of students to teachers, but also for the fact that teachers select into the condition of having a master's degree. As we note below, when we use teacher fixed effects to control statistically for time invariant characteristics of teachers, we are not able to estimate the effects of having a pre-entry master's degree.

4. Data and methods

This analysis takes advantage of rich administrative data from the North Carolina Education Research Data Center (NCERDC). Course membership data matches students to each of their enrolled courses and teachers, and tracks them longitudinally from the 2005-2006 to 2010-2011 school years. For students in grades six through eight, we have information on End of Grade (EOG) standardized test scores in mathematics and reading comprehension, student absenteeism, demographic characteristics, and other information such as limited English proficiency, free/reduced lunch eligibility, gifted and exceptionality status, grade retention, disciplinary offenses, and parent education. For students in high school, we also have End of Course (EOC) performance data for a variety of subjects: English 1, civics, U.S. history, algebra II, geometry, biology, physical science, and chemistry. We normalize the EOG and EOC scores by grade, subject, and year to have a mean of zero and standard deviation of one. Because

some of the regressions require lagged test scores to control for student ability, our analytical sample excludes student observations in the 2005-2006 school year.

For teachers, our sample includes any middle school teacher of math or ELA or any high school teacher in one of the eight tested subjects that is matched to students during our 2006 to 2011 observation period. The final sample includes approximately 1.3 million student-year observations in middle school and 1.2 million student-year-subject observations in high school, summed across the different subject areas.

To estimate returns to graduate degrees for middle school and high school teachers, we use several model specifications that account in different ways for the empirical challenges just described. For middle school student outcomes, we compare estimates from three possible models.

$$(1) Y_{ijgt} = \beta_0 + \beta_1 Degree_{jt} + \beta_2 TV_{jt} + \beta_3 XV_{it} + \beta_4 Y_{it-1} + \beta_5 X_i + \alpha_j + \gamma_s + \delta_{gt} + \varepsilon_{ijgt}$$

In Model 1, shown above, student outcomes are regressed on an indicator of whether or not the matched teacher has a master's degree $Degree_{jt}$ in year t , time-varying teacher characteristics such as experience TV_{jt} , time-varying student characteristics such as school change XV_{it} , the lagged test score or outcome variable Y_{it-1} , time-invariant student characteristics X_i , teacher fixed effects α_j , school fixed effects γ_s , and grade-by-year fixed effects δ_{gt} . With the use of teacher fixed effects, our identification relies on within-teacher changes in effectiveness that result from attainment of a master's degree during the teacher's career. The time-varying teacher characteristic variables include a detailed set of experience indicators such that graduate degree effects are not conflated with returns to experience, which are significant and nonlinear (Papay and Kraft 2013; Ladd and Sorensen 2014).

Model 1, therefore, accounts for teacher selection into having a master's degree and controls for observable student characteristics. However, it could be that student-teacher matching occurs based on unobservable student characteristics. Thus, in Model 2 we introduce student fixed effects θ_i

to control for any unobservable student ability factors. We use an iterative algorithm developed by Guimaraes and Portugal (2010) to run this model with two high-dimensional fixed effects.

$$(2) Y_{ijgt} = \beta_0 + \beta_1 Degree_{jt} + \beta_2 TV_{jt} + \beta_3 XV_{it} + \alpha_j + \theta_i + \delta_{gt} + \varepsilon_{ijgt}$$

Finally, to be consistent with the methods of prior research, we estimate a third model without teacher fixed effects. Instead this model contains school fixed effects γ_s ; student fixed effects θ_i ; time-invariant teacher characteristics such as gender, race, licensure, and certification T_j ; and the same other primary control variables from Model 1.

$$(3) Y_{ijgt} = \beta_0 + \beta_1 Degree_{jt} + \beta_2 TV_{jt} + \beta_3 XV_{it} + \beta_4 T_j + \theta_i + \gamma_s + \delta_{gt} + \varepsilon_{ijgt}$$

This strategy relies on across-teacher variation in advanced degree attainment to identify the coefficient on $Degree_{jt}$, in addition to the within-teacher variation examined in Models 1 and 2.

To facilitate comparison among models, we estimate Model 3 with two different samples of teachers. First, in Model 3a, we estimate the association between teacher master's degrees and student outcomes only for the sample of teachers who attained their degree during the 2006 to 2013 observation period and not prior to the start of their teaching career. In this way, we can directly compare these results to Model 1 and Model 2 since it uses the same effective sample. In Model 3b, we expand the estimation sample to *all* teachers matched to student outcomes. Hence we are able to estimate the returns to both pre-entry and post-entry master's degrees, although the teacher selection problem remains. We prefer Model 2 since it ameliorates both sources of potential bias: unobservable student-teacher matching and teacher selection into degree attainment.

For high school outcomes, we are only able to estimate Models 1, 3a, and 3b. There is no within-student variation for us to exploit as with the middle school End of Grade test and absence outcomes.

Our preferred model at the high school level is model 1.

5. Results

For students in grades 6-8, we estimate average effects of teachers earning master's degrees on three student outcomes: math and reading test scores, and absenteeism. Table 2 presents the test score results for our three model specifications. For Model 1, we find no statistically significant effect of a master's degree on reading scores, and a weakly significant 0.01 standard deviation increase in math test scores. This model includes teacher fixed effects and controls for observable student characteristics. However, once student fixed effects are added in Model 2, even the modest effects on math test scores disappear. Models 3a and 3b, which do not account for teacher selection into having a master's degree, show either insignificant or slightly negative effects on reading and math test scores. This set of results essentially confirms the findings from prior studies that earning a master's degree does not lead to any test score improvements at the middle school level.

We observe a similar pattern at the high school level. In Table 3, outcome variables are listed by row rather than by column because we have so many different subjects. The estimates in each cell represent coefficients on the master's degree indicator for each end-of-course test score outcome (row) and model specification (column). As can be seen for our preferred specification in column 1 the coefficients on attaining a master's degree are not statistically different from zero for four of the tested high school courses: English 1, US history, civics, and geometry. Although the coefficients for three of the subjects do differ from zero, two of them are negative (algebra II and biology). Thus we find essentially no evidence that master's degrees generate positive returns in the form of higher student test scores at the high school level. Results from Model 3a, which is based on the post-entry degree sample, and Model 3b, which is based on the full teacher sample, reinforce this conclusion. In addition, in regressions not shown, we find suggestive evidence that earning a master's degree from a for-profit institution may in fact decrease student achievement in math in middle school (-0.06 standard deviations) and science subjects in high school (-0.11 standard deviations).

Somewhat more positive results emerge, however, in terms of how master's degrees affect student absenteeism, arguably a proxy for some noncognitive skills that are important for a student's future success (Heckman, Stixrud and Urzua 2006). Attendance itself as early as sixth grade strongly predicts the likelihood of graduating high school (Balfanz et al. 2007; Allensworth et al. 2007). In Table 4, the outcome variable is an indicator of whether or not the student has greater than 10 absences in a single year, and results are from a linear probability model.⁴ Although a Poisson or negative binomial regression would have been more appropriate for estimating the effects since absences are a count variable, performing Poisson or negative binomial regressions with our large sample size and two high-dimensional fixed effects is computationally impossible. As can be seen in the Model 2 columns, master's degrees are associated with a two percentage point decline in high student absenteeism. The magnitude of this effect may not be impressive by itself, but it does open the possibility that perhaps teacher advanced degrees have positive effects on student behavior even in absence of any test score effects. Jackson (2012) and Gershenson (2014) have confirmed that high quality teachers can and do have a causal impact on student attendance, and that these teachers are not necessarily the same as those with high test score value-added.

A secondary objective of this study is to explore heterogeneity in returns to advanced degrees by the type or subject of degree. In Table 4 we examine the heterogeneous effects on absenteeism. The coefficient on the initial master's degree variable now represents the estimated effect of a master's degree in a subject other than those listed. The rows below present coefficients for interaction terms of a master's degree and an indicator for each degree type. Therefore, the total magnitude of an effect of

⁴ This threshold was chosen to correspond to the 75th percentile value. We tested alternative thresholds and found that the effects of master's degrees are stronger for students in the upper tail of the absences distribution and lower for students in the lower tail of the distribution. This makes intuitive sense since it is more plausible for teachers to be able to affect the motivation of students with potential truancy problems than to affect the likelihood of otherwise high-attendance students from getting sick for a few days.

a degree in school administration, for example, would equal the sum of the coefficient on master's degree and the coefficient on master's degree×school administration. Within the sample of middle school math teachers that earn master's degrees, there appear to be robust differences by three main types of degrees: school administration, math, and other. A degree in school administration reduces high absenteeism by 7.7 percent ($p < 0.01$) whereas a degree in math only reduces high absenteeism by 2.3 percent ($p < 0.01$). Other types of master's degrees seem to slightly increase student absenteeism within the math teacher sample. These differences do not emerge for the ELA teacher sample.

Table 5 presents the results of master's degree by subject of degree for middle school and high school test score outcomes. Our expectation was that subject-specific master's degrees (such as earning a graduate degree in science when the teacher teaches high school chemistry) would be more effective than other types of graduate degrees. However, this does not appear to be the case. For middle school math teachers, master's degrees in math actually have a 0.04 standard deviations lower effect than other types of degrees, and a negative 0.03 effect overall. For physical science teachers in high school, science master's degrees have 0.15 standard deviations lower effectiveness than other types of degrees such as school administration. In civics, however, both school administration and social studies degrees have large positive effects (0.14 and 0.13 standard deviations). These results indicate that, beneath the net zero effect of master's degrees on student test scores, there are some interesting and significant differences among the various degree types. These differential returns among degree types, however, do not translate obviously across course subjects. Therefore, they generate no obvious generalizable implications for policy.

6. Discussion

Motivated by recent debates policy debates about teacher pay, this study uses a rich longitudinal administrative data set of North Carolina teachers and students for the years 2006-2013 to

re-examine the role of master's degrees. The paper contributes to the existing literature in a number of ways. First, we provide descriptive information on which teachers choose to attain advanced degrees, at what points in their career, and for what purposes. Second we estimate the returns to master's degrees. In doing so, this paper adds to prior research by expanding student outcomes from the traditional research focus on reading and math scores at the elementary level to subject-specific performance and student attendance at the middle school level. It does so while accounting for teacher selection into graduate degrees through teacher fixed effects and detailed experience indicators. And finally, this study investigates heterogeneity in returns to master's degrees by type of degree.

Contrary to our expectations when we started this project, we do not provide any new results that would question the standard wisdom that master's degrees are not useful for raising student performance as measured by their test scores. Although we find a few positive effects for specific types of master's degrees, the effects are limited and not generalizable. However, we do uncover some suggestive evidence that earning an advanced degree may better equip middle school teachers to reduce student absenteeism. Further research could determine whether these benefits extend to other student behavioral dimensions.

In light of these findings, we return to the question of the extent to which states or districts should incentivize teachers to earn master's degrees through salary supplements. If the sole purpose is to increase student test scores in the short-term, then there are undoubtedly more efficient practices than pay raises for master's degrees. However, providing salary boosts for advanced education for teachers could potentially generate other benefits. Our descriptive finding, that teachers who are more highly qualified on a number of dimensions such as Praxis scores and college competitiveness are more likely than other teachers to enter the profession with a master's degree, suggests that salary bumps for pre-entry master's degrees could be a potential mechanism for recruiting high-quality teachers into the profession.

In addition, our descriptive finding that teachers are most likely to earn graduate degrees during their 4th through 6th years of teaching suggests that the current policy may increase teacher retention during this critical time within their career. The timely salary raise and human capital investment could impel teachers to remain in the profession and continue their on-the-job learning. This retention is especially important given that, as has been shown elsewhere, teacher productivity rises through at least 12 years of experience, and teacher exit early in the career has become more common (Ladd and Sorensen 2014; Wiswall 2013; Ingersoll and Merrill 2010). Whether pay raises for master's degrees do causally improve teacher recruitment and retention, however, is an empirical question that still requires testing.

A final potential benefit from such a policy comes in the form of career mobility for teachers. Ashworth (2014), for example, finds that teachers who obtain master's degrees are more likely to transfer to higher quality schools with better working conditions. Moreover, our descriptive finding that school administration is the single most popular choice of advanced degree indicates that for many teachers, pursuing a master's degree may constitute preparation for future administration positions, such as an assistant principal or department head rather than as a means of improving their teaching skills. Teachers are clearly strategic in their decision to attain a master's degree, and the task for future research is to determine how best to encourage them to invest in ways that will improve outcomes for children not only in the form of short term gains in test scores but also in terms of the development of a quality teaching force.

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Tables & Figures

Figure 1. Proportion of North Carolina teachers with master's degrees: 2006 – 2013

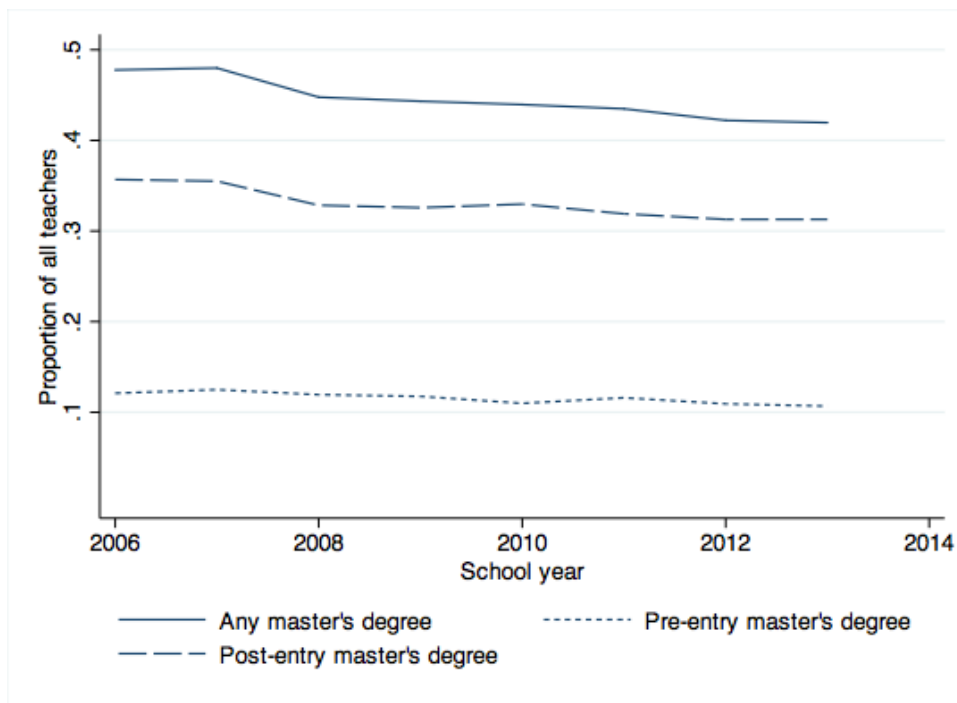
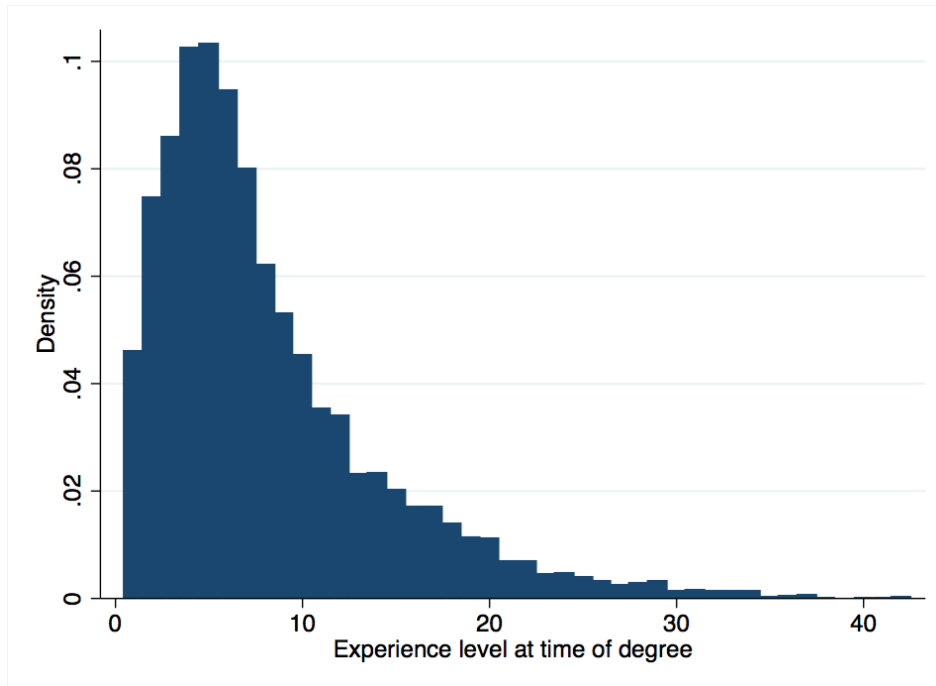


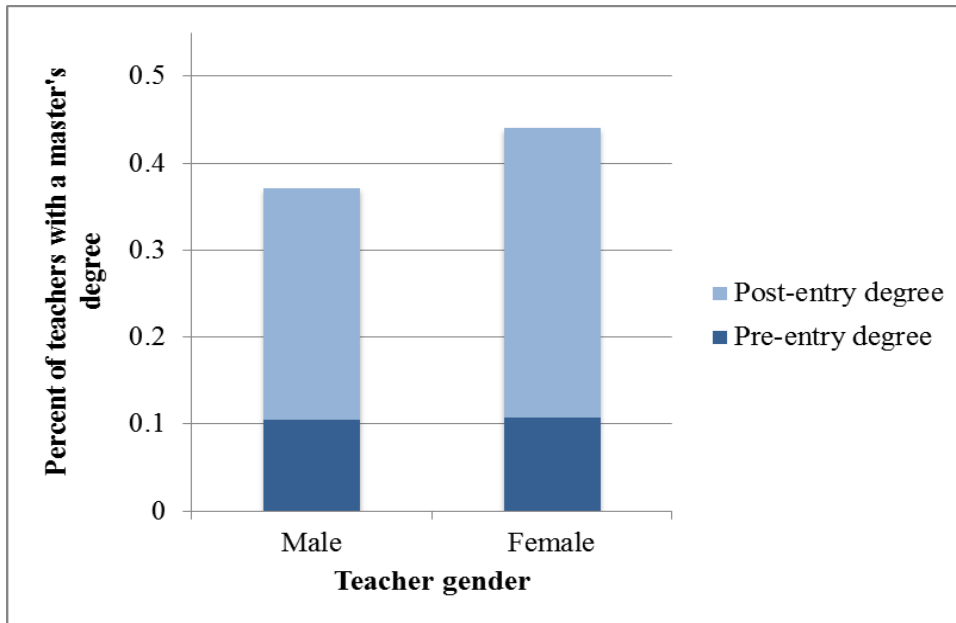
Figure 2. Estimated experience level at time of mid-career master's degrees



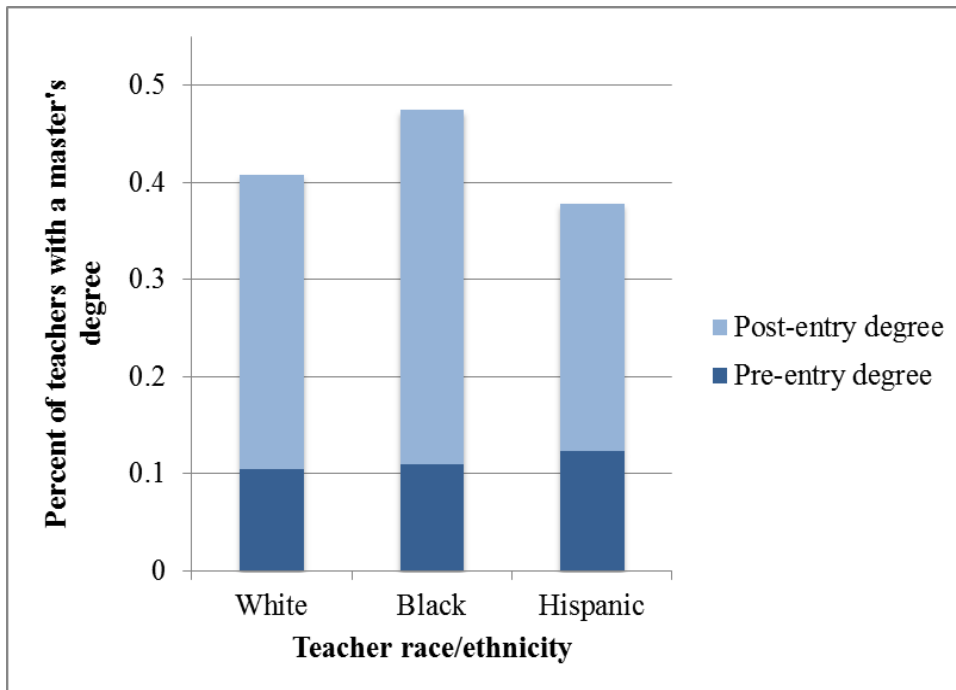
Note. This density plot includes any teachers observed teaching in North Carolina middle or high schools in the 2012-2013 school year.

Figure 3. Summary of master's degree acquisition by teacher and school characteristics

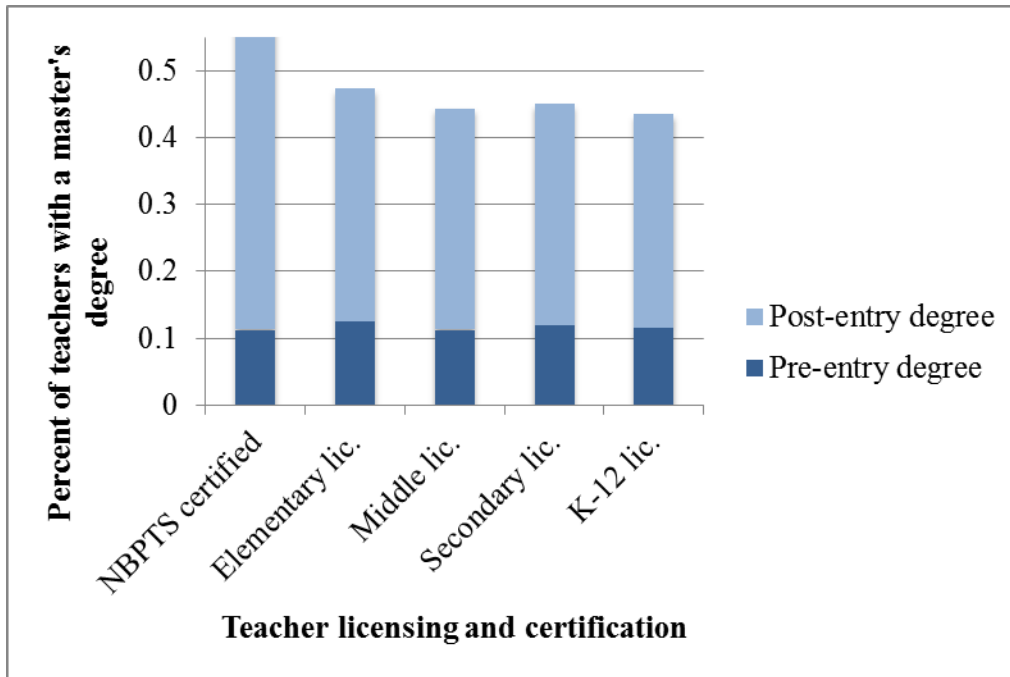
3a. Likelihood of earning a master's degree, by teacher gender



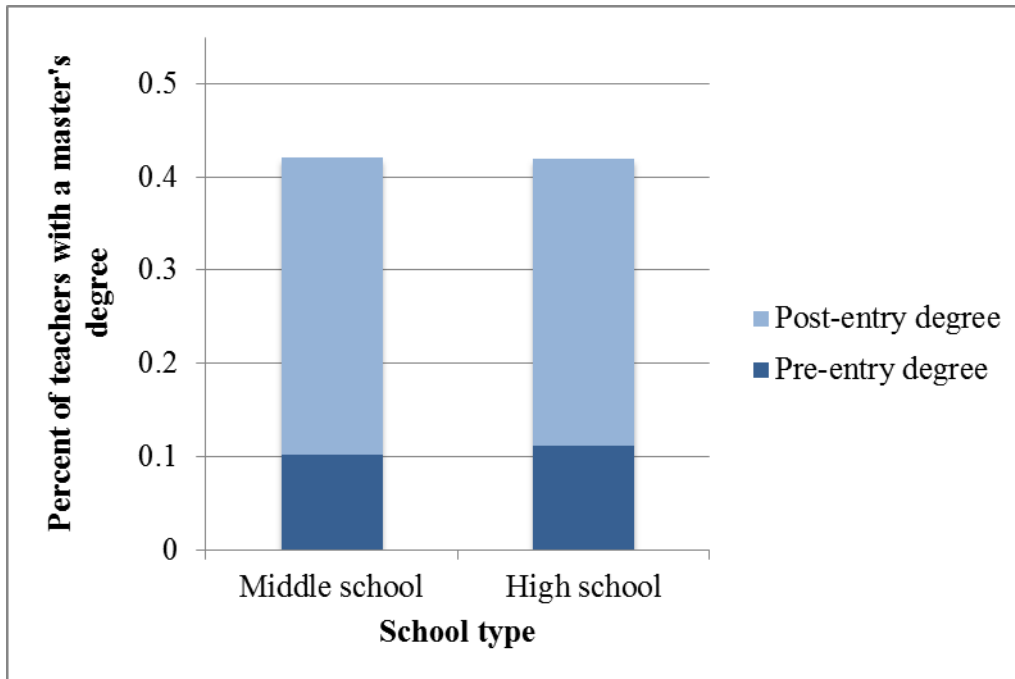
3b. Likelihood of earning a master's degree, by teacher race/ethnicity



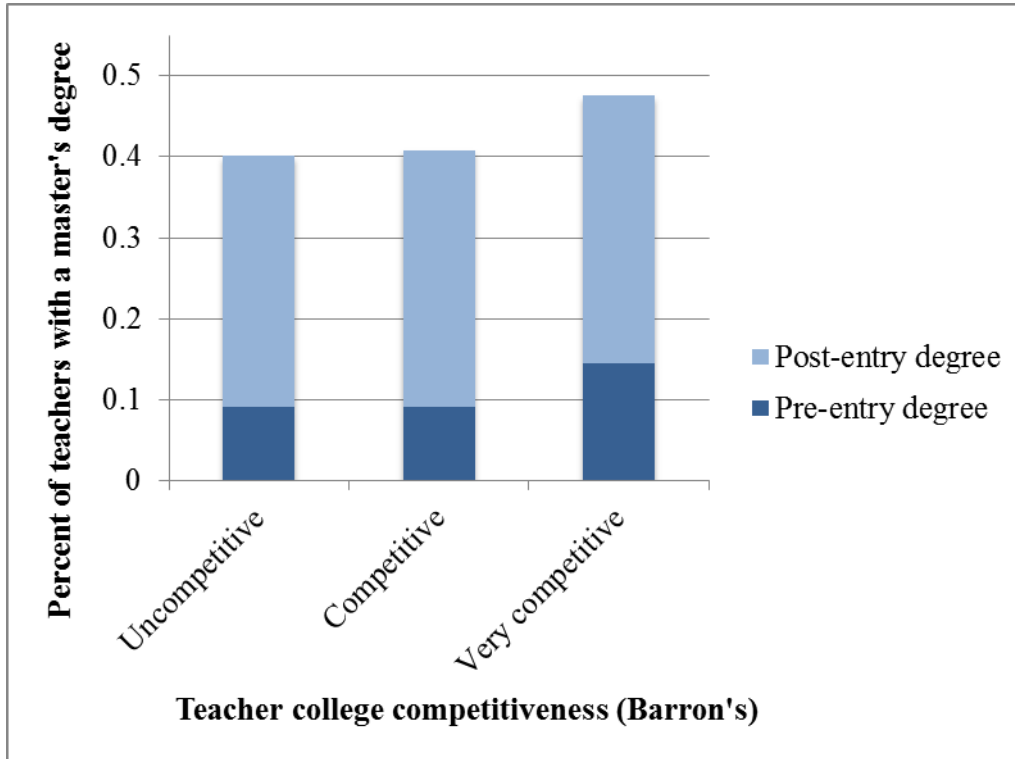
3c. Likelihood of earning a master's degree, by teacher licensing and certification



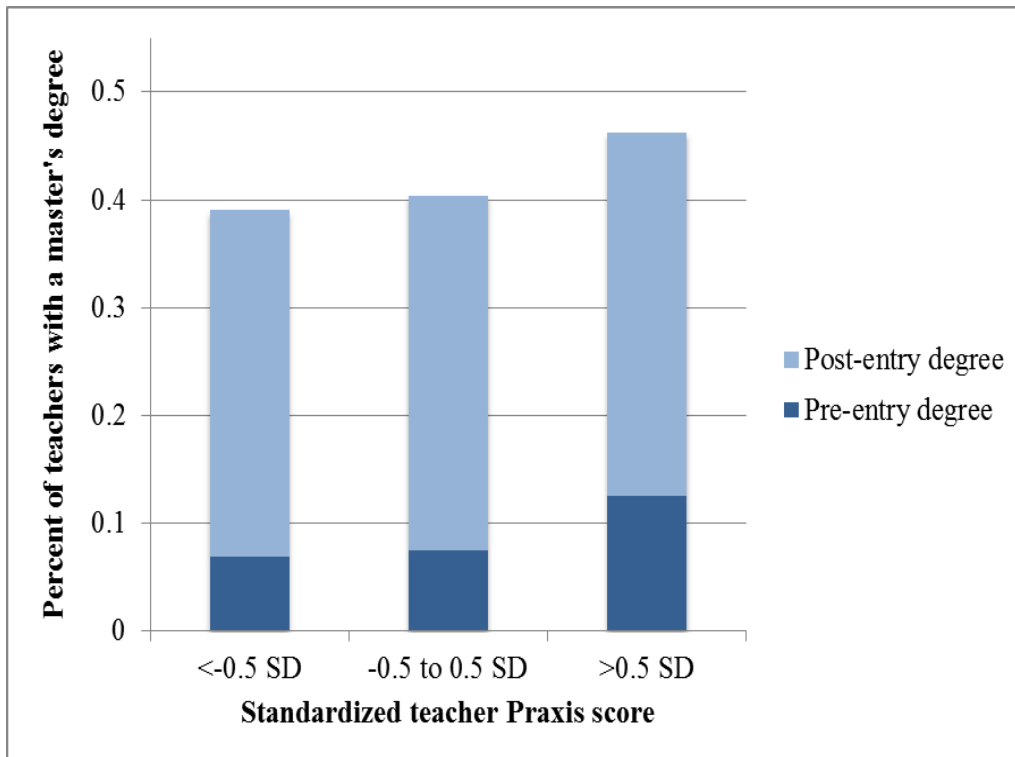
3d. Likelihood of earning a master's degree, by school type



3e. Likelihood of earning a master's degree, by teacher's college competitiveness



3f. Likelihood of earning a master's degree, by teacher Praxis score



Note. Graphs 3a through 3f include any teachers observed teaching in North Carolina middle or high schools in the 2012-2013 school year with teacher characteristics data available.

Table 1a. Most common master’s degrees by subject taught: Pre-entry degrees

	Middle school		High school							
	Math	ELA	Eng1	Geom	PSci	Alg2	Bio	Chem	USH	Civics
(1)	ScAdm	ScAdm	Eng	Math	Scien	Math	Scien	Scien	Eng	Hist
(2)	Math	Rdg	SpeEd				Biol		Hist	SocSt
(3)	EIEdu	EIEdu					Couns		SocSt	

Course abbreviations: ELA = English/Language arts; Eng1 = English 1; Geom = Geometry; PSci = Physical science; Alg2 = Algebra 2; Bio = Biology; Chem = Chemistry; USH = UH History

Degree abbreviations: ScAdm = School administration; EdLdr = Education leadership; SpeEd = Special education; Rdg = Reading; EIEdu = Elementary education; LgArt = Language arts; Scien = Science; Biol = Biology; Couns = Counseling; SocSt = Social studies; Hist = History.

Table 1b. Most common master’s degrees by subject taught: Post-entry degrees

	Middle school		High school							
	Math	ELA	Eng1	Geom	PSci	Alg2	Bio	Chem	USH	Civic
(1)	Math	Rdg	Eng	Math	ScAdm	Math	ScAdm	ScAdm	ScAdm	ScAdm
(2)	ScAdm	LgArt	Scadm	ScAdm	Scien	ScAdm	Scien	Scien	SocSt	SocSt
(3)	EIEdu	ScAdm	Rdg	EdLdr	EdLdr	EdLdr	Biol	EdLdr	Hist	Hist

Course abbreviations: ELA = English/Language arts; Eng1 = English 1; Geom = Geometry; PSci = Physical science; Alg2 = Algebra 2; Bio = Biology; Chem = Chemistry; USH = UH History

Degree abbreviations: ScAdm = School administration; EdLdr = Education leadership; SpeEd = Special education; Rdg = Reading; EIEdu = Elementary education; Eng = English; LgArt = Language arts; Scien = Science; Biol = Biology; SocSt = Social studies; Hist = History.

Table 2. Effects of earning a master’s degree on middle school student test scores

	Reading test score				Math test score			
	Model 1	Model 2	Model 3a	Model 3b	Model 1	Model 2	Model 3a	Model 3b
Master’s degree	0.003 (0.005)	-0.001 (0.005)	-0.002 (0.004)	-0.004** (0.001)	0.011* (0.005)	-0.004 (0.005)	-.0281** (0.008)	0.0003 (0.001)
F.E.								
Teacher	X	X			X	X		
Student		X	X	X		X	X	X
School	X		X	X	X		X	X
Controls								
TV _{it}	X	X	X	X	X	X	X	X
T _i			X	X			X	X
XV _{it}	X	X	X	X	X	X	X	X
X _i	X				X			
Obs	1,322,252	1,241,541	305,883	1,215,982	1,317,131	1,237,112	156,112	1,206,784
R-sq	0.522	0.925	0.974	0.923	0.609	0.936	0.984	0.930

Robust standard errors in parentheses; TV_{it} = time-varying teacher characteristics; T_j = time-invariant teacher characteristics; XV_{it} = time-varying student characteristics; X_i = time-invariant student characteristics; all models include grade-by-year fixed effects and classroom-level control variables such as class size.

** p<0.01, * p<0.05, + p<0.1

Table 3. Effects of earning a master's degree on high school student test scores

Outcome (score)	Model 1	Model 3a	Model 3b	Observations	R-squared
English I	-0.0029 (0.009)	-0.0159 (0.016)	0.0011 (0.006)	307,779 (53,938)	0.706
U.S. History	-0.0245 (0.020)	0.0095 (0.045)	0.0059 (0.017)	141,060 (23,729)	0.564
Civics	0.0106 (0.014)	-0.0102 (0.030)	-0.0226* (0.010)	207,812 (37,794)	0.656
Geometry	-0.0044 (0.022)	0.0289 (0.064)	-0.0152 (0.019)	117,080 (16,708)	0.691
Algebra II	-0.0668** (0.021)	-0.0313 (0.056)	-0.0096 (0.017)	143,972 (17,996)	0.632
Physical science	0.0639+ (0.037)	0.0417 (0.079)	-0.0672** (0.021)	86,528 (11,295)	0.560
Biology	-0.0308* (0.012)	-0.0211 (0.027)	0.0138 (0.011)	211,817 (28,785)	0.659
Chemistry	0.0000 (0.000)	0.1921 (0.818)	0.0095 (0.045)	23,476 (2,580)	0.623
F.E.					
Teacher	X				
School	X	X	X		
Controls					
TV _{jt}	X	X	X		
T _j		X	X		
XV _{it}	X	X	X		
X _i	X	X	X		

For each subject, the dependent variable is the end of course test score in that subject and the estimates listed in each column are the coefficients on the master's degree indicator for each model; robust standard errors in parentheses. The observations column lists first the total number of student observations for that outcome (sample for Model 3a), and in parentheses gives the number of student observations matched to teachers that earn a master's degree during the observed time period (effective sample for Model 1 and 3b). The R-squared is presented for Model 1 only.

TV_{jt} = time-varying teacher characteristics; T_j = time-invariant teacher characteristics; XV_{it} = time-varying student characteristics; X_i = time-invariant student characteristics; all models include grade-by-year fixed effects and classroom-level control variables such as class size.

** p<0.01, * p<0.05, + p<0.1

Table 4. Effects of earning a master’s degree on student absenteeism

	Greater than 10 absences (ELA)			Greater than 10 absences (Math)		
	Model 1	Model 2	By Subj.	Model 1	Model 2	By Subj.
Master’s degree	-0.019** (0.003)	-0.020** (0.005)	-0.019 (0.013)	-0.008* (0.003)	-0.017** (0.005)	0.054** (0.013)
xSchool adm.			-0.003 (0.018)			-0.131** (0.018)
xEnglish / LA			0.001 (0.017)			--
xReading/Literacy			-0.004 (0.018)			--
xElem. education			-0.019 (0.013)			--
xMath			--			-0.077** (0.017)
F.E.						
Teacher	X	X	X	X	X	X
Student		X	X		X	X
School	X			X		
Controls						
TV _{it}	X	X	X	X	X	X
T _i						
XV _{it}	X	X	X	X	X	X
X _i	X			X		
Observations	1,329,293	1,243,509	1,243,509	1,319,748	1,238,541	1,238,541
R-squared	0.218	0.722	0.722	0.218	0.720	0.720

Indicator for “missing degree subject x master’s” also included; robust standard errors in parentheses; TV_{it} = time-varying teacher characteristics; T_j = time-invariant teacher characteristics; XV_{it} = time-varying student characteristics; X_i = time-invariant student characteristics; all models include grade-by-year fixed effects and classroom-level control variables such as class size.
 ** p<0.01, * p<0.05, + p<0.1

Table 5. Effects of earning a master’s degree on student test scores: by degree subject

	Middle school		High School						
	Math	ELA	Eng 1	USH	Civics	Geom	Alg II	P Sci	Bio
Degree	0.015 (0.012)	0.003 (0.013)	-0.034 (0.047)	-0.014 (0.064)	-0.034 (0.030)	0.100 (0.183)	-0.079 (0.194)	0.219** (0.022)	-0.056 (0.081)
<i>xScAdm</i>	-0.024 (0.017)	-0.003 (0.019)	0.023 (0.055)	0.029 (0.159)	0.144** (0.030)	--	-0.075 (0.203)	--	-0.003 (0.134)
<i>xELA</i>	--	-0.003 (0.018)	0.041 (0.058)	--	--	--	--	--	--
<i>xRdg</i>	--	-0.011 (0.019)	0.032 (0.063)	--	--	--	--	--	--
<i>xElEdu</i>	--	-0.001 (0.035)	--	--	--	--	--	--	--
<i>xMath</i>	-0.044** (0.016)	--	--	--	--	-0.126 (0.189)	-0.018 (0.229)	--	--
<i>xScience</i>	--	--	--	--	--	--	--	-0.152* (0.063)	0.046 (0.087)
<i>xSocst</i>	--	--	--	-0.176 (0.223)	0.133* (0.065)	--	--	--	--
F.E									
Teacher	X	X	X	X	X	X	X	X	X
Student	X	X							
School									
Controls									
TV _{jt}	X	X	X	X	X	X	X	X	X
T _j									
XV _{it}	X	X	X	X	X	X	X	X	X
X _i			X	X	X	X	X	X	X
Obs	1,237,11 2	1,241,54 1	307,779	141,060	207,812	117,080	143,972	143,972	211,817
R-sq	0.936	0.925	0.603	0.398	0.550	0.539	0.437	0.437	0.535

Indicator for “missing degree subject x master’s” also included; robust standard errors in parentheses; TV_{jt} = time-varying teacher characteristics; T_j = time-invariant teacher characteristics; XV_{it} = time-varying student characteristics; X_i = time-invariant student characteristics; all models include grade-by-year fixed effects and classroom-level control variables such as class size.

Course abbreviations: ELA = English/Language arts; Eng1 = English 1; Geom = Geometry; PSci = Physical science; Alg II = Algebra 2; Bio = Biology; Chem = Chemistry; USH = UH History

Degree abbreviations: ScAdm = School administration or education leadership; Rdg = Reading or literacy; ElEdu = Elementary education; ELA = English or language arts; Scien = Science, biology, or chemistry; SocSt = Social studies or history.

** p<0.01, * p<0.05, + p<0.1