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Path to the Principalship and Value Added: A Cross-state Comparison of Elementary and Middle School Principals

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Abstract

An increasing emphasis on principals as key to school improvement has contributed to efforts to elevate principal effectiveness that have taken various forms across the US. The primacy of the state as the focal point of educational reform elevates the value of understanding commonalities and differences among states in characteristics of principals, the distribution of principals among schools and ultimately the policies associated with more effective school leadership, particularly for disadvantaged children. This paper describes major state policies, the distribution of elementary school principals among schools along a several dimensions, and pathways to the principalship to illustrate similarities and differences among six states in the tenure and experience distributions and how these vary by student demographic characteristics and district size. Measurement of principal effectiveness and its relationship with principal characteristics and state policies would be ideal, but complications introduced by the dynamics of principal influences and confounding effects of other factors inhibit this effort. Nonetheless, school value added to achievement provides information on differences in principal effectiveness, and we report within-school variation value added across principal regimes and the associations between value added and principal characteristics. The analysis reveals many similarities and some differences among the states, some of which are related to differences in governance structures. Perhaps the most striking differences relate to the pathways to the principalship including the fraction of principals with experiences as assistant principals and teachers.

1. The Importance of School Leadership

The introduction of school accountability and evidence on the substantial variation in teacher effectiveness have contributed to a growing emphasis on school leadership as central to school improvement efforts. Principals play a central role that includes teacher evaluation and mentoring, the creation of professional learning communities, as well as overseeing discipline and managing operations.

The primacy of the state as the focal point of educational reform elevates the value of understanding commonalities and differences among states in characteristics of principals, the distribution of principals among schools and ultimately the policies associated with more effective school leadership, particularly for disadvantaged children. In this paper, we describe major state policies, the distribution of elementary and secondary school principals among schools along several dimensions, and pathways to the principalship to illustrate similarities and differences among states in the tenure and experience distributions and how these vary by student demographic characteristics and district size. The states include Georgia, Massachusetts, Missouri, North Carolina, Texas, and Washington. Note that the choice of states reflects data availability; the states are not nationally representative, but they are states in which the long administrative data panels allow detailed investigation of the pathways to the principalship. Similarly, we focus on schools that include grades 3-8 (i.e., we exclude secondary schools and small schools with non-standard grade configurations, such as K-2) based on the availability of annual achievement scores.

Next we measure variation between principals in value-added to student achievement, and the predictive power of principal characteristics over value-added. Principals almost certainly contribute to achievement growth and the quality of instruction. However, this

component of the analysis does not necessarily identify the causal contributions of principals to student test achievement—we elaborate on this caveat to these estimates below.

State administrative longitudinal data on students and educators make this study possible. In particular, key to our analyses is the ability to follow students as they move through grades regardless of whether they remain in the same school attendance zone or switch schools or districts; this enables the measurement of achievement growth and estimation of school value added. An educator identifier enables similar tracking of educator careers.

The descriptions of principal characteristics, pathways to the principalship, and within-school variation over time in student achievement associated with principal spells reveal many similarities and some differences among the states. Perhaps the most striking differences relate to the pathways to the principalship. In Georgia, North Carolina, and Texas more than 75 percent or principals had prior experience as assistant principals; by contrast, that number falls to 50 percent or below for Massachusetts, Missouri, and Washington. Massachusetts serves as a real outlier along this dimension, as even in large districts with more than 10,000 students less than one third of the principals had assistant principal experience.

Section 2 discusses the state administrative data and major policies and regulations related to school leadership, focusing on the commonalities and differences among the states. Section 3 describes the distributions of principal experience and tenure by student demographics and the distributions of principals by prior administrative and teaching experience. Our descriptions of the pathways to the principal position consider not only the shares with prior experience as an assistant principal and teacher but also the location of that experience to highlight variation among states in the hiring of principals with prior experience in the same district or even the same school. Section 4 examines variation in achievement growth within

schools to highlight potential contributions of principals and systematic differences by experience and tenure. Finally, Section 5 summarizes the findings, discusses future work and considers implications for policy.

2. Data and Principal Policies

This section begins by describing the administrative data used by each state and presents basic descriptive statistics about enrollment and achievement. Next we outline major state policies that govern the school administrators. Given the similarities among the states we do not provide detailed descriptions for each. Rather we highlight salient differences along both the data and policy dimensions.

2.a. Data

The administrative data about principals, schools, and students that allow us to describe principal distributions and value added are provided by state departments of education.[1] The basic structure of the data is the same across all six states: principals and students are linked to schools and can be tracked over time even if they switch schools or, in the case of principals, roles and job titles. Although each state's data are unique in the sense that they span different years and contain slightly different information, they have similar structures and contain much information in common. For instance, each state provides information on educator experience,

[1] Specifically, from the GAAWARDS database in Georgia, which contains K-12 data from the Georgia Department of Education and is administered by the Governor's Office of Student Achievement. Data for Massachusetts have been provided by the Department of Elementary and Secondary Education in Massachusetts. Data for Missouri have been provided by Missouri Department of Elementary and Secondary Education. The North Carolina data come from the North Carolina Education Research Data Center (NCERDC). This research was also made possible through data provided by the Texas Schools Project at the University of Texas at Dallas. Data for Washington have been provided by the Office of the Superintendent of Public Instruction in Washington state. We are grateful to each of these states for providing the data for this research.

standardized student achievement tests, and student demographics including race, gender, and free- or reduced-price lunch (FRL) eligibility status.

Appendix Table A.1 reports the time period, number of principals and number of students for each state. Not surprisingly, the total number of principals differs substantially across states, exceeding 11,000 in Texas but below 700 in Massachusetts. The beginning date of the longitudinal panel also varies by state, which contributes to this variation. We use the first school year in which principals can be linked to schools as the start of the data panel—for most states this takes us back to the 1990s. We also restrict the data panels in several ways to make them consistent across states. Specifically, the last school year of the panels is 2014-15 in all states (the most recent, common year of cleaned data). We restrict our analyses to principals of K-8 schools, which we define as settings where the highest grade is less than or equal to 9th grade (e.g. non-high schools); high schools are excluded because we cannot estimate value added for principals in high schools in all states given the lack of year-over-year high school state assessments. Charter schools are excluded for this study because some states have no charter schools during the time period of our panel (e.g. Washington only passed a charter law in 2012) and others have very few.[2] Finally, to ensure that we are capturing individuals whose main job is serving as a principal, we restrict the data to principals who serve in a single school for at least .5 FTE in a given year.

For some of our descriptive analyses about the pathways to the principalship we use the full panel of data in each state. But information about principals and their school assignments predates the availability of data necessary to estimate value-added, which require that students also be linked to schools and that there be year-over-year testing in the same subject. Thus, for

[2] Where available, we use data on charter school employment to determine the amount of *prior* employment experience and tenure of principals.

the value-added analyses we use a subset of the data in each state that includes just the time period over which reliable value-added models can be estimated.

Table 1 provides comparisons of achievement, the structure of schools and districts, student demographics, and changes in population for our six states. Panel A shows means and standard deviations for 8th grade NAEP scores in mathematics and reading that illuminate substantial differences across both dimensions. First, average NAEP scores are much higher in Massachusetts than all other states; they exceed the next highest state by about 25 percent of a standard deviation in math and 20 percent in reading. The differences in achievement for the other states tend to be far smaller and the rank ordering of the remaining states differs by subject. Importantly, these scores reflect myriad family, school and community influences and do not indicate differences in school quality. Second, the range of the standard deviation in mathematics across states is almost twice as large as the range in reading. The smaller standard deviation in Texas NAEP mathematics scores suggests that a one standard deviation move in the standardized Texas state test score distribution reflects a smaller difference in actual knowledge than, for example, a one standard deviation change in the standardized Washington state test score distribution (which has the largest standard deviation).

Panel B shows the number of school districts, number of schools, school size, and enrollment share by district size, where a threshold of ten thousand students divides small and large districts. Differences among the number and size of districts illuminate striking differences in administrative structures across states that almost certainly affect the structure of the principal labor market. On the one hand, over 90 percent of the districts in Texas, Missouri and Massachusetts have fewer than 10,000 students. On the other hand, one third of North Carolina and almost 20 percent of Georgia districts have enrollment that exceeds 10,000, and the fewer

number of districts creates relatively larger administrative units. Most of North Carolina's 115 districts, for example, are geographically large and county wide. Georgia schools tend to be much larger and Washington and Missouri schools much smaller than other states. This likely affects the use of assistant principals and potentially the structure of the principal pipeline—e.g., district internal labor markets might be relatively more important in the states with fewer and larger districts.

Panel C presents percentiles of student demographics at the school level in 2014-15, and here too we observe large differences across states. For instance, consistent with much higher NAEP scores, the Massachusetts distribution of share eligible for a subsidized lunch lies to the left of the other states. While the 25th percentile school in Massachusetts has only 17 percent of low-income students, the shares of students at the 25th percentile is more than twice as high in all the other states. The difference at the 50th percentile is smaller but still sizeable.[3] There are also large differences in racial and ethnic diversity. Black enrollment shares are much smaller in the non-southern states than in North Carolina and Georgia. Washington in particular has only a small number of schools with even a 5 percent black enrollment share. Hispanic enrollment is especially low in Missouri, while the median school in Texas is almost 50 percent Hispanic.

Finally, Panel D of Table 1 shows changes in the number of K-8 schools and K-8 enrollment between 2004-05 and 2014-15. These changes have important implications for the demand for new principals in public schools. Enrollment and growth in the number of schools are much higher in Georgia and Texas than in the other states, and enrollment and growth are declining over the course of our data panel in Massachusetts.

[3] Note that the upper end of the distribution of students eligible for subsidized lunch likely overstates the level of poverty as the Community Eligibility Provision provides that all students in high-poverty schools can receive free ro reduced price lunch even if they would not individually qualify.

2.b. Principal Eligibility Requirements

A recent Education Commission of the States report (Scott, 2018) indicates that all states have adopted standards to guide school leadership policies. This can entail the requirement of: specific types of preparation and training in leadership certification programs;[4] minimum hours of supervised field experiences prior to certification; achieving a minimum GPA; and while not universal, most states require that principals have a master's degree, have at least some prior experience as a teacher, and pass one or more certification tests.

While at a high level states appear to have similar requirements for principal licensure, there are differences beneath the surface (see Appendix Table A.2). For example, all six states currently require between two and three years of prior experience in schools or the education system generally, a valid teacher's certificate, and, with the exception of Washington, a passing score on any standardized exam adopted by the state board. That said, alternative routes to administrator/principal certification are available to those who hold a Bachelor's degree but did not complete a traditional certification program in Massachusetts, Missouri, North Carolina, and Washington. Washington's alternative routes also apply to other specific populations, including paraeducators with associate's degrees. A leadership preparation program is also required by all five states (Missouri even specifically requires the completion of a course in "psychology/education of the exceptional child' in addition to the preparation program).

Additionally, there is some degree of flexibility around the master's degree requirement across the six states. For example, Massachusetts has the most flexible standard, allowing for either the completion of an approved master's program with a supervised practicum, completion of an apprenticeship, or approval through a panel review. On the other hand, North Carolina is

[4] For instance, degrees in educator preparation programs that are aligned with standard outline by the Council for the Accreditation of Educator Preparation.

more stringent, requiring that the individual's master's degree be from a public school administration program. Otherwise, the individual must also complete a public school administration program meeting the established standards in addition to their master's degree from an accredited college or university. Notably, North Carolina also has more pronounced distinctions between Assistant Principals and Principals with respect to the expectations, responsibilities, and requirements of the position. Along with seven other states, North Carolina invests in the professional development program, AP Ready, which prepares assistant principals for the demands of the Principal role and is tailored to fit regional needs (New Leaders, 2018).

Many of the standards described above were in place prior to the passage of the Every Student Succeeds Act (ESSA), which shifted considerable control of the public education system to state and local governments but required states to submit plans to the federal goverment outlining, among other things, the state's system of certification and licensing (McGuinn, 2016). ESSA, however, gives "unprecedented recognition" for the role of principals and urges the implementation of effective principal recruitment as well as preparation and ongoing professional learning (NAESP). States implemented some changes (see Appendix Table A.2) and accordingly, ESSA also likely influenced the training of principals. For example, Massachusetts has made it a priority to expand the pipeline of qualified principals in the school system and reduce waivers of requirements.[5]

Still, on the whole, there appears to be little legislative reform of requirements for new principals in our focus states over the timespan of our analysis:[6] a search on principal

[5] In Massachusetts, a principal candidate can have his or her requirements waived by the commissioner, which leads to educators being placed in positions for which they are not certified.

[6] The only notable exception is a Washington House Bill in 2002 that added the requirement of candidates to have held a valid teacher or educational staff associate certificate and demonstrated school experience (see Appendix Table A.2).

requirements in all six states' administrative code in the last 20 years revealed no significant legislative changes related to principals.[7] This is consistent with a report by the National Center for Education Statistics (Hill, et al., 2016) studying principal characteristics in 1987-88 compared to 2011-2012, which finds little in the way of change in principal demographics over this time period.[8]

3. Descriptive analysis of principal characteristics and prior experience

The section describes the distributions of principals by tenure, experience as a principal, and prior experience as an assistant principal and teacher, by district size and school demographic characteristics across states. All tables report distributions for the 2014-2015 academic year and we have structured tenure and experience categories to account for the fact that many principal spells and educator careers are left-censored. In the most states, we observe at least eleven years for a sample window that begins in academic year 2003-2004; our top experience and tenure categories in these states therefore capture principals with eleven or more years. For states with shorter windows the top tenure/experience categories captures individuals with six or more years. We also assume that a principal in her first year in a school in 2014-2015 did not previously serve as a principal if we do not observe her in another principal position during the sample period. Violations of this assumption will lead to the underestimation of experience, but this likely only relates to a very small number of cases.

[7] It is possible, however, that there are more significant changes in regulatory interpretation of state laws, unfortunately this is more difficult to track.

[8] The report found that across the two periods, only one to three percent of public school principals had a bachelor's degree or less. The percentage of those with a master's degree was 62 percent in 2011-2012 compared to 53 percent in 1987-1988. Likewise, public school principals in 2011-2012 had only about one less year of teaching experience than in 1987-88.

Because the data do not report separate experience levels by position, we cannot be sure of educator roles in the years prior to the start of our sample period. We assume that someone in a teaching position in the earliest year of the data panel did not serve in either an assistant principal or a principal position previously—i.e., we assume the individual's prior experience is in teaching only. Finally, we exclude principals who are in the first year of our data panel in each state with an experience level above one (because our data do not allow us to determine the nature of the individual's prior experience).

3.a. Experience and tenure

Table 2 shows principal experience and tenure across the six states, where experience is defined as years as a principal in any state public school including charter and high schools and tenure is defined as the number of years in the current spell as a principal. The distribution of experience is strikingly similar across states, and lines up with national figures showing that principals tend to have 6-7 years of experience on average and median spells of roughly 4 years.[9] Note that experience is not higher in Massachusetts despite the declining number of traditional public schools in that state.[10]

There is variation in the tenure distribution, as a principal in Georgia and to a lesser extent Missouri is less likely to be in her first or second year in a school than a principal in North Carolina, Texas or Washington. Interestingly, Georgia has a low share of principals in the first or second year despite experiencing substantial growth in the number of schools in the state. Principals in Missouri and Washington are especially likely to have long tenure: almost 10 percent have served at least eleven years in the current position.

[9] See Table 6 of the National Teacher and Principal Survey administered by the National Center for Education Statistics, https://nces.ed.gov/surveys/ntps/tables/Table_6_042717.asp.

[10] As discussed above, Massachusetts has the shortest panel of the states in our sample, and we only consider whether principals have 6 or more years of principal experience and tenure.

Table 3 examines variation across states in experience patterns by proportion eligible for a subsidized lunch, proportion black, proportion Hispanic, and average student achievement. Note that these are not quartiles of the distribution but rather groups divided by specified shares of students; we organize the table this way in order to compare distributions among schools with similar demographic compositions in the six states.[11] The left panel reveals sharp differences in the extent to which principals with little experience are concentrated in high poverty schools. In neither Georgia nor Washington does the probability of having a principal in her first or second year increase monotonically with share eligible for a subsidized lunch; it lies between 0.20 and 0.23 for all categories in Georgia and between 0.23 and 0.29 for all categories in Washington. In the other 4 states it does rise monotonically by poverty rate, and the differences are particularly large in Massachusetts and Missouri where the probability of having a principal in her first or second year is roughly one third in schools with at least 75 percent of students eligible for a subsidized lunch but less than twenty percent in schools with less than 25 percent eligible.

Patterns by race and ethnicity diverge from those by income, being much more pronounced in Texas and North Carolina. The probability of having a principal in her first or second year exceeds one third in North Carolina and approaches 50 percent in Texas in schools where black enrollment exceeds 75 percent of the total. Although the probability rises monotonically in Georgia, differences by the black enrollment share are much smaller than in Texas or North Carolina, particularly in very high proportion black schools. Finally, the states also diverge in the strength of the association of principal experience and Hispanic enrollment share. On the one hand, the ordering is quite strong in Massachusetts, while on the other hand it is quite weak in Texas. The marked differences between these states in the overall level of

[11] Information on the *percentile* distribution is available from authors upon request.

Hispanic enrollment, the association between Hispanic ethnicity and income, and the distribution by country of origin may all contribute to these differences.

Finally, the strongest and most consistent associations between the probability of having a principal with little experience and student composition emerges along the average test score dimension. With the exception of Washington, the probability of a principal with little or no experience declines monotonically with test scores.[12] Particularly large differences emerge in Massachusetts and Missouri, the two states with the largest differences by share eligible for a subsidized lunch.

3.b. Prior assistant principal, teaching and principal experience

The next two tables , Tables 4 and 5, report distributions of years of experience as a teacher and assistant principal, respectively, while Figure 1 illustrates distributions of principals by whether they obtain any assistant principal or teaching experience in a state public school, and if so, whether the experience was obtained in the same school, same district but not in the same school, or only in another district.

Panel C of Table 4 for all districts shows pronounced differences in the distribution of prior teaching experience across states. The share of principals with 0 or only one year of experience exceeds 35 percent in Massachusetts and 20 percent in North Carolina but is below 10 percent in Missouri, Texas and Washington. In Texas in particular, less than 4 percent of principals have fewer than two years of teaching experience, consistent with the state requirements to become a principal. Although Panels A and B show that the probability of having little or no teaching experience tends to be slightly larger in the larger districts, the pattern holds regardless of district size.

[12] Student test scores are normalized to be mean zero with a standard deviation of 1 within each grade, subject (math and ELA/reading), and year.

Given the standard view that principals should be qualified to serve as instructional leaders, we were surprised to find that in three states (MA, NC and WA) more than 10 percent of the principals apparently had zero years of public school teaching experience in the same state in which they served in a principalship. Note that our figures may understate teacher experience, however, because the experience may have taken place prior to our sample periods and our data do not include any teaching experience that principals may have had in private schools or in states other than the one in which we are observing their employment as principals.[13] In addition, some principal spells likely started prior to teaching requirements,[14] and in some cases, the state might have waived the teaching requirement.

Turning to Table 5, which reports the proportions of principals with experience as an assistant principal, we find, contrary to our expectations, that being an assistant principal is not a stepping stone for the majority of principal in four states – Georgia, Massachusetts, Missouri and Washington - where at least 40 percent of principals had no assistant principal experience.[15] By comparison, only 13 percent of principals had no assistant principal experience in North Carolina and Texas, where the majority of principals had at least three years of such experience.

In contrast to the case of teaching experience, consistent differences emerge in the probability of little or no assistant principal experience by district size. In all six states this probability is higher in small districts. The gap is roughly 10 percentage points in most states, though it exceeds twenty percentage points in Texas.

[13] In Massachusetts, for example, we find that about half of principals who are not observed with teaching experience but can be matched to a teaching license. This suggests, but does not necessarily imply, that they have teaching experience that we cannot observe.

[14] Though examination of each state's recent legislative history in the last 15-20 years did not reveal any significant changes in the principal eligibility requirements in our focus states. One exception is a Washington House bill explained in Appendix table A.2.

[15] Though, as is the case with teachers, we may miss assistant principal experience occurring prior to the first year in the panel or in private schools or another state.

Figure 1 summarizes the salient differences in the joint distributions of teaching and assistant principal experience by experience location and district size.[16] Experiences are lexically ordered with assistant principal experience prior to teaching experience. This means that the figure ignores teaching experience for those with assistant principal experience, and then reports the distributions of teaching experience by location. The third bar for each state shows the fraction of principals with no prior assistant principal or teaching experience in the state public system.

We begin with a detailed discussion of the experience distribution for Texas in Panel A to clarify the structure of the figure. The left bar illustrates that 86 percent of principals have assistant principal experience, with 19 percent having worked as assistant principals in the same school (blue rectangle), roughly half in the same district but not in the same school (orange rectangle), and around 15 percent in another Texas district (grey rectangle). Out of the 13 percent of principals with no prior assistant principal experience, 1 percent had no teaching experience and most of the remainder had teaching experience in the same district but not the same school.

Comparisons among the states in the top panel produce patterns consistent with both the marginal distributions reported in Tables 4 and 5 and the administrative structures discussed in Section 2. Internal labor markets seem particularly important in Georgia and North Carolina, two states with relatively large districts. In these states, the vast majority of principals accumulated experience in the same district. By comparison, principals in Washington and Massachusetts, two states with relatively large numbers of smaller districts, were more likely to gain experience in other districts.

[16] Appendix Table A3 presents the full joint distributions.

The probability that a principal obtains assistant principal experience in another district is higher in smaller than in larger districts. This makes sense given the larger number and geographic proximity of district schools. It is also not surprising that the probability of having obtained experience in the same school is higher in smaller districts where the school constitutes a larger fraction of the internal labor market.

Table 6 presents the final component of the descriptive analysis of the distribution of principal characteristics. It shows the fractions of principals who previously served in a principal position at a different school in the same district and in a different district. The bottom panel of the table reveals pronounced differences in the share with previous principal experience, ranging from over one third in Washington, to roughly 30 percent in Missouri, North Carolina and Texas, to less than 20 percent in Georgia and Massachusetts. There are also differences in where principals previously worked. In North Carolina, Georgia, and to a lesser extent Texas, principals were much more likely to lead another school in the same district, while in Massachusetts principals were much more likely to have led a school in a different district. Principals in Missouri and Washington are roughly equally divided in terms of whether they previously led a school in the same or in a different district. A comparison of the top two panels shows the expected pattern that principals in small districts were more likely than those in a large district to obtain any previous experience as a principal in another district.

4. Within-school differences in principal value added

The importance and policy relevance of differences in principal characteristics and prior experiences hinges largely on the importance of leadership quality for student outcomes. This section examines patterns of achievement differences across principals who work in the same

school during the sample period. It begins with the development of a conceptual framework in which to consider differences in achievement growth, highlighting factors that complicate the interpretation of differences in value-added across principals within schools. We compare the identification of principal effects with those of teachers and discuss impediments to the measurement of principal effectiveness, our approach to mitigate these impediments, and our interpretation of the resulting estimates. Following this discussion, we present two sets of value-added estimates. The first aims to recover estimates of the within school variation in principal value added across states, and the second aims to assess differences in value added by experience, tenure and highest degree earned for each state. We focus on mathematics achievement in this section because research shows that school-based factors tend to have stronger effects on mathematics than reading.[17] Note that because states administer different test instruments the estimates do not support direct comparisons across states.

4.a. Analytic Approach

We first describe the specifications used to estimate the *within-school* variation in value added across principals and the relationship between value added and principal tenure, experience and other characteristics. We outline key issues that complicate the estimation and interpretation of the differences in value added prior to describing the specifics of the regression models.

4.a.1. Within-school variance

A growing body of literature estimates teacher effects on learning and achievement, and it is possible to apply similar methods to estimate effects of principals.[18] However, there are

[17] Following on the literature on teacher value-added, we expect variation in principal value-added to be larger in mathematics than in reading (Hanushek and Rivkin, 2010; Koedel, Mihaly, and Rockoff, 2015).

[18] As highlighted in Branch et al. (2018), estimation of principal value added must address many of the same but also some very different issues as estimation of teacher value added. A growing body of literature generates

some different challenges associated with the identification of principal effects that raise questions about interpreting these estimates as causal measures of principal quality. The most fundamental of these is that it is difficult to separate the influence of the principal from other factors associated with the school. Estimation of principal effects is essentially equivalent to the estimation of average school effects during all or a specified portion of a principal's spell at a school. Consequently, myriad factors out of the control of the principal, such as school and neighborhood shocks, pre-existing relationships amongst teachers, will influence the estimates.

Another issue is that the influence of one principal may transcend his or her spell at a school. For instance, principals can influence school quality even after leaving through teacher hiring or the establishment of school norms and culture. Controls for prior achievement account for effects of the school prior to the entry of the new principal, but they do not account for influences of the prior principal that persist following her departure. Consequently, although differences in value added between years in which a school is led by different principals will reflect differences in principal productivity, they also capture other factors and should thus be interpreted with care. The concept of principal value added as used in this analysis refers to value added during all or part of a principal's spell at a school.

Our procedure for estimating principal value added closely follows the teacher value added literature. We aim to isolate within-school differences in principals over time. First, we estimate the following value added model of student achievement:

$$(1) \qquad A_{ishpt} = f(A_{ist-1}) + X_{ist} + S_{st} + \delta_h + \phi_t + \theta_{ps} + \varepsilon_{ishpt}$$

estimates of principal effects and considers the methodological impediments. This includes: (Clark and Martorell 2009; Branch, Hanushek, and Rivkin 2012; Chiang, Lipscomb, and Gill 2012; Coelli and Green 2012; Hochbein and Cunningham 2013; Dhuey and Smith 2014; and Grissom, Kalogrides, and Loeb 2015).

Equation (1) models outcome (A) for student *i,* in school *s,* in grade *h*, with principal *p*, and in year *t* as a function of individual, school, and principal factors. $f(A_{ist-1})$ is a cubic polynomial of prior year standardized test scores in math and reading. X_{ist} is a vector of student controls that include indicators for gender, ethnicity, free and reduced-price lunch eligibility, special education, and whether the student is in her first year at school *s* due to a non-structural move (i.e. it is not the first grade offered in the school). The vector S_{st} consists of school averages of the student variables in X_{ist}. The terms δ_h and ϕ_t are indicators for grade and year, respectively. θ_{ps} is a principal-by-school fixed effect, and ε_{ishpt} is an error term clustered at the school level. To minimize the influence of any turbulence around principal transitions, we exclude the first and last years of all principal spells.

θ_{ps} contains information about principal value added but is likely confounded by other school factors per the discussion above. To remove the influences of fixed school factors, we demean θ_{ps} within schools by subtracting the school-average value, $\bar{\theta}_{ps}$, where $\bar{\theta}_{ps} = \sum_{p=1}^{P_s} \pi_p \theta_{ps}$, π_p is the ratio of years principal *p* leads school *s* to the total number of years school *s* appears in the data panel, and P_s is the number of principals who served at school *s* over the course of the data panel. We denote the demeaned values as $\theta'_{ps} = \theta_{ps} - \bar{\theta}_{ps}$, where θ'_{ps} can be interpreted as the difference in school performance during the tenure of principal *p* relative to school performance during the tenure of other principals at the same school

Note that our focus on principal by school fixed effects differs from studies such as Grissom et al., (2015) and Chiang et al (2016) that estimate principal fixed effects using models that also include school fixed effects. Those specifications include a single indicator for each principal, and appearance of a principal in multiple schools creates linkages among schools that foster comparisons of all principals who share the same connected network as described in the

aforementioned papers.[19] By comparison, we estimate a separate effect for each principal spell in a school and focus on comparisons across principals in the same school. This is consistent with the notion that these estimates capture differences in school average value added between periods in which a school is led by a different principal. Although the estimates capture principal influences, the complex dynamics and contributions of other factors precludes the interpretation of within-school differences as measures of differences in principal effectiveness.

The demeaned principal-by-school effects from equation (1) can be used to recover the distribution of within-school principal value added. The variance of this distribution is informative about the potential importance of principals in determining student achievement. For example, if there is no variance, it would suggest that differences in principals do not contribute to student achievement growth, or put differently, that the assignment of specific principals is not consequential for student test scores.

The raw variance of θ'_{ps} will overstate the true variance of principal value added because of sampling variance. To address this problem, we will develop a randomized-inference procedure by which the sampling variance of θ'_{ps} can be estimated, and subsequently subtracted from the raw variance estimate, leaving only variance that can be plausibly attributable to principals. This will be operationalized in the subsequent draft; the variances reported in this paper include the error variance.

[19] As documented by Chiang et al. (2016), a complication with this approach is that unlike for teachers, networks of principals across schools are thin and there are many broken connections. Correspondingly, the variance of principal value-added estimated by this approach is not directly interpretable as either the total variance or the within-school variance. Rather, it is the within-network variance, which should be more than the within-school variance alone if there is cross-network variance, but less than the total variance.

4.a.2. Differences by principal characteristics

In addition to assessing the overall importance of principals as measured by the within-school variance of principal fixed effects, we are also interested in whether specific principal characteristics are associated with achievement growth. To examine this question we use a model akin to what we show in equation (1), but we replace the principal-by-school fixed effects with a vector of principal qualifications and attributes (P_{pt}). We also add school fixed effects (γ_s) to the model, preserving our fundamental within-school identification strategy for recovering the parameters of interest:

$$(2) \qquad A_{ishpt} = f(A_{ist-1}) + X_{ist} + S_{st} + P_{pt} + \delta_h + \phi_t + \gamma_s + \epsilon_{ishpt}$$

The vector P_{pt} contains indicators for highest degree earned by principal *p* in year *t*, along with categories of principal tenure and experience. The categories of principal tenure and experience included in the regression are 3, 4, 5, 6 to 10, and 11 or more years, relative to the holdout group of 2 years (recall that first-year principal spells are omitted from the data). ϵ_{ishpt} is an error term clustered at the school level.

4.b. Results

Table 7 reports estimates of the standard deviation of the distribution of principal value-added for each state overall, and separately for small and large districts. As noted above, we focus on principal value-added to math achievement. Also recall that our estimates are constructed to isolate within-school variation in principal value-added only, as shown in equation (1). Any cross-school variation is necessarily omitted.

As noted above, the standard deviations in Table 7 are unadjusted for sampling variance at present, which surely leads to an overstatement of the true variability in principal value-added. Noting this caveat, the estimates suggest the potential for meaningful differences in principal

value-added within schools. The estimates also suggest there are differences across states in the amount of variation in principal value-added. Specifically, the results indicate that differences in principal value-added are most important in Texas and North Carolina, and least important in Missouri. Some of these differences may be attributable to contextual factors across states—for example, the much smaller variance of NAEP scores in Texas suggests that a within-school standard deviation based on the state standardized test corresponds to less variation in underlying knowledge than in the other states. Consequently, the larger estimates for Texas may not actually correspond to larger effects on the actual variation in knowledge gained. That said, to the extent that the differences across states persist after adjustments for sampling variance and cross-state differences in context, they would motivate further inquiry into why there is more variability in principal value-added in some states relative to others. A potential explanation is cross-state variation in the regulations surrounding principal certification—for example, all else equal, states that permit more diverse pathways into principalship should expect a more heterogeneous pool or principals.

Next, in Table 8 we report on the extent to which principal experience and education are predictive of within school estimates of principal value-added, per equation (2). We focus on the two measures of principal experience described above: tenure at the current school and overall experience. Although these two measures are correlated, they are sufficiently distinct to permit separate identification. Because we omit the first year of each principal spell at a new school from the analytic sample, the first observed year of principal experience or tenure is year-2. We use year-2 as the omitted comparison group, which means the other coefficients are estimated relative to principals in their second year (either at a school or in terms of overall experience). Because previous research suggests that the returns to principal experience plateau quickly

(Clark, Martorell, and Rockoff, 2009), we differentiate experience year-by-year early in the career, but after year-5 we group principals more coarsely by whether they have 6-10 years of experience/tenure, or 11 or more years.

There is variation in the education credentials that principals carry across states, specifically with respect to whether "education specialists" are observed in principal positions. For the sake of consistency in Table 8, in each state we omit principals with master's degrees and compare all other education categories to that group. (Note that the Massachusetts data only includes information about educational attainment for in-state program completers. As such, we have not included educational attainment in the model estimated for Massachusetts.)

Focusing first on the results for tenure in the school and overall experience, there is not consistent evidence that either of these measures is systematically related to principal value-added. Most of the estimates for the tenure and experience gradients are small and statistically insignificant, with exceptions for tenure in North Carolina and overall experience in Texas and Washington. We do not draw strong inference from these selected results because they do not replicate across states and are inconsistent in sign; moreover, given the large number of tests we perform in the various states, some spurious significant correlations would be expected. Overall, we conclude from Table 8 that principal tenure in the school and overall experience are not consistently related to student achievement growth.[20]

Finally, we turn to the estimates that compare the education categories. There is also no consistent evidence that achievement growth is related to the education level of the principal.

[20] Clark et al. (2009) find that schools have higher achievement when they are led by more experienced principals in New York City, which is similar to what we find in Texas but not in the other states. Clark et al. (2009) find the largest jump in achievement occurs between experience years 1 and 2, which we do not compare in our study because we drop all year-1 principal spells at the onset, as described above—this may help to explain the discrepancy. More broadly, our ability to test the relationship between experience and student test score growth across multiple states simultaneously using common methods raises our confidence in the results.

The one significant coefficient is in Washington for principals with a bachelor's degree (again, relative to a master's degree), but this estimate is based on a very small sample of principals and it is not buttressed by the estimates in the other states. Similarly to tenure and experience, we conclude from Table 8 that differences in principals' education levels are not important predictors of value-added.

5. Summary and Policy Considerations

This paper describes the distributions of principals along a number of dimensions across six states to get a better understanding of differences in the markets for school leaders and the potential contributions of principals to observed variation in student achievement. Although distributions of principal experience and tenure appear to be quite similar across the states, larger differences emerge in pathways to the principal position. In particular, there is substantial variation in the share of principals who previously served as assistant principals and in the probability that a principal previously worked in the same school or district. Although some of these differences come from variation in state population density and urbanicity, differences in district structures also seem to be important. Some states have far fewer but larger districts than others, and internal markets play a larger role in these states.

The preliminary achievement analysis is consistent with significant variation in principal effectiveness, though more work needs to be done to account for sampling error. Moreover, the complicated dynamics of estimating principal effects suggests caution in interpreting the estimates as direct measures of principal quality; our measures of variation in achievement growth differences among principals who lead the same school therefore provide only suggestive evidence of productivity differences. There does not seem to be systematic variation by

experience or highest degree earned. This is consistent with research on teachers showing substantial variation among educators with similar credentials.

In terms of policy, state differences in test instruments preclude strong inference from cross-state differences in the distributions of value added. State differences in district structures seem to play an important role in the determination of the use of external and internal labor markets. Greater district reliance on their own educators to serve as principals in some states elevates the importance of producing school leaders, while in other states external hiring plays a more important role. Perhaps the single largest difference among the states is the probability a principal has assistant principal experience, and the value of such experience merits additional consideration.

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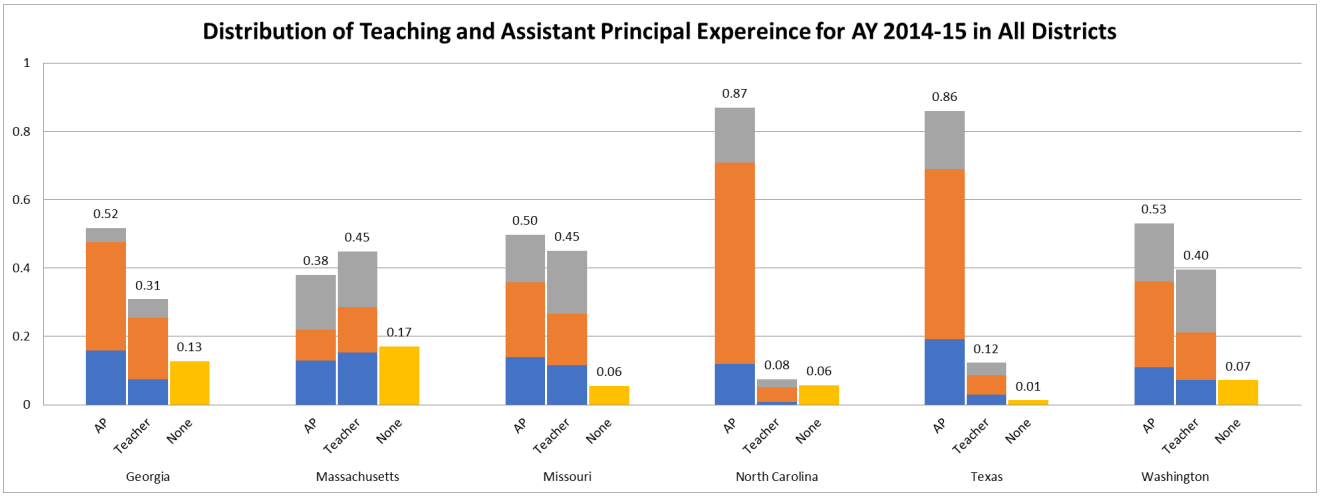
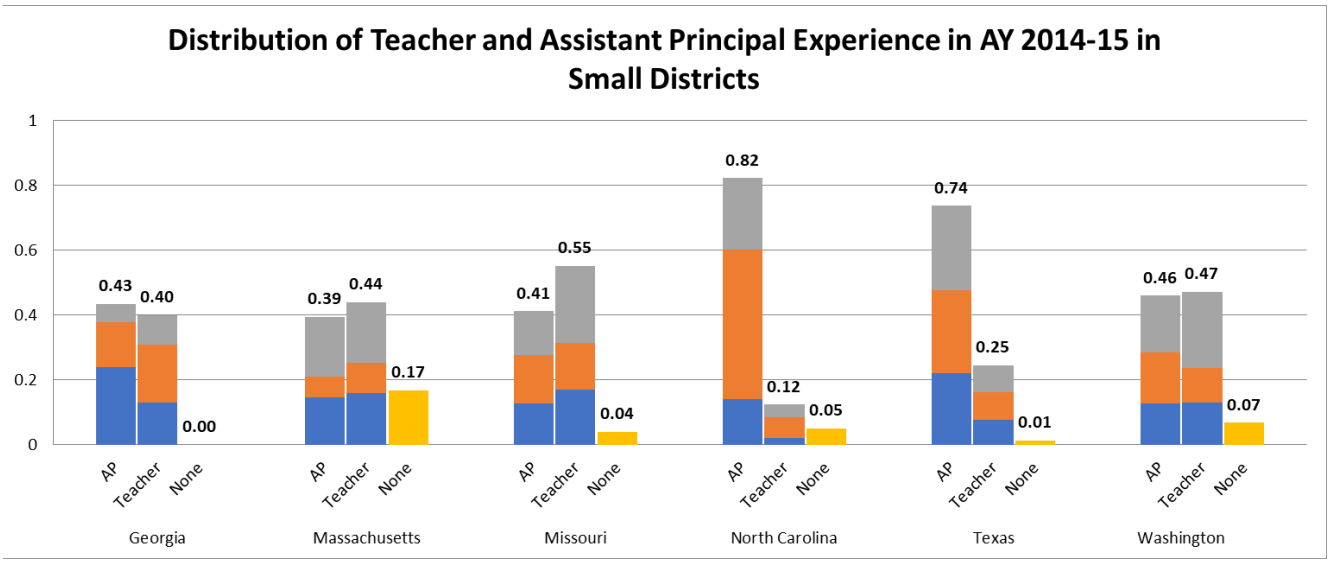
Tables and Figures

Figure 1. Proportion of principals with prior experiences as an assistant principal, and for those with no prior experience as an assistant principal, as a teacher, by location of prior experience and state

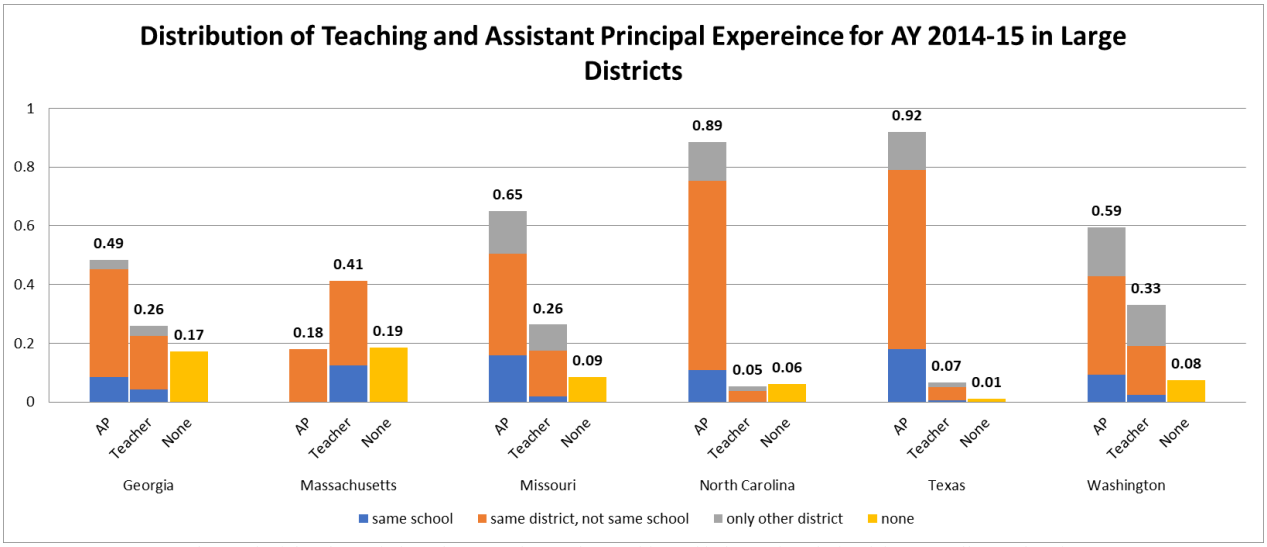
A. All districts



B. Small Districts



C. Large Districts



Notes: In some states the total of the shares is less than one due to the masking of information derived from small samples sizes.

Table 1. Distributions of Student and School District Characteristics in the Six States

	Panel A. 2014-15 National Assessment for Education Progress				Panel B. Numbers of districts, schools serving K-8 and enrollment share, by district enrollment in 2014-15							
	Math		Reading		# Districts		# Schools		Mean School Size		Enrollment Share	
	Mean	SD	Mean	SD	Small dist.*	Large dist.*	Small dist.*	Large dist.*	Small dist.*	Large dist.*	Small dist.*	Large dist.*
GA	279	36	262	35	146	34	608	1174	563.2	707.5	0.709	0.291
MA	297	39	274	35	395	10	1109	316	417.0	426.9	0.792	0.208
MO	281	36	267	34	253	20	557	309	398.3	497.2	0.591	0.409
NC	281	38	261	38	77	38	548	1260	423.4	606.8	0.226	0.774
TX	284	33	261	35	1111	108	2060	3565	442.9	704.7	0.266	0.734
WA	287	40	267	36	264	31	816	795	366.0	517.7	0.435	0.565

Table 1. (Continued)

	Panel C. Percentile cutoffs for student demographic characteristics, for K-8 school in 2014-15									Panel D. Change in the number of K-8 Schools and Enrollment from 2004-2005 to 2014-2015	
	% Economically Disadvantaged			% Black			% Hispanic			Schools	Enrollment
	25th %ile	50th %ile	75th %ile	25th %ile	50th %ile	75th %ile	25th %ile	50th %ile	75th %ile		
GA	0.452	0.649	0.830	0.137	0.326	0.660	0.047	0.088	0.171	6.40%	22.30%
MA	0.173	0.349	0.668	0.016	0.037	0.098	0.037	0.074	0.239	-4.30%	-5.80%
MO	0.382	0.566	0.741	0.014	0.057	0.171	0.018	0.034	0.065	2.70%	0.50%
NC	0.435	0.611	0.956*	0.079	0.218	0.410	0.070	0.122	0.208	5.18%	4.96%
TX	0.436	0.663	0.841	0.015	0.056	0.150	0.240	0.472	0.788	8.04%	13.50%
WA	0.354	0.554	0.728	0.005	0.015	0.043	0.090	0.147	0.261	1.70%	5.20%

Notes: Figures are reported from U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2015 Mathematics and Reading Assessments. Panel A figures represent mean and standard deviation of 8th grade composite scores for all students tested in each sample state. *Small and large districts are defined as having student enrollment less than or greater than 10,000 for grades K-12. All other statistics are restricted to K-8 settings, as defined by schools that have a maximum grade of 9 or less (e.g. excluding K-12 schools). Enrollment share is the proportion of student enrollment in the state served by small or large districts. Panel C reported figures are the 25, 50, and 75th percentile of the indicated student demographic for each state. These are calculated among "K-8" schools, defined in the previous panel, for the 2014-15 school year. Panel D Figures for schools represent the change in the number of K-8 schools from 2004-05 and 2014-15, and figures for enrollment represent the similar change in student enrollment for K-8 schools.

Table 2. Distribution of K-8 School Principal Tenure and Experience in 2014-15, by State

	1	2	3	4	5	6 to 10	11 or more
Panel A. Years of experience as a principal							
Georgia[a]	0.12	0.11	0.14	0.09	0.09	0.45 with 6 or more [a]	
Massachusetts[b]	0.14	0.12	0.10	0.09	0.54 with 5 or more [b]		
Missouri	0.09	0.14	0.11	0.08	0.08	0.32	0.18
North Carolina	0.14	0.12	0.10	0.08	0.09	0.29	0.18
Texas	0.15	0.14	0.12	0.09	0.08	0.29	0.14
Washington	0.14	0.11	0.10	0.07	0.07	0.26	0.25
Panel B. Years of tenure at current school as a principal							
Georgia[a]	0.18	0.14	0.16	0.11	0.09	0.32 with 6 or more [a]	
Massachusetts[b]	0.22	0.16	0.13	0.11	0.39 with 5 or more [b]		
Missouri	0.16	0.19	0.13	0.10	0.08	0.25	0.09
North Carolina	0.24	0.19	0.16	0.10	0.09	0.17	0.05
Texas	0.22	0.19	0.15	0.10	0.07	0.20	0.05
Washington	0.23	0.17	0.13	0.10	0.08	0.20	0.08

Notes: Individuals in the sample include only principals who work in K-8 schools (defined in Table 1), in the 2014-15 school year. Prior experience includes any experience as a principal in the data regardless of sector (e.g. K-8 or high school), and we include prior experience as a principal in a charter school where data is available. By construction, all individuals in the sample have at least 1 year of experience & 1 year of tenure at current school. We ignore gaps in service, and calculate the sum over all years for tenure at current school. We define "pre-service windows" in each state to deal with left censuring of experience, and use these to identify whether individuals have 11 or more years of experience or tenure. [a] Georgia has a shorter panel at 9 years, and as such we are not able to classify higher ranges of experience. For this reason we report 6 or more years of experience or tenure in the 6th column. [b] Massachusetts has the shortest panel at 8 years, and as such, we are not able to classify higher ranges of experience, and so report only individuals with 5 or more years of experience or tenure.

Table 3. Share of schools in 2014-15 who have a principal in their first or second year in the principal role, by school characteristics and state

Panel A. Share of schools by student demographics

	% economically disadvantaged			% Black			% Hispanic		
	<=25 %	25 to 75 %	>75 %	<=25 %	25 to 75 %	>75 %	<=25 %	25 to 75 %	>75 %
Georgia	0.221	0.206	0.229	0.203	0.210	0.255	0.217	0.210	0.190
Massachusetts	0.195	0.276	0.326	0.253	0.318	0.182	0.229	0.323	0.415
Missouri	0.137	0.215	0.317	0.219	0.237	0.305	0.224	0.379	*[b]
North Carolina	0.211	0.251	0.287	0.253	0.265	0.354	0.260	0.268	0.50[c]
Texas	0.237	0.286	0.293	0.278	0.301	0.444	0.276	0.283	0.290
Washington	0.259	0.234	0.286	0.249	0.257	*[a]	0.243	0.270	0.242

Panel B. Share of schools by average math and reading test scores

	<= 25th percentile	25th to 75th percentile	> 75th percentile
Georgia	0.243	0.222	0.178
Massachusetts	0.359	0.233	0.174
Missouri	0.297	0.232	0.149
North Carolina	0.295	0.265	0.220
Texas	0.334	0.284	0.225
Washington	0.307	0.223	0.230

Notes: The columns in Panel A are defined as K-8 schools (defined in Table 1) as either having less than or equal to 25%, 25% to 75%, or greater than 75% of their students as the indicated category (e.g. economically disadvantaged, Black) in the 2014-15 school year. The columns in Panel B are defined by percentiles of student achievement, normalized to mean 0 standard deviation 1 by state, year, grade, and subject, and averaged across mathematics and reading. Each entry represents the proportion of schools in the given category that have a principal in their first or second year in the principal role. [a] WA has no schools with more than a 75% Black student population. [b] MO has a very small number of schools with more than a 25% Hispanic student population. [c]NC has only 2 school in >75% category.

Table 4. Distribution of prior experience as a teacher for AY 2014-15 K-8 principals, by district size and state

	0	1	2	3 to 5	6 to 10	11 or more
Panel A. Small Districts (less than 10K)						
Georgia	0.080	*	*	0.06	0.246	0.606
Massachusetts	0.207	0.148	0.141	0.504 with 3 or more [a]		
Missouri	0.055	*	0.025	0.169	0.463	0.273
North Carolina	0.141	0.048	0.048	0.229	0.405	0.130
Texas	0.012	0.012	0.022	0.236	0.400	0.318
Washington	0.091	*	0.015	0.136	0.370	0.377
Panel B. Large Districts (10K +)						
Georgia	0.197	*	*	0.070	0.311	0.403
Massachusetts	0.193	0.160	0.101	0.546 with 3 or more [a]		
Missouri	0.105	*	0.041	0.229	0.373	0.236
North Carolina	0.190	0.065	0.074	0.276	0.355	0.041
Texas	0.022	0.010	0.022	0.290	0.424	0.232
Washington	0.109	0.018	0.030	0.193	0.407	0.244
Panel C. All Districts						
Georgia	0.155	*	*	0.067	0.288	0.475
Massachusetts	0.204	0.151	0.132	0.513 with 3 or more [a]		
Missouri	0.073	0.016	0.031	0.191	0.431	0.260
North Carolina	0.175	0.059	0.066	0.262	0.370	0.068
Texas	0.019	0.011	0.022	0.273	0.417	0.259
Washington	0.101	0.014	0.023	0.166	0.390	0.306

Notes: Individuals in the table include all principals who work in K-8 schools (defined in Table 1) in the 2014-15 school year who (a) appear after the first year of each state's panel or (b) appear in the first year of the panel as a teacher. For educators appearing in the first year as a teacher, all prior experience is assumed to be teacher experience. Prior experience includes any experience as a teacher in the data regardless of sector (e.g. K-8 or high school), and we include prior experience as a teacher in a charter school where data is available. Note, unlike Table 2 on principal experience and tenure, it is possible for individuals to have zero years of experience as a *teacher*. [a] Massachusetts has the shortest panel at 8 years, and as such, we are not able to classify higher ranges of experience, and so report only individuals with 3 or more years of teaching experience. In Georgia, Missouri, and Washington, cells that represent less than 10 individuals are masked with an asterisk (*).

Table 5. Distribution of prior experience as an assistant principal for AY 2014-15 K-8 principals, by district size and state

	0	1	2	3 to 5	6 to 10	11 or more
Panel A. Small Districts (less than 10K)						
Georgia	0.414	0.264	0.155	0.166	* with 6 or more [a]	
Massachusetts	0.607	0.096	0.134	0.151	* with 6 or more [b]	
Missouri	0.590	0.092	0.097	0.169	0.044	*
North Carolina	0.172	0.141	0.178	0.383	0.115	0.011
Texas	0.258	0.100	0.133	0.340	0.153	0.015
Washington	0.540	0.083	0.065	0.198	0.106	*
Panel B. Large Districts (10K +)						
Georgia	0.435	0.178	0.146	0.218	* with 6 or more [a]	
Massachusetts	0.664	*	0.118	0.134	* with 6 or more [b]	
Missouri	0.350	0.147	0.147	0.226	0.124	*
North Carolina	0.112	0.089	0.155	0.439	0.191	0.014
Texas	0.079	0.056	0.133	0.468	0.235	0.029
Washington	0.406	0.133	0.113	0.226	0.113	*
Panel C. All Districts						
Georgia	0.427	0.210	0.149	0.199	* with 6 or more [a]	
Massachusetts	0.619	0.092	0.131	0.147	* with 6 or more [b]	
Missouri	0.505	0.111	0.115	0.189	0.073	*
North Carolina	0.131	0.105	0.162	0.422	0.168	0.013
Texas	0.136	0.070	0.133	0.428	0.209	0.025
Washington	0.468	0.110	0.091	0.213	0.110	0.008

Notes: Individuals in the table include all principals who work in K-8 schools (defined in Table 1) in the 2014-15 school year who (a) appear after the first year of each state's panel or (b) appear in the first year of the panel as a teacher. For educators appearing in the first year as a teacher, all prior experience is assumed to be teacher experience. Prior experience includes any experience as an assistant principal in the data regardless of sector (e.g. K-8 or high school), and we include prior experience as an assistant principal in a charter school where data is available. Note, unlike Table 2 on principal experience and tenure, it is possible for individuals to have zero years of experience as an *assistant principal.* [a] Georgia has a relatively shorter panel at 9 years, and as such we are not able to classify higher ranges of experience, and so report only individuals with 6 or more years of assistant principal experience. [b]Massachusetts has the shortest panel at 8 years, and as such, we are not able to classify higher ranges of experience, and so report only individuals with 6 or more years of assistant principal experience.

Table 6. Distribution of AY 2014-2015 K-8 principals by location of prior principal experience in another position, by district size and state

	Same district and not the same school	Only other district	None
Small Districts			
Georgia	0.086	*	0.874
Massachusetts	0.024	0.153	0.824
Missouri	0.106	0.197	0.697
North Carolina	0.242	0.086	0.672
Texas	0.146	0.143	0.711
Washington	0.159	0.208	0.633
Large Districts			
Georgia	0.083	*	0.898
Massachusetts	0.101	0.084	0.815
Missouri	0.213	0.162	0.624
North Carolina	0.329	0.071	0.600
Texas	0.234	0.081	0.685
Washington	0.274	0.162	0.565
All Districts			
Georgia	0.084	0.027	0.889
Massachusetts	0.040	0.138	0.823
Missouri	0.144	0.185	0.671
North Carolina	0.302	0.076	0.622
Texas	0.206	0.100	0.693
Washington	0.220	0.183	0.596

Notes: Individuals in the table include all principals who work in K-8 schools (defined in Table 1) in the 2014-15 school year who (a) appear after the first year of each state's panel or (b) appear in the first year of the panel as a teacher. For educators appearing in the first year as a teacher, all prior experience is assumed to be teacher experience. Columns indicate whether the prior experience as a principal is in the same district that they now serve, prior experience only in a different school district, or no prior experience as a principal. The last category also includes individuals who may have out-of-state principal experience that is not observed. Each entry represents the proportion of K-8 principals in 2014-15 with prior experience indicated by the column. In Georgia, cells that represent less than 10 individuals are masked with an asterisk (*).

Table 7. Estimated Within-School Variation in Principal Value-Added to Math Test Scores in Standard Deviation Units, by District Size and State.

	Georgia	Massachu-setts	Missouri	North Carolina	Texas	Washington
Small districts	0.041	0.085	0.054	0.121	0.179	0.082
Large districts	0.038	0.132	0.079	0.111	0.128	0.071
All districts	0.039	0.097	0.064	0.116	0.149	0.087

Notes: The value-added models regress student test scores on a cubic polynomial of prior year achievement, student indicators for gender and race/ethnicity, an indicator for whether the student is in their first year in the school, and indicators for participation in LEP, SPED, and FRL programs. We also include school-averaged versions of these variables, year and grade indicators, and principal-by-school fixed effects. After estimating the models we demean the principal-by-school fixed effects by school means. School means are the weighted average of principal-by-school fixed effects, weighted by the years of service for each principal.

Table 8. Within-School Differences in Principal Mathematics Value Added by Tenure, Experience, and Education, by State

	Georgia	Massachusetts	Missouri	North Carolina	Texas	Washington
Tenure at Current School						
3 years	0.029	0.012	0.018**	0.008	-0.006	-0.004
	(0.035)	(0.008)	(0.009)	(0.008)	(0.006)	(0.006)
4 years	-0.024	0.015	0.007	-0.020***	-0.009	0.004
	(0.045)	(0.014)	(0.011)	(0.007)	(0.007)	(0.008)
5 years	-0.064	0.010	-0.007	0.001	-0.013	0.001
	(0.066)	(0.019)	(0.012)	(0.007)	(0.008)	(0.009)
6-10 years	-0.094	0.024	-0.003	-0.011*	-0.010	0.001
	(0.080)	(0.026)	(0.013)	(0.006)	(0.008)	(0.011)
>=11 years	*	*	-0.010	0.038**	-0.013	-0.011
			(0.020)	(0.015)	(0.019)	(0.023)
Principal experience						
3 years	0.006	0.006	-0.007	-0.025	0.008	-0.016
	(0.035)	(0.037)	(0.010)	(0.015)	(0.006)	(0.035)
4 years	0.040	-0.045	-0.005	-0.012	0.011	-0.059+
	(0.43)	(0.034)	(0.012)	(0.015)	(0.008)	(0.034)
5 years	0.055	-0.024	0.020	0.002	0.017**	-0.089*
	(0.059)	(0.034)	(0.013)	(0.014)	(0.008)	(0.041)
6-10 years	0.093	0.019	0.008	-0.009	0.014*	-0.006
	(0.075)	(0.036)	(0.014)	(0.013)	(0.008)	(0.021)
>=11 years	*	*	0.018	-0.014	0.006	-0.020
			(0.019)	(0.013)	(0.015)	(0.019)
Highest degree earned						
bachelor's	*		0.016	0.006*	-0.011	-0.221**
			(0.023)	(0.004)	(0.009)	(0.081)
specialist	0.015		-0.003	0.007	*	*
	(0.047)		(0.010)	(0.007)		
doctorate	0.057		0.007	0.003	0.011	0.043
	(0.048)		(0.011)	(0.014)	(0.013)	(0.027)
Observations	314,980	538,438	1,052,578	1,465,443	3,606,578	947,199

Notes: The value-added models regress student test scores on a cubic polynomial of prior year achievement, student indicators for gender and race/ethnicity, an indicator for whether the student is in their first year in the school, and indicators for participation in LEP, SPED, and FRL programs. We also include school-averaged versions of these variables, year and grade indicators, and school fixed effects, in addition to the focal indicators for principal tenure, experience, and degree type. Note that not all states have education specialists working as school principals—states without specialists have that cell blank. Also note two limitations of the MA data panel for this analysis; (1) the MA data do not include information on the education levels of principals so these variables are omitted from the model using MA data, and (2) the MA data panel is not long enough to identify principals in the highest tenure/experience categories (11+ years). Similarly, the Georgia panel is not long enough to identify principals in the highest tenure/experience categories (11+ years). In Georgia, cells that represent less than 10 individuals are masked with an asterisk (*).

Table A.1. Sample Years and Observations Across All States

	Employment Data		Value Added Sample Data			
	From	To	From	To	Principal-Year Observations (Unique Principals)	Student-Year Observations (Unique Students)
Georgia	2006-2007	2014-2015	2008-2009	2014-2015	1010 (401)	314,980 (203,555)
Massachusetts	2007-2008	2014-2015	2009-2010	2014-2015	2055 (664)	538,438 (298,647)
Missouri	1991-1992	2014-2015	2006-2007	2014-2015	4595 (1252)	1,052,578 (528,119)
North Carolina	1998-1999	2014-2015	1998-1999	2014-2015	18,677 (4,449)	3,809,076 (1,908,307)
Texas	1994-1995	2014-2015	1995-1996	2014-2015	49,135 (11,431)	9,359,523 (4,936,073)
Washington	1983-1984	2014-2015	2006-2007	2014-2015	3791 (906)	947,199 (485,986)

Notes: Each panel uses the earliest available year of data, and all panels are normalized to end in 2014-15. Principal observations are unique counts of individuals identified as serving as a principal in any year. Student observations are restricted to available ranges of achievement data, and do not necessarily comport with the length of the employment panel.

Table A.2. Requirements for principal role and major reforms across sample states

	2018 Requirements			Major Reforms in Last 15-20 Years
	Practicum Requirement	**Prior Experience**	**Waiver of Requirements?**	**Every Student Succeeds Act Consolidated State Plan (effective 2017) and Other Legislation**
GA	750 hours	Yes, no minimum specified	Not specified	Four-tiered certification structure adopted in 2014. Principal candidates must earn an Educational Leadership – Tier II certificate. [a]
MA	Minimum 500 hours	3 years	Yes	Implemented the Massachusetts Tests for Educator Licensure, which is designed to align with the subject matter knowledge requirements for educators. [b]
MO	Minimum 300 hours	2 years	Not specified	Paths toward certification: traditional (bachelor's degree in some education field earning an initial certificate), alternative (bachelor's degree in a different discipline, return to a college of education and teach simultaneously to earn initial certificate), temporary authorization (bachelor's degree in another discipline, take self-directed courses and teach under a mentor; pass exit examinations and work under a one-year renewable certificate to earn initial certificate), ABCTE (bachelor's degree, meet ABCTE requirements and be issued Initial Professional Certificate). [c]
NC	Yes, no minimum specified	3 years	Not specified	No additional changes were made to the licensing protocol. [d]
TX	Yes, no minimum specified	2 years	Not specified	No additional changes were made to the licensing protocol. [e]
WA	Minimum 540 hours	3 years	Not specified	Will develop, improve, and implement programs that establish, expand, or improve alternative routes for certification, as well as mechanisms for recruiting and retaining school leaders. [f] Substitute House Bill 2415 (2002): In addition to the administrative certificate, the amendment requires candidates to have held a valid teacher or educational staff associate certificate and demonstrated school experience. [g]

Notes: Information retrieved from https://www.ecs.org/50-state-comparison-school-leader-certification-and-preparation-programs/

[a] https://www.gapsc.com/Rules/Current/Certification/505-2-.153.pdf?dt=%3C%#Eval('strTimeStamp')%20%%3E

[b] http://www.doe.mass.edu/federalgrants/essa/stateplan/ [c] https://dese.mo.gov/sites/default/files/ESSA-Plan-Final.pdf

[d] https://www2.ed.gov/admins/lead/account/stateplan17/ncconsolidatedstateplan.pdf

[e] https://tea.texas.gov/About_TEA/Laws_and_Rules/ESSA/Every_Student_Succeeds_Act/

[f] http://www.k12.wa.us/ESEA/ESSA/pubdocs/ESSAConsolidatedPlan-Final.pdf?_sm_au_=iVVw1VFTFRRvqwQH

[g] http://lawfilesext.leg.wa.gov/biennium/2001-02/Pdf/Bills/Session%20Laws/House/2415-S.SL.pdf?cite=2002%20c%2078%20%C2%A7%201;

Table A3. Distribution teaching and assistant principal experience for AY 2014-15 K-8 principals by location of assistant principal and teaching experience and district size

A. Small Districts

Assistant principal experience	Teaching experience	GA	MA	MO	NC	TX	WA
Same school	Same school	0.120	0.047	0.044	0.027	0.078	0.032
Same school	Same district and not the same school	0.120	0.033	0.044	0.042	0.081	0.031
Same school	Only other district	*	0.054	0.034	0.055	0.063	0.060
Same school	None	*	*	*	0.016	*	*
Same district and not the same school	Same school	*	*	0.018	0.046	0.029	*
Same district and not the same school	Same district and not the same school	0.137	0.042	0.076	0.225	0.138	0.071
Same district and not the same school	Only other district	*	*	0.051	0.148	0.087	0.068
Same district and not the same school	None	*	*	*	0.044	*	*
Only other district	Same school	*	*	*	0.007	0.008	*
Only other district	Same district and not the same school	*	*	*	0.027	0.019	*
Only other district	Only other district	0.057	0.16	0.109	0.161	0.234	0.145
Only other district	None	*	*	*	0.024	*	*
None	Same school	0.131	0.16	0.169	0.022	0.078	0.130
None	Same district and not the same school	0.177	0.092	0.146	0.064	0.084	0.106
None	Only other district	0.091	0.188	0.236	0.038	0.083	0.236
None	None	*	0.167	0.039	0.051	0.014	0.068

Notes: Individuals in the table include all principals in small school districts who work in K-8 schools (defined in Table 1) in the 2014-15 school year who (a) appear after the first year of each state's panel or (b) appear in the first year of the panel as a teacher. For educators appearing in the first year as a teacher, all prior experience is assumed to be teacher experience. Prior experience includes any experience as an assistant principal or teacher in the data regardless of sector (e.g. K-8 or high school), and we include prior experience as an assistant principal or teacher in a charter school where data is available. In Texas, cells that represent less than 5 individuals are masked with an asterisk (*). In Georgia, Massachusetts, Missouri, and Washington, cells that represent less than 10 individuals are masked with an asterisk (*).

B. Large Districts

Assistant principal experience	Teaching experience	GA	MA	MO	NC	TX	WA
Same school	Same school	*	*	0.051	0.018	0.033	0.020
Same school	Same district and not the same school	0.086	*	0.051	0.048	0.113	0.047
Same school	Only other district	*	*	0.054	0.028	0.034	0.024
Same school	None	*	*	*	0.015	*	*
Same district and not the same school	Same school	*	*	*	0.026	0.020	0.015
Same district and not the same school	Same district and not the same school	0.332	0.143	0.264	0.396	0.462	0.201
Same district and not the same school	Only other district	0.035	*	0.064	0.137	0.117	0.096
Same district and not the same school	None	*	*	*	0.084	0.010	0.022
Only other district	Same school	*	*	*	0.002	*	*
Only other district	Same district and not the same school	*	*	0.032	0.026	0.011	0.019
Only other district	Only other district	0.032	*	0.099	0.082	0.115	0.135
Only other district	None	*	*	*	0.024	0.005	*
None	Same school	0.042	0.126	*	0.002	0.006	0.024
None	Same district and not the same school	0.182	0.286	0.156	0.035	0.045	0.166
None	Only other district	0.035	*	0.089	0.017	0.016	0.140
None	None	0.172	0.185	0.086	0.061	0.012	0.075

Notes: Individuals in the table include all principals in large school districts who work in K-8 schools (defined in Table 1) in the 2014-15 school year who (a) appear after the first year of each state's panel or (b) appear in the first year of the panel as a teacher. For educators appearing in the first year as a teacher, all prior experience is assumed to be teacher experience. Prior experience includes any experience as an assistant principal or teacher in the data regardless of sector (e.g. K-8 or high school), and we include prior experience as an assistant principal or teacher in a charter school where data is available. In Texas, cells that represent less than 5 individuals are masked with an asterisk (*). In Georgia, Massachusetts, Missouri, and Washington, cells that represent less than 10 individuals are masked with an asterisk (*).

C. All districts

Assistant principal experience	Teaching experience	Panel C. All Districts GA	MA	MO	NC	TX	WA
Same school	Same school	0.061	0.042	0.047	0.021	0.047	0.026
Same school	Same district and not the same school	0.098	0.031	0.047	0.046	0.103	0.040
Same school	Only other district	*	0.048	0.041	0.036	0.043	0.041
Same school	None	*	*	*	0.016	*	*
Same district and not the same school	Same school	0.022	*	0.017	0.032	0.023	0.014
Same district and not the same school	Same district and not the same school	0.262	0.064	0.143	0.344	0.359	0.140
Same district and not the same school	Only other district	0.033	*	0.056	0.141	0.107	0.083
Same district and not the same school	None	*	*	*	0.072	0.007	0.014
Only other district	Same school	*	*	*	0.004	*	*
Only other district	Same district and not the same school	*	*	0.017	0.027	0.013	0.015
Only other district	Only other district	0.041	0.136	0.105	0.106	0.153	0.140
Only other district	None	*	0.018	*	0.024	0.005	0.012
None	Same school	0.074	0.153	0.116	0.008	0.029	0.073
None	Same district and not the same school	0.180	0.134	0.150	0.044	0.057	0.138
None	Only other district	0.055	0.162	0.184	0.023	0.037	0.185
None	None	0.127	0.171	0.056	0.058	0.013	0.072

Notes: Individuals in the table include all principals who work in K-8 schools (defined in Table 1) in the 2014-15 school year who (a) appear after the first year of each state's panel or (b) appear in the first year of the panel as a teacher. For educators appearing in the first year as a teacher, all prior experience is assumed to be teacher experience. Prior experience includes any experience as an assistant principal or teacher in the data regardless of sector (e.g. K-8 or high school), and we include prior experience as an assistant principal or teacher in a charter school where data is available. In Texas, cells that represent less than 5 individuals are masked with an asterisk (*). In Georgia, Massachusetts, Missouri, and Washington cells that represent less than 10 individuals are masked with an asterisk (*).