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The Apprentice: Pathways to the Principalship and Student Achievement

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Abstract

Background: Nascent empirical research demonstrates the sizable impacts of principals on student achievement. More research is needed on the pathways to the principalship and how principals' characteristics and training experiences influence their performance. **Purpose:** (1) To describe the characteristics of first-time principals and the schools that hire them and (2) to assess the extent to which the characteristics of early-career principals and the environments in which they previously worked are associated with changes in student achievement in the schools they lead. **Setting:** North Carolina public schools. **Sample:** All first-time principals (981 in total) from 2006-2007 through 2009-2010 and the students attending the schools where they serve. **Data:** Administrative data on students, school personnel (teachers, assistant principals, principals), and schools provided by the North Carolina Department of Public Instruction. **Research Methods:** Covariate adjustment and fixed effects value-added models. **Findings:** We find that first-time principals are "homegrown"—hired from within the district. On average, first-time principals wait 5.12 years between completing formal principal preparation and assuming school leadership and spend 4.15 years as assistant principals in North Carolina public schools. Several principal

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characteristics, including holding a doctorate from an in-state private or out-of-state institution (negative) and serving as an assistant principal in a high–value-added school (positive), are significantly associated with student achievement gains. **Conclusions:** This study suggests that the effectiveness of early-career principals may be affected by the environment where they served as assistant principals. Further analyses are needed to better understand the attributes of meaningful assistant principal experiences.

Keywords
principal labor markets, principal preparation, principal effectiveness, value-added models

Introduction

In recent years a body of research has begun to estimate the effects of principals using value-added models and other measures of student, teacher, and school outcomes. This research has focused on (1) the magnitude of principal effects on outcomes of interest—student achievement, absences, and graduation rates; teacher retention and on-the-job learning; and school working conditions (Boyd et al., 2011; Branch, Hanushek, & Rivkin, 2012; Coelli & Green, 2012; Dhuey & Smith, 2010; Loeb, Kalogrides, & Beteille, 2012); (2) the relationship between principal actions, such as recruiting and retaining high-quality teachers or acting as the school's instructional leader, and principal effectiveness (Grissom & Loeb, 2011; Grissom, Loeb, & Master, 2013; Horng, Klasik, & Loeb, 2010; Robinson, Lloyd, & Rowe, 2008); (3) the characteristics of principals—demographics, career trajectories, preparation—and (4) whether principal characteristics, such as experience or preparation type, influence principal effectiveness (Clark, Martorell, & Rockoff, 2009; Corcoran, Schwartz, & Weinstein, 2012).

While these foci are relevant for all principals, two factors suggest that further research is particularly pressing for inexperienced principals. First, inexperienced principals comprise a significant percentage of school leaders. For example, as shown in Figure 1, during the most recent 5 years of available data (2006-2007 through 2010-2011), 1 out of 10 principals in North Carolina was in his or her first year (no prior experience in the position), and overall, principals with less than 5 years of experience (early-career principals) comprised more than 50% of all public school leaders in the state (authors' analysis).

Second, evidence suggests that a school's transition to a first-time principal adversely affects student and school outcomes of interest (Beteille, Kalogrides, & Loeb, 2012; Burkhauser, Gates, Hamilton, & Ikemoto, 2012;

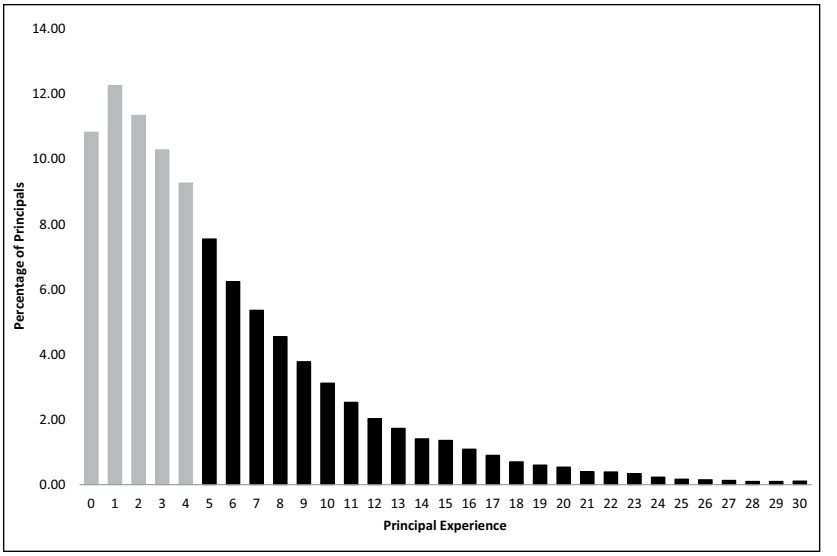

Figure 1. The distribution of principal experience: 2006-2007 through 2010-2011.
Note. This figure displays the levels of principal experience for all North Carolina public school principals in the 2006-2007 through 2010-2011 school years.

Dhuey & Smith, 2013; Miller, 2013). For example, work by Beteille et al. (2012) in Miami-Dade County Public Schools indicates that students make significantly smaller mathematics achievement gains (approximately 0.015 *SD* units) in schools led by a first-time principal. Similarly, Dhuey and Smith (2013) show that first-time principals are associated with lower levels of student attendance and higher rates of teacher turnover.

Therefore, given the prevalence of inexperienced principals and the adverse achievement effects for schools transitioning to a first-time principal, this study seeks to contribute to the principal effects research by better understanding pathways to the principalship and whether characteristics of principals or those of their prior work environments are associated with their impact on student achievement gains. Specifically, we ask the following questions:

Research Question 1: What are the characteristics of first-time principals, including their prior work experiences in educational settings, and the schools that hire them?
Research Question 2: Are there characteristics of early-career principals or the school environments in which they previously worked that are associated with student achievement gains?

By way of preview, we find that first-time principals are "homegrown,"—a large majority become first-time principals within the same school district in which they once worked as assistant principals and/or teachers—wait more than 5 years between earning their principal preparation degree and assuming school leadership and spend more than 4 years as assistant principals in North Carolina public schools (NCPS). Additionally, better credentialed first-time principals assume positions in schools with less challenging student populations and better credentialed teachers. Several individual principal characteristics are significantly associated with adjusted-average student achievement gains, including minority status (negative), holding a doctorate from an in-state private or out-of-state institution (negative), and years of experience as a principal (positive in middle grades reading). Notably, indicators of principal human capital and assistant principal experience are rarely associated with adjusted-average student achievement gains. Concerning prior work environments, estimates indicate that secondary grades principals (particularly at the middle grades level) who served as an assistant principal in a high–value-added school are associated with significantly larger adjusted-average achievement gains than their peers without such an assistant principal experience. This suggests that the effectiveness of early-career principals may be influenced by the environment in which they served as assistant principals.

In the remainder of this article, we first review literature on principal effectiveness and the mechanisms by which principals affect student and school academic outcomes. Next, we detail our data sources, research sample, and analysis measures. Then, we describe the methodological challenges in estimating principal effectiveness and lay out our analytical approach. Finally, we present results for each research question and conclude with a discussion of future research directions and potential policy implications.

Background

Research on Principal Effectiveness and Its Determinants

To estimate the effects of principals or principal characteristics on outcomes of interest, researchers are beginning to employ rich administrative data sets and sophisticated econometric techniques. Specifically, researchers are using the education production function, which identifies the principal as one of many inputs (along with student/home, teacher/classroom, and school characteristics) in the process that produces an educational outcome, as the theoretical basis for modeling principals' effects. Below, we review the findings from these studies.

Overall, these studies present compelling evidence that principals significantly influence student academic outcomes. For example, a 1 standard deviation increase in effectiveness for principals switching schools in Texas is associated with a 0.10 standard deviation increase in student achievement (Branch et al., 2012); a one standard deviation increase in effectiveness for principals switching schools in British Columbia boosts student achievement by approximately 0.10 to 0.20 standard deviations between fourth- and seventh-grade exams (Dhuey & Smith, 2010). Breaking the principal effect down into two parts—that which is fixed across school settings and that which varies across principal–school matches—Dhuey and Smith (2013) estimate the fixed component to be 0.04 and 0.02 standard deviations in mathematics and reading and the variable component to be 0.07 and 0.04 standard deviations in mathematics and reading. Additionally, a principal one standard deviation higher in the effectiveness distribution increases graduation rates by 2.6 percentage points—roughly one third of the standard deviation across schools (Coelli & Green, 2012)—and principals in the top quartile of effectiveness are associated with significantly higher student attendance rates (Branch et al., 2012).

To understand what factors account for these variations in principal performance, researchers have begun to examine the effects of three principal characteristics—preparation, experience or tenure at a school, and career trajectories. Regarding principal preparation, results indicate that type of training does not appear to have a sizable effect on student achievement. For example, (1) principals prepared in university training programs are no more effective than those prepared in school district programs (Vanderhaar, Munoz, & Rodosky, 2006) and (2) schools led by graduates of one alternative entry program for principals—New York City's Aspiring Principals Program—are initially lower performing but narrow the gaps over time (Clark et al., 2009; Corcoran et al., 2012). As more alternative principal preparation programs develop and university-based programs revamp their curriculum, type and components of principal preparation merit continued research.

Concerning returns to principal experience—whether principals' effectiveness increases over time—results are mixed across studies. Findings from some early and more recent studies indicate no relationship between principal experience and effectiveness (Brewer, 1993; Dhuey & Smith, 2010). Other work, especially studies using single-year principal experience indicators, display significant early-career principal returns to experience (Branch et al., 2012; Clark et al., 2009; Eberts & Stone, 1988). Regardless of overall principal experience, school academic outcomes also appear to improve with principal tenure at a school, indicating that it may take time for principals to substantially influence student performance (Handa, Thompson, Marcus,

& Smith, 2010; Miller, 2013). Finally, only one study to date, by Clark et al. (2009), has examined variables related to work experiences prior to becoming a principal—whether an individual was ever a teacher or an assistant principal in the same school in which he or she became the principal. Here, evidence indicates that for first- and second-year principals, having served as an assistant principal in the current principalship school is positively associated with student achievement gains; having served as a teacher in the current principalship school is negatively associated with student achievement gains in English (Clark et al., 2009).

How Principals Influence Achievement Outcomes

In addition to examining principal characteristics, researchers are identifying the key behaviors and skills of principals. Here, research efforts have both categorized the myriad of principal actions and activities into a smaller number of domains and examined the extent to which variations in these behaviors predict school and student achievement outcomes. Regarding the classification of principal actions, recent factor analysis work by Grissom and Loeb (2011) found five broad domains of principal action: (1) instructional management—the promotion, support, and improvement of classroom instruction and school curricula; (2) organizational management—overseeing the budgets, resources, facilities, and environment of the school; (3) internal relations—building strong interpersonal relationships with students, teachers, and parents; (4) external relations—working with stakeholders beyond the school; and (5) administrative duties—routine, day-to-day tasks such as completing paperwork and managing schedules and discipline.

Given teachers' sizable effects on student achievement gains, principals' ability to recruit and retain high-quality teachers is widely expected to be a key mechanism through which they influence outcomes, and research is beginning to support this expectation. For example, Grissom and Loeb (2011) and Horng et al., (2010) find that organizational management, which includes hiring teachers and distributing resources (e.g., assigning teachers to classes), is associated with better school outcomes. Branch et al., (2012) find that less effective teachers exit schools with higher value-added principals; Loeb et al. (2012) show that more effective schools attract better teachers, assign novice teachers more equitably, develop teachers more rapidly, and retain high-quality teachers.

Beyond organizational management, results are not as clear regarding the effects of principals' instructional management. Meta-analysis results from Robinson et al., (2008) indicate that instructional management—for example, evaluating curriculum, planning professional development, observing

teachers—is a critical component of principal effectiveness, while findings by Grissom et al. (2013) show that only certain instructional management tasks, specifically coaching and evaluating teachers, are related to student achievement. This suggests that instructional management is an additional way that principals may influence student achievement by influencing teaching quality.

Finally, through their organizational management, instructional management, internal relations, and administrative behaviors, principals influence the working conditions of their school. This includes (1) articulating a shared school vision and culture, (2) creating a safe and orderly environment, and (3) empowering teachers to assume critical roles in this process. Recent research evinces that school leadership, distributed leadership, and administrator quality are significantly related to teacher persistence, indicating another way that principals influence student outcomes by affecting teacher quality (Boyd et al., 2011; Ladd, 2011; Schweig, 2013).

Overall, the mechanisms through which principals influence student outcomes appear to be linked by a focus on teachers—hiring and keeping high-quality teachers as well as developing and supporting high-quality instruction. These mechanisms also indicate that the influence of a principal on student academic outcomes is indirect and may be related to a principal's autonomy to shape her or his teaching staff.

Why Prior Work Environments May Matter for Principals

In the present study, we hypothesize that principals' prior work environments affect their ability to improve student outcomes. Essentially, the assistant principalship serves as an *apprenticeship* to learn and practice effective school leadership behaviors, and the characteristics of this assistant principal environment will be likely to influence future principal performance. Below, we explain why the assistant principalship may affect future principal performance.

In contrast to the traditional pathway into teaching—a 4-year education degree, student teaching, and an immediate transition to classroom teaching—promotion to the principalship often occurs several years after completing the formal requirements for a principal license. In North Carolina, for example, first-time principals wait 5.12 years, on average, from the time they complete their formal principal preparation until they first assume school leadership (Figure 2). Most frequently, principals begin their careers as teachers, acquire a principal license through formal education (sometimes while still teaching), and serve an apprenticeship of varying length as an assistant principal—in our sample 94% of first-time principals served as assistant

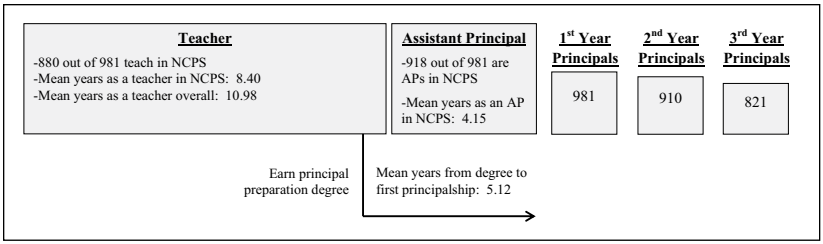

Figure 2. Career trajectories for first-time principals.
Note. This figure displays both the average career trajectory (teaching, principal preparation, serving as an assistant principal) for the first-time principals in our sample and the persistence of these principals over their first 3 years.

principals in NCPS and the average length of assistant principal service was 4.15 years (Figure 2). During the apprenticeship period as an assistant principal, on-the-job learning is likely to shape their future performance as principals.

One lens through which to conceptualize this on-the-job learning is Bandura's self-efficacy model. This postulates that individuals' efficacy expectations are most malleable early in learning—especially salient to assistant principals and early-career principals—and are shaped by mastery and vicarious experiences, attribution beliefs, and social persuasion (Bandura, 1977).[1] For assistant principals, mastery experiences could come through directly engaging in practices, such as formally observing teachers, participating in teacher hiring, or analyzing student achievement data, to increase teacher and student performance; vicarious experiences could occur as sitting principals model effective school leadership behaviors. When apprentices witness these practices succeeding, their tendency to attribute desired school outcomes to school leadership actions could be enhanced.

Although traditional assistant principal job responsibilities—managing student discipline, transportation, and textbooks—may not be well aligned with these vicarious and mastery experiences that prepare assistant principals for the principalship (Koru, 1993), there is a developing emphasis on (1) the assistant principalship as preparation for the principalship and (2) the principal as a mentor to facilitate assistant principal learning (Calabrese & Tucker-Ladd, 1991; Johnson-Taylor & Martin, 2007; Matthews & Crow, 2003). With this expanded conception of the assistant principalship, the responsibilities of assistant principals are broadening to include tasks that provide meaningful training/learning experiences—for example, observing/evaluating teachers, serving on school improvement teams, creating a school vision/climate, and acting as instructional leaders (Bartholomew, Melendez-Delaney, Orta,

& White, 2005; Kaplan & Owings, 1999). Given the research evidence that principals learn by doing and acquire skills on-the-job, efforts to push this learning back into the assistant principalship may produce better prepared beginning principals (Portin, Schneider, DeArmond, & Gundlach, 2003).

In the present study, we use several measures to examine whether prior learning environments influence early-career principal performance. First, whether the principal previously served as a teacher or assistant principal in the principalship school. Second, whether the principal previously worked as an assistant principal at the same school level (elementary, middle, or high) as the principalship school, which may familiarize a principal with the requirements of managing students, teachers, and school operations at that level. A final measure is whether the principal previously served as an assistant principal in a high–value-added school. If principal practices contribute to student achievement gains, as research suggests (Grissom et al., 2013; Grissom & Loeb, 2011; Horng et al., 2010), serving as an assistant principal in a high–value-added school may indicate that a principal is better prepared to implement effective school leadership strategies after directly participating in and/or being vicariously exposed to such practices. This last measure was developed by analogy to research in the field of teacher quality, which shows that the school environment in which student teachers work and learn significantly affects their performance as novice teachers. Those individuals who student taught in "model environments"—schools that were easier to staff and with greater teacher collaboration—were more effective beginning teachers (Ronfeldt, 2012). Therefore, this measure will allow us to test whether the quality of the apprenticeship learning environment is similarly associated with early-career principal performance.

Data and Research Sample

Data Sources

For this study, we relied on data from the University of North Carolina General Administration (UNCGA) and the North Carolina Department of Public Instruction (NCDPI) to track the career trajectories and identify the characteristics of first-time principals. Specifically, the UNCGA supplied an education file detailing principal preparation degrees earned at a UNC (University of North Carolina) system school. The NCDPI provided a comprehensive set of personnel data, including the following key files: (1) annual salary files and a pay history file that allowed us to determine what positions (e.g., teacher, assistant principal) individuals held, how long they held those positions, in what districts and schools they worked, and when they first

became a principal; (2) a personnel education file that detailed the type of degrees individuals earned, the degree-granting institutions, and the graduation dates; (3) personnel licensure files that indicated individuals' teaching license areas and National Board Certification status; and (4) test score files that contained teacher and principal licensure exam scores. In addition to these files, the NCDPI provided student test score data, classroom rosters, and school-level characteristics to enable value-added analyses.

Research Sample

For this analysis, we identified a set of first-time principals in NCPS. To define a principal–school combination in administrative data, we specified the following rules: (1) an individual had to work 100% full-time equivalency as a principal at a school; (2) an individual had to begin work as a principal at a school in one of the fiscal year's first three pay periods (July, August, or September); and (3) after beginning work in one of the first three pay periods, an individual had to remain as a full-time principal for at least eight pay periods (months). Using these guidelines, we identified all first-time principals in NCPS, 981 in total, in the 2006-2007, 2007-2008, 2008-2009, and 2009-2010 schools years. Data described above in the data sources section allow us to identify the previous teaching and assistant principal experiences and formal preparation to become a principal for (1) our sample of 981 first-time principals, (2) the sample of principals who immediately precede our first-time principals, and (3) if our first-time principals attrite from the school during our study period, the sample of principals who succeed them. This set of principals—our first-time principals and those who precede and, if available, succeed them—comprise our sample for value-added analyses. Additionally, student test score data are available from 2005-2006 through 2010-2011 in elementary grades and 2004-2005 through 2010-2011 in middle and high school grades. This means for our first cohort of first-time principals—assuming school leadership in the 2006-2007 academic year—we have up to 2 years of student achievement data prior to their promotion to the principalship and up to 5 years of data while they are principal; for our last cohort of first-time principals—starting in the 2009-2010 school year—we have up to 5 years of student achievement data prior to their promotion to the principalship and up to 2 years of data while they are principal.

Measures

Dependent variables. The dependent variables for this analysis are students' test scores on either the North Carolina End-of-Grade (EOG) mathematics and reading exams (Grades 3-8) or the five high school (Grades 9-12)

End-of-Course (EOC) exams that North Carolina required for graduation during the study period (English 1, algebra 1, biology, civics, and U.S. history). Although our value-added analyses focus only on a subset of schools, we standardized our dependent variables using the full, statewide population of student test scores. Specifically, we standardized all EOG exams within subject, grade, and year and all EOC exams within subject and year. To further control for secular trends or other year-to-year anomalies, we include year fixed effects in our value-added specifications. In addition to serving as the dependent variables, standardized mathematics and reading scores from the previous grade, or from eighth grade for high school students, serve as measures of prior achievement (covariates) in these value-added models.

Focal variables. The focal variables for this study are individual principal characteristics and characteristics of the environments in which principals previously worked.

The individual principal characteristics included in the study can be broken into four categories: (1) demographic traits, (2) human capital indicators, (3) principal preparation measures, and (4) job experience indicators. In several cases, we identified variables that have been included and found significant in research on teachers' value-added and incorporated them into this research (Clotfelter, Ladd, & Vigdor, 2010; Goldhaber, 2007; Goldhaber & Anthony, 2007).

1a. Principal gender: A dichotomous indicator for female principals
1b. Principal ethnicity: A dichotomous indicator for minority (non-White) principals
2a. National Board Certification: A dichotomous indicator for whether an individual was a National Board–certified teacher prior to assuming the principalship
2b. Principal licensure exam scores: A dichotomous indicator for an exam score in the top quintile on the state required principal licensure exam; we created an indicator for principals missing a licensure exam score and included this variable in our value-added analyses
3. Principal preparation degree type: A set of dichotomous indicators comparing the reference group—individuals whose principal preparation was a master's degree from an in-state public university—to those who earned the following principal preparation degrees: (1) a master's degree from an in-state private university, (2) a master's degree from an out-of-state university, (3) a doctorate from an in-state public university, (4) a doctorate from an in-state private university, or (5) a doctorate from an out-of-state university

4a. Years of assistant principal experience: Linear and quadratic variables for the number of years an individual served as an assistant principal in NCPS; more years of assistant principal experience may indicate greater familiarity with the requirements of effective school leadership; however, more years of assistant principal experience may also suggest that individuals were less competitive for open principal positions.
4b. Principal experience: Linear and quadratic variables for individuals' years of principal experience[2]

The prior work environment characteristics included in the study examine whether a principal's familiarity with or exposure to (1) a specific school, (2) a specific school level, or (3) a high–value-added school is significantly associated with student achievement gains once principals assume leadership.

1a. Teacher–school match: A dichotomous indicator for whether an individual became a principal in the same school in which he or she once taught
1b. Assistant principal–school match: A dichotomous indicator for whether or not an individual became a principal in the same school in which he or she was once an assistant principal; results from this work will suggest whether familiarity with administrative leadership at a particular school is associated with principal performance
2. Assistant principal–school level match: A dichotomous indicator for whether or not an individual becomes a principal at the same school level (e.g., elementary, middle, high) in which he or she was once an assistant principal
3. Quality of the assistant principal learning environment: A standardized, continuous variable for the value-added at the assistant principalship school and a dichotomous indicator for an assistant principalship school in the top quintile of school value-added (see Appendix A for a description of how we estimated this measure of the assistant principal-learning environment). Because these focal variables may require student achievement data—from the school in which an individual last served as an assistant principal—prior to our first year of available data (2004-2005 or 2005-2006 depending on school level), these measures are available only for our sample of first-time principals (see the analysis plan section for changes in model specification to accommodate).

Covariates. To isolate the associations between our focal principal variables and adjusted-average student achievement gains, we control for a set of student and school covariates. Student variables include prior test scores, peer ability, days absent, mobility (between-year, within-year, and structural), underage/overage for grade, giftedness, disability, eligibility for subsidized school lunches, race/ethnicity, gender, and limited English proficiency. For high school value-added models, we also include a set of indicators for English 1, biology, U.S. history, and civics courses (reserving algebra 1 as the reference group). School variables include school size, total per-pupil expenditures, average teacher salary supplements, the percentage of students eligible for subsidized school lunches, and the percentage of racial/ethnic minorities.

Estimating Principal Effects

Challenges to Estimating Principal Effects

Recent efforts to estimate the effects of principals and principal characteristics with models based on the education production function present several conceptual and methodological challenges. First, unlike teachers, principals do not directly affect student learning, and instead, researchers must assume that measured academic outcomes attributed to principals are due to their indirect effects—for example, hiring and retaining teachers, establishing a positive school climate, and overseeing instruction (Branch et al., 2012). Second, principals' effects may not be immediate but rather may develop over time (Coelli & Green, 2012; Grissom, Kalogrides, & Loeb, 2014; Handa et al., 2010; Miller, 2013). Third, when estimating principal effects, researchers need, to the extent possible, to eliminate or reduce bias caused by principals sorting into schools based on unobserved characteristics.[3] Drawing implications from these points, researchers must carefully consider what variables to control for in an education production function (Beteille et al., 2012; Clark et al., 2009; Grissom et al., 2014; Loeb, Kalogrides, & Horng, 2010). For example, principals typically have repeated effects on the same students (e.g., in third, fourth, and fifth grades), meaning controlling for prior student achievement also controls for prior principal effects (Grissom et al., 2014).[4] Additionally, because the effects attributable to principals are mediated by teachers, controlling for elements of teacher quality and classroom composition will attenuate principal effect estimates (Clark et al., 2009; Grissom & Loeb, 2011; Horng et al., 2010). The issue of principals sorting into schools based on unobserved characteristics presents a final challenge: how to conceive of and model principals' contributions to student achievement gains. As presented by Grissom et al.

(2014) these choices include (1) models that estimate school effectiveness, thereby attributing the entire school effect to the principal; (2) models that estimate principal effectiveness separate from the school, thereby attempting to isolate principals' unique contributions; and (3) models that estimate improvements in student/school achievement under a principal's leadership. Importantly, there is not a single, most appropriate specification; rather, choice of model is related to the amount of control principals have over the factors that influence student learning and how long it may take principals to influence outcomes (Grissom et al., 2014).

To address threats to internal validity and to separate the effect of principals from those of schools, researchers often model the education production function using fixed effects. In these models (1) principal fixed effects attempt to control for time-invariant principal characteristics, such as ability, and estimate deviations from principals' average effects on student achievement gains over time (Branch et al., 2012); (2) school fixed effects attempt to separate principal effects from school effects by estimating the deviations from the average school effect over time for different principals who have worked in the same school at different times (Branch et al., 2012; Clark et al., 2009); and (3) principal and school fixed effects attempt to control for unobserved principal characteristics and school factors by limiting comparisons to principals who serve in two or more schools and schools that have two or more principals during the study period (Coelli & Green, 2012; Dhuey & Smith, 2010). Given that the effectiveness of a school may be due to factors in place before a principal's arrival and research indicates principals prefer to lead schools with fewer poor, minority, and low-achieving students, it is likely that these fixed effects approaches better identify principals' unique contributions to student learning and reduce the bias of principal effect estimates (Li, 2012; Loeb et al., 2010). However, because these fixed effects approaches (school or principal and school fixed effects) require principal transitions to identify effects, their use limits the sample to groups of principals and schools that may be different from the excluded schools and principals. Therefore, the estimates may be inferred to a distinct subpopulation, in which schools with high principal turnover are overrepresented (Chiang, Lipscomb, & Gill, 2012; Grissom et al., 2014).

Analysis Plan

In the present study, we estimate the relationships between characteristics of individual principals or those of the school environments in which they previously worked and adjusted-average student achievement gains. To do so, we

employ two main model specifications: (1) a value-added model with student- and school-level covariates and cluster adjusted standard errors at the school level and (2) a value-added model with student and (time varying) school covariates, cluster adjusted standard errors at the school level, and a school fixed effect. These models include all principal–school year combinations from our sample of four cohorts of first-time principals, to which we have added comparable data for the years immediately preceding and, if available, succeeding the first-time principals. Although our primary focus is on first-time principals, we have broadened our sample to include the preceding and, if available, succeeding principals, so that we can employ school fixed effects—a more rigorous analytic method.[5] Using school fixed effects is particularly important given the sorting of principals into schools—shown in prior research (Loeb et al., 2010) and our own sample—and our desire to separate the effect of the principal from that of the school. An implication of this choice, however, is that our coefficients can be interpreted not solely as characteristics of first-time principals but rather as those of first-time principals and their peers immediately preceding and (if available) succeeding them.

We run value-added models in elementary grades mathematics and reading, middle grades mathematics and reading, and for the five high school EOC exams (combined) required for graduation during the study period. Each model controls for our full set of individual and prior workplace characteristics (except for the apprenticeship learning environment, which we estimate in Equation 3). The equations for our two model specifications are as follows:

$$A_{ist} = \alpha A_{it-n} + \beta Prin\_char_{st} + \gamma X_{ist} + \theta S_{st} + \varepsilon_{ist}, \quad (1)$$

$$A_{ist} = \alpha A_{it-n} + \beta Prin\_char_{st} + \gamma X_{ist} + \theta S_{st} + \sigma_s + \varepsilon_{ist}, \quad (2)$$

where A_{ist} is the test score for student i in school s at time t, A_{it-n} represents the prior test score(s) for student i, $Prin\_char_{st}$ is a set of focal principal characteristics, β estimates the association between the principal characteristics and students' adjusted-average test score growth, X_{ist} represents a set of time invariant and varying individual student characteristics, S_{st} represents a set of school characteristics, σ_s is a school fixed effect to adjust for time-invariant school factors (Equation 2), and ε_{ist} is a disturbance term representing all unexplained variation in student achievement.

Here, Equation 1 relies on a set of student and school covariates to adjust for factors that potentially confound estimates of our focal variables

(e.g., principals with higher levels of cognitive ability finding positions in less challenging schools). While this model does allow for coefficient estimates relative to our full sample, there are two potential concerns with Equation 1: (1) its set of covariates may be insufficient to fully adjust for factors that confound our focal variable estimates and (2) it does not disentangle the effect of a principal from that of the school. With the inclusion of a school fixed effect, Equation 2 helps address both these concerns by adjusting for time-invariant school characteristics and limiting estimates to different principals working in the same schools over time—a first-time principal and the principal that immediately preceded and, when available, succeeded her.

Given the research debate regarding the most appropriate method to estimate principal effectiveness, we also employed an alternate two-stage model to examine the associations between principals' individual and prior workplace characteristics and adjusted-average student achievement gains. Here, in Stage 1, we used statewide student achievement data to estimate a principal fixed effect for all NCPS principals leading schools with tested grades/subjects during our study period.[6] Then, in Stage 2, we regressed this measure of principal effectiveness on the set of focal principal (individual and prior workplace) characteristics for our sample of first-time principals and those immediately preceding and, if available, succeeding them (see Table A.3 for these results). Importantly, these second-stage results may differ from those estimated in Equations 1 and 2 because (1) the Stage 1 sample includes all NCPS principals leading schools with tested-grades/subjects; (2) the *felsdvregdm* procedure used in Stage 1 generates a single effectiveness estimate for each principal—no additional weight is given to principals linked to more students; and (3) the *felsdvregdm* procedure estimates principal effectiveness as deviations from the average principal. This means the coefficients in Stage 2 capture the relationship between principal characteristics and a single estimate of principal effectiveness rather than the relationship between principal characteristics and adjusted-average student achievement gains (Equations 1 and 2).

Finally, because our measure of the apprenticeship learning environment—the value-added at the assistant principal school—is available only for our four cohorts of first-time principals, we altered our sample and model specification to estimate this coefficient of interest. For our covariate adjustment model, we limited the sample to the schools and years led by our first-time principals. This means coefficients are estimated relative to other administrators in our first-time principal sample only. For our school fixed effects model, we retained data for our first-time principals and those principals immediately preceding them and used a differences-in-differences

estimation approach.[7] Specifically, we identified (1) a time-invariant treatment variable, which we label *Treat*, equal to 1 for schools that will be or are led by a principal with an apprenticeship in a top quintile value-added school (this indicator falls out of the school fixed effects models); (2) a *Post* variable equal to 1 for the years in which these schools were led by an individual in our first-time principal sample; and (3) an interaction between the *Treat* and *Post* variables to estimate the coefficient of interest. To better isolate this association, we excluded principals from both of these analyses who assumed leadership at the same school in which they were assistant principals. This excludes the possibility that any significant associations are due to assistant principals from high–value-added schools being promoted to the principalship in the same school. Additionally, we estimated our differences-in-differences school fixed effects model with 2 to 3 years of pre data (schools before the arrival of a first-time principal) and 2 to 3 years of post data (schools led by a first-time principal). The equation for our differences-in-differences school fixed effects model (standard errors clustered at the school level) is as follows:

$$A_{ist} = \alpha A_{it-n} + \beta_1 Treat_s + \beta_2 Post_{st} + \beta_3 Treat * Post_{st} + \gamma X_{ist} + \theta S_{st} + \sigma_s + \varepsilon_{ist}, \quad (3)$$

where A_{ist} is the test score for student i in school s at time t, A_{it-n} represents the prior test score(s) for student i, $Treat_s$ is a time-invariant indicator for schools that will be or are led by a principal with an apprenticeship in a top quintile value-added school (without any variation within schools, this indicator falls out of the school fixed effects models), $Post_{st}$ identifies the schools and years led by an individual in our first-time principal sample, $Treat * Post_{st}$ is the focal variable of interest, β_3 estimates the association between the focal principal characteristic and students' adjusted-average test score growth, X_{ist} represents a set of time-invariant and varying individual student characteristics, S_{st} represents a set of school characteristics, σ_s is a school fixed effect to adjust for time-invariant school factors, and ε_{ist} is a disturbance term representing all unexplained variation in student achievement.

Overall, we acknowledge the methodological and conceptual challenges to estimating the effect of principal characteristics. Therefore, we use associational language when discussing the relationships between principal characteristics and student achievement gains. Furthermore, because the research on principal quality is in nascent stages, we contend that our associations provide the basis for hypothesis generation, and accordingly, we report statistical significance for estimates at the 0.10, 0.05, and 0.01 levels, respectively.

Table 1. Demographic, Teaching, and Principal Preparation Information.

Variables	Full sample	Female principals	Male principals	White principals	Minority principals
Count	981	586	395	713	265
Average age at first principalship, years	41.37	42.63	39.51	41.58	40.73
Standardized principal exam scores	0.192	0.344	-0.035	0.327	-0.032
National Board Certification	97	79	18	75	22
Teaching licenses					
Elementary	366	282	84	271	95
Mathematics	105	64	41	84	21
English	206	157	49	151	55
Science	114	53	61	92	22
Social studies	159	70	89	132	27
Exceptional children	160	135	25		
Principal preparation					
North Carolina public master's	655	396	259	477	178
North Carolina private master's	116	71	45	93	23
Out-of-state master's	97	48	49	57	40
North Carolina public doctorate	67	44	23	58	9
North Carolina private doctorate	5	1	4	5	0
Out-of-state doctorate	40	25	15	23	17

Note. This table displays basic counts and averages of demographic, teaching, and principal preparation information for our full sample of first-time principals, overall, and by gender and race. Race/ethnicity is not available for three individuals in our sample.

What Are the Characteristics of First-Time Principals and the Schools That Hire Them?

Demographics

Our first-time principal sample is composed of 981 principals whose average age at first assuming school leadership is 41 years and whose standardized principal licensure exam scores are one fifth of a standard deviation above the mean for all test-takers (see Table 1). Overall, nearly 60% of first-time

principals are female and 73% are White. Although average age at first principalship is fairly comparable across gender and ethnicity, there are sizable differences in licensure exam scores—on average, female and White principals outscore their male and minority peers by more than one third of a standard deviation, respectively.

Career Trajectories

As shown in Figure 2, a total of 880 of the 981 first-time principals in our sample were previously teachers in NCPS. On average, these individuals worked as teachers in the state's public schools for nearly 8.5 years and as teachers overall for nearly 11 years. Approximately 11% of these individuals held National Board Certification (displayed in Table 1); the most common teaching license was in elementary grades, followed by English (secondary grades), exceptional children, and social studies (secondary grades). Regarding career trajectories as assistant principals, Figure 2 shows that a large majority—918 out of 981—of the first-time principals in our sample were previously assistant principals in NCPS. On average, these individuals worked as assistant principals in the state's public schools for 4.15 years. Finally, Figure 2 indicates that approximately 93% and 84% of the first-time principals in our sample returned to the position for a second year and third year, respectively.

Principal Preparation

Overall, (1) 67% of the first-time principals earned a master's degree from an in-state public institution as their last degree; (2) the last degree for nearly 89% of our sample was a master's; and (3) approximately 14% of individuals earned their last degree out-of-state. As shown in Figure 2, there was an average of just over 5 years between earning the last degree and assuming school leadership, indicating that a typical individual completed principal preparation slightly before or concurrent with becoming an assistant principal.

Matching First-Time Principals to Prior Work Environments

Perhaps the most striking career trajectory findings concern the propensity of first-time principals to assume school leadership in the same districts, schools, and school levels in which they previously worked. Of the 880 first-time principals in our sample who also taught in NCPS, Figure 3 shows that nearly 75% taught in the same school district in which they became a principal, more than 11% taught in the same school, and nearly

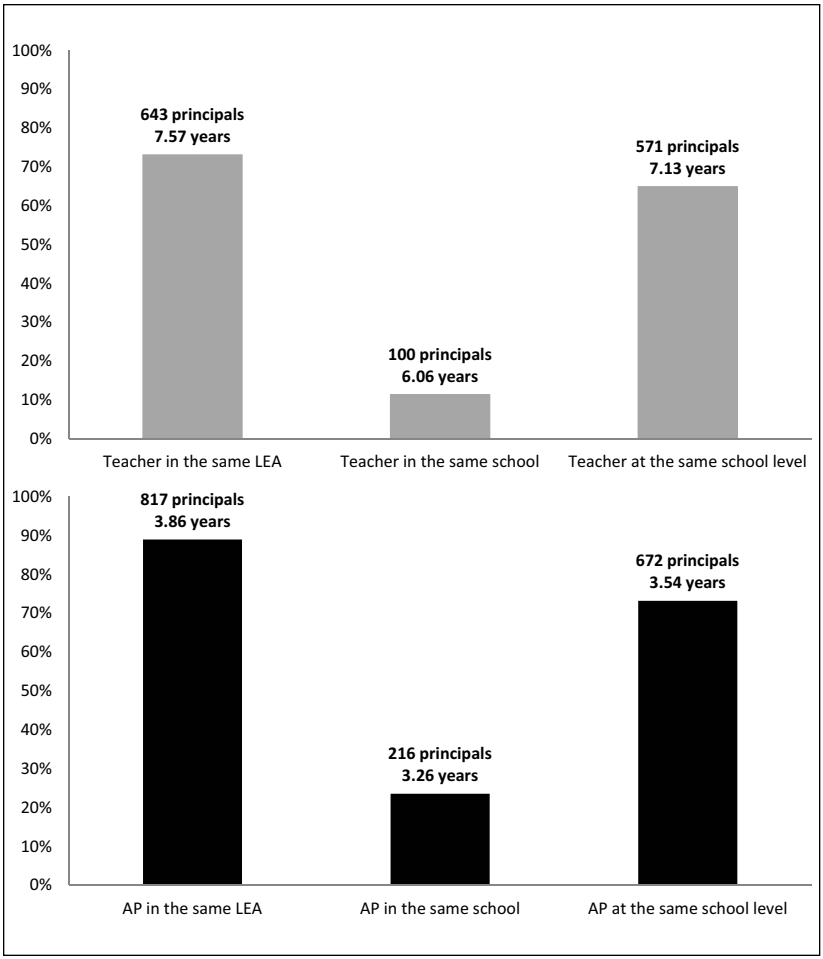

Figure 3. Matching first-time principals to prior work environments.
Note. For the 880 first-time principals in our sample who also taught in North Carolina public schools, the top graph indicates how many taught in the same district, school, or at the same school level and the average number of years for each category. For the 918 first-time principals in our sample who were also assistant principals in North Carolina public schools, the bottom graph indicates how many served as assistant principals in the same district, in the same school, or at the same school level and the average number of years for each category.

65% taught at the same school level. On average, individuals served as teachers in these environments for 7.57, 6.06, and 7.13 years, respectively. Of the 918 first-time principals in our sample who were also assistant

principals in NCPS, almost 90% served as assistant principals in the same district, nearly 24% were assistant principals in the same school, and more than 73% were assistant principals at the same school level. The average time spent as assistant principals in these environments was 3.86, 3.26, and 3.54 years, respectively. Finally, 586 individuals—nearly 60% of our sample—became a first-time principal in the same school district in which they had both served as a teacher and an assistant principal; on average, the combined years of service in these districts prior to assuming the principalship was 11.45 years. When considering these results, it is important to note that the configuration of North Carolina school districts, which are mostly large, countywide units, likely influences this tendency for first-time principals to be homegrown—previously teachers and/or assistant principals in the same school district.

School Descriptives

Beyond investigating the demographics, preparation, and career trajectories for our sample of first-time principals, we also examined characteristics—academic performance, student composition, teacher qualifications—of the schools in which first-time principals assume leadership.[8] To determine whether school characteristics differ according to principal experience, Table 2 presents descriptive information for both first-time and more experienced principals. Here, evidence suggests that in comparison to their more experienced peers, first-time principals assume leadership at schools with (1) fewer students passing their required state exams (performance composite), (2) higher concentrations of students qualifying for subsidized school lunches, and (3) less well-credentialed teachers. To examine whether these differences in school characteristics vary systematically *within* our sample of first-time principals, Table 3 provides three comparisons (1) White versus minority first-time principals, (2) first-time principals with top quintile versus bottom quintile licensure exam scores, and 3) first-time principals who were assistant principals in high–value-added schools (top quintile) versus those from low–value-added schools (bottom quintile). White and top-scoring first-time principals take control of higher performing schools with fewer minority or high-poverty students and better credentialed teacher workforces; those who apprenticed in high–value-added schools assume leadership in higher performing schools with fewer high-poverty students. How much these differences in first-time principal assignments are due to the preferences of individual principals, the hiring practices of school districts, or a combination of the two is unknown.

Table 2. School Characteristics Inherited by First-Time Principal Sample.

School characteristics	Principal experience comparisons		
	Sample of first-time principals	Principals with 5-10 years experience	Principals with >10 years experience
Performance composite (no. of tests passed/no. of tests taken)	58.14	60.01	62.35
Percentage of minority students	47.10	44.50	46.46
Percentage of subsidized school lunch students	56.23	52.53	50.33
Short-term suspension rate (per 100 students)	25.11	23.24	21.29
Urbanicity percentages			
City	18.94	24.22	26.82
Suburb	12.62	13.87	16.20
Town	18.49	13.57	13.90
Rural	49.94	48.35	43.08
Total per-pupil expenditures, $	9,263	9,266	9,456
Average teacher supplements, $	2,837	2,966	3,152
Percentage of National Board Certification teachers	8.59	9.54	9.88
Percentage of novice teachers	24.06	22.48	21.85
Percentage of teachers with an advanced degree	26.75	27.71	29.42
Percentage of teachers returning to the school	76.67	79.72	80.25
Total no. of principal–school-year combinations	905	2,325	1,660

Note. This table displays school-level data for our sample of first-time principals and more experienced principals. Data for first-time principals are from the year before they were appointed (descriptive data for the schools they inherit). In total, there are 905 principal–school combinations for our sample, indicating that 76 first-time principals assume leadership at brand new schools (no previous-year school-level data).

What Principal Characteristics Are Associated With Student Achievement Gains?

Individual Characteristics

Regarding individual demographics, Table 4—which presents findings for our covariate adjustment models in odd numbered columns and school fixed

Table 3. Variation in First-time Principal Characteristics and the Schools in Which They Serve.

	White versus minority principals		Principal licensure exam scores		Value-added at the last assistant principal school	
School characteristics	White first-time principals	Minority first-time principals	Top-scoring first-time principals	Bottom-scoring first-time principals	First-time principals from high–value-added schools	First-time principals from low–value-added schools
Performance composite (no. of tests passed/no. of tests taken)	61.35	49.60	60.67	55.17	61.67	55.30
Percentage of minority students	38.72	69.01	43.82	52.42	48.17	49.98
Percentage of subsidized school lunch students	51.77	67.93	50.80	61.11	52.61	62.56
Short-term suspension rate (per 100 students)	20.76	36.72	20.51	36.50	27.73	26.37
Urbanicity percentages						
City	14.94	29.51	19.28	18.60	19.75	16.54
Suburb	14.48	7.79	16.87	12.21	15.29	11.28
Town	16.62	23.36	18.07	21.51	19.11	23.31
Rural	53.96	39.34	45.78	47.67	45.86	48.87
Total per-pupil expenditures, $	8,990	9,998	9,378	9,799	9,314	9,301
Average teacher supplements, $	2,752	3,060	3,215	2,736	3,043	2,592
Percentage of National Board Certification teachers	9.54	6.08	9.68	6.25	8.73	7.59
Percentage of novice teachers	22.94	26.98	24.76	24.85	24.75	24.75
Percentage of teachers with an advanced degree	27.20	25.54	27.32	25.05	27.02	24.93
Percentage of teachers returning to the school	77.92	73.35	76.92	74.75	75.50	75.77
Total number of principal-school-year combinations	657	245	166	172	158	133

Note. This table displays school-level data, by principal characteristic or credential, within our sample of first-time principals. Data for first-time principals are from the year before they were appointed (descriptive data for the schools they inherit).

Table 4. Individual and Prior Workplace Characteristics and Student Achievement.

	Elementary math		Elementary reading		Middle math		Middle reading		High school	
Focal variable	1	2	3	4	5	6	7	8	9	10
Principal demographic traits										
Female principal	−0.006	0.013†	0.003	−0.005	−0.005	−0.004	0.005	−0.003	0.011	0.009
	(0.007)	(0.008)	(0.005)	(0.006)	(0.007)	(0.007)	(0.004)	(0.004)	(0.014)	(0.012)
Minority principal	−0.002	−0.019†	0.001	−0.006	−0.010	−0.003	−0.008†	−0.008†	−0.017	−0.043**
	(0.008)	(0.010)	(0.006)	(0.007)	(0.009)	(0.008)	(0.005)	(0.005)	(0.022)	(0.015)
Human capital indicators										
National Board Certificate	0.021†	0.009	0.013	0.008	−0.017	−0.005	−0.013	−0.011	0.029	0.017
	(0.013)	(0.012)	(0.010)	(0.010)	(0.017)	(0.015)	(0.010)	(0.011)	(0.035)	(0.026)
Top quintile exam score	0.005	0.011	0.001	0.007	0.030**	0.008	−0.002	0.002	−0.007	−0.026
	(0.008)	(0.009)	(0.006)	(0.006)	(0.010)	(0.007)	(0.006)	(0.005)	(0.022)	(0.016)
Principal preparation indicator										
North Carolina private masters	0.014	0.004	−0.011	0.003	−0.001	−0.020*	−0.001	−0.007	−0.030	−0.036*
	(0.012)	(0.013)	(0.007)	(0.009)	(0.012)	(0.010)	(0.007)	(0.007)	(0.019)	(0.014)
Out-of-state master's	−0.008	−0.004	0.004	−0.001	0.005	−0.012	0.011†	−0.005	−0.016	0.020
	(0.011)	(0.013)	(0.008)	(0.008)	(0.012)	(0.011)	(0.006)	(0.006)	(0.023)	(0.018)
North Carolina public doctorate	−0.000	0.001	−0.011	0.007	−0.001	−0.012	0.000	−0.008	−0.041†	0.001
	(0.011)	(0.010)	(0.008)	(0.009)	(0.011)	(0.011)	(0.008)	(0.009)	(0.022)	(0.016)
North Carolina private doctorate	−0.042	−0.053**	−0.071	−0.133*	−0.079**	−0.172**	−0.176**	−0.299**	0.023	0.023
	(0.074)	(0.020)	(0.051)	(0.051)	(0.015)	(0.012)	(0.008)	(0.009)	(0.056)	(0.072)
Out-of-state doctorate	−0.038*	−0.014	−0.008	−0.011	−0.033*	−0.036**	−0.003	−0.016	0.007	−0.042
	(0.015)	(0.021)	(0.011)	(0.014)	(0.014)	(0.013)	(0.008)	(0.011)	(0.035)	(0.030)

(continued)

Table 4. (continued)

	Elementary math		Elementary reading		Middle math		Middle reading		High school	
Focal variable	1	2	3	4	5	6	7	8	9	10
Job experience indicators										
Assistant principal experience	−0.005	−0.005	0.002	−0.002	0.000	−0.003	−0.001	−0.001	0.013†	−0.009*
	(0.003)	(0.004)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.007)	(0.004)
Assistant principal experience squared	0.000	0.000	−0.000	0.000	−0.000	0.000	−0.000	−0.000	−0.001	0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Principal experience	0.002	0.003†	0.002	0.002	0.004*	0.002	0.003**	0.003**	0.004	0.001
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)
Principal experience squared	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000	0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Previous work environment characteristics										
Teacher-school match	−0.033**	−0.026*	−0.004	−0.003	−0.017	−0.009	−0.003	−0.012	−0.024	−0.007
	(0.012)	(0.011)	(0.009)	(0.010)	(0.012)	(0.010)	(0.008)	(0.007)	(0.019)	(0.014)
Assistant principal-school match	0.011	0.005	0.007	0.005	−0.010	−0.002	0.001	0.006	−0.014	−0.015
	(0.008)	(0.009)	(0.006)	(0.007)	(0.010)	(0.008)	(0.005)	(0.006)	(0.016)	(0.011)
Assistant principal-school level match	−0.014†	0.001	−0.010	−0.000	0.013	−0.002	0.006	0.004	0.028	0.018
	(0.008)	(0.008)	(0.006)	(0.006)	(0.008)	(0.008)	(0.005)	(0.005)	(0.020)	(0.015)
Cases	1,061,588		1,467,263		943,243		1,015,205		977,194	

Note. Odd numbered columns display results from covariate adjustment (ordinary least squares) models. Even numbered columns display results from models with school fixed effects. All standard errors were clustered at the school level. Models include prior student test scores.
†$p < .10$. *$p < .05$. **$p < .01$.

effects models in even numbered columns—indicates that female principals are generally not associated with significantly larger adjusted-average achievement gains (positive and significant associations in elementary grades mathematics school fixed effects models only); results from our two-stage models (Table A.3) return positive and significant coefficients for female principals in elementary and middle grades reading. Minority principals are associated with significantly reduced adjusted-average achievement gains in school fixed effects models in elementary grades mathematics, middle grades reading, and high school. In two-stage approaches, there are negative associations between minority principals and principal effectiveness in elementary and middle grades reading.

Concerning human capital indicators, our preferred ordinary least squares and school fixed effects models return little evidence that those principals who once held National Board Certification as a teacher or score in the top quintile on their principal licensure exam are associated with significantly larger adjusted-average achievement gains. In models that exclude prior student test scores (Table A.1), however, top quintile scoring principals are associated with significantly larger adjusted-average achievement in elementary grades mathematics and reading.

For principal preparation, estimates in Table 4 show that principals holding a master's degree from an in-state public institution are associated with significantly larger adjusted-average achievement gains than in-state private master's degree holders in middle grades mathematics and high school (school fixed effects models) and those holding a doctorate from an in-state private (both reading and math for elementary and middle schools) or out-of-state university (middle school math). Finally, we tested two job experience measures—linear and squared terms for years of assistant principal and principal experience in NCPS. For high school principals, there is a positive association for the linear assistant principal experience term in the covariate adjustment model, indicating benefits to additional years of assistant principal experience. Comparing within schools, however, there is an indication of nonlinearity—a negative association for the linear experience term and a positive squared term, indicating negative, but marginally diminishing, returns to assistant principal experience. For principal experience, the covariate adjustment models indicate significant returns to experience in middle grades mathematics and reading; estimating within schools, there are significant experience returns in elementary grades mathematics and middle grades reading. Models that specify a full set of principal experience indicators (available on request) show few significant experience returns in the early-career period, with more robust experience estimates for mid- to late-career principals and principals in middle grades reading. These results differ from

those of Clark et al. (2009), who found significant early-career returns to experience for New York City principals and suggest only a modest relationship between principal experience and adjusted-average student achievement.

Prior Workplace Characteristics

The focal variables considered in this category examine whether a principal's familiarity with or exposure to (1) a specific school, (2) a specific school level, or (3) a high–value-added school is significantly associated with adjusted-average student achievement once principals assume leadership. Concerning familiarity with a specific school, the bottom panel of Table 4 shows that taking control of a school in which a principal once taught is negatively and significantly associated with adjusted-average student achievement in elementary grades mathematics. This result is robust to alternate specifications that exclude prior student controls (Table A.1) or use a two-stage estimation approach (Table A.3). Taking control of a school in which a principal once served as an assistant principal is not significantly associated with adjusted-average student achievement. This result differs from Clark et al. (2009) in New York City, who found positive and significant test score associations for principals assuming leadership at schools in which they had served as assistant principals. Familiarity with a specific school level is generally not associated with significant adjusted-average achievement gains. In our two-stage specifications, however, serving as an assistant principal in a high school is significantly associated with effectiveness for high school principals.

Finally, Table 5 indicates that the most consistent value-added result is the association between a measure of the quality of the apprenticeship learning environment and adjusted-average student achievement. In covariate adjustment models limited to our sample of first-time principals, estimates in the top panel of Table 5 return positive and significant associations in four out of five school-level/subject-area combinations with the continuous, standardized measure and three out of five models that contain an indicator for an assistant principalship in a top quintile value-added school. When we exclude student prior test scores, all the estimates in the top panel of Table A.2 are statistically significant. Using a differences-in-differences specification with school fixed effects, the focal interaction (bottom panel of Table 5) is positive and significant in middle grades mathematics and reading. The interaction coefficient is largest in high school (0.062 standard deviation units) but is imprecisely estimated and not statistically significant. Importantly, all these specifications exclude cases where the assistant principal transitioned to the

Table 5. The Apprenticeship Learning Environment.

Focal variable	Elementary math	Elementary reading	Middle math	Middle reading	High school
Standardized apprenticeship learning environment (no same school observations)	0.011*	0.005	0.013*	0.006†	0.018†
	(0.005)	(0.004)	(0.006)	(0.003)	(0.010)
Top quintile apprenticeship learning environment (no same school observations)	0.011	0.014	0.037**	0.020**	0.047†
	(0.012)	(0.009)	(0.013)	(0.007)	(0.027)
Cases	399,336	542,945	333,466	355,285	254,689
Differences-in-differences with a school fixed effect and no same school observations					
Post	0.012	−0.007	−0.012	−0.010	−0.033
	(0.020)	(0.015)	(0.016)	(0.011)	(0.027)
Treat * Post	−0.005	0.008	0.042**	0.026*	0.062
	(0.020)	(0.014)	(0.016)	(0.010)	(0.038)
Cases	493,443	683,011	552,263	602,381	408,603

Note. The top panel displays results from covariate adjustment models (ordinary least squares) limited to our sample of first-time principals. The bottom panel displays results from differences-in-differences models with school fixed effects. All models exclude first-time principals who assumed leadership at the same school in which they were last assistant principals. All standard errors were clustered at the school level. Models include all other individual and prior work environment variables. Models include prior student test scores.
†$p < .10$. *$p < .05$. **$p < .01$.

principalship at the same school, meaning we can be confident that the estimates are not due to assistant principals from high–value-added schools staying on as principals in the same school.

Discussion

Nascent empirical research using an education production function indicates that principal effectiveness significantly influences student achievement, teacher retention and development, and school working conditions (Boyd et al., 2011; Branch et al., 2012; Loeb et al., 2012). Principal quality represents an important policy lever with which to improve outcomes of interest, but in order to do so, researchers and policy makers need a better understanding of why some principals succeed and others do not. Given the prevalence

of inexperienced principals in the workforce, this study contributes to this developing body of research by (1) examining pathways to the principalship and (2) estimating the associations between individual principal characteristics and those of their prior work environments and adjusted-average student achievement gains.

Overall, we found that a large majority of first-time principals were "homegrown"—assuming school leadership in the same districts in which they once taught and/or served as an assistant principal. This finding corroborates and updates prior work by Brewer (1996), which indicated that districts in New York State promoted a majority of their assistant principals and principals from positions within the district. While this finding may be emphasized in this sample because of the configuration of North Carolina school districts—mostly large, countywide units—it appears that districts prefer to have familiarity with those elevated to principal positions and/or principal candidates prefer to work in districts with which they are familiar or in close proximity. In either case, this suggests that districts select principal candidates from a limited pool. Regarding preparation and training for the principalship, we found that, on average, 5.12 years pass between completing formal principal preparation and assuming school leadership; first-time principals spent 4.15 years, on average, as assistant principals in NCPS. Since so much time passes between the completion of formal preparation and assuming school leadership, these results highlight the potential importance of the assistant principalship to future principal performance. Finally, descriptive analyses indicated that first-time principals who have high licensure exam scores or apprenticed in a high–value-added school secured positions in schools with higher levels of academic performance, fewer high-poverty or minority students, and/or better credentialed teachers. Whether this pattern is the result of first-time principals with certain characteristics choosing positions in more attractive environments, the hiring practices of districts, or a combination of both is unknown. Regardless, this finding indicates that high-need schools lack access to better credentialed principals; as summarized in the next paragraphs, however, our analyses do not return strong relationships between principals' credentials and students' test score gains.

Concerning our value-added analyses, we found that several individual principal characteristics were significantly related to student performance. Minority principals were associated with significantly lower adjusted-average student achievement gains in multiple comparisons. This is noteworthy since, on average, minority first-time principals lead schools with many more minority, high-poverty, and low-performing students (see Table 3). Across school levels, principals prepared at the master's degree level

by in-state public institutions were associated with larger adjusted-average student achievement. Whether this result is related to selection into these preparation categories and/or the training provided within these categories is subject for more research. Finally, results indicate a modest and somewhat inconsistent relationship between principal experience and adjusted-average achievement gains. These results are not as robust as those in prior work—see Clark et al. (2009)—and should encourage examination of the underlying heterogeneity of these relationships.

Turning to our indicators of prior work environments, results in elementary grades mathematics show that taking control of a school in which a principal once taught is negatively associated with student achievement. This suggests that transitioning from a peer to a supervisory role may be a challenge that adversely affects principal performance in elementary schools (typically much smaller organizations than middle or high schools). We acknowledge, however, that despite the careful model design this result may also be due to selection—indicative of the types of principals or the types of schools in which principals are appointed from within. In our two-stage estimation approach, high school principals who had previously served as an assistant principal at the same school level were more effective. This suggests that (1) there may be unique aspects of high school environments learned through experience in a leadership position at that level; (2) high schools may offer assistant principals greater opportunities to experience mastery and vicarious experiences; and/or (3) high school assistant principals promoted into high school principalships have higher levels of cognitive ability and/or job-specific skills than the principals at other levels. We investigated this last possibility by examining the standardized principal exam scores of our first-time principal sample and found no significant difference in the scores of those who were assistant principals at the high school level. Finally, evidence indicates that secondary grades (especially middle grades) principals who previously worked as an assistant principal in a high–value-added school were associated with significantly larger adjusted-average achievement gains than their peers without this apprenticeship experience. Given our model specification (differences-in-differences with school fixed effects) and focus on principals that assume leadership at a different school, these estimates suggest that experiences as assistant principals benefit future principal performance.

From a research perspective, we acknowledge the methodological and conceptual challenges to estimating principal effectiveness (Grissom et al., 2014). Therefore, we use associational language when discussing our results and contend that our estimates provide empirical support for

hypothesis generation and continued research. Specifically, findings from this analysis suggest a need to better understand the characteristics of high-quality assistant principal experiences and whether such experiences significantly affect future principal performance. Toward this end, researchers should (1) examine the process by which individuals are assigned to assistant principal schools, (2) determine the tasks/responsibilities of assistant principals, (3) determine how often assistant principals have opportunities for meaningful vicarious—observing sitting principals model effective leadership practices—and mastery—directly engaging in school leadership practices—experiences, and (4) test additional indicators of high-quality learning environments on measures of early-career principal performance (Bandura, 1977; Hoy & Spero, 2005; Mulholland & Wallace, 2001).

From a policy perspective, we believe that conceptualizing the determinants of principal effectiveness in these two broad categories—individual characteristics and those of prior work environments—provides a clearer focus for policy action. If individual characteristics, such as human capital indicators (e.g., principal licensure exam scores) or preparation type, matter, this suggests policy levers targeted at recruiting and selecting individuals with those desired qualities. If previous work experiences matter, this indicates that effective school leadership may be learned through exposure and that districts' patterns of assigning assistant principals and principals to schools should be carefully considered. Through continued research, implications for policy should become clearer and facilitate action to improve early-career principal performance.

Appendix A

Estimating the Assistant Principal Learning Environment

For this analysis, we quantify an assistant principal's learning environment quality using a measure of school value-added. Due to censoring concerns—some individuals are assistant principals for longer periods than we can examine the value-added learning environment—and the hypothesis that the most recent assistant principal experiences exert the strongest effect on early-career principal effectiveness, we focus on the apprenticeship learning environment quality from the year immediately prior to entrance into the principalship. To estimate this value any specification needed to address the following two objectives: (1) it must measure school (not only principal) effectiveness, since we want to identify the overall learning environment an

assistant principal experienced, and (2) it must generate yearly school value-added estimates for each North Carolina public school from 2005-2006 through 2008-2009—the 4-year period in which our sample of first-time principals last worked as assistant principals.

To address the requirements above, we estimated the quality of the apprenticeship learning environment using a two-level random effects model with a rich set of student and school covariates. Here, we identified school-year value-added with the school-level random effect, which represents the unexplained variation in achievement between schools. This school year residual estimates the overall value-added effectiveness of the school—that produced by the principals, teachers, and other (uncontrolled for) school resources. Equations for the school year random effect and the full measurement model are as follows:

$$r_s = Y - \hat{Y}, \tag{1}$$

where r_s represents the school-year residual measuring school effectiveness, Y is the actual test score outcome for the school, and $\hat{Y}$ is the predicted test score outcome for the school, given the rich set of controls.

$$Y_{ist} = \beta_0 + \beta_1 Y_{it-n} + \gamma_x X_{ist} + \gamma_w W_{st} + \varepsilon_i + r_s, \tag{2}$$

where Y_{ist} is the test score for student i in school s at time t; Y_{it-n} represents the prior test score(s) for student i; X_{ist} and W_{st} represent the set of individual student and school covariates; γ_x and γ_w represent a vector of fixed, average effects for each student and school covariate; and ε_i and r_s are terms representing the unexplained variation at the student and school levels, respectively.

For these models, we ran separate analyses in elementary grades mathematics and reading, middle grades mathematics and reading, and a combined model for the five high school EOC exams required for graduation—algebra 1, English 1, biology, civics, and U.S. history. We included all NCPS in these specifications, rather than limit the data to the schools our sample of first-time principals apprenticed in, to take advantage of the full range of variability in the data and to create focal variables based on the full population of schools. Post estimation, we averaged the math and reading value-added random effects for elementary and middle grades to generate a single school year measure of the apprenticeship learning environment quality. Finally, with this measure of the apprenticeship learning environment quality, we created two focal variables for this analysis (1) a standardized, continuous measure of the school effectiveness and (2) a dichotomous indicator for being an assistant principal in a top quintile value-added school.

Table A.1. Individual and Prior Workplace Characteristics and Student Achievement.

	Elementary math		Elementary reading		Middle math		Middle reading		High school	
Focal variable	1	2	3	4	5	6	7	8	9	10
Principal demographic traits										
Female principal	−0.004	0.012	0.003	−0.006	−0.007	−0.005	0.003	−0.004	0.007	0.012
	(0.009)	(0.009)	(0.008)	(0.007	(0.009)	(0.007)	(0.006)	(0.005)	(0.014)	(0.012)
Minority principal	0.001	−0.014	0.004	−0.001	−0.018†	−0.005	−0.015*	−0.009	−0.013	−0.047**
	(0.011)	(0.013)	(0.009)	(0.009)	(0.010)	(0.009)	(0.007)	(0.006)	(0.022)	(0.015)
Human capital indicators										
National Board Certification	0.026	0.020	0.018	0.017	−0.024	−0.007	−0.019	−0.011	0.045	0.017
	(0.018)	(0.014)	(0.015)	(0.013)	(0.020)	(0.017)	(0.015)	(0.015)	(0.034)	(0.024)
Top quintile exam score	0.017	0.019†	0.012	0.016†	0.035**	0.011	0.003	0.003	−0.013	−0.021
	(0.011)	(0.011)	(0.009)	(0.009)	(0.011)	(0.008)	(0.008)	(0.006)	(0.021)	(0.015)
Principal preparation indicator										
North Carolina private masters	0.028†	0.009	0.002	0.008	0.002	−0.021†	0.006	−0.005	−0.038*	−0.033*
	(0.016)	(0.015)	(0.011)	(0.011)	(0.016)	(0.011)	(0.011)	(0.009)	(0.018)	(0.014)
Out-of-state master's	−0.012	−0.006	−0.001	−0.003	0.012	−0.010	0.019†	−0.004	−0.013	0.017
	(0.015)	(0.016)	(0.012)	(0.011)	(0.015)	(0.012)	(0.010)	(0.007)	(0.022)	(0.019)
North Carolina public doctorate	0.004	0.015	−0.006	0.021†	0.005	−0.013	0.011	−0.008	−0.044*	0.002
	(0.015)	(0.013)	(0.011)	(0.012)	(0.014)	(0.012)	(0.011)	(0.012)	(0.020)	(0.016)
North Carolina private doctorate	−0.066	−0.039†	−0.097**	−0.120	−0.061**	−0.155**	−0.148**	−0.281**	0.042	0.050
	(0.139)	(0.022)	(0.018)	(0.080)	(0.017)	(0.012)	(0.012)	(0.010)	(0.056)	(0.074)
Out-of-state doctorate	−0.050†	−0.013	−0.019	−0.009	−0.043**	−0.038**	−0.012	−0.015	−0.010	−0.040
	(0.026)	(0.022)	(0.019)	(0.016)	(0.016)	(0.015)	(0.010)	(0.012)	(0.034)	(0.028)

(continued)

Table A.1. (continued)

	Elementary math		Elementary reading		Middle math		Middle reading		High school	
Focal variable	1	2	3	4	5	6	7	8	9	10
Job experience indicators										
Assistant principal experience	−0.008*	−0.004	−0.001	−0.001	−0.002	−0.004	−0.005	−0.003	0.016*	−0.010*
	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)	(0.007)	(0.004)
Assistant principal experience squared	0.001*	0.000	0.000	0.000	−0.000	0.000	0.000	0.000	−0.001	0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Principal experience	0.002	0.003	0.002	0.001	0.004†	0.001	0.003†	0.001	0.005	0.001
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.003)	(0.002)
Principal experience squared	0.000	−0.000	−0.000	−0.000	−0.000	0.000	−0.000	−0.000	0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Previous work environment characteristics										
Teacher–school match	−0.043**	−0.029*	−0.014	−0.005	−0.018	−0.003	−0.004	−0.006	−0.025	−0.016
	(0.016)	(0.013)	(0.013)	(0.012)	(0.015)	(0.011)	(0.012)	(0.009)	(0.016)	(0.014)
Assistant principal–school match	0.017	0.005	0.013	0.006	−0.011	−0.002	−0.002	0.005	−0.012	−0.013
	(0.011)	(0.011)	(0.010)	(0.009)	(0.012)	(0.009)	(0.008)	(0.007)	(0.013)	(0.011)
Assistant principal–school level match	−0.023*	0.006	−0.017*	0.004	0.015	0.001	0.011	0.009	0.027	0.016
	(0.011)	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.007)	(0.006)	(0.019)	(0.015)
Cases	1,061,588		1,467,263		943,243		1,015,205		977,194	

Note. Odd numbered columns display results from covariate adjustment (ordinary least squares) models. Even numbered columns display results from models with school fixed effects. All standard errors were clustered at the school level. Models do NOT include prior student test scores.
†$p < .10$. *$p < .05$. **$p < .01$.

Table A.2. The Apprenticeship Learning Environment.

Focal variable	Elementary math	Elementary reading	Middle math	Middle reading	High school
Standardized apprenticeship learning environment (no same school observations)	0.017* (0.007)	0.011† (0.006)	0.018* (0.007)	0.012† (0.005)	0.025* (0.010)
Top quintile apprenticeship learning environment (no same school observations)	0.031† (0.017)	0.032* (0.013)	0.044** (0.016)	0.028** (0.010)	0.054† (0.028)
Cases	399,336	542,945	333,466	355,285	254,689
Differences-in-differences with a school fixed effect and no same school observations					
Post	0.001 (0.023)	−0.017 (0.019)	−0.017 (0.016)	−0.018 (0.012)	−0.017 (0.026)
Treat * Post	0.019 (0.023)	0.030† (0.017)	0.051** (0.017)	0.035** (0.013)	0.054 (0.035)
Cases	493,443	683,011	552,263	602,381	408,603

Note. The top panel displays results from covariate adjustment models (ordinary least squares) limited to our sample of first-time principals. The bottom panel displays results from differences-in-differences models with school fixed effects. All models exclude first-time principals who assumed leadership at the same school in which they were last assistant principals. All standard errors were clustered at the school level. Models include all other individual and prior work environment variables. Models do NOT include prior student test scores.
†$p < .10$. *$p < .05$. **$p < .01$.

Table A.3. Individual and Prior Workplace Characteristics and Student Achievement.

Focal variable	Elementary math	Elementary reading	Middle math	Middle reading	High school
Principal demographic traits					
Female principal	0.007 (0.008)	0.011† (0.007)	−0.000 (0.011)	0.014† (0.007)	0.000 (0.019)
Minority principal	−0.013 (0.009)	−0.023** (0.007)	−0.007 (0.012)	−0.020* (0.008)	−0.007 (0.021)
Human capital indicators					
National Board Certification	0.007 (0.015)	0.002 (0.012)	0.021 (0.025)	−0.017 (0.017)	−0.040 (0.043)
Top quintile exam score	0.010 (0.011)	−0.001 (0.009)	0.019 (0.016)	0.007 (0.011)	−0.026 (0.027)
Principal preparation indicator					
North Carolina private masters	0.032* (0.014)	−0.004 (0.011)	−0.035* (0.018)	−0.025* (0.012)	−0.025 (0.029)

(continued)

Table A.3. (continued)

Focal variable	Elementary math	Elementary reading	Middle math	Middle reading	High school
Out-of-state master's	−0.002 (0.014)	0.008 (0.011)	0.004 (0.018)	0.013 (0.012)	0.007 (0.028)
North Carolina public doctorate	−0.008 (0.014)	−0.015 (0.011)	−0.045* (0.019)	−0.002 (0.013)	−0.035 (0.028)
North Carolina private doctorate	−0.027 (0.097)	−0.042 (0.077)	−0.060 (0.148)	−0.199* (0.097)	0.061 (0.140)
Out-of-state doctorate	−0.024 (0.021)	−0.026 (0.017)	−0.004 (0.026)	0.005 (0.017)	−0.041 (0.040)
Assistant principal experience					
Assistant principal experience	0.000 (0.004)	0.003 (0.003)	0.005 (0.005)	0.002 (0.003)	0.001 (0.009)
Assistant principal experience squared	−0.000 (0.000)	−0.000 (0.000)	−0.000 (0.000)	−0.000 (0.000)	−0.000 (0.000)
Previous work environment characteristics					
Teacher–school match	−0.031* (0.015)	−0.006 (0.012)	−0.027 (0.018)	0.006 (0.012)	−0.033 (0.030)
Assistant principal–school match	0.003 (0.011)	−0.002 (0.009)	0.005 (0.016)	0.005 (0.010)	0.033 (0.026)
Assistant principal–school level match	0.008 (0.009)	0.006 (0.007)	0.001 (0.012)	0.005 (0.008)	0.064** (0.023)
Cases	1240	1240	771	771	502

Note. Columns display results from a second-stage model regressing a principal fixed effect on the focal covariates. All Stage 1 models include prior student test scores and cluster standard errors at the school level.
†$p < .10$. *$p < .05$. **$p < .01$.

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Notes

1. The concept of efficacy is particularly relevant since research over the past two decades has found that teacher self-efficacy and the collective efficacy of schools is significantly associated with student achievement (Goddard, Hoy, & Woolfolk Hoy, 2000).
2. Estimates from models that control for a set of indicator variables for principal experience—2nd year, 3rd year, 4th year, 5th year, 6-10 years, 11-15 years, 16-20 years, and >20 years (in reference to 1st-year principals)—are available on request.
3. For example, recent work by Li (2012) shows that more effective school principals in North Carolina respond to the No Child Left Behind Act accountability threats by moving to schools less likely to face No Child Left Behind Act sanctions.
4. To explore this concern we perform sensitivity tests (see Tables A.1 and A.2) that exclude prior student test scores from our value-added models.
5. We do not use school fixed effects in models limited to our first-time principal sample because the coefficients would be poorly identified—there are very few schools in which a departing first-time principal is replaced by another first-time principal.
6. In Stage 1, we control for the same set of student and school covariates as in Equations 1 and 2 and use the Stata *felsdvregdm* procedure to estimate a principal fixed effect for all principals in NCPS during our study period (Mihaly, McCaffrey, Lockwood, & Sass, 2010). We limit the Stage 2 models to our analysis sample of principals for whom we have the focal principal characteristics. Because our outcome in these Stage 2 models is time invariant (principal fixed effect), we do not control for principal experience in our Stage 2 models.
7. In these ordinary least squares and school fixed effects models, we continue to control for student and school covariates and all the focal individual and prior workplace principal characteristics.
8. Because principals can influence many of the characteristics presented in Tables 2 and 3 (e.g., percentage of adequate yearly progress goals met or teacher retention rates), we display school characteristics from the year prior to a principal from our sample assuming leadership.

References

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*, 191-215.

Bartholomew, S., Melendez-Delaney, G., Orta, A., & White, S. (2005). Untapped resources: Assistant principals as instructional leaders. *Principal Leadership*, *5*(9), 22-26.

Beteille, T., Kalogrides, D., & Loeb, S. (2012). Stepping stones: Principal career paths and school outcomes. *Social Science Research*, *41*, 904-919.

Boyd, D., Grossman, P., Ing, M., Lankford, H., Loeb, S., & Wyckoff, J. (2011). The influence of school administrators on teacher retention decisions. *American Educational Research Journal*, *48*, 303-333.

Branch, G., Hanushek, E., & Rivkin, S. (2012, February). *Estimating the effect of leaders on public sector productivity: The case of school principals* (NBER Working Paper No. 17803). Cambridge, MA: National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w17803.pdf

Brewer, D. (1993). Principals and student outcomes: Evidence from U.S. high schools. *Economics of Education Review*, *12*, 281-292.

Brewer, D. (1996). Career paths and quit decisions: Evidence from teaching. *Journal of Labor Economics*, *14*, 313-339.

Burkhauser, S., Gates, S., Hamilton, L., & Ikemoto, G. (2012). *First-year principals in urban school districts: How actions and working conditions relate to outcomes*. Santa Monica, CA: RAND Education.

Calabrese, R. L., & Tucker-Ladd, P. R. (1991). The principal and assistant principal: A mentoring relationship. *NASSP Bulletin*, *75*(533), 67-74.

Chiang, H., Lipscomb, S., & Gill, B. (2012). Is school value-added indicative of principal quality. *Mathematica Policy Research*. Retrieved from http://mathematica-mpr.com/publications/pdfs/education/value-added_principal_quality.pdf

Clark, D., Martorell, P., & Rockoff, J. (2009, December). *School principals and school performance* (Calder Institute Working Paper No. 38). Washington, DC: CALDER, The Urban Institute. Retrieved from https://www0.gsb.columbia.edu/cfusion/faculty/jrockoff/cmr_principals_calder_WP38.pdf

Clotfelter, C., Ladd, H., & Vigdor, J. (2010). Teacher credentials and student achievement in high school: A cross-subject analysis with student fixed effects. *Journal of Human Resources*, *45*, 655-681.

Coelli, M., & Green, D. (2012). Leadership effects: School principals and student outcomes. *Economics of Education Review*, *31*(1), 92-109.

Corcoran, S., Schwartz, A. E., & Weinstein, M. (2012). Training your own: The impact of New York City's aspiring principals program on student achievement. *Educational Evaluation and Policy Analysis*, *34*, 232-253.

Dhuey, E., & Smith, J. (2010). *How important are principals in the production of school achievement?* Retrieved from http://www.aefpweb.org/sites/default/files/webform/dhuey_smith_princ_nov22.pdf

Dhuey, E., & Smith, J. (2013). *How school principals influence student learning*. Retrieved from http://www4.ncsu.edu/~rghammon/workshop/S13_Dhuey.pdf

Eberts, R., & Stone, J. (1988). Student achievement in public schools: Do principals make a difference? *Economics of Education Review*, *7*, 291-299.

Goddard, R. D., Hoy, W. K., & Woolfolk Hoy, A. (2000). Collective teacher efficacy: Its meaning, measure and effect on student achievement. *American Education Research Journal*, *37*, 479-507.

Goldhaber, D. (2007). Everyone's doing it, but what does teacher testing tell us about teacher effectiveness? *Journal of Human Resources*, *47*, 765-794.

Goldhaber, D., & Anthony, E. (2007). Can teacher quality be effectively assessed? National Board Certification as a signal of effective teaching. *Review of Economics and Statistics*, *89*, 134-150.

Grissom, J., & Loeb, S. (2011). Triangulating principal effectiveness: How perspectives of parents, teachers, and assistant principals identify the central importance of managerial skills. *American Educational Research Journal*, *48*, 1091-1123.

Grissom, J., Kalogrides, D., & Loeb, S. (2014). Using student test scores to measure principal performance. *Educational Evaluation and Policy Analysis*. Advance online publication.

Grissom, J., Loeb, S., & Master, B. (2013). *Effective instructional time use for school leaders: Longitudinal evidence from observations of principals*. Retrieved from http://cepa.stanford.edu/sites/default/files/effective%20instructional%20time%20use.pdf

Handa, S., Thompson, C. L., Marcus, J. V., & Smith, A. A. (2010). *The effects of UNC Master of School Administration programs on NC public schools, 2004-2008*. Chapel Hill, NC: Institute for Public Policy. Retrieved from http://publicpolicy.unc.edu/research/publications-presentations-and-reports

Horng, E., Klasik, D., & Loeb, S. (2010). Principal's time use and school effectiveness. *American Journal of Education*, *116*, 491-523.

Hoy, A. W., & Spero, R. B. (2005). Changes in teacher efficacy during the early years of teaching: A comparison of four measures. *Teaching and Teacher Education*, *21*, 343-356.

Johnson-Taylor, C., & Martin, M. (2007). Next in line: Preparing assistant principals for the principalship. *Principal Leadership*, *7*(8), 22-25.

Kaplan, L. S., & Owings, W. A. (1999). Assistant principals: The case for shared instructional leadership. *NASSP Bulletin*, *83*(610), 80-94.

Koru, J. M. (1993). The assistant principal: Crisis manager, custodian, or visionary? *NASSP Bulletin*, *77*(556), 67-71.

Ladd, H. (2011). Teachers' perceptions of their working conditions: How predictive of planned and actual teacher movement? *Educational Evaluation and Policy Analysis*, *33*, 235-261.

Li, D. (2012). *School accountability and principal mobility: How No Child Left Behind affects the allocation of school leaders*. Retrieved from http://econ-www.mit.edu/files/5437

Loeb, S., Kalogrides, D., & Beteille, T. (2012). Effective schools: Teacher hiring, assignment, development, and retention. *Education Finance and Policy*, *7*, 269-304.

Loeb, S., Kalogrides, D., & Horng, E. L. (2010). Principal preferences and the uneven distribution of principals across schools. *Educational Evaluation and Policy Analysis*, *32*, 205-229.

Matthews, J., & Crow, G. (2003). *Being and becoming a principal: Role conception for contemporary principals and assistant principals*. Needham, MA: Longman.

Mihaly, K., McCaffrey, D., Lockwood, J. R., & Sass, T. (2010). Centering and reference groups for estimates of fixed effects: Modifications to felsdvreg. *Stata Journal*, *10*(1), 82-103.

Miller, A. (2013). Principal turnover and student achievement. *Economics of Education Review*, *36*, 60-72.

Mulholland, J., & Wallace, J. (2001). Teacher induction and elementary science teaching: Enhancing self-efficacy. *Teaching and Teacher Education*, *17*, 243-261.

Portin, B., Schneider, P., DeArmond, M., & Gundlach, L. (2003). *Making sense of leading schools: A study of school principalship*. Seattle, WA: Center on Reinventing Public Education. Retrieved from http://www.crpe.org/pubs/MakingSense_PortinWeb.pdf

Robinson, V., Lloyd, C., & Rowe, K. (2008). The impact of leadership on student outcomes: An analysis of the differential effects of leadership types. *Educational Administration Quarterly*, *44*, 635-674.

Ronfeldt, M. (2012). Where should student teachers learn to teach? Effects of field placement school characteristics on teacher retention and effectiveness. *Educational Evaluation and Policy Analysis*, *34*, 3-26.

Schweig, J. (2013). Cross-level measurement invariance in school and classroom environment surveys: Implications for policy and practice. *Educational Evaluation and Policy Analysis*. Advance online publication. doi:10.3102/0162373713509880

Vanderhaar, J., Munoz, M., & Rodosky, R. (2006). Leadership as accountability for learning: The effects of school poverty, teacher experience, previous achievement, and principal preparation programs on student achievement. *Journal of Personnel Evaluation in Education*, *19*(1-2), 17-33.

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