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CALDER
National Center for Analysis of
Longitudinal Data in Education Research

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Abstract

Anecdotal evidence points to the importance of school principals, but the limited existing research has neither provided consistent results nor indicated any set of essential characteristics of effective principals. This paper exploits extensive student-level panel data across six states to investigate both variations in principal performance and the relationship between effectiveness and key certification factors. While principal effectiveness varies widely across states, there is little indication that regulation of the background and training of principals yields consistently effective performance. Having prior teaching or management experience is not related to our estimates of principal value-added.

1. Introduction

School leadership has increasingly been found to be a crucial element of an effective school, but considerable questions remain about the efficacy of existing personnel and regulatory policies designed to ensure effective leaders. We employ state administrative data with panel data methods to conduct parallel analyses across states of the relationship between the performance of school principals and state policies, district structures, and prior educational experience. Variations in district structures and pathways to the principalship for six U.S. states underscore sharp policy differences in many dimensions, but surprisingly these differences bear little relationship to school-average achievement growth.

We are able to replicate a common analytical strategy across six geographically dispersed US states: Georgia, Massachusetts, Missouri, North Carolina, Texas, and Washington. Each has a rich history of supporting independent research on school outcomes in student-level administrative data, but prior work has not effectively exploited the possibility of investigating the impact of the separate institutional and regulatory structures of these states on schooling outcomes.[1]

The sample states differ in a number of important dimensions that provide the backdrop for our cross-state analysis.[2] For example, while Massachusetts was the highest-performing state in 2015 on the eighth-grade math and reading assessments of the National Assessment of Educational Progress (NAEP), Missouri and North Carolina were slightly below the national average (Appendix Table A1). The states differ dramatically in the number and size of districts: for example, over 90 percent of the districts in Texas, Missouri and Massachusetts have fewer

[1] Grissom, Egalite, and Lindsay (2021) do highlight the lack of consensus in the research on the determinants of principal effectiveness, which could contribute to the inconsistent regulations and patterns of principal backgrounds.
[2] A detailed description of state differences in potentially important dimensions can be found in Appendix A.

than 10,000 students, while only two-thirds of North Carolina districts are that small (Appendix Table A2). The demographic distribution of students across the states also differs: Massachusetts has many fewer economically disadvantaged students than the other states; the southern states (Georgia and North Carolina) have proportionately more Black students than the other states (Appendix Table A3). Finally, in terms of numbers of schools and enrollment, Massachusetts is declining over the decade 2005-2015. but Georgia and Texas are growing (Appendix Table A4).

The states have adopted very different approaches to regulating entry into leadership positions, and these have resulted in significant differences among practicing principals in the different states. Compare Texas and Massachusetts principals: 2 percent of Texas public school principals do not have prior experience as a teacher and only 13 percent do not have prior experience as an assistant principal in the Texas public schools; the corresponding numbers for Massachusetts are 20 percent and 62 percent. State differences in the organization of schools into districts also translate into differences in the pathway to becoming a principal. Texas has ten times as many districts as North Carolina but only three times as many schools. Not surprisingly, principals are much more likely to come from outside each district in Texas than in North Carolina where within-district labor markets are more important.

Such state differences in the organization and regulation of schools might be expected to generate differences across states in the distribution of principal effectiveness. Analyzing differences in principal value added to achievement is inherently complicated by differences among schools and within schools that are outside of the control of the principal. Thus, definitively addressing the institutional-performance nexus is beyond current analytic capacity. Nevertheless, the stylized facts about consistent patterns of achievement growth differences

across principals and across states provide suggestive evidence on the relationships between principal effectiveness and the background, regulatory, and environmental factors.

We focus on achievement, which is the primary outcome identified by state accountability systems and the outcome for which we have consistent data across all states. Principals may also affect the development of noncognitive skills. Importantly, Hanushek et al. (2023) find that middle school principal value added to achievement and to noncognitive skills are both strongly related to post-secondary schooling and employment. The lack of comparability in state testing regimes, however, means that we cannot directly assess achievement across states. Instead, we focus on state differences in the variance of standardized achievement growth and within state associations between achievement value added and principal experiences.

We first describe the organization of schools and pathways to school leadership and then use identical specifications to estimate the variance in achievement growth across principal spells and the relationships between achievement growth and prior teaching and administrative experiences for all six states. The estimation of value-added models that control for fixed and time-varying school differences across a variety of state contexts generates valuable new evidence that expands upon what we know about the relationships between achievement growth and prior principal experiences.

We find large variation across our six states in the routes that individuals take in becoming a principal including differences in the shares of principals with experiences as a public school teacher or assistant principal. We also find substantial differences in the use of external versus internal labor markets in principal hiring. Somewhat surprisingly, prior

experience as a teacher or assistant are not closely related to estimated differences in principal effectiveness, raising questions about their frequent use in setting state standards for principals.

The next section places this work within the existing approaches to estimation of principal effects and their determinants. This is followed by a description of the administrative data for the six states along with their regulatory approaches. Section 4 develops the conceptual framework and empirical specifications. Section 5 presents the estimates of the variance of achievement growth across principal spells. Section 6 describes state differences in pathways to the principalship and presents estimates of the relationship between achievement growth and prior experiences as a teacher and assistant principal. This section also describes variation in principal experience and tenure by demographic characteristics, since the pathway to a school leadership position often includes prior experience as a principal. The final section summarizes the findings and discusses any implications for personnel policies designed to raise the quality of school leadership.

2. Relationship to Prior Research

This work builds on multiple strands of research, much of which is summarized in Grissom, Egalite, and Lindsay (2021). Estimation of principal effectiveness as measured by value-added to test scores constitutes the first. As Grissom, Egalite, and Lindsay (2021) discuss, disentangling the effects of principals on achievement from other influences presents a significant challenge. Existing papers adopt different strategies, but they typically involve estimation of the variance in principal effectiveness from specifications that control for student heterogeneity and school fixed effects.[3] The resulting estimates vary in magnitude, partly due to sample differences (e.g. a single district v. an

[3] These papers include Bartanen and Grissom (forthcoming), Branch, Hanushek, Rivkin, and Schiman (2020), Chiang, Lipscomb, and Gill (2016), Dhuey and Smith (2014), Hochbein and Cunningham (2013), and Laing, Rivkin, Schiman, and Ward (2016).

entire state) and partly due to methodology. The smaller estimates such as the finding in Laing, Rivkin, Schiman, and Ward (2016) and Branch, Hanushek, Rivkin, and Schiman (2020) that a one standard deviation change in principal effectiveness equals roughly a 0.05 standard deviation change in test score appear more compelling because the empirical approach accounts better for random variation in principal effects and time-varying school factors including those highlighted by the critique in Bartanen, Husain, and Liebowitz (2022). Importantly, these studies also account for the turbulence around principal transitions including achievement decreases in the final year of a spell. The specification used in this study also accounts for random variation and disruptions with transitions and produces estimates of the variance in achievement growth across principal spells similar in magnitude to those in Branch, Hanushek, Rivkin, and Schiman (2020).

Grissom, Egalite, and Lindsay (2021) describes national trends in principal experiences as a teacher and assistant principal, experience and tenure as a principal, post-graduate schooling and demographic characteristics. Virtually all principals have held a degree beyond a BA since at least 1988, leading us to focus on prior experiences rather than formal education. Average years of prior experience as a teacher has fluctuated, trending downward since 2000, while the share of principals who had served previously as an assistant principal has climbed from 50 percent in 1988 to 77 percent in 2016. As we show below, however, the national trends do not capture pronounced state differences in the shares of principals with no prior teaching experience or no prior experience as an assistant principal in the state public schools.

As noted above, principals are not randomly assigned to have different types of experiences, impeding efforts to identify the causal effects of prior teaching and assistant principal experience effects on achievement growth. Of particular concern is the possibility that principals with more limited prior experiences may have been hired because of other offsetting strengths. Nevertheless, evidence on the relationships between effectiveness as a principal and prior experiences can provide valuable information for educators. Goldring, Rubin, and Herrmann (2021) summarize the mixed

qualitative and quantitative evidence on the effects of assistant principal experience on effectiveness as a principal. On the one hand, six studies found that principals believed that experience as an assistant principal provided important preparation for school leadership.[4] Bowers and White (2014) also found that test score proficiency was positively related to principal experience as an assistant principal in Chicago Public Schools. Finally, Bastian and Henry (2015) find that prior experience as an assistant principal in a high value-added school increases effectiveness as a principal. On the other hand, Goldring, Rubin, and Herrmann (2021) found little relationship between principals' and teachers' perceptions of school climate and their job satisfaction and whether the principal had experience as an assistant principal. Grissom, Egalite, and Lindsay (2021) also found no significant relationship between principal effectiveness as measured by supervisor evaluations and prior experience as an assistant principal. Bastian and Henry (2015) also found no significant relationship between math and reading scores on state standardized tests and years of prior experience as an assistant principal. Finally, Clark, Martorell, and Rockoff (2009) found no significant relationship between math and ELA test scores and years of prior experience as an assistant principal, though they do find some evidence that service as an assistant principal in the same school increases the productivity of novice principals.

In contrast to the small but growing body of research on the effects of prior experience as an assistant principal, little work investigates the effects of having any prior teaching experience. Although it may be typical for principals to have prior teaching experience, some of our states include a nontrivial share of principals with no prior teaching experience in their state's public schools. Moreover, advocates of attracting businesspeople to school leadership positions typically emphasize the importance of general leadership skills while downplaying prior experience as a teacher. Therefore, we believe that our work provides some of the most compelling evidence on the

[4] These studies include Caruso (2013), DiPaola and Tschannen-Moran (2003), Fuller, Hollingworth, and An (2019), Lee (2015), Nelson, Maria, and Boone (2008) and Parylo, Zepeda, and Bengtson (2013).

relationship between achievement growth and whether a school principal has prior experience as a teacher.

3. Data and State Regulations

This section describes the state administrative data and regulatory environments that determine eligibility to work as a school principal. There are many similarities in state data systems and regulations governing school leaders, though there are also some differences that we discuss in each subsection.

3.1 State Data

State departments of education provide administrative data about principals, schools, and students that allow us to estimate value-added models and describe pathways to the principalship.[5] 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. Each state's data span different years and contain slightly different information, but our strategy exploits the fact that they have similar structures and contain much information in common. For instance, each state provides information on educator experience and education, standardized achievement tests, and student demographics including race, gender, and free- or reduced-price lunch (FRL) eligibility status.

Table 1 reports the time-period, number of principals and number of students for each state. Not surprisingly, the total number of principals differs substantially, exceeding 11,000 in

[5] 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.

Texas while falling below 700 in Massachusetts. The beginning date of the longitudinal panel also varies; we use the first school year in which principals can be linked to schools for the employment panel, which goes back to the 1990s in most states. We set a common last school year of the panels at 2014-15.

We consider principals of K-8 schools, which we define as settings where the highest grade is equal to or less than 8th grade (i.e., non-high schools). High schools were excluded because we could not estimate value-added for principals in high schools in all states given the limited high-school state assessments. We exclude charter schools because some states have no charter schools (e.g., Washington only passed a charter law in 2012) and others have very few.[6] Finally, to ensure that we are capturing individuals whose main job is serving as a principal, we restrict the data to principals reported to serve in a single school for at least .5 FTE in a given year.

For some of our descriptive analyses about the pathway to the principalship we use all of the historical data in each state. But information about principals and their school assignments predates the ability to estimate value-added models, a task that requires that students be linked to schools and that there be annual testing. Thus, for the value-added analyses we use a subset of the historical data in each state that includes just the time period over which reliable value-added models could be estimated.

3.2 State Regulations

Education Commission of the States reports (Scott (2017, 2018)) indicate that all states have adopted standards to guide school leadership policies. This can entail the requirement of

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

specific types of preparation and training in leadership certification programs[7]; minimum hours of supervised field experiences prior to certification; achievement of a minimum GPA; and although 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.

Although states have similar sets of requirements for principal licensure, there are differences beneath the surface (see Appendix Table A.11). For example, all six states currently require between two and three years of prior experience in schools or the education system, 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. A leadership preparation program is required by all six states.

The states also vary in the degree of flexibility around the master's degree requirement. 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 more stringent, requiring a master's degree from a public-school administration program or a different master's degree from an accredited program plus completion of a public-school administration program meeting established standards. 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

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

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 government 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 strategies as well as strong preparation and ongoing professional learning. States implemented some changes (see Appendix Table A11), and ESSA 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.[8]

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;[9] a search on principal requirements in all six states' administrative code in the last 20 years revealed no significant legislative changes related to principals.[10] This is consistent with a report by the National Center for Education Statistics 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 (Hill, Ottem, and DeRoche (2016)).[11]

[8] In Massachusetts, a principal candidate can have their requirements waived by the commissioner, which leads to educators being placed in positions for which they are not certified.
[9] 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 A11).
[10] It is possible, however, that there are more significant changes in regulatory interpretation of state laws; unfortunately, it is infeasible to track such changes.
[11] 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

4. Conceptual Framework

The importance of personnel policies for principals ultimately depends on the impact of school leaders on school quality and surprisingly this remains an open question. The evaluation of principal effectiveness is inherently a difficult problem, and prior analyses – relying on specialized samples and employing different analytical strategies – have reached varying conclusions about the impact of principals.[12] Our cross-state estimation of consistent models with very large samples allows addressing the most serious estimation issues and provides a clearer picture both of principal impact and of key policy concerns.

We consider two different models in the empirical analysis. The first uses trimmed-spell fixed effects models to estimate the variance in principal effectiveness in each state. These semi-parametric specifications produce estimates of average achievement growth during each principal spell at a school, controlling for student and school characteristics. The second model presents a value-added specification that allows us to estimate the relationship between achievement growth and prior principal experiences as a teacher and assistant principal. Essentially this latter specification substitutes the prior experience variables in place of principal fixed effects.

Throughout we focus on math achievement, the place on which prior research indicates schools have their largest effects.[13] Importantly, we do not control for teacher effectiveness

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.

[12] As noted, growing body of literature considers the methodological impediments to estimation of principal effects. See Clark, Martorell, and Rockoff (2009), Branch, Hanushek, and Rivkin (2012), Chiang, Lipscomb, and Gill (2012), Coelli and Green (2012), Hochbein and Cunningham (2013), Dhuey and Smith (2014), Grissom, Kalogrides, and Loeb (2015), Grissom and Bartanen (2019), and Bartanen, Husain, and Liebowitz (2022). The discussion below addresses the key issues in this estimation.

[13] The larger impact of teachers on math tests as opposed to reading is documented in Hanushek and Rivkin (2010) and Koedel, Mihaly, and Rockoff (2015).

because raising the quality of instruction through personnel practices constitutes one channel through which a principal could raise achievement.

4.1 Estimation of the Variance in Principal Value-added

The estimation of the value-added of principals is similar to that for teacher value-added but faces some unique challenges. In the estimation of teacher value-added, the small samples of students in classrooms leads to potentially large sampling errors that are eliminated with principals who deal with all students in school. But offsetting this advantage, it is more difficult to separate the impact of principals from other contemporaneous and historical impacts on student achievement.

The value-added of principals is based on estimation of models like Equation (1) that portray achievement (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.

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

$f(A_{ist-1})$ is a cubic polynomial of prior year standardized test scores in math and reading; X_{ist} is a vector of student controls that includes indicators for gender, ethnicity, free and reduced price lunch eligibility, special education, and whether the student is in their 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 a random error.

To remove the influences of fixed school factors, we demean θ_{ps} within schools by subtracting the school-average fixed effect, $\bar{\theta}_{ps}$, 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 school fixed effects cannot be included in models that include school-by-principal fixed effects due to perfect collinearity.[14] The vectors X and S account for the effects of time-varying student characteristics.

But, if θ'_{ps} is estimated over the full term of each principal in a school, it almost certainly is a biased estimate of the effectiveness the principal. Both the first and last year of a principal's spell are likely, for the reasons sketched below, to provide error-prone signals about the value-added of the principal. This concern is heightened if principal fixed effects are estimated across the stays of principals at multiple schools, where the weight of these transition years is likely to increase relative to the non-transition years that we believe provide better information on principal value-added.

First, the impact of a principal on school quality likely persists even after a principal exits a school. Principals shape their staffs through teacher hiring and retention decisions, thus they affect the future stock of teachers. Similarly, they establish school norms and culture in ways that likely take time to change. Controls for prior student 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 their departure. Consequently, although differences in fixed effects between two principals in the sample will reflect differences in school productivity, they

[14] Our focus on principal-by-school fixed effects differs from studies such as Grissom, Kalogrides, and Loeb (2015), Chiang, Lipscomb, and Gill (2016) and Bartanen, Husain, and Liebowitz (2022) that estimate principal fixed effects using models that also include school fixed effects. Those specifications include a single indicator for each principal, and the 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 these papers.

will tend to understate the variation in principal value-added due to the persistence of the effects of the previous school leader.

Second, principal departures may be related to a variety of circumstances that affect achievement. A principal may be removed because of poor performance, or a principal who has decided to leave may devote less care and energy to the school's management in their final year. Consistent with such concerns, Miller (2013) illustrates a substantial decline in average achievement in the year prior to a principal transition, and this negative shock would not only reduce achievement growth in that year but inflate growth in the first year following the transition.

To minimize the influences of any turbulence around principal transitions and to downplay a year in which the principal has far less effect on operations, we exclude the first and last years of all principal spells. These trimmed-spells provide, we believe, the best estimates of the systematic differences among principals. Importantly, trimming also alters the interpretation of the variance estimates, as we estimate the variance in value added during principal spells over the set of principals who remain in a school for at least three years.

An important technical issue is that the variance in estimated value added during a principal spell also reflects sampling error that is likely to differ in magnitude across states due to state differences in the distribution of school size and demographic changes over time. The sources of such random error include test measurement error, random differences among school cohorts, and random school productivity shocks. To address this problem, we develop a randomized-inference procedure described in Appendix B by which the sampling variance of θ'_{ps} can be estimated separately for each state. We use these estimates to adjust the estimates of the variance in principal effectiveness for each state.

A final issue related to cross-state comparisons of the variance in residual achievement growth concerns the association between movements along state test score distributions and differences in actual knowledge. Because the content of state tests can differ, it is difficult to relate differences in the state score distributions reliably to differences in knowledge. But, under the assumption that the variance in NAEP scores provides a good measure of the variation in knowledge on the material tested on the state standardized tests, a one standard deviation movement along the state test-score distribution captures a larger difference in knowledge when the variance in NAEP scores is higher. Consequently, the smaller standard deviation in Texas NAEP mathematics scores relative to other states shown in Appendix Table A1 suggests that a one standard deviation move along 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). Importantly, the differences in standard deviations on the NAEP math test are small. Other than Texas with a standard deviation of 0.33, the standard deviations in the remaining five states range from 0.36 to 0.4.

4.2 Estimation of the Prior Assistant Principal and Teacher Experience Effects

Equation (2) substitutes a vector of principal characteristics in place of the principal-school fixed effects to estimate the relationship between achievement growth and prior principal experiences as an assistant principal and teacher

$$A_{ishpt} = f(A_{ist-1}) + \beta X_{ist} + \eta C_{ps} + \gamma S_{st} + \delta_h + \phi_t + \varepsilon_{ishpt}$$

The vector C includes an indicator for no prior experience as a public-school assistant principal or teacher, an indicator for prior experience as a teacher but not as an assistant principal, and principal experience indicators (some specifications).

As stated above, the parameters η do not identify the causal effects of prior experiences on value-added to mathematics achievement due to the potential relationship between prior experiences (C) and unmeasured factors in the error. In general, it is not possible to sign that relationship definitively. But it seems likely that in specifications that account for school fixed effects, C, experience is negatively correlated with the error due to the selection process for principals. In particular, one might guess that skills unobserved by the researcher affect estimated value-added of principals and compensate for limited prior experiences. Consequently, a finding of no significant returns to experience is consistent with the possibility that other skills can compensate for a lack of prior experiences and that requiring such prior experiences excludes some principals from the applicant pool whose effectiveness would be as high on average as those with prior experiences teaching or serving as an assistant principal.

5. Estimation of the Variance in Principal Effectiveness

Our estimation of the variance in principal effectiveness is designed to provide direct evidence on the importance of principals in guiding school performance. We present the baseline estimates of principal impacts based on Equation 1. Recognizing, however, that these estimates potentially contain considerable sampling error, we use the random inference procedure described in Appendix B to estimate the variance across principal spells that would be observed if there were no actual variation in principal effectiveness. This allows us to remove the variance due to sampling error and to obtain direct estimates of the true variation in principal effectiveness.

Table 2 reports the unadjusted estimates of the variance, estimates of the sampling variance, and the estimates of the variance adjusted for this random variation (difference between rows 1 and 2 expressed in standard deviation units), based on Equation 1. Note that Table 2 includes estimates for only five of the six states because estimates are not available for North

Carolina. The adjusted estimates of a one standard deviation change in value added during principal spells range from 0.042 in Missouri to 0.064 in Massachusetts. Importantly, larger differences appear in the unadjusted variance estimates, and the much smaller variation across states following the adjustment highlights the importance of accounting for sampling error. These values show the range of impacts of principal across each of the states. Thus, focusing on the state of Washington, for example, a move from an average principal to one at the 86th percentile (i.e., a principal one standard deviation more effective) is associated with 0.051 standard deviation higher school average achievement.

Interestingly, the estimate of 0.056 standard deviations for Texas is quite similar to an alternative estimate for Texas of 0.052 standard deviations based on a different empirical approach that accounts more comprehensively for unobserved school trends (Branch, Hanushek, Rivkin, and Schiman (2020)). Thus, while it is possible that the variation in principal effectiveness estimated here is contaminated by unmeasured factors, the close similarity with estimates produced using the alternative method supports the interpretation that they capture differences in the variance of principal effectiveness.

At first inspection, these differences in effectiveness might seem small since the standard deviation of within-school gains for teachers has been estimated at more than twice that magnitude (Hanushek and Rivkin (2010)). But that would be an incorrect comparison because the teacher gains relate to a single classroom as opposed to the whole school. If the hiring of a more effective principal were to increase value added by 0.05 standard deviations for *all students* in the school, the impact of hiring a one-standard deviation more effective principals would be substantially greater than that of hiring one teacher who is one standard deviation more effective.

The range across states in estimates of the variance in principal effectiveness is large. The standard deviation of value-added in Massachusetts is fully fifty percent larger than that in Missouri. This range of performance differences among our five states underscores the importance of looking at state differences in a more systematic manner. As already noted, Massachusetts has many small districts, making it possible that more limited internal labor markets or a larger variance in the quality of district governance contributes to the larger variance in value added across principal spells. For example, if predictions of leadership quality are noisier for applicants from outside of the district, the greater use of external markets would be expected to raise the variance.

6. Principal Pathways and Value-added

An interesting difference among the six states is the variation in prior backgrounds of principals, variation that is at least partially the result of different organizational and regulatory environments of the states. It is possible to describe key elements of the pathways to the principalship in the six states and to estimate the relationships between achievement growth and prior experiences as a teacher and assistant principal. This section begins with a description of the distributions of principals by previous service as an assistant principal and by their teaching experience. Importantly, prior experiences in private schools or in other states will not be counted because of a lack of data.[15] Given that some principals likely taught in other states or outside of the public schools, the tables and figures may involve some overstatement of the shares with no prior teaching experience. This section also considers whether principals gained any experiences in the same district or school. It then reports results from value-added regressions based on Equation (2) that investigate the effects of prior experiences on

[15] This issue may be more important in Massachusetts where large cities are located close to places in other states that might be feeders for schools hiring principals.

achievement growth. The final component of this section describes principal experience distributions by SES and racial composition to highlight differences in the shares of new principals with prior principal experience by student composition.

6.1 Prior Teaching and Administrative Experience

There are surprisingly large differences across states in the typical pathways to a school leadership position. Table 3 reports the proportion of first-time principal for the 2014-2015 academic year that had no prior teaching experience and no prior managerial experience as an assistant principal. (The complete distribution of prior managerial and teaching experience is found in Appendix Tables A7-A9). Because of the heterogeneity in district structures and urbanicity – items that might affect elements of the labor market for principals, we also consider differences by district size.

Across the states, only two percent of new principals in Texas had no teaching experience in state public schools, but a surprising 20 percent in Massachusetts did not. Indeed, given the standard view that principals should be 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 teaching experience. It is more likely that principals without prior teaching are found in large districts (greater than 10,000 students) than in small districts (less than 10,000 students). Even more striking is the difference in prior experience as an assistant principal in a state public school. Almost two thirds (62 percent) of new principals in Massachusetts had no such experience, over four times the rate for new principals in North Carolina (13 percent) and Texas (14 percent).

It is useful to put these two distributions together. Figure 1 summarizes the salient differences in the joint distributions of teaching and assistant principal experience by district size for those in their initial principal job in 2015. It also adds information on location of experience.

The left bar of the graph for each state shows the distribution of new principals that had experience as an assistant principal along with describing where the stint as an assistant principal occurred. The middle bar describes the distribution of teaching experience for new principals who had not been assistant principals. The right bar shows the proportion of new principals with neither type of prior experience.[16]

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 14 percent of principals with no prior assistant principal experience, 1 percent had no teaching experience while most of the remainder had teaching experience in the same district but not the same school.

Internal labor markets seem particularly important in Georgia and North Carolina, two states with smaller numbers of relatively large districts. In these states, the vast majority of principals accumulated experience in the same district before their first stint as a principal. By comparison, principals in Washington and Massachusetts, two states with large numbers of small districts, were relatively more likely to gain experience in other districts. Across all states 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 smaller pool of potential principals and principal positions in smaller districts. 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.

[16] See Appendix Table A10 for the full joint distribution.

6.2 Value-Added Differences by Pathway

Are these characteristics related to principal achievement growth? Although we are not able to identify causal effects, the following estimates show the relationship between achievement growth and prior experiences. These illustrate systematic differences by pathway and provide information with which to consider certification requirements and district practices.

The coefficients reported in Table 4 come from the estimation of variations of Equation (2) over a trimmed sample that excludes the first and final years in a principal spell. Coefficients reported in Panel A come from specifications that neither control for principal experience nor school fixed effects; specifications reported in Panel B control for school fixed effects, and the specifications reported in Panel C control for both experience and school fixed effects. Standard errors are clustered at the school level in all specifications.

Interestingly, the table reveals little or no evidence of systematic differences by either prior teaching experience or assistant principal experience in any state, despite the large differences in experience distributions illustrated in Figure 1. In the top row only two of the six coefficients on the indicator for no prior experience as a teacher or assistant principal in the state public schools is negative, and none of the estimates in any specification are significant at conventional levels. The absence of a positive effects of prior teaching or assistant principal experience would support the notion that principals without prior teaching or assistant-principal experience are as effective on average as those with such experiences.

The interpretation of this basic finding needs to be nuanced. If employers prefer prior teaching and associate principal experience, new principals who lack these may well be superior in other dimensions identified during the selection process. Consequently, the failure to find that prior teaching or assistant principal experience raises value-added does not prove that these are not beneficial. Rather it supports the notion that any benefits are not large enough to offset other

factors considered in the hiring process. For example, experience in business, other leadership positions, or a strong educational background may be valued and raise effectiveness as a principal. This finding does, nevertheless, raise doubts that prior experience as a teacher or assistant principal plays a special role in the development of principal skills and suggests that imposing such requirements likely excludes some who would be effective school leaders.

6.3 Observed Differences in Principal Experience and Tenure

Service as an elementary or middle school principal is an important steppingstone to another, potentially more desirable principal position such as high school principal, as districts likely value such experience. Districts likely also value stability, as frequent transitions can disrupt school operations and adversely affect achievement (Miller (2013)). Unstable school leadership in schools serving high-poverty children evokes particular concern, leading us to describe tenure and experience distributions by student demographic characteristics.

Table 5 highlights the key elements of the distribution of principal experience and tenure across our states. The proportion of new principals is remarkably similar across the states, particularly given the differences in school and enrollment growth.[17] The overall pattern 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 (Taie and Goldring (2017), Table 6).

There is more variation in the tenure distribution. As seen in Table 5, North Carolina and Texas have fewer principals with long tenure in their school, whereas 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 (Appendix Table A4). A principal in Georgia and to a lesser

[17] Interestingly, Texas and Georgia had strong enrollment growth over the 2005-2015 decade, but Massachusetts had significant declines (Appendix Table A4). Nonetheless, neither the proportion of new principals nor the proportion of more experienced principals (five years or more) varies hugely across the states.

extent Missouri is less likely to be in their first or second year in a school than a principal in North Carolina, Texas or Washington.

Table 6 shows the variation across states in the placement of beginning principals by student characteristics including proportion eligible for a subsidized lunch and proportion Black.[18] The left panel reveals large differences in the extent to which principals with little experience are concentrated in high poverty schools. In contrast to the other four states, the probability of having a principal in their first or second year does not increase monotonically with share eligible for a subsidized lunch in either Georgia or Washington. Massachusetts and Missouri, by contrast, exhibit particularly strong ordering by poverty rate, where the probability of having a principal in their 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 20 percent in schools with less than 25 percent economically-disadvantaged students.

Patterns by race diverge from those by income, being much more pronounced in Texas and North Carolina (right panel). The probability of having a principal in their first or second year in schools where Black enrollment exceeds 75 percent of the total is greater than 30 percent in Missouri and North Carolina and approaches 50 percent in Texas. Although the probability rises monotonically in Georgia, differences by the Black enrollment share are much smaller than in these three states. As noted above, these three states possess divergent district structures, regulatory environments, and practices in terms of prior experiences as a teacher or assistant principal. This suggests the need for other policies to stabilize leadership in schools that currently exhibit extensive turnover.

[18] Note that these are schools divided by specified shares of students in each school with the identified characteristic, not by percentiles of the student population per se. We organize the table this way in order to compare distributions among schools with similar demographic compositions in the six states.

7. Some Conclusions

Popular sentiment and considerable anecdotal evidence consistently point to the importance of school leadership, but the available research provides a mixed picture. Much of the uncertainty in research revolves around methodological issues that are intertwined with the inherent complexity of the evaluation task. We have addressed this task by estimating a consistent model of principal impacts on achievement across a set of six states, each with extensive historical achievement data that provide large samples of school performance that can be related to individual principals. The underlying model focuses on principal-spell fixed effects in a sample of trimmed-spells of principals that eliminates the uncertainty of outside influences on schools at the beginning and end of each principal spell.[19]

State differences do not permit the ranking of states by leadership effectiveness at raising achievement. It is, however, possible to provide some policy insights by focusing on state comparisons in the achievement growth variance across principal spells and on how that variance relates to differences in the pathways to the principal position. Much of the existing state regulation attempts to reduce the variations in principal impacts, specifically by putting a floor on the quality of applicants for principal positions. Regulations dealing with training requirements such as the ubiquitous requirement of graduate level leadership training fit this purpose. So do requirements for prior teacher or assistant principal experience. While there are substantial challenges to the identification of the causal effects of licensing and certification requirements and other policies on principal effectiveness, our analysis provides little support for the efficacy of such regulatory policies. We find an absence of significant effects of prior

[19] As discussed earlier, the reliance in most of the prior evaluations on full spells of principals in either individual or multiple schools means that the clearest signals of principal impacts are contaminated by very noisy observations at the ends of principal spells. While it is difficult to analyze the impact of this conclusively, the median spell of a principal is just four years, thus underscoring the potential impact on estimates of principal effectiveness.

teaching or assistant principal experience on math achievement growth. These requirements are designed to guarantee that principals have the requisite experiences to succeed in their positions and to rule out ineffective leadership. Even if these experiences have some value, the estimates suggest that principals without such experiences possess other skills that enable them to be as effective in terms of raising value-added.

Importantly, education and experience requirements increase the "cost" of becoming a principal and may discourage some with strong leadership skills from entering the profession. These findings echo the findings of research on teachers showing substantial overlap in effectiveness across educators with different credentials, post-graduate schooling and experience. As is the case for teachers, they suggest the possibility that it may be more productive to focus on the evaluation and support of principals than on entry requirements for leadership positions.

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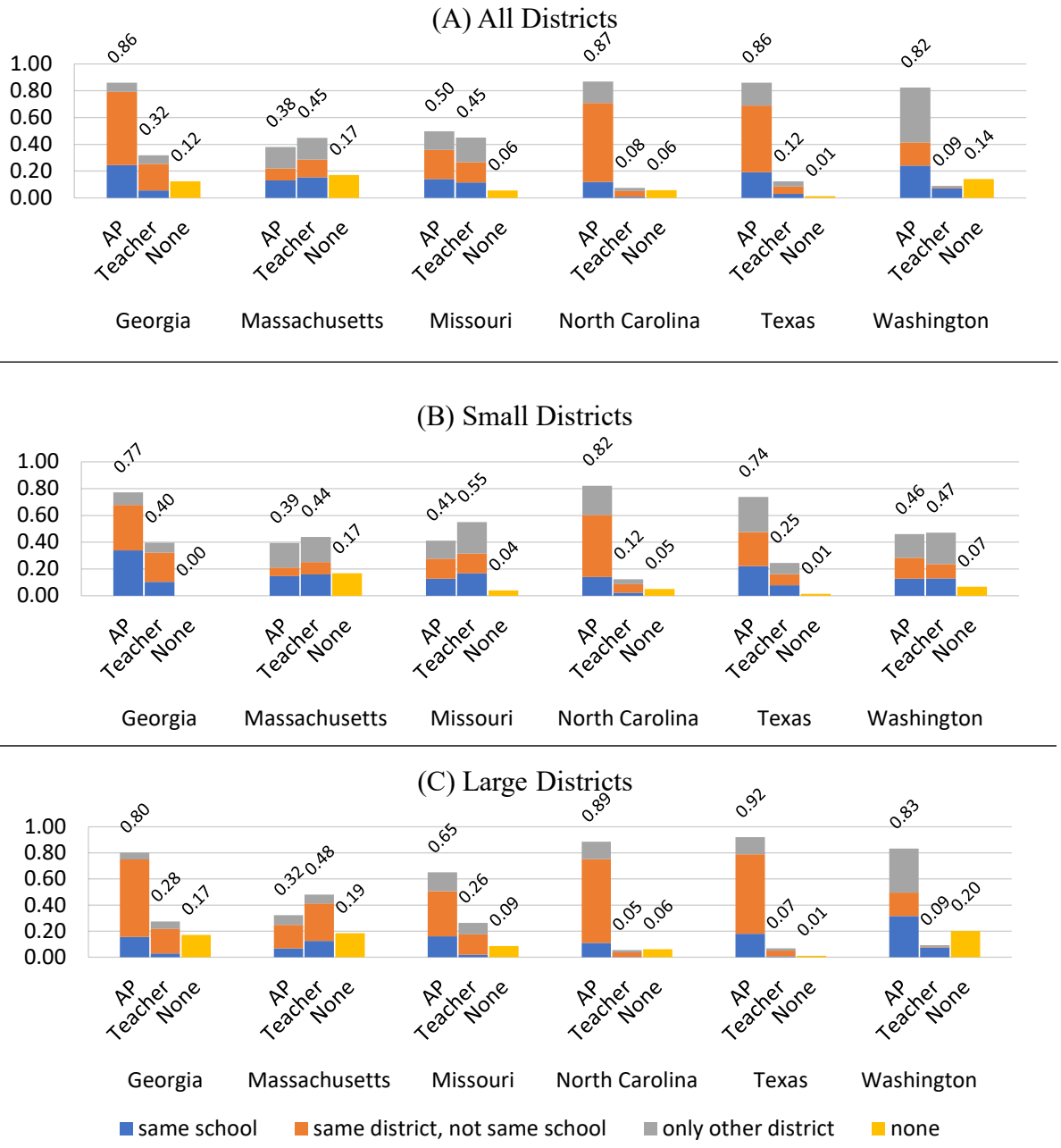
Figures and Tables

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



Notes: The samples 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. The left bar for each state shows the share of principals with prior experience as an assistant principal, by location, regardless of whether they had prior experience as a teacher. The middle bar for each state shows that share of principals with prior teaching experience but no prior experience as an assistant principal, by location.

Table 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)

Table 2. Estimated Within-School Standard Deviation in Value-Added during principal spells to Math Test Scores Accounting for Sampling Error, by State

	GA	MA	MO	TX	WA
1. Estimated variance based on actual data	0.012	0.009	0.008	0.023	0.008
2. Estimated variance under the null of no true quality variation based on the average of 300 iterations	0.009	0.005	0.006	0.019	0.005
3. Estimated standard deviation of principal quality (square root of difference between 1 and 2)	0.049	0.064	0.042	0.056	0.051

Notes: Variance estimates for North Carolina are unavailable. 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. Appendix A describes the adjustment of the variance estimates to account for state differences in sampling variance.

Table 3. Proportion of First-Time Principals with No Prior Experience as Teacher or Assistant Principal, AY 2014-15 K-8 Principals, by District Size and State

	No Prior Teaching Experience	No Prior Experience as Assistant Principal
Panel A. Small Districts (less than 10K)		
Georgia	0.080	0.414
Massachusetts	0.207	0.607
Missouri	0.055	0.590
North Carolina	0.141	0.172
Texas	0.012	0.258
Washington	0.091	0.540
Panel B. Large Districts (10K +)		
Georgia	0.197	0.435
Massachusetts	0.193	0.664
Missouri	0.105	0.350
North Carolina	0.190	0.112
Texas	0.022	0.079
Washington	0.109	0.406
Panel C. All Districts		
Georgia	0.155	0.427
Massachusetts	0.204	0.619
Missouri	0.073	0.505
North Carolina	0.175	0.131
Texas	0.019	0.136
Washington	0.101	0.468

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.

Table 4. Differences in Achievement Growth by Pathway to the Principal Position, by State and controls (sample restricted to the first time an educator is observed as a principal)

	Georgia	Massachusetts	Missouri	North Carolina	Texas	Washington
A. No controls for principal experience or school fixed effects						
No prior experience as a public-school assistant principal or teacher	-0.011 (0.016)	0.017 (0.009)	0.005 (0.012)	0.008 (0.005)	0.002 (0.015)	-0.001 (0.013)
Prior experience as a teacher but not as an assistant principal	-0.006 (0.021)	0.035 (0.012)	0.014 (0.009)	-0.000 (0.010)	0.004 (0.005)	0.019 (0.009)
B. Controls for principal experience						
No prior experience as a public-school assistant principal or teacher	-0.014 (0.015)	0.017 (0.009)	0.003 (0.013)	0.005 (0.005)	0.001 (0.015)	-0.003 (0.013)
Prior experience as a teacher but not as an assistant principal	-0.006 (0.015)	0.039 (0.012)	0.012 (0.009)	-0.001 (0.010)	0.003 (0.005)	0.017 (0.009)
C. Controls for principal experience and school fixed effects						
No prior experience as a public-school assistant principal or teacher	0.035 (0.042)	-0.002 (0.019)	-0.045 (0.031)	0.007* (0.004)	0.013 (0.022)	0.039 (0.017)
Prior experience as a teacher but not as an assistant principal	-	0.037 (0.027)	0.022 (0.027)	0.021*** (0.007)	0.003 (0.013)	0.020 (0.014)
Observations	285833	684144	703579	2,476,359	2805267	1237479

Notes: The value-added models regress student test scores on indicators for 1) prior experience as a teacher but not as an assistant principal; 2 no prior experience as a teacher or an assistant principal (prior experience as an assistant principal is the excluded category), 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 indicators for principal experience or school fixed effects in some specifications. In Georgia, cells that represent less than 10 individuals are masked with a dash (-).

Table 5. Distribution of K-8 School Principal Tenure and Experience in 2014-15, by State

	1-2	5 or more
Years of Experience as Principal		
Georgia[a]	0.23	0.54
Massachusetts[b]	0.26	0.54
Missouri	0.23	0.58
North Carolina	0.26	0.56
Texas	0.29	0.51
Washington	0.25	0.58
Years of Tenure at Current School		
Georgia[a]	0.32	0.41
Massachusetts[b]	0.38	0.39
Missouri	0.35	0.42
North Carolina	0.43	0.31
Texas	0.31	0.32
Washington	0.40	0.36

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 5 or more years of experience or tenure.

Table 6. Share of Schools in 2014-15 who Have a Principal in their First or Second Year in the Principal Role, by School Demographic Characteristics and State

	% Economically Disadvantaged			% Black		
	<=25 %	25 to 75 %	>75 %	<=25 %	25 to 75 %	>75 %
GA	0.221	0.206	0.229	0.203	0.210	0.255
MA	0.195	0.276	0.326	0.253	0.318	0.182
MO	0.137	0.215	0.317	0.219	0.237	0.305
NC	0.211	0.251	0.287	0.253	0.265	0.354
TX	0.237	0.286	0.293	0.278	0.301	0.444
WA	0.259	0.234	0.286	0.249	0.257	*[a]

Notes: The columns are defined as K-8 schools (defined in Table 1) 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. 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.

Appendix A. Characteristics of Sample States

Appendix Tables A1-A4 provide comparisons of achievement, the structure of schools and districts, and student demographics for our six states. Appendix Tables A1 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 relative to other states 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).

Appendix Tables A2 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.

Appendix Tables A3 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.

Appendix Tables A4 shows the changes in schooling across the six states between 2005 and 20215. While Massachusetts lost significant numbers of schools and students, Texas and Georgia showed dramatic growth in both.

Appendix Table A1. 8th grade scores on National Assessment of Educational Progress (NAEP) Tests, Math and Reading

	Math		Reading	
	Mean	SD	Mean	SD
GA	279	36	262	35
MA	297	39	274	35
MO	281	36	267	34
NC	281	38	261	38
TX	284	33	261	35
WA	287	40	267	36

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.

Appendix Table A2. Numbers of districts, Schools Serving K-8 and Enrollment Share, by District Enrollment in 2014-15

	# Districts		# Schools		Mean School Size		Enrollment Share	
	Small dist.	Large dist.	Small dist.	Large dist.	Small dist.	Large dist.	Small dist.	Large dist.
GA	146	34	608	1174	563.2	707.5	0.709	0.291
MA	395	10	1109	316	417.0	426.9	0.792	0.208
MO	253	20	557	309	398.3	497.2	0.591	0.409
NC	77	38	548	1260	423.4	606.8	0.226	0.774
TX	1111	108	2060	3565	442.9	704.7	0.266	0.734
WA	264	31	816	795	366.0	517.7	0.435	0.565

Notes: 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).

Appendix Table A3. Percentile Cutoffs for Student Demographic Characteristics, for K-8 Schools in 2014-15

	% Economically Disadvantaged			% Black			% Hispanic		
	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
MA	0.173	0.349	0.668	0.016	0.037	0.098	0.037	0.074	0.239
MO	0.382	0.566	0.741	0.014	0.057	0.171	0.018	0.034	0.065
NC	0.435	0.611	0.956*	0.079	0.218	0.410	0.070	0.122	0.208
TX	0.436	0.663	0.841	0.015	0.056	0.150	0.240	0.472	0.788
WA	0.354	0.554	0.728	0.005	0.015	0.043	0.090	0.147	0.261

Appendix Table A4. Change in Number of K-8 Schools and Enrollment, 2005-2015

	Change in Schools (percent)	Change in Enrollment (percent)
GA	6.40%	22.30%
MA	-4.30%	-5.80%
MO	2.70%	0.50%
NC	5.18%	4.96%
TX	8.04%	13.50%
WA	1.70%	5.20%

Appendix Table A5. 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

Appendix Table A6. 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		
	<=25 %	25 to 75 %	>75 %	<=25 %	25 to 75 %	>75 %
Georgia	0.221	0.206	0.229	0.203	0.210	0.255
Massachusetts	0.195	0.276	0.326	0.253	0.318	0.182
Missouri	0.137	0.215	0.317	0.219	0.237	0.305
North Carolina	0.211	0.251	0.287	0.253	0.265	0.354
Texas	0.237	0.286	0.293	0.278	0.301	0.444
Washington	0.259	0.234	0.286	0.249	0.257	*[a]

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

Appendix Table A7. 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: 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 (*)

Appendix Table A8. 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: 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 (*)

Appendix Table A9. 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

Appendix Table A10. Distribution Teaching and Assistant Principal Experience for AY 2014-15 K-8 Principals by Location of Assistant Principal and Teaching Experience and District Size

Panel 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

Panel 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

Panel C. All Districts

Assistant principal experience	Teaching experience	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: 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 (*)

Appendix Table A11. 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]

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

Appendix B. Randomized Inference Procedure

We report the standard deviation of principal value-added within schools in each state based on calculations using the value-added estimates from equation (1), demeaned by school, as described in the text. The reporting of these values requires an adjustment to account for sampling variance. This appendix describes the procedure we use for the adjustment, which estimates and removes sampling variance from the total variance of the principal value-added estimates.

We estimate the sampling variance using a randomized inference procedure, which is implemented as follows. First, we vertically separate the principal identifiers from the rest of the dataset. Next, we shuffle them at random, keeping principal spells at schools together (e.g., if a principal spent four years at school A, when the principal identifiers are re-shuffled those four years stay together during the reshuffling). Then we reattach the reshuffled principal identifiers to the school data so that principal spells are effectively assigned to schools at random in the data. This reshuffling process preserves the true covariance structure in the real data—it just moves the principal spells across schools.[20]

With the dataset of randomly-assigned principals, we re-estimate equation (1) in the text and produce the estimates $(\hat{\theta}_{ps} - \bar{\hat{\theta}}_{ps})$ for each principal p. The variance of these estimates is under the condition that the true values are zero because we randomly assign the principals, but the estimated variance will be non-zero due to sampling variance. We repeat the reshuffling and re-estimation procedure 300 times and at each iteration we store the estimated variance of the

[20] An additional challenge is that the random assignment of principals to schools must not break true principal spells across schools—e.g., a principal who spent five years at school A in the real data must not have that spell split into two and three year spells at schools B and C in the random-assignment scenario. This would create additional principal-by-school variance not present in the real data, which could influence the estimation-error variance. The coding structure for the simulations includes constraints that prevent such splits from occurring.

principal value-added estimates. This gives the empirical distribution when we know the true principal effects are zero by virtue of the random assignment. If our estimates using the real data—i.e., using principals' real school assignments—are outside of the 95 percent confidence interval of the empirical distribution estimated with known null effects, we can say that our variance estimates are statistically distinguishable from zero.

Beyond testing for statistical significance, we also report the magnitude of the variance of the principal fixed effects in each state (by their standard deviations). To arrive at these estimates, and noting that the true variance of principal value-added is equal to the total variance minus the sampling variance, we subtract the average value of $[\text{var}(\hat{\theta}_{ps} - \overline{\hat{\theta}}_{ps})]$ over the 300 random-assignment iterations—our estimate of the sampling variance—from the value based on the real data. The calculation for the adjusted standard deviations reported in the paper is as follows:

$$\sqrt{\text{var}(\hat{\theta}^{rd}_{ps} - \overline{\hat{\theta}}^{rd}_{ps}) - \frac{1}{300}\sum_{n=1}^{300}\text{var}(\hat{\theta}^{n}_{ps} - \overline{\hat{\theta}}^{n}_{ps})} \qquad \text{(A1)}$$

where the superscript *rd* refers to an estimate taken from the real data and the superscript *n* refers to an estimate taken from the *n*th iteration of the randomized inference procedure.