Essays on Human Capital in Turnaround Schools

By

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INTRODUCTION

In this dissertation, I examine three different perspectives on the recruitment, development, and retention of teachers in turnaround schools. The first chapter responds to mixed evidence from evaluations of school turnaround suggesting a need for research to help explain why some reform models succeed while others fail. Responding to that need, the first chapter estimates difference-in-differences models within a structural equation modeling framework to examine mediating mechanisms for the positive effects of the Innovation Zones (iZones) turnaround model, implemented in Shelby County School District in Memphis, Tennessee. I find that iZone schools successfully increased peer collaboration between teachers, which was associated with improved student achievement. Also, iZone schools focused on recruiting effective teachers, which was positively related to an improved learning environment and ultimately with student achievement. Finally, iZone reforms increased opportunities for professional development, but professional development was not associated with gains in student test scores. These results highlight peer collaboration, an improved learning environment, and the retention of effective educators as important practices that will likely facilitate improved school performance under ESSA reform plans.

The second chapter stems from how turnaround interventions often require or encourage low-performing schools to replace teachers, assuming that the school can hire high-performing teachers who will remain effective after they transfer. However, teacher effectiveness may change after transferring into a turnaround environment, which could help explain why some staff replacement efforts do not improve student achievement. The second chapter contributes new information on the stability of teacher effectiveness by examining teachers who transfer into turnaround schools relative to teachers who transfer into low-performing but non-turnaround

schools. Using difference-in-differences models with teacher and school fixed effects to examine Tennessee's turnaround schools, I find that teacher effectiveness can change after transferring into a turnaround school, suggesting that school reform efforts should consider ways to not only recruit effective teachers but also create an environment where they can succeed once they arrive. Overall, this study helps to reconcile mixed effects from previous studies of school turnaround and indicates that differences in the effect of reforms may be partly explained by changes in teacher effectiveness after they transfer into the turnaround school.

The third chapter responds to how the conversation around turnaround has focused primarily on effects in the turnaround school. However, reforms can have unintended spillover effects when they encourage teachers to transfer from the turnaround school into non-turnaround receiving schools. Using turnaround schools in Tennessee, the third chapter expands the literature on school reform by examining the characteristics of teachers who transfer when their schools begin turnaround, describing characteristics of receiving schools, and estimating the extent to which turnaround reforms affect how transferring teachers impact student achievement in receiving schools. I find that less-effective teachers are more likely to transfer away from turnaround schools and are likely transferring into nearby schools that are themselves low-performing. In receiving schools, teachers who transfer from turnaround schools after reforms are put into place fare better than teachers who transferred from these same schools pre-reforms, suggesting that reforms are not negatively affecting student achievement in receiving schools.

CHAPTER 1

WHY DO WE FIND THESE EFFECTS? AN EXAMINATION OF MEDIATING PATHWAYS EXPLAINING THE EFFECTS OF SCHOOL TURNAROUND

Introduction

Reform initiatives to turn around low-performing schools share an ambitious goal of dramatic improvement in a short amount of time, but there is no similar consensus on how to turn schools around. Federal investments in school turnaround, including over US$7 billion in School Improvement Grant (SIG) funding (Carlson & Lavertu, 2018), have grown in response to an unprecedented amount of policy attention to chronically low-performing schools under No Child Left Behind (NCLB) and now the Every Student Succeeds Act (ESSA). Armed with increased support and attention, turnaround efforts over the past two decades have promised dramatic improvements in two to three years of reform (Herman et al., 2008), but empirical evaluations of these turnaround initiatives report mixed effects (e.g., Dragoset et al., 2017; Henry & Harbatkin, 2018; Papay & Hannon, 2018; Strunk, Marsh, Hashim, Bush-Mecenas, et al., 2016; Zimmer et al., 2017).

Conflicting evidence suggests that turnaround can be effective, but there is a dearth of research examining *why* some models are successful while others fall short (Henry et al., 2020). One logical starting point for answering these questions is to examine what turnaround interventions do to alter the way low-performing schools operate. However, the extant literature comprises mainly quantitative impact evaluations estimating overall effects on student outcomes (Dee, 2012; Dougherty & Weiner, 2017; Sun, Penner, & Loeb, 2017; Zimmer et al., 2017); qualitative and mixed methods studies detailing how a specific intervention was implemented (Lachlan-Haché et al., 2012; Leithwood & Strauss, 2008; Strunk, Marsh, Hashim, & Bush-

Mecenas, 2016); and theoretical or review pieces that make recommendations for best practices (Anrig, 2015; Herman et al., 2008), but current research lacks sufficient quantitative evidence to link schoolwide, organizational changes with student outcomes in turnaround schools.

This paper contributes new evidence illuminating factors that mediate the effects of school turnaround using a focal theoretical framework called the resource-based view or RBV (Barney, 1991; Zollo & Winter, 2002). RBV aligns with previous research on school turnaround because it predicts that successful reforms require schools to first recruit effective teachers as human resources (Henry et al., 2020) then leverage them to build and maintain productive school practices and routines (Johnson et al., 2012). Within RBV, organizational routines leveraging resources to improve performance are called *dynamic capabilities* (Eisenhardt & Martin, 2000; Peurach et al., 2016; Teece et al., 1997; Zollo & Winter, 2002). Although the term dynamic capabilities is not often used in the school reform literature (Peurach et al., 2016), the concept of collective routines aimed at improving school performance is commonly examined as working conditions or professional environment (Kraft & Papay, 2014; Ladd, 2011). As predicted by RBV, rigorous qualitative work supports both effective teachers (human resources) and schoolwide routines (dynamic capabilities) as important factors in the reform process (Le Floch et al., 2016), but no study has used quantitative methods to empirically test dynamic capabilities as mediators of turnaround. I fill this gap in the literature by testing three dynamic capabilities as potential mediators: peer collaboration between teachers, an orderly learning environment, and opportunities for professional development. Specifically, I answer two questions:

1) What is the effect of turnaround reforms on teacher collaboration, orderly learning environment, and professional development in turnaround schools?

2) To what extent are the effects of turnaround reforms mediated by teacher collaboration, learning environment, and professional development?

To test these mediating factors, I examine school turnaround in Shelby County Schools (SCS) District located in Memphis, Tennessee. SCS is a useful context for examining turnaround because the district primarily serves low-income students and students of color, making the SCS experience generalizable to many similar contexts where turnaround efforts are most active. Additionally, SCS implemented a turnaround model called Innovation Zones (iZones) which manages low-performing schools in an intradistrict cluster with specialized support and increased autonomy to focus on improvement. The iZone model is widely popular in districts across the country (Iyengar et al., 2017), and evidence from the SCS iZone will help inform similar efforts nationwide. Additionally, previous research found that SCS iZone schools produced positive improvements to student achievement (Pham et al., 2020; Zimmer et al., 2017), motivating an examination of mechanisms to explain the positive results.

To answer the research questions, I use administrative data provided by the Tennessee Department of Education (TDOE), along with survey data from SCS. With the survey data, I use factor analysis to derive measures of three dynamic capabilities (peer collaboration, orderly learning environment, and professional development). Then, I examine the mediating influence of effective teacher recruitment and the three dynamic capabilities using difference-in-differences (DID) models within a structural equation modeling (SEM) framework. I find that the level of teacher collaborations increased in iZone schools, which was positively associated with student achievement. Second, positive iZone effects were sequentially mediated by the recruitment of effective teachers who then supported a more orderly learning environment that ultimately led to improved student test scores. Finally, iZone schools increased professional

development opportunities for teachers, but the additional professional development did not improve student achievement.

This paper contributes to both the policy and research literature on school reform. As states and districts implement new school reforms under ESSA, findings from this paper will inform ESSA reform plans by illuminating dynamic capabilities that will likely improve student achievement. Contributing to the research literature, this paper is the first to empirically test predictions of the RBV framework in turnaround schools, and using RBV as a focal lens to better understand the school turnaround process will contribute important theoretical insights to future developments in school reform.

Review of the School Reform and Turnaround Literature

Desimone (2002) classifies the long history of school reform in the U.S. as occurring in multiple waves. The first was a response to *A Nation at Risk*, where educational leaders enacted systemic changes centered on increasing standards and regulations. Then, responding to the criticism that first wave reforms were top-down directives paying too little attention to capacity-building, second wave reforms involved recruiting and retaining effective staff, addressing the needs of special groups of students, and improving relationships between schools and the communities they serve (Desimone, 2002). These second wave reforms, however, were also criticized for doing too little to change how schools operate and for not supporting improvements in instructional practice. These criticisms sparked a renewed focus on interventions that support schools in creating a professional environment that is conducive to teaching and learning. This third wave was also characterized by increasing attention to schools as complex organizations with multiple interacting characteristics that work together to improve student learning (Purkey

& Smith, 1983). Also, the third wave reforms sparked an era of whole-school interventions that include major initiatives such as New American Schools (Berends et al., 2002) and Comprehensive School Reform (Aladjem et al., 2006; Gross et al., 2009).

Following in the footsteps of these whole-school reform models, urgency around improving the nation's lowest-performing schools coalesced around an approach characterized by swift and dramatic interventions designed to turn around low-performing schools within two (Mass Insight, 2010; Yatsko et al., 2012) or three years (Herman et al., 2008). Under the collective moniker of "school turnaround," these reform initiatives have received unparalleled federal support through multibillion dollar funding initiatives including Race to the Top, SIGs, and the Investing in Innovation Fund (Kutash et al., 2010). With these substantial investments, the federal government placed itself in a strong position to guide how states and local educational agencies (LEAs) approach school turnaround, which it used to promote the four turnaround models prescribed by SIGs: (1) transformation, which required schools to replace the principal, make student achievement a component of teacher evaluations, and use teacher evaluation scores in personnel decision-making; (2) turnaround, which required all components of the transformation model in addition to replacing at least 50 percent of teachers; (3) restart, which required schools to close and reopen under either charter or other private management; and (4) closure.

These four federal turnaround models have been widely adopted as the dominant approach to whole-school reform in the U.S. in recent years; however, billions of dollars and over a decade of investment in these turnaround models have not produced the desired improvements to the nation's lowest-performing schools. Large-scale quantitative evaluations of these turnaround efforts have found mixed results on student achievement. In addition to

evaluations in Tennessee (Pham et al., 2020; Zimmer et al., 2017), rigorous evaluations of school turnaround have provided evidence of positive effects on student test scores in California (Dee, 2012; Sun et al., 2017), Ohio (Carlson & Lavertu, 2018), and Kentucky (Bonilla & Dee, 2017) but other studies report null (Dragoset et al., 2017) or even negative effects (Dougherty & Weiner, 2017; Heissel & Ladd, 2017; Henry & Harbatkin, 2018). Discrepancies across these evaluations support the need for research that asks what mediating mechanisms lead to success in some models and not others.

The federal approach to school turnaround is based on a theory of action that hinges on bringing effective principals and teachers into persistently low-performing schools and then using the newly recruited staff to build schoolwide practices that focus on improved teaching and learning. This theory of action suggests that the success of school turnaround depends on both the educators working in these schools and how these educators build productive schoolwide routines (e.g., a consistent approach to discipline). This theory of action suggests a two-step, sequential pathway linking school turnaround with improved student achievement. First, hire effective educators and keep them. Then, use their expertise to create a schoolwide culture that protects, encourages, and supports effective teaching and learning. Although the growing number of quantitative impact evaluations of school turnaround have provided descriptive information to support this two-step sequential pathway, there is very little research using quantitative methods to test how this two-step process mediates the effects from turnaround.

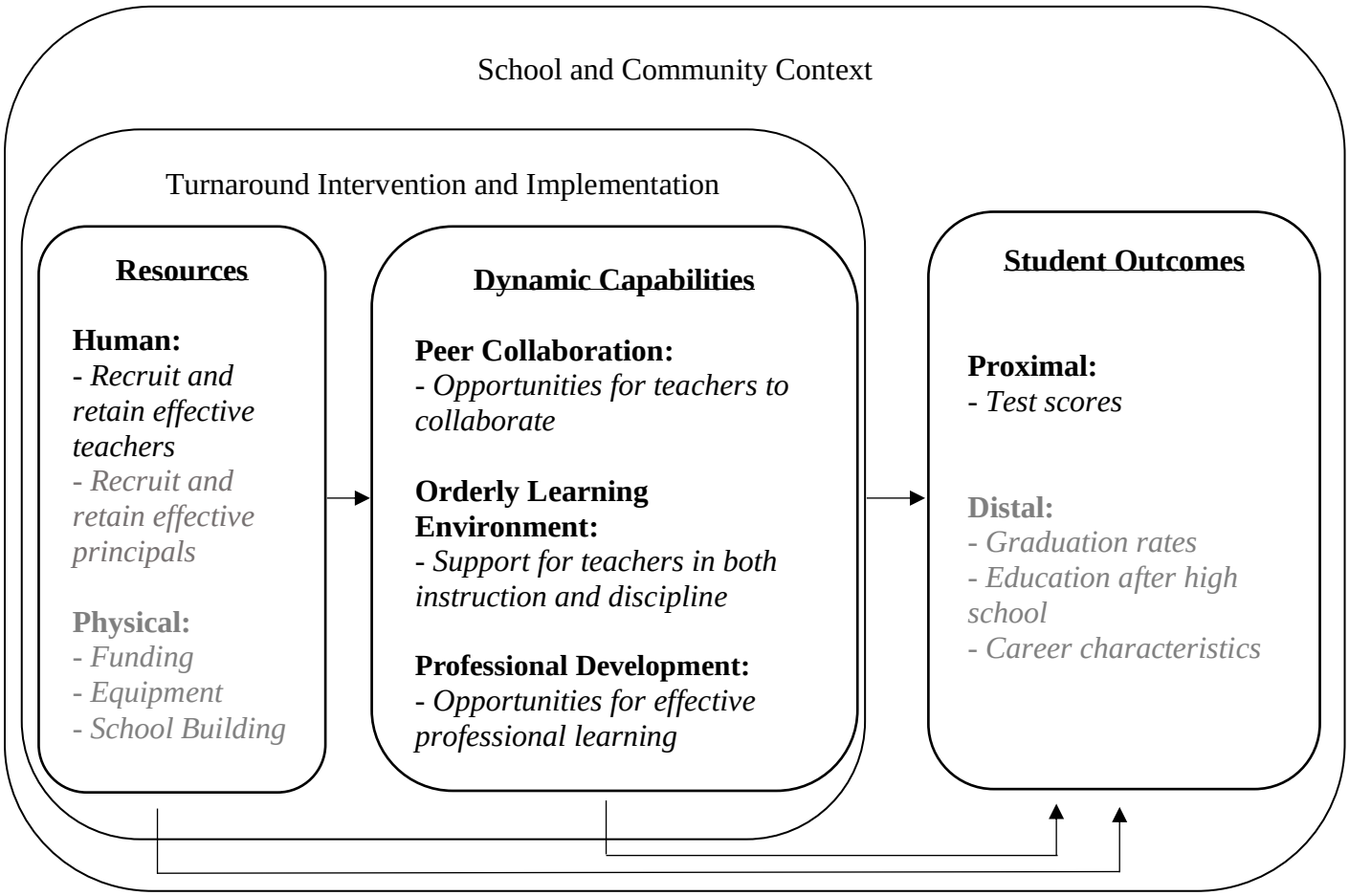
In one exception, Henry and colleagues (2020) examined mediators related to the mobility and effectiveness of principals and teachers in all of Tennessee's turnaround schools. They find that attracting effective teachers and principals explains some positive effects of iZone reforms, supporting step one in the federal theory of action for school turnaround. However,

Henry and colleagues (2020) also find that attracting more effective educators does not fully explain the positive iZone effects, suggesting that there are other important factors in the pathway linking turnaround reforms with improved student achievement.

Theoretical Framework

In this paper, I extend the quantitative research literature on school turnaround (Henry et al., 2020) by examining a sequential mediation model that encompasses both components of the federal theory of action guiding school turnaround: (1) recruiting effective educators and (2) building and maintaining productive operating routines. To do so, I apply a theoretical framework from the strategic management literature: RBV. Although the RBV framework is underutilized in education (Peurach et al., 2016), it is closely aligned with the existing theory of action for turnaround as presented in Figure 1 below.

Figure 1. Resource Based View of School Turnaround Integrating Human Resources with Dynamic Capabilities



Notes. Concepts in lighter gray are not the focus of this analysis.

RBV hypothesizes that organizations (i.e., schools) sustain desirable outcomes when they obtain valuable resources (Barney, 1991); therefore, RBV aligns with the existing turnaround literature by designating effective teachers as human resources that need to be recruited (Henry et al., 2020). However, simply obtaining resources is insufficient. More recently, RBV has been extended with the concept of *dynamic capabilities*, defined as "a learned and stable pattern of collective activity through which the organization systematically generates and modifies its

operating routines in pursuit of improved effectiveness" (Zollo & Winter, 2002, p. 340). Thus, RBV predicts that successful turnaround models need to leverage effective teachers to develop these dynamic capabilities in order to sustain improvements.

Although the term dynamic capabilities is not often used in school reform, these schoolwide practices are components of what scholars have termed "organizational context" (Kraft & Papay, 2014), "working conditions" (Ladd, 2011; Loeb et al., 2005), or "school culture" (Johnson et al., 2012; Kraft et al., 2015). Because dynamic capabilities are strategies that organizations use to optimally leverage their resources (Eisenhardt & Martin, 2000), school routines and practices are dynamic capabilities if they leverage leadership capacity and collective teacher effort (a valuable resource) to either build or sustain improved school performance.

Researchers have identified multiple school practices that can potentially serve as mediating dynamic capabilities (see for example Bryk et al., 2010), but examining all potential dynamic capabilities is beyond what I can accomplish here, so I choose dynamic capabilities that have been supported in the school reform and strategic management literature, can be reasonably measured in my data, and align with the iZone model of reform in SCS (described below). More specifically, I examine three dynamic capabilities: levels of peer collaboration between teachers, efforts to maintain an orderly learning environment despite turbulent conditions, and regular opportunities for professional development.

First, facilitating opportunities for regular teacher collaboration is a dynamic capability that has been shown to improve student achievement, staff satisfaction, and teacher retention (Johnson et al., 2012; Kraft et al., 2016). Researchers have also shown that moving to schools with more effective peers can be helpful to teachers' instructional performance (Jackson & Bruegmann, 2009). Outside of education, peer collaboration is a dynamic capability often called

coevolving, a process that allows for connections between different parts of the organization to stimulate innovative new practices (Eisenhardt & Galunic, 2000; Jarzabkowski et al., 2018).

Second, efforts to maintain an orderly learning environment despite internal and external change is a dynamic capability that is strongly linked to teacher satisfaction and student achievement (Horng, 2010; Ladd, 2011; Viano et al., 2018). Distinct from the general professional environment of a school, an orderly learning environment with a consistent approach to discipline allows teachers and students to concentrate on teaching and learning (Steinberg et al., 2011), and the importance of an orderly learning environment is supported by research which finds that disruptive students have a negative effect on the performance of their peers (Carrell et al., 2018). In the strategic management literature, maintaining an orderly environment is an integrative capability that allows organizations to embed new information into current operating routines (Pavlou & El Sawy, 2011).

Third, case studies of turnaround schools point to job-embedded professional development as a dynamic capability that allows schools to introduce new instructional practices while developing teacher capacity (Calkins et al., 2007; Herman et al., 2008; Portin et al., 2009). Providing teachers with effective professional development opportunities is a dynamic capability that has been shown to correlate positively with teacher retention and instructional performance (Kraft & Papay, 2014; Loeb et al., 2005), and prior evidence also suggests that providing teachers with high quality coaching helps improve student achievement in low-performing schools (Thompson et al., 2011). In the strategic management literature, professional development opportunities are a dynamic capability known as knowledge creation routines that allow organizations to bring in new knowledge and resources from outside of the organization (Nieves & Haller, 2014). Together, peer collaboration, orderly learning environment, and

professional development are likely mediators of the effects of school turnaround because previous research has shown them to be positively associated with teacher effectiveness and school performance.

School Turnaround in Shelby County Schools

In 2010, Tennessee was awarded over $500 million in Race to the Top funding to implement its First to the Top legislation, which outlined the state's ongoing approach to turning around low-performing schools (TDOE, 2010; USDOE, 2010). Tennessee's plan required the state to identify its lowest performing five percent of schools, called priority schools, and when the state released its list of priority schools in 2012, more than 80 percent were located in Memphis. The large number of priority schools in Memphis meant that most of Tennessee's turnaround efforts were focused on SCS schools, so TDOE provided SCS with additional funding from SIGs to improve its priority schools. The district used these SIG funds to help open its iZone beginning in 2012-13.

As part of the federal stipulation for receiving SIG funds, schools were required to implement one of the four federally-prescribed turnaround models (transformation, turnaround, restart, closure). All SCS iZone schools used the transformation model, making them comparable to many turnaround schools across the country that also chose transformation after receiving a SIG (Dragoset et al., 2017). In addition to implementing reforms required by the transformation model, iZone models nationwide rely on placing schools into a semi-autonomous cluster to be managed by a separate office within the district. The SCS iZone office is led by an assistant superintendent who oversees a unit staffed by full-time district staff.

In alignment with the RBV emphasis on obtaining human resources, the iZone model prioritizes recruiting effective teachers and principals. When a school first joins the iZone, the district iZone office immediately recruits a new principal and then supports the principal in hiring high-performing teachers. To help with recruitment, iZone schools offered teachers $1,000 recruitment bonuses along with additional bonuses every year for meeting district performance benchmarks (Iyengar et al., 2017). At the same time, TDOE also supported teacher recruitment with signing bonuses where highly effective teachers (i.e., teachers with an score of five out of five on the state's teacher evaluation system) were offered a $7,000 bonus in exchange for working in priority schools for at least two years (TDOE, 2013). Highly effective teachers who were already working in a priority school were given $5,000 bonuses for staying in the school (TDOE, 2013). Although the transformation model does not mandate that schools replace teachers, the emphasis on recruiting effective teachers meant that most schools did replace most teachers upon entering the iZone (Henry et al., 2014).

After the initial efforts to hire a new principal and new teachers, iZone schools are given broad autonomy to pursue specific improvement efforts, with only two ongoing requirements. First, all SCS iZone schools extended the school day by an additional hour. The extended school day meant that schools have scheduling flexibility for teachers to collaborate in planning and addressing instructional obstacles. Second, teachers in iZone schools were given additional professional development from a team of instructional coaches in math, reading, science, and social studies. Besides extending the school day and working with coaches, teachers and principals in iZone schools had wide flexibility to pursue reforms as the district iZone office monitored progress. However, these two ongoing requirements likely helped iZone schools to facilitate peer collaboration and professional development as dynamic capabilities.

The funding to support iZone schools originally came from SIGs, but when SIG funding ended, iZone schools continued to receive funding through a combination of philanthropic support and reallocations of the district budget (Burnette II, 2015; Iyengar et al., 2017). Therefore, between 2012-13 (when the SCS iZone first began operating schools) through 2017-18 (the last year of data for this study) all iZone schools continued to receive full funding to support all of the reforms described above.

Given substantial resource investments in iZone schools, SCS did not have the capacity to place all of its priority schools into the iZone. At the same time, TDOE was also implementing a different reform model where some priority schools were placed into the state's Achievement School District (ASD). ASD schools were removed their local districts and restarted under the governance of TDOE. With two major reform options operating simultaneously, the decision of which schools would join the iZones were made in meetings between TDOE and district leaders. To better understand how schools were selected, I interviewed a number of TDOE and SCS leaders and found that the only commonly mentioned criterion for choosing schools was an emphasis on selecting schools in the same feeder patterns. That is, the iZone first took over elementary schools then expanded into the middle and high schools in the same feeder pattern. Beyond a desire to stay within feeder patterns, I find no evidence that iZone schools were systematically chosen based on pre-existing characteristics, and show below that baseline school characteristics were very similar between priority schools not chosen for turnaround and priority schools placed into the iZone. Given evidence that schools were not systematically chosen for reform, in this analysis, I compare SCS priority schools chosen for iZone reforms with SCS priority schools not receiving any interventions and exclude all ASD schools. My interviews with SCS leaders find that the remaining non-iZone priority schools did not receive any

interventions or supports from either the district or TDOE. Thus, between 2012-13 and 2017-18, my analytic sample comprises 62 SCS priority schools. From these 62 priority schools, 7 were placed into the SCS iZone in 2012-13; six in 2013-14; four in 2014-15; one in 2015-16; three in 2016-17; and no additional schools were added in 2017-18. Throughout the analysis, I use the remaining priority schools (those not placed into the iZone) as the comparison group.

Methods

Data

Data for this analysis come from two sources: administrative data provided by TDOE and survey data from SCS. The TDOE data are managed by the Tennessee Education Research Alliance and comprise student, staff, and school-level datasets. The student-level datasets contain test scores along with a rich set of demographic variables from 2006-07 through 2017-18. The teacher-level datasets include demographic and professional characteristics, such as value-added effectiveness ratings on Tennessee's value-added assessment system (TVAAS). Teachers and students can be linked with schools in every year, and school-level data comprise characteristics such as the grade level (elementary, middle, high school) and total enrollment. Also, all student and teacher characteristics can be aggregated to the school level.

Survey data provided by SCS come from districtwide administrations of the Insight Survey which was developed by the New Teacher Project (TNTP). These surveys are administered electronically via links e-mailed to all teachers in SCS schools from 2011-12 through 2017-18, with an average response rate of 85 percent. The survey captures teachers' perceptions of their school environment using Likert items ranging from 1 (Completely

Disagree) to 5 (Completely Agree). See Appendix Table 1 for a complete list of survey items. Due to privacy restrictions, I have access to only school-level averages for each survey item in each year.

After merging the administrative and survey data, I restrict the sample to only include students and teachers in the 62 SCS priority schools.[1] In this sample, the intervention group comprises iZone schools and the comparison group includes only priority schools that have never received any turnaround interventions. The mediational analysis is also restricted to only the years between 2011-12 and 2017-18, which captures one year prior to turnaround (2011-12) and six years post-turnaround (2012-13 through 2017-18). Although it would be helpful to extend the analysis to include more years of pre-turnaround data, the survey data are only available beginning in 2011-12. However, with a longer panel of student test scores extending back to 2006-07, below I show that student achievement trends are parallel between iZone and comparison schools before turnaround reforms began. Also, previous work using these data have shown that the DID estimates of iZone effects on student test scores yield similar conclusions when all years of pre-turnaround data are included (Pham et al., 2020).

Measures

The main outcome of interest is student test scores. TDOE's student-level datasets contain test scores on Tennessee's end-of-grade (EOG) tests for grades 3-8 and end-of-course (EOC) exams for high school subjects.[2] The EOG scores are standardized by subject, year, and grade, and end-of-course scores by subject, year, and semester. EOG tests take precedence in

[1] Priority schools that ever are part of the ASD are not included in any year.
[2] Note that, in 2015-16, Tennessee experienced complications from rolling out a new test. In response, the state decided not to report any scores form EOG exams. Therefore, I use not test scores from that year in this analysis.

observations where by both EOG and EOC scores are available, and subject indicators are used to control for systematic differences across subjects in models that pool all subjects together.

To test the mediating pathways of interest, I use four variables: the proportion of effective teachers who are new to the school and three dynamic capabilities (peer collaboration, orderly learning environment, and professional development). I test these four mediators in a sequential pathway following the predictions of RBV where schools first recruit effective teachers then leverage them to build productive dynamic capabilities. The variable capturing recruitment of effective teachers operationalizes effectiveness as receiving a TVAAS (value-added) score of four or higher out of five. The variable is a continuous proportion ranging from zero to one, but to ease the interpretation of my mediated effects, I standardize the proportion to have a mean of zero and unit variance.

Survey data provided by SCS are used to construct the three measures of dynamic capabilities. To do so, I follow previous research on school contextual factors by utilizing both theory and the data structure to guide the measurement model. First, I retain only items that ask about peer collaboration, learning environment, or professional development and are included on the survey every year. Then, I used exploratory factor analysis to test whether the retained items load well onto the three theoretically supported dynamic capabilities. Factors are only kept if their eigenvalues are above 1, and only items with factors loadings of 0.4 or larger are included. Each survey item is included in only one factor. After identifying meaningful factors, I used an orthogonal rotation to maximize differences between the factors. Standardized measures are derived for each dynamic capability in each school and year using these rotated factor loadings. Table 1 below shows the rotated factor loadings for each latent factor, and Appendix Table 2 shows correlations between each mediator and student test scores.

Table 1. Factor Loading of Each Item Onto Each of Three Factors: Peer Collaboration, Orderly Learning Environment, and Professional Development

Items	Factor Loading
Factor: Peer Collaboration ($\alpha = 0.93$)	
The time I spend collaborating with my colleagues is productive.	0.67
Teachers at my school share a common vision of what effective teaching looks like.	0.70
There are many teachers at my school who set an example for me of what highly effective teaching looks like in practice.	0.71
There is a low tolerance for ineffective teaching at my school.	0.72
Factor: Orderly Learning Environment ($\alpha = 0.96$)	
Teachers and leaders at my school immediately address student misbehavior in shared school spaces like hallways and the lunch room.	0.64
Across my school, there are consistent expectations and consequences for student behavior.	0.70
School leaders consistently support me in addressing student misbehavior when I have exhausted my classroom consequences.	0.75
My school is a good place to teach and learn.	0.79
School leaders promote a safe and productive learning environment in my school.	0.81
Factor: Professional Development ($\alpha = 0.92$)	
Professional development opportunities at my school include demonstrations (either live or in video) of what effective teaching looks like in practice.	0.51
My school is committed to improving my instructional practice.	0.57
Professional development opportunities at my school are well planned and facilitated.	0.57
In the past six months, I have learned new skills that I was able to immediately use in my own classroom.	0.58

As shown on Table 1, reliability for the three latent measures of peer collaboration ($\alpha = 0.93$), orderly environment ($\alpha = 0.96$), and professional development ($\alpha = 0.92$) are all high, suggesting items within each group are closely related. I use factors predicted from the exploratory factor analysis as my preferred measures of school dynamic capabilities throughout the analysis; however, as a check, I also fit a measurement model using confirmatory factor analysis to test the goodness-of-fit for the relevant items onto a three-factor model (see Appendix Figure 1). The model yielded good fit with $\chi^2 = 407.84$ ($p < 0.001, df = 44$); $RMSEA =$

$0.08; CFI = 0.98; TLI = 0.97; SRMR = 0.02$.[3] Besides the four mediators of interest, all models used in the analysis included a number of student and school characteristics as control variables, which I describe below.

Finally, since the iZone took over new schools in multiple years, I also code a centered year variable that captures the number of years before and after schools join the iZone. Under this coding scheme, the first cohort of iZone schools began year one of reforms in 2012-13. Then, the second cohort began their first year of reforms in 2013-14. Extending this logic means that the fifth iZone cohort began year one of reforms in 2016-17 (with two years of post-reform data for 2016-17 and 2017-18). For comparison schools that were never taken over by the iZone, the centered year variable is coded as one for the first year they are designated as a priority school.

Analytic Approach

In order to test for mediation, I first establish the overall effect of iZone reforms on student achievement using a DID model, similar to previous work evaluating school turnaround in Tennessee (Henry et al., 2020; Pham et al., 2020; Zimmer et al., 2017). To establish plausibly causal estimates of the effects of iZone reforms on student achievement, I model test scores y for student i, in school s, grade g, subject c, and time t:

$$y_{igsct} = \beta_0 + \beta_1 After_{st} + \beta_2 EveriZone_s * After_{st} + \boldsymbol{X'_{it}\alpha} + \boldsymbol{S'_{st}\eta} + \boldsymbol{d_s} + \boldsymbol{p_g} + \boldsymbol{k_c} + \varepsilon_{igsct}$$

(Equation 1)

[3] Values above 0.95 for CFI and TLI and below 0.08 for RMSEA were considered acceptable to good fit (Hair et al., 2010).

Equation 1 regresses student test scores on $After_{st}$ (an indicator for years after a school joins the iZone) and the interaction of $After_{st}$ with $EveriZone_s$ (an indicator for schools that are ever placed into the iZone).[4] Equation 1 controls for student characteristics $\mathbf{X_{it}}$ including a prior year measure of student achievement, gender, race, free-or-reduced price meal (FRPM) eligibility, English language learner (ELL) status, and special education (SPED) status. Equation 1 also controls for school characteristics $\mathbf{\Gamma_{st}}$ including the proportion minority race, proportion ELL status, proportion SPED status, and proportion of FRPM eligible students. Finally, equation one includes a set of school ($\boldsymbol{d}_s$), grade ($\boldsymbol{p}_g$), and subject ($\boldsymbol{k}_c$) fixed effects along with a random error term (ε_{igsct}). The coefficient of interest in this model, β_2, represents the pre-post difference in student achievement for students in iZone schools minus the same pre-post difference for students in comparison schools. All standard errors are clustered at the school level to account for interdependencies between students in the same school.

In a traditional, multi-step mediation analysis using OLS (Baron & Kenny, 1986), the second step would be to estimate the effect of iZone reforms on each mediator (i.e., four models where each of the four mediators is an outcome). The third step would then involve estimating a model that includes all of the mediators:

$$\begin{aligned} y_{igsct} = \gamma_0 + \gamma_1 After_{st} + \gamma_2 EveriZone_s * After_{st} + \gamma_3 EffectiveTeachers_{st} \\ + \gamma_4 PeerCollaboration_{st} + \gamma_5 LearningEnvironment_{st} \\ + \gamma_6 ProfDevelopment_{st} + \boldsymbol{X'_{it}\alpha} + \boldsymbol{S'_{st}\eta} + \boldsymbol{d_s} + \boldsymbol{p_g} + \boldsymbol{k_c} + \varepsilon_{igsct} \end{aligned}$$

(Equation 2)

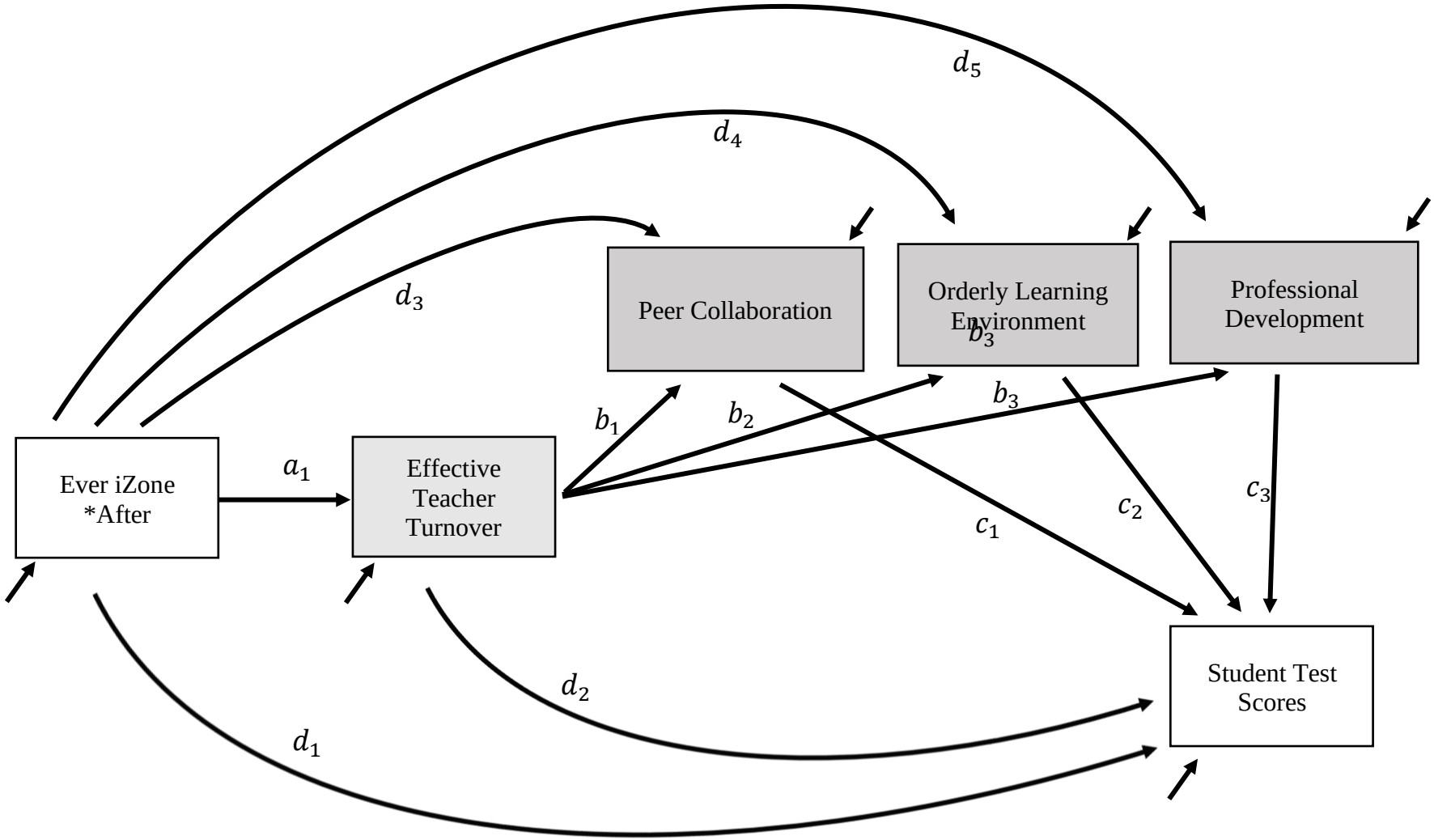
Equation 2 is similar to Equation 1 but also estimates associations between student test scores and (1) the recruitment of effective teachers, γ_3; (2) peer collaboration, γ_4; (3) an orderly

[4] The $EveriZone_s$ indicator is not included on its own between it is perfectly collinear with the school fixed effect.

learning environment, γ_5; and (4) professional development opportunities, γ_6. Accounting for all four mediators leaves the direct effect iZone reforms on student achievement (γ_2).

Although the multi-step approach to mediation analysis depicted in Equations 1 and 2 has been used in many studies, the approach has several limitations. First, estimating both Equations 1 and 2 would not model a sequential mediation hypothesis where iZone reforms affect two mediators in order, and I am especially interested in this sort of sequential mediation because RBV predicts a two-step process where iZone reforms first recruit effective teachers who then help build dynamic capabilities. Rather, the mediation models depicted in Equations 1 and 2 test the mediating effects of effective teachers and the mediating effect of each dynamic capability separately. Second, estimating multiple mediating equations and looking for patterns of significance in each model is not a direct statistical test of the mediating effect (Preacher & Hayes, 2004). To overcome these limitations, I instead estimate all models in the multi-step approach simultaneously using SEM (Preacher & Hayes, 2008), as depicted in Figure 2.

Figure 2. DID Model Estimated within an SEM Framework



The model depicted in Figure 2 estimates both Equations 1 and 2 along with paths that estimate how iZone reforms affect each mediator. Observed variables are shown in rectangles with errors represented by arrows pointing at each rectangle. Though not shown in the figure, all covariates listed in Equation 1 are included in the model and standard errors are clustered at the school level. For simplicity, Figure 2 shows only the $EveriZone_s * After_{st}$ interaction to represent the effect of iZone reforms. The four mediators are highlighted with gray shading, and the three dynamic capabilities are shown in darker gray rectangles. The dynamic capabilities are shown in rectangles because I use predicted measures derived from EFA, but in Appendix Table 3, I also test a model where I allow relevant items to load onto latent factors (which would be depicted as ovals) for each dynamic capability and obtain similar results.

Figure 2 models all coefficients from Equation 2 as paths that point directly to student test scores. More specifically, d_1 is the direct effect of iZone reforms on test scores (γ_2 $in\ Equation\ 2$); d_2 is equivalent to coefficient γ_3; and paths $c_1 - c_3$ are the equivalent of coefficients $\gamma_4 - \gamma_6$, respectively. Additionally, using SEM allows me to simultaneously estimate intermediate paths representing the effect of iZone reforms on each of the mediators (a_1, d_3, d_4, d_5) and the effect of one mediator on another (b_1, b_2, b_3). The model hypothesizes that iZone reforms have an effect on the proportion of effective teachers who are newly recruited to the school (a_1). Then, the recruitment of effective teachers correlates with each of the three dynamic capabilities ($b_1, b_2, and\ b_3$). Dynamic capabilities in turn are associated with student test scores (c_1, c_2, c_3). Thus, the sequential indirect effect of iZone reforms through effective teachers and then peer collaboration is $a_1 * b_1 * c_1$. Similarly, there is a sequential indirect effect of iZone reforms through effective teachers and learning environment ($a_1 * b_2 * c_2$) and professional development ($a_1 * b_3 * c_3$). Besides the sequential indirect effect through two

mediators, the model predicts indirect effects through each of the four mediators. Specifically, there is an indirect effect of iZone reforms through recruiting effective teachers $(a_1 * d_2)$, through peer collaboration $(d_3 * c_1)$, through orderly learning environment $(d_4 * c_2)$, and through professional development $(d_5 * c_3)$. Finally, after accounting for these various indirect effects, iZone reforms may continue to have a direct effect on student test scores (d_1). If $d_1$continues to be statistically significant after controlling for all hypothesized mediators, this would suggest that the reforms are affecting student achievement through other pathways not modeled here. Together, the direct effect of iZone reforms (d_1) added to all of indirect effects described above yields the overall or total effect of iZone reforms on student achievement. After estimating the various paths in Figure 2, I use a bootstrap procedure with 5,000 replications to test the statistical significance of each indirect effect estimate (Preacher & Hayes, 2004, 2008). With this method, I first take a sample of the same size from my original data with replacement while keeping clusters of school intact. Then, I estimate the model depicted in Figure 2 using SEM, calculate indirect effects by multiplying the relevant path coefficients, and store the results. I repeat this process 5,000 times to obtain a distribution for each indirect effect. Taking the estimate at 2.5 and 97.5 percent of the distributions yields a 95 percent confidence interval that can be used to test the statistical significance of the indirect effect. Simulation studies support the use of these bootstrap confidence intervals because they do not make assumptions about the distribution of the indirect effect, though they can yield intervals that are slightly asymmetric (Preacher, 2015; Preacher & Hayes, 2004). Finally, although my preferred results reported in this paper are from the SEM model shown in Figure 2, estimates from Equation 1 using OLS are included in Appendix Table 11 and yield largely similar estimates of overall effect of the iZone interventions.

Results

Descriptive Results

Before discussing the mediation results, Table 2 shows descriptive characteristics of iZone schools and comparison schools for the years prior to reform, year one after reforms began, and for all years after year one. The table splits results between years one and later years, because efforts to recruit effective teachers are most vigorous in the first year after a school is placed into the iZone. Table 2 shows that student characteristics are similar between iZone and comparison schools in the periods before and after turnaround. Most students in these priority schools are FRPM eligible (89 to 93 percent). Few are English language learners (between 1 and 6 percent), and between 11 and 15 percent are eligible for special education services. Also, most students are Black (between 89 and 97 percent), reflecting the demographics of historically Black communities in Memphis.

Since recruiting effective teachers is emphasized by the iZone model, Table 2 also describes teacher characteristics in iZone and comparison schools. The proportion of teachers new to the school increased dramatically in year one after schools enter the iZone, from an average of 24 percent pre-turnaround to about 57 percent in year one, reflecting intentional efforts to bring in new teachers. Teachers in iZone and comparison schools are relatively similar: about three-quarters female and minority race with about two-thirds holding a master's degree or higher. One noticeable change is the decrease in average teacher experience when schools are placed into the iZone, decreasing from an average 12 years to between 9 and 10 years. This change in average teacher experience is corroborated by previous work in Tennessee which finds that iZone schools attracted younger teachers (Henry et al., 2014).

Additionally, Table 2 shows descriptive averages for each of the four mediating variables. The averages suggest that iZone schools successfully recruited effective teachers in the first year of reform, because the proportion of teachers new to the school with a TVAAS score of four or higher increased from about four percent prior to turnaround to 26 percent in year one. After year one, when there was less focus on recruiting teachers, the proportion decreases to about 7 percent. The standardized measure of peer collaboration suggests that perceived collaboration in iZone schools increased from -0.36 standard deviation units (SDUs) pre-turnaround to about 0.10-0.27 SDUs post-turnaround. Likewise, both efforts to maintain an orderly learning environment and opportunities for professional development increased after schools joined the iZone. These averages provide descriptive evidence that iZone reforms helped schools to build more productive dynamic capabilities.

Table 2. Descriptive Characteristics of iZone and Comparison Schools for Pre-Turnaround Years, Year 1, and Years Two and After

	Non-iZone Priority			iZone		
	Pre-Turnaround	Year 1	Years 2+	Pre-Turnaround	Year 1	Years 2+
Student Characteristics						
Female	0.49	0.49	0.49	0.49	0.49	0.49
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
FRPM	0.91	0.89	0.89	0.91	0.93	0.90
	(0.29)	(0.32)	(0.31)	(0.29)	(0.25)	(0.30)
ELL	0.02	0.03	0.06	0.01	0.03	0.04
	(0.15)	(0.17)	(0.23)	(0.10)	(0.16)	(0.20)
SPED	0.13	0.11	0.14	0.15	0.14	0.15
	(0.34)	(0.31)	(0.35)	(0.36)	(0.34)	(0.36)
Black	0.95	0.94	0.89	0.97	0.94	0.92
	(0.22)	(0.25)	(0.32)	(0.16)	(0.23)	(0.28)
Hispanic	0.04	0.06	0.10	0.02	0.04	0.07
	(0.20)	(0.23)	(0.30)	(0.14)	(0.21)	(0.25)
White	0.01	0.00	0.01	0.01	0.01	0.01
	(0.07)	(0.07)	(0.08)	(0.07)	(0.08)	(0.11)
Other Race	0.00	0.00	0.00	0.00	0.01	0.00
	(0.07)	(0.06)	(0.06)	(0.04)	(0.07)	(0.07)
Average Enrollment	663.91	647.53	643.97	668.10	644.29	640.55
	(367.62)	(351.03)	(279.85)	(261.39)	(162.99)	(150.79)
Teacher Characteristics						
New to School	0.24	0.21	0.26	0.24	0.57	0.32
	(0.16)	(0.10)	(0.13)	(0.15)	(0.14)	(0.13)
Female	0.75	0.73	0.75	0.72	0.71	0.75
	(0.12)	(0.12)	(0.12)	(0.12)	(0.11)	(0.12)

Minority Race	0.74	0.74	0.74	0.75	0.76	0.74
	(0.11)	(0.10)	(0.12)	(0.07)	(0.07)	(0.09)
Years of Experience	11.42	11.83	11.68	11.88	10.13	8.95
	(2.96)	(2.89)	(2.60)	(2.84)	(2.17)	(1.94)
MA Degree or Above	0.60	0.68	0.68	0.59	0.65	0.66
	(0.09)	(0.09)	(0.09)	(0.09)	(0.12)	(0.13)
Mediators						
Proportion Effective Incoming Teachers	0.02	0.03	0.06	0.04	0.26	0.07
	(0.06)	(0.06)	(0.09)	(0.07)	(0.21)	(0.09)
Peer Collaboration	-0.30	-0.26	-0.34	-0.36	0.10	0.27
	(1.26)	(1.04)	(0.90)	(0.83)	(0.62)	(0.89)
Orderly Learning Environment	-0.02	0.08	-0.09	0.03	0.18	0.16
	(0.98)	(1.00)	(1.00)	(0.98)	(1.13)	(0.93)
Professional Learning	-0.08	-0.07	-0.04	-0.04	0.10	0.13
	(1.11)	(1.11)	(0.86)	(0.97)	(1.00)	(0.97)

Note. Standard deviations in parentheses. FRPM: Free or reduced priced meals eligibility; ELL: English Language Learner Status; SPED: Special Education Status; MA is master's degree.

Student Achievement Trends

In order to support the assumption of linear trends between iZone and comparison schools, Figure 3 below graphs average standardized student test scores for both groups of schools in every year and before and after turnaround. The graph shows a centered year variable where year zero is the year immediately before schools join the iZone, and one is the first year of reforms. For comparison schools, year zero is the year immediately before they are designated as priority. The graph shows that average student achievement in iZone schools is somewhat lower than in comparison schools, but the average *trend* in student achievement is similar between the two sets of schools with no sudden spikes or dips in performance for either group. In the first couple of years after schools join the iZone, however, there is a noticeable increase in the student achievement that then diminishes in years three and four to increase again in years five and six. Though somewhat uneven, these trends suggest positive effects of iZone reforms in early years and less consistent effects in later years, which aligns with results from previous evaluations of iZones in Tennessee (Pham et al., 2020; Zimmer et al., 2017).

Figure 3. Student Test Score Trends in iZone and Non-iZone Priority Schools for Each Year Before and After Turnaround

Mediation Results

Figure 4 below shows estimated path coefficients with standard errors in parentheses from the SEM model pooling together all years. The figure shows statistically significant paths with solid arrows and insignificant paths as dashed arrows. The figure shows that iZone reforms have a 0.04 SDU effect on the recruitment of effective teachers, a 0.29 SDU effect on peer collaboration, and a 0.43 SDU effect on opportunities for professional development. Comparing the three dynamic capabilities shows that iZone reforms led to increased peer collaboration which in turn was positively associated with student test scores. In contrast, iZone reforms increased opportunities for professional development, but increased professional development did not have an effect on student test scores. The model also suggests one sequential mediating

pathway where iZone reforms increased the recruitment of effective teachers, which had a positive relationship with the learning environment in the school, which in turn was positively associated with student test scores. Finally, results in Figure 4 suggest that iZone reforms continued to have a 0.14 SDU direct effect on student test scores even after accounting for all of the proposed mediators.

The pattern of significant path coefficients in Figure 4 suggest a number of mediating pathways, but the model does not test the statistical significance of the indirect effects. To do so, I conduct 5,000 Monte Carlo replications of the model to obtain bias-corrected bootstrap confidence intervals, with results in Table 3. Additionally, I show in Appendix Table 4 that percentile bootstrap confidence intervals are nearly identical. Table 3 shows that the indirect effect of iZone reforms on student achievement through recruiting effective teachers who then support an orderly learning environment ($a_1 * b_2 * c_2$) is 0.005 SDU. This indirect effect can be calculated from the estimated path coefficients in Figure 4 ($0.04 * 1.90 * 0.06 = 0.005$), but Table 3 also displays bootstrap confidence intervals, suggesting that the sequential indirect effect is marginally significant at the 10 percent level. Also, Table 3 shows a statistically significant indirect effect of iZone reforms on student achievement through increased peer collaboration (0.014 SDU). None of the other indirect effect estimates are statistically significant. However, the direct effect of iZone reforms continues to be statistically significant when tested with bootstrap confidence intervals, suggesting that there are mechanisms explaining the effect of iZone reforms other than those modeled here (such as a direct effect of being publicly named an low-performing, turnaround school).

Adding all of the indirect effects with the direct effect yields a positive overall iZone effect of 0.151 SDU, which is nearly the same as the iZone effect from estimating Equation 1

using OLS (see Appendix Table 11). To help put these mediated effects into perspective, the indirect sequential effect of iZone reforms through recruiting effective teachers who then support an orderly learning environment is about 3 percent of the overall iZone effect ($\frac{0.005}{0.151} = 0.03$). The indirect effect of iZone reforms through peer collaboration is about 9 percent ($\frac{0.014}{0.151} = 0.09$) of the overall iZone effect.

Figure 4. Path Coefficients from DID Model Estimated with SEM

ß

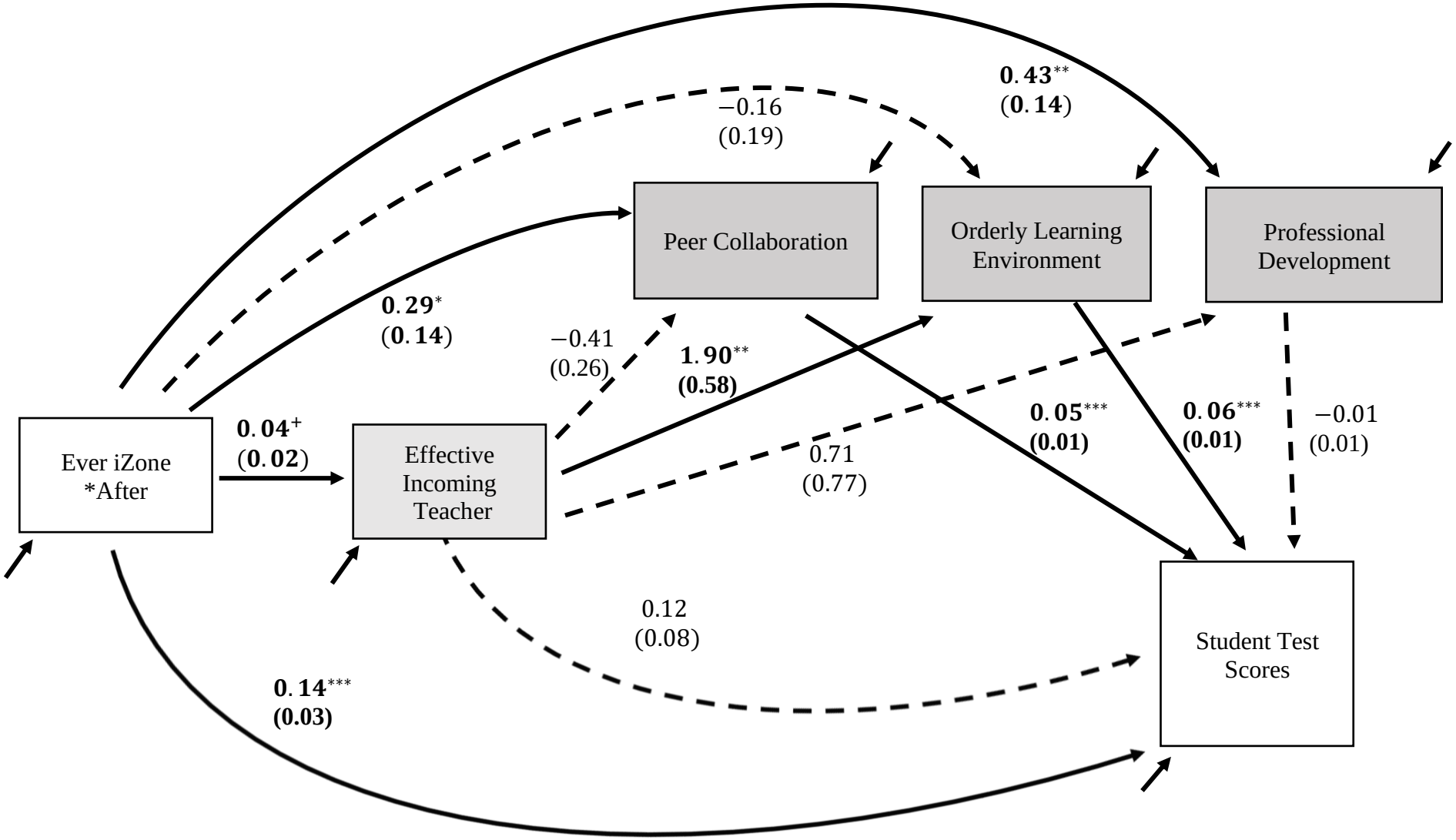


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Table 3. Indirect, Direct, and Total Effects with Bias-Corrected Bootstrap Confidence Intervals

	Estimate and Confidence Interval
Indirect Effects	
(1) iZone → Effective Teachers → Peer Collaboration → Test Scores	-0.001 [-0.004, 0.000]
(2) iZone → Peer Collaboration → Test Scores	0.014* [0.001, 0.035]
(3) iZone → Effective Teachers → Learning Environment → Test Scores	0.005+ [0.000, 0.016]
(4) iZone → Learning Environment → Test Scores	-0.009 [-0.031, 0.014]
(5) iZone → Effective Teachers → Professional Development → Test Scores	-0.000 [-0.004, 0.000]
(6) iZone → Professional Development → Test Scores	-0.005 [-0.020, 0.001]
(7) iZone → Effective Teachers → Test Scores	0.005 [-0.001, 0.021]
Direct Effect	
(8) iZone → Test Scores	0.143*** [0.076, 0.221]
Total Effect	
(1) + (2) + (3) + (4) + (5) + (6) + (7) + (8)	0.151*** [0.076, 0.231]

Note. Bias corrected bootstrap 95% confidence interval shown in brackets. + p<0.10 * p<0.05 ** p<0.01 *** p<0.001

Although Figure 4 and Table 3 shows evidence for significant mediating pathways, pooling together all years obscures an important distinction between reforms in the first year after schools begin iZone reforms (when efforts to recruit new teachers were intentional) and later years (when ongoing teacher turnover can be an obstacle to school improvement). To examine this possibility, I estimate the SEM model on two different sub-samples. First, I compare only the first year after schools join the iZone with all pre-turnaround years. Second, I compare only outcomes in years two and after with the pre-turnaround years. I choose to examine two different sub-samples instead of adding indicators and interactions for years post-turnaround to ease the interpretation of the coefficients. Table 4 shows indirect, direct, and total effects from this analysis with bias-corrected bootstrap confidence intervals (see Appendix Table 5 for estimates of each path coefficient in the model). Column 1 of the table examines the

subsample containing only year one after turnaround, whereas column 2 shows estimates from only years two and after. The estimates suggest that indirect effects of iZone reforms through peer collaboration is strongest in the first year after turnaround (0.045 SDU or 23 percent of the overall iZone effect in year one) and insignificant after year one. Likewise, the sequential mediating effect of iZone reforms through both effective teachers and learning environment is positive and marginally significant in year one but insignificant in years two and after. The indirect of effect of iZone reforms through the recruitment of effective teachers is positive and significant in year one (0.04 SDU or 20 percent of the overall year one effect) but is indistinguishable from zero in later years. This suggests that after the first year of reforms, iZone schools were less successful at attracting effective teachers and maintaining productive dynamic capabilities. Finally, Table 4 shows positive direct iZone effects in all years, but the total iZone effect is largest in year one and smaller in magnitude in later years.

Table 4. Indirect, Direct, and Total Effects with Bias-Corrected Bootstrap Confidence Intervals for Year One and Years Two and After

	Year 1	Year 2+
Indirect Effects		
(1) iZone → Effective Teachers → Peer Collaboration → Test Scores	-0.004	0.001
	[-0.018, 0.004]	[-0.002, 0.004]
(2) iZone → Peer Collaboration → Test Scores	0.045*	0.007
	[0.014, 0.108]	[-0.012, 0.032]
(3) iZone → Effective Teachers → Learning Environment → Test Scores	0.007+	-0.006
	[0.000, 0.034]	[-0.012, 0.001]
(4) iZone → Learning Environment → Test Scores	-0.002	-0.007
	[-0.031, 0.012]	[-0.037, 0.029]
(5) iZone → Effective Teachers → Professional Development → Test Scores	-0.003	0.001
	[-0.014, 0.003]	[-0.001, 0.003]
(6) iZone → Professional Development → Test Scores	-0.004	-0.008
	[-0.027, 0.002]	[-0.027, 0.005]
(7) iZone → Effective Teachers → Test Scores	0.040*	-0.009
	[0.001, 0.109]	[-0.021, 0.004]
Direct Effect		
(8) iZone → Test Scores	0.120*	0.171***
	[0.026, 0.219]	[0.086, 0.251]
Total Effect		
(1) + (2) + (3) + (4) + (5) + (6) + (7) + (8)	0.199***	0.150***
	[0.108, 0.296]	[0.059, 0.238]

Note. Bias corrected bootstrap 95% confidence interval shown in brackets. + p<0.10 * p<0.05 ** p<0.01 *** p<0.001

Robustness Checks

Although evaluating the overall effect of iZone reforms on student achievement is not the main focus of this paper, an examination of mediating effects depends on first establishing the total effect. Therefore, I conduct a series of robustness checks to support an arguably causal effect of iZone reforms. I briefly discuss these checks here and note that more extensive work evaluating Tennessee's iZones have been conducted in previous studies (Pham et al., 2020; Zimmer et al., 2017).

First, besides establishing evidence parallel trends in student achievement in Figure 3, I also compare pre-turnaround characteristics of iZone and comparison schools to support the assumption that positive iZone effects are not driven by pre-existing differences between these two groups of schools. I find no significant differences in school characteristics prior to reform (see Appendix Table 6). I also estimate DID models predicting whether reforms led to significant changes in student characteristics in iZone schools (e.g., proportion female, proportion minority race, proportion FRPM eligible, proportion ELL status, proportion SPED status, and total school enrollment). I find no significant effect on student or school characteristics, suggesting that positive iZone results are not driven by changes in the students served by iZone schools (see Appendix Table 7). Additionally, I test for whether the results are driven by mean reversion from a potential dip in performance in the year prior to reforms. I do so by shifting the indicator for years after turnaround back to one year before actual reform implementation and find no significant effect. I also test a model including student fixed effects, a model where I change the comparison group to schools in the bottom 6-10 percent, and models where I remove observations of students who move between iZone and non-iZone schools. These models find no

evidence to support alternative explanations for the positive iZone effects (see Appendix Table 8). Finally, I test whether conclusions from the DID model are robust when I instead model the trend in student achievement prior to turnaround using a comparative interrupted times series (CITS) model. Again, the results support the conclusions of the DID model (see Appendix Table 9). Note that I use the DID model instead of CITS for mediation analyses because the survey data used to measure dynamic capabilities are available only one year prior to the beginning of iZone reforms in SCS.

Besides testing the robustness of the DID model itself, an important consideration for mediation analysis is the possibility of omitted confounders affecting the mediators. Mediation analyses rely on the assumption of sequential ignorability, which assumes that both assignment to treatment and mediators are exogeneous. First, sequential ignorability assume that, conditional on covariates, assignment to the iZone is independent of outcomes and mediators. This assumption of exogeneity in the iZone "treatment" is supported by the above checks for the validity of the DID estimates. Second, sequential ignorability assumes that mediators are themselves exogeneous after accounting for the iZone treatment status and observed covariates.

Researchers have argued that the assumption of exogenous mediators is not testable and cannot be fully ruled out even when experiments are designed to explicitly randomize both assignment to treatment and levels of each mediator. See Imai et al. (2010) for a more thorough discussion of this issue. However, I can test the extent to which my results are sensitive to the assumption of exogenous mediators and follow methods to do so described by Imai and colleagues (2010). This approach essentially quantifies the extent to which sequential ignorability must be violated before a mediating effect is reversed. Following this approach, I estimate two equations for each mediator. First, I regress the mediator on the full DID model.

Then, I regress student test scores on the full DID model and include the mediator. These two models allow me to calculate mediation effects for given values of ρ, the correlation between the error term in the mediator model and the error term in the student test scores model. The mediation effects are considered sensitive if they vary widely as a function of ρ, and although the true value of ρ is unknown, I can calculate the value of ρ where the average mediation effect equals zero and report them in Table 5 below.

Although ρ quantifies the degree of sensitivity, it is difficult to interpret substantively (e.g., "large" versus "small" values of ρ). To aid with this interpretation, Table 5 also shows the sensitivity of each mediator in terms of a change in R^2 for both the mediator and outcome models. This alternative formulation of the sensitivity parameter is interpreted as the proportion of total variance in the mediator and outcome explained by a hypothetical unobserved confounder. With this parameter, my findings would be considered sensitive if a hypothetical unobserved confounder needs to explain only a small portion of the variance in the mediator and outcome for the mediation effect to equal zero. Table 5 below shows these sensitivity parameters for each mediator. The results suggest that the proportion of effective teaches new to the school and professional development are more sensitive to potential confounding than peer collaboration and orderly learning environment. For example, for the mediation effect through the recruitment of effective teachers to equal zero, there must be an unobserved confounder that affects both the incoming teachers and student test scores such that the magnitude of the correlation between the two errors terms is greater than 0.011. Interpreted as a change in R^2, an unobserved confounder would render the mediating effect of effective incoming teachers statistically insignificant if the product of the proportion of variance explained in student test

scores and the proportion of variance explained in incoming effective teachers is greater than 0.0001.

Table 5. Sensitivity Parameters

	Effective Incoming Teachers	Peer Collaboration	Orderly Learning Environment	Professional Development
Sensitivity Parameters				
ρ	0.011	0.076	0.077	0.009
$R_m^2 * R_Y^2$	0.0001	0.004	0.005	0.0001

Note. ρ is the correlation between the error term in the mediator model and the error term in the outcome model, where the average mediation effect is expected to equal 0. $R_m^2 * R_Y^2$ represents the product of the total variation explained for the mediator times the total variation explained for the outcome from a hypothetical unobserved confounder that would render the mediation effect statistically insignificant. The outcome is always standardized student test scores and each mediator is tested separately.

Although 0.0001 appears quite small, note that the variables available to explain student achievement in education data typically explain very little of the variance in test scores. Moreover, the proportions shown in Table 5 are further diminished because they are products of two R^2 values that are both less than one. To put these sensitivity results in context, I examine the proportion of variance explained in the mediator and outcome for each of the observed variables used as controls in the model. For example, FRPM eligibility would be a confounder if it were not included as a control variable because prior research suggests that FRPM eligibility affects both student achievement and teacher recruitment. When I regress student test scores on FRPM eligibility, I find that $R^2 = 0.0036$, suggesting that FRPM eligibility explains less than 1 percent (0.36%) of the total variation in test scores. Similarly, $R^2 = 0.00016$ when I regress the proportion of effective incoming teachers on FRPM. Thus, the product of the proportion of total variance in student test scores and effective incoming teachers that is explained by FRPM is 0.00000057 (0.0036 * 0.00016). Compared with the sensitivity parameters shown in Table 5, the

FRPM example suggests that any potential omitted confounder must explain may times more the variation in test scores and effective incoming teachers than FRPM eligibility for the average mediating effect of effective incoming teachers to become statistically insignificant. In fact, none of the observed covariates included in the DID model, which prior research has shown to be predictive of both student achievement and effective incoming teachers, can explain enough of the variation in both to render the average indirect effect statistically insignificant. Appendix Table 10 shows R^2 values from (1) regressing student test scores on each observed covariate; (2) regressing of each mediator on each covariate; and (3) the product of (1) and (2). Comparing these results with Table 5, I conclude that the mediating variables tested are robust to potential unobserved confounders, because a potential confounder must explain a relatively large proportion of the variance in both test scores and each mediator compared to the observed covariates.

Discussion

Using SEM to estimate DID models, this paper examines the mediating effects of iZone turnaround on student achievement through recruiting effective teachers, increasing peer collaboration, building an orderly learning environment, and expanding opportunities for professional development. My results support RBV as a useful theoretical framework for understanding the effects of school turnaround. First, RBV predicts that hiring effective staff is an important initial step to improving organizational capacity. In the first year of reforms, iZone schools focused on recruiting effective teachers, and I find that indirect effects through teacher recruitment accounts for about 20 percent of the overall iZone effect in year one. This finding

supports predictions from RBV and aligns with previous research finding that the recruitment of effective teachers is a key driver of positive effects in iZone schools (Henry et al., 2020).

After hiring effective teachers, RBV suggests that productive organizations will leverage the effective staff they recruit to build dynamic capabilities in order to produce desirable outcomes. Of the three dynamic capabilities tested in this study, I find that hiring more effective teachers did not lead to higher levels of peer collaboration or professional development in iZone schools, suggesting that simply bringing more effective teachers together does not mean that they will collaborate or that they will participate in professional development. Future efforts to turn schools around should invest in differentiated strategies that encourage ongoing development for already effective teachers to continue improving their practice after they arrive in the turnaround school.

However, I do find that recruiting more effective teachers directly led to a more orderly learning environment, and this sequential mediating mechanism accounts for about 3 percent of the overall iZone effect. This result aligns with previous research suggesting that shared teacher responsibility is critical in supporting a school's culture and climate (Cannata, 2007). That is, concerted effort from all teachers is important to maintaining schoolwide expectations within classrooms and in shared school spaces. Thus, my findings suggest that hiring effective teachers with the skills to maintain consistent expectations throughout the school building is a key ingredient for creating and maintaining an orderly learning environment, which ultimately improves student achievement. Though statistically significant, the relatively modest magnitude of this indirect effect suggests that other components of the iZone reforms may also be important to consider in building an orderly learning environment. In iZone schools, hiring experienced school leaders was likely also important because previous research finds that school leaders are

critical in developing the school's culture (Leithwood & Jantzi, 2000) and investing teachers in maintaining that culture (Price et al., 2015).

Also, I find that iZone reforms increased peer collaboration, which was positively associated with test scores. The mediating effect through increased teacher collaboration accounts for about 9 percent of the overall iZone effect. Ongoing school reform plans under ESSA would do well to consider the different ways that iZone reforms may have encouraged greater teacher collaboration. For example, iZone schools hired new school leaders and more teacher coaches while also lengthening the school day. Effective school leaders can help prioritize and encourage collaborative teacher teams. Coaches likely facilitated productive collaborative meetings, and the extended school day gave teachers more time to meet and plan together. These various interventions provide an important blueprint for potentially effective ways to expand productive teacher collaborations in turnaround chools.

Moreover, I find that iZone schools increased opportunities for professional development, but the professional development offered was not associated with improved student achievement. More opportunities for professional development are likely the result of explicit efforts by SCS leaders to support teachers in iZone schools (e.g., by hiring more instructional coaches). However, with no association between professional development and student test scores, future reform initiatives should consider the efficacy of any chosen development activities. Research suggests that effective models of professional development include core features such as being sustained over time, focused on relevant content, and embedded in teachers' practice (Darling-Hammond et al., 2009; Desimone, 2009). Thus the type of professional development, the way it is structured, and how it is delivered are all important features that must be considered as part of a plan to deliver effective professional development in turnaround schools. In SCS iZone

schools, professional development opportunities offered to teachers may have increased, but they did not appear to be very helpful in increasing student performance.

Even after including all hypothesized mediating pathways, I find that the positive direct effect of iZone reforms continued to be positive and significant, suggesting that other mediating mechanisms may be important to explaining the positive iZone effects such as the recruitment and retention of effective principals (Henry et al., 2020). Besides recruiting effective teachers and the three dynamic capacbilities I test, other important potential mediators include potential positive effects from the iZone designation itself (Chiang, 2009), the role of school leaders (Leithwood et al., 2010), partnerships with local communities (Glazer & Egan, 2018), and district-level capacity to support low-performing schools (Iyengar et al., 2017). Previous research finds that the accountability pressure which comes with being publicly labeled a low-performing school can itself push schools to improve (Chiang, 2009). School leaders have crucial roles in hiring and supporting teachers and maintaining a vision for improvement (Leithwood & Strauss, 2008), and strong relationships with local communities are important because community resistance can make it difficult to maintain improvement efforts (Glazer & Egan, 2018). Finally, a key feature of the iZone model is district-level support for schools in the iZone, suggesting that dedicated support from district leaders can play an important role in the successful implementation of reforms. One limitation for the current turnaround literature is the lack of measures for these and other potential mediating mechanisms, and ongoing research should continue to develop ways to monitor these important components of the reform process.

Appendix

Appendix Table 1. Survey Items on SCS Insight Survey

Items
My school is a good place to teach and learn.
School leaders promote a safe and productive learning environment in my school.
Across my school, there are consistent expectations and consequences for student behavior.
School leaders consistently support me in addressing student misbehavior when I have exhausted my classroom consequences.
Teachers and leaders at my school immediately address student misbehavior in shared school spaces like hallways and the lunch room.
I get enough feedback on my instructional practice.
The feedback I get from being observed helps me improve student outcomes.
Short observations reported per teacher (< 15 mins) - Median
Long observations reported per teacher (> 15 mins) - Median
I regularly discuss instructional plans and get feedback from the person who evaluates me.
Each time I am observed, I get feedback that gives me specific actions to improve my teaching practice.
When I get feedback after an observation, I receive support to implement those changes (i.e. someone models suggestions for me, I have time to practice outside of class).
My observer consistently follows up to see how successfully I am implementing feedback from our last observation.
Teachers at my school track the performance of their students toward measurable academic goals.
Before the start of the year, I reviewed the assessments my students are expected to take with other teachers or with school leaders.
After each interim assessment, I collaborate with others at my school to make action plans based on student performance.
Teachers of the same content area at my school share a common set of rigorous interim assessments that ensure students are ready for college.
My school has dedicated time for teachers to analyze interim assessments and to re-teach content based on student performance.
My school is committed to improving my instructional practice.
Professional development opportunities at my school are well planned and facilitated.
Professional development opportunities at my school include demonstrations (either live or in video) of what effective teaching looks like in practice.
In the past six months, I have practiced teaching techniques in a professional development setting outside my own classroom.
In the past six months, I have learned new skills that I was able to immediately use in my own classroom.
I am satisfied with the support I receive at my school for instructional planning.
A leader at my school regularly helps me to improve my lesson plans.
I regularly meet with other teachers throughout my school or district who teach in my same grade or subject area to plan and share resources.

My school implements a rigorous academic curriculum.
The expectations for effective teaching are clearly defined at my school.
At my school, evaluation ratings are accurate reflections of teacher effectiveness.
I know the criteria that will be used to evaluate my performance as a teacher.
I agree with the criteria that will be used to evaluate my performance as a teacher.
The teacher evaluation process helps identify my strengths and weaknesses.
The person who evaluates my performance has an accurate perception of my classroom practice.
The person who evaluates my performance knows how much growth and progress my students have made this year.
Teachers at my school share a common vision of what effective teaching looks like.
There are many teachers at my school who set an example for me of what highly effective teaching looks like in practice.
The time I spend collaborating with my colleagues is productive.
There is a low tolerance for ineffective teaching at my school.
Over the long-term, my workload as a teacher is sustainable.
My schedule is structured in a way that helps me to meet the expectations of my job as a teacher.
When I am asked to do work outside of my core instructional responsibilities, leaders clearly explain how the work benefits students.
Teachers at my school have the opportunity to provide input on their work schedules.
I can consistently accomplish essential work during my regular planning time.
Average weekly hours spent on classroom duties both inside and outside of school

Note. All items use Likert format responses ranging from one for Completely Disagree to five for Completely Agree.

Appendix Table 2. Correlations Between Each Dynamic Capability and Student Test Scores

	Reading	Math	Science	Effective Incoming Teachers	Peer Collaboration	Orderly Learning Environment	Professional Development
Reading	1.00						
Math	0.60	1.00					
Science	0.68	0.62	1.00				
Effective Incoming Teachers	0.01	0.05	0.06	1.00			
Peer Collaboration	0.09	0.11	0.10	-0.00	1.00		
Orderly Learning Environment	0.06	0.09	0.08	0.17	0.28	1.00	
Professional Learning	0.02	0.01	0.05	0.06	0.07	0.24	1.00

Appendix Table 3. SEM Models Estimating Effects Using Dynamic Capabilities Extracted from EFA and as Latent Variables in a Measurement Model

	(1) EFA Factors	(2) Latent Factors
Outcome: Proportion Effective Incoming Teachers		
Ever iZone*After	0.041+	0.041+
	(0.024)	(0.024)
Outcome: Peer Collaboration		
Ever iZone*After	0.287*	0.214+
	(0.144)	(0.113)
Proportion Effective Incoming Teachers	-0.408	0.804+
	(0.260)	(0.489)
Outcome: Learning Environment		
Ever iZone*After	-0.159	0.088
	(0.193)	(0.170)
Proportion Effective Incoming Teachers	1.904**	1.140*
	(0.583)	(0.519)
Outcome: Professional Development		
Ever iZone*After	0.429**	0.243+
	(0.141)	(0.132)
Proportion Effective Incoming Teachers	0.708	0.815+
	(0.767)	(0.458)
Outcome: Test Scores		
Ever iZone*After	0.143***	0.134***
	(0.033)	(0.034)
Proportion Effective Incoming Teachers	0.123	0.122
	(0.081)	(0.080)
Peer Collaboration	0.050***	0.000
	(0.013)	(0.058)
Learning Environment	0.059***	0.065*
	(0.011)	(0.033)
Professional Learning	-0.012	0.012
	(0.009)	(0.050)
School Fixed Effect	Yes	Yes
Observations	161511	161511
Schools	62	62

Note. Standard errors in parentheses, clustered at the school level. All models contain the full set of covariates and fixed effects. FRPM: Free or Reduced Price Meals; ELL: English Language Learner; SPED: Special Education + $p<0.10$ * $p<0.05$ ** $p<0.01$ *** $p<0.001$

Appendix Table 4. Indirect, Direct, and Total Effects with Percentile Bootstrap Confidence Intervals

	Estimate and Confidence Interval
Indirect Effects	
(1) iZone → Effective Teachers → Peer Collaboration → Test Scores	-0.001 [-0.003, 0.000]
(2) iZone → Peer Collaboration → Test Scores	0.014+ [-0.000, 0.034]
(3) iZone → Effective Teachers → Learning Environment → Test Scores	0.005+ [-0.000, 0.015]
(4) iZone → Learning Environment → Test Scores	-0.009 [-0.031, 0.013]
(5) iZone → Effective Teachers → Professional Development → Test Scores	-0.000 [-0.002, 0.001]
(6) iZone → Professional Development → Test Scores	-0.005 [-0.016, 0.003]
(7) iZone → Effective Teachers → Test Scores	0.005 [-0.002, 0.019]
Direct Effect	
(8) iZone → Test Scores	0.143*** [0.073, 0.217]
Total Effect	
(1) + (2) + (3) + (4) + (5) + (6) + (7) + (8)	0.151*** [0.077, 0.234]

Note. Bias corrected bootstrap 95% confidence interval shown in brackets. + p<0.10 * p<0.05 ** p<0.01 *** p<0.001

Appendix Table 5. Full DID Model Estimated Using SEM For Year One Separate from Years Two and Later

	(1) Year 1	(2) Year 2+
Outcome: Proportion Effective Incoming Teachers		
Ever iZone*After	0.185**	-0.056***
	(0.062)	(0.016)
Outcome: Peer Collaboration		
Ever iZone*After	0.667**	0.159
	(0.233)	(0.194)
Proportion Effective Incoming Teachers	-0.309	-0.248
	(0.296)	(0.539)
Outcome: Orderly Learning Environment		
Ever iZone*After	-0.084	-0.106
	(0.299)	(0.258)
Proportion Effective Incoming Teachers	1.293*	1.550+
	(0.617)	(0.918)
Outcome: Professional Learning		
Ever iZone*After	0.320	0.630**
	(0.231)	(0.237)
Proportion Effective Incoming Teachers	1.278	0.847
	(0.777)	(0.915)
Outcome: Test Scores		
Ever iZone*After	0.120**	0.171***
	(0.045)	(0.038)
Proportion Effective Incoming Teachers	0.216*	0.164
	(0.095)	(0.110)
Peer Collaboration	0.068**	0.047**
	(0.023)	(0.015)
Orderly Learning Environment	0.028+	0.064***
	(0.014)	(0.012)
Professional Learning	-0.012	-0.013
	(0.012)	(0.010)
School Fixed Effect	Yes	Yes
Observations	86008	129552
Schools	62	62

Note. Standard errors in parentheses clustered at the school level. All models contain the full set of covariates and fixed effects. FRPM: Free or Reduced Price Meals; ELL: English Language Learner; SPED: Special Education + p<0.10 * p<0.05 ** p<0.01 *** p<0.001

Appendix Table 6. Descriptive *t*-tests Comparing Characteristics of iZone and Non-iZone Priority Schools in the Pre-Turnaround Years

	Non-iZone Priority	iZone
Student Test Scores		
Average reading score	-.941	-1.02
Average math score	-.906	-.949
Average science score	-1.08	-1.16
Student Characteristics		
Proportion Female	.485	.491
Proportion Minority	.993	.991
Proportion FRPM	.903	.892
Proportion SpED	.151	.169
Proportion ELL	.0217	.0192
Proportion Mobile	.345	.277
Total Enrollment	404	508
Teacher Characteristics		
Average Standardized Teacher VA (1-Yr)	-.39	-.514
Average Standardized Teacher VA (3-Yr)	-.485	-.516
Prior Year TVAAS Among Incoming Teachers	-.618	-.672
Proportion of Female Teachers	.799	.747
Proportion Minority Teachers	.749	.737
Average Teacher Experience	12.7	12.7
Proportion of Teachers with Fewer than 3 Years of Experience	.198	.215
Proportion of Teachers with MA or Above	.639	.608
Average Teacher Age	44.4	44.3
Average Teacher Salary ($1000)	55.6	54.9
Average Teacher Tenure (Years)	4.91	5

Note. All models contain the full set of covariates and fixed effects. iZone: Innovation Zone; FRPM: free and reduced price meals; SpED: special education; ELL: English language learners + $p<0.10$ * $p<0.05$ ** $p<0.01$ *** $p<0.001$

Appendix Table 7. DID Models Examining Each Covariate as an Outcome

	(1) Total Enrollment	(2) Female	(3) Minority	(4) FRPM	(5) ELL	(6) SPED
Ever iZone*After	43.828	0.003	0.002	-0.001	0.002	0.002
	(26.368)	(0.010)	(0.001)	(0.006)	(0.007)	(0.010)
After Turnaround	-15.406	0.002	0.002	0.002	-0.005	0.014
	(10.903)	(0.010)	(0.001)	(0.004)	(0.004)	(0.008)
Student and School Covariates	Yes	Yes	Yes	Yes	Yes	Yes
School Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Number of Schools	64	64	64	64	64	65
Observations	49231	49231	49234	49231	49231	96312
Adjusted R Squared	0.115	0.046	0.004	0.057	0.331	0.025

Note. All models contain the full set of covariates and fixed effects. iZone: Innovation Zone; FRPM: free and reduced price meals; SpED: special education; ELL: English language learners + $p<0.10$ * $p<0.05$ ** $p<0.01$ *** $p<0.001$

Appendix Table 8. Alternative Models and Validity Checks Testing iZone Effects on Student Test Scores

	(1) Preferred Model	(2) Include Total Enrollment	(3) Test for Placebo Effect	(4) Student Fixed Effects	(5) Comparison Group is Lowest 6-10%	(6) Only 2012 Priority Schools	(7) Remove Students Moving from ASD/iZone to Comparison Schools	(8) Remove All Students who Move Into or Out of ASD/iZone After First Year
Ever iZone * After	0.098***	0.098***	0.072**	0.129***	0.120***	0.103**	0.101***	0.100***
	(0.028)	(0.028)	(0.026)	(0.009)	(0.026)	(0.032)	(0.029)	(0.029)
After Turmaround	0.100***	0.100***	0.061***	0.133***	0.062***	0.107***	0.085***	0.085***
	(0.017)	(0.017)	(0.017)	(0.007)	(0.012)	(0.019)	(0.017)	(0.017)
Student and School Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Student Fixed Effects				Yes				
School Fixed Effect	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Number of Schools	101	101	101	101	135	70	101	101
Observations	449781	449781	449781	449781	735187	322172	449019	447843
Adjusted R Squared	0.398	0.398	0.396	0.044	0.448	0.395	0.398	0.397

Note. All models contain the full set of covariates and fixed effects. + p<0.10 * p<0.05 ** p<0.01 *** p<0.001

Appendix Table 9. Comparative Interrupted Time Series Model

	(1) All Subjects	(2) Reading	(3) Math	(4) Science
Ever iZone * After	0.098*	0.103	0.209**	0.304***
	(0.046)	(0.057)	(0.066)	(0.080)
After Turnaround	0.136***	0.058*	0.155***	0.175***
	(0.027)	(0.027)	(0.039)	(0.050)
Linear Time Trend	-0.023***	-0.019*	-0.033***	-0.023*
	(0.006)	(0.008)	(0.008)	(0.010)
Ever iZone*Linear Trend	0.003	0.001	-0.006	-0.011
	(0.007)	(0.009)	(0.010)	(0.013)
Student and School Covariates	Yes	Yes	Yes	Yes
School Fixed Effect	Yes	Yes	Yes	Yes
Number of Schools	101	65	65	65
Observations	449781	113297	99574	92074
Adjusted R Squared	0.398	0.423	0.364	0.353

Notes. All models contain the full set of covariates and fixed effects. + p<0.10 * p<0.05 ** p<0.01 *** p<0.001

Appendix Table 10. Proportion of Variance Explained R^2 by Regressing (1) Test Scores on Covariate and (2) Mediator on Covariate and Product of the Two R^2 Values from (1) and (2)

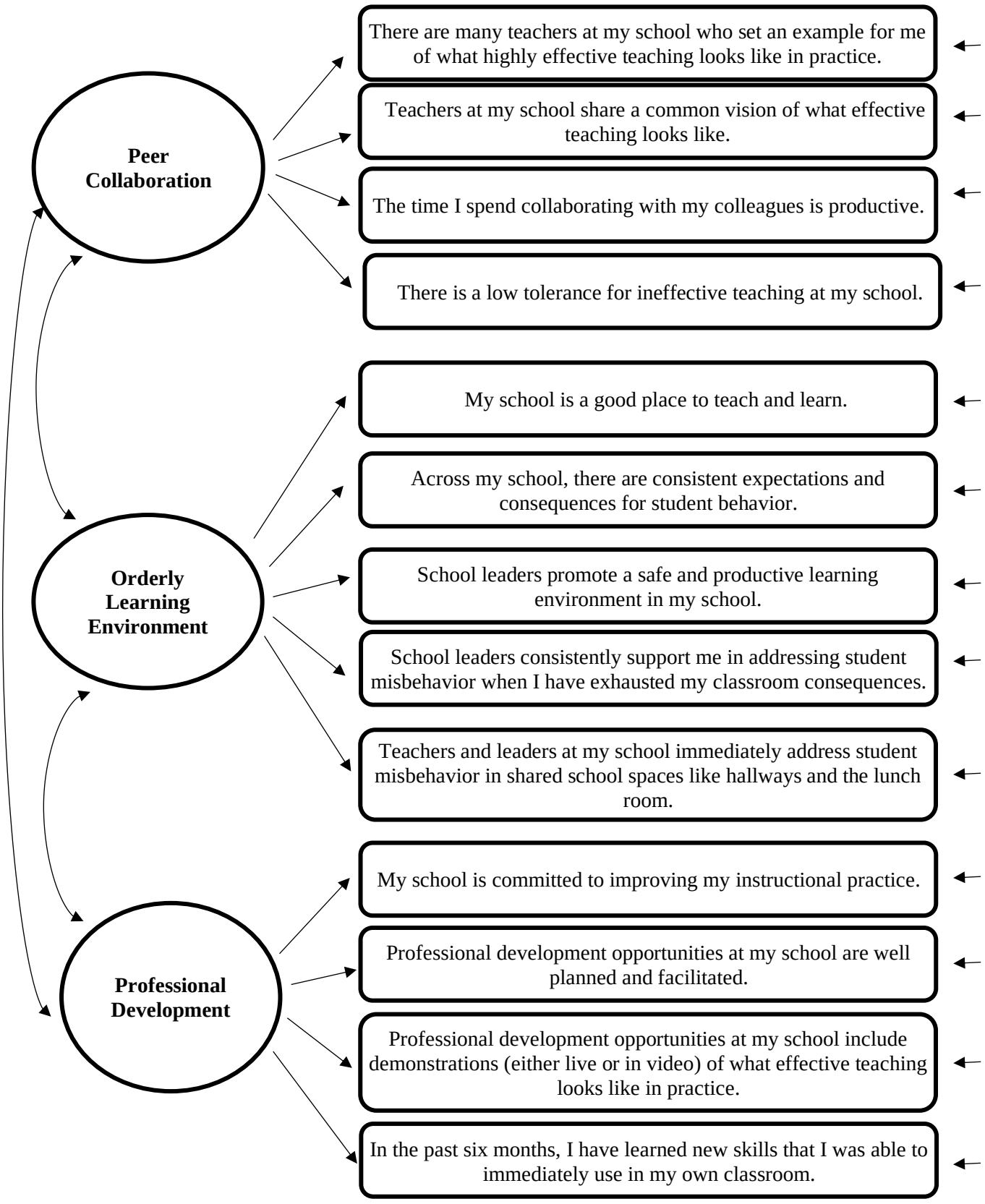
	Test Scores	Effective Incoming Teachers	Product	Test Scores	Peer Collaboration	Product	Test Scores	Orderly Learning Environment	Product	Test Scores	Professional Development	Product
Prior Year Test Score	.3874204	.0003745	.0001451	.3874204	.0029075	.0011264	.3874204	.0005615	.0002175	.3874204	.000105	.0000407
Female	.0076782	7.11e-06	5.46e-08	.0076782	2.86e-08	2.19e-10	.0076782	.0000122	9.38e-08	.0076782	.0000646	4.96e-07
FRPL	.0036149	.0001572	5.68e-07	.0036149	.0021934	7.93e-06	.0036149	.0005338	1.93e-06	.0036149	.0000236	8.54e-08
ELL	.0044223	.0004126	1.82e-06	.0044223	.0033379	.0000148	.0044223	.004328	.0000191	.0044223	.0046057	.0000204
SPED	.0740796	.0000726	5.38e-06	.0740796	.0009757	.0000723	.0740796	.0000675	5.00e-06	.0740796	.0002004	.0000148
Minority	.0038134	.0005082	1.94e-06	.0038134	.0001959	7.47e-07	.0038134	1.57e-06	5.98e-09	.0038134	.0003231	1.23e-06
Proportion FRPL	.0018039	.0015935	2.87e-06	.0018039	.0975453	.000176	.0018039	.0109077	.0000197	.0018039	.000243	4.38e-07
Proportion ELL	.0001146	.0018147	2.08e-07	.0001146	.0248551	2.85e-06	.0001146	.0357341	4.10e-06	.0001146	.0427119	4.90e-06
Proportion SPED	.0045758	.0038721	.0000177	.0045758	.0275944	.0001263	.0045758	.0031797	.0000145	.0045758	.001418	6.49e-06
Proportion Minority	.000039	.0052158	2.03e-07	.000039	.0000705	2.75e-09	.000039	7.74e-08	3.02e-12	.000039	.0109102	4.25e-07

Note. Each cell is an individual regression model. R^2 values are multiplied together to obtain values in the product column.

Appendix Table 11. OLS Results for Test Scores and Each Mediator

	(1) Test Scores	(2) Proportion Effective Incoming Teachers	(3) Peer Collaboration	(4) Safe and Orderly Learning Environment	(5) Support and Development
Ever iZone*After	0.17***	0.03	0.43+	-0.15	0.48*
	(0.05)	(0.03)	(0.22)	(0.26)	(0.20)
After Turnaround	0.06*	0.04**	0.21	0.09	-0.04
	(0.02)	(0.01)	(0.16)	(0.09)	(0.13)
Student Characteristics					
Prior Year Lag	0.61***	-0.00*	0.00	-0.01	0.00
	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Female	0.05***	0.00	0.00	0.00	0.00
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
FRPM	-0.04***	-0.00	-0.02	0.02	0.01
	(0.01)	(0.00)	(0.01)	(0.01)	(0.02)
ELL	-0.16***	-0.01***	-0.05+	-0.00	0.02
	(0.03)	(0.00)	(0.02)	(0.04)	(0.03)
SPED	-0.31***	-0.01*	0.01	-0.04*	0.03
	(0.02)	(0.00)	(0.02)	(0.02)	(0.02)
Black	-0.17***	0.00	-0.03	0.06	0.01
	(0.02)	(0.01)	(0.03)	(0.04)	(0.03)
Hispanic	-0.00	0.01	0.01	0.06	-0.01
	(0.03)	(0.01)	(0.02)	(0.05)	(0.04)
Asian	0.05	0.02	0.03	0.09	0.07
	(0.03)	(0.01)	(0.04)	(0.09)	(0.05)
Pacific Islander	-0.05	0.01	-0.07	0.51***	0.23*
	(0.09)	(0.05)	(0.13)	(0.11)	(0.10)
Native American	-0.15+	-0.01	-0.10	-0.07	0.01
	(0.08)	(0.02)	(0.08)	(0.09)	(0.09)
Proportion Minority	-0.22	2.78+	6.76	-10.70	-5.66
	(1.53)	(1.51)	(6.93)	(8.18)	(10.82)
Proportion FRPL	0.18	0.09	1.93**	-0.97	-1.28
	(0.11)	(0.10)	(0.72)	(0.80)	(0.88)
Proportion ELL	0.34	0.38	3.09	-8.66+	4.02
	(0.66)	(0.43)	(2.88)	(4.71)	(3.06)
Proportion SpED	0.28	0.30	1.69	8.12*	3.66
	(0.37)	(0.41)	(1.81)	(3.83)	(3.41)
Constant	0.06	-2.83+	-9.17	10.00	5.79
	(1.60)	(1.53)	(6.88)	(8.32)	(11.16)
Observations	161511	161511	161511	161511	161511
Schools	62	62	62	62	62

Note. + p<0.10; * p<0.05; ** p<0.01; *** p<0.001 All model include school, grade, and subject fixed effects.



Appendix Figure 1. Measurement Model. For simplicity, correlations between errors for all items loading onto each latent factor are not shown.

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CHAPTER 2

IS TEACHER EFFECTIVENESS STABLE ACROSS SCHOOL CONTEXTS? AN EXAMINATION OF TEACHERS WHO TRANSFER INTO TURNAROUND SCHOOLS

Introduction

School turnaround initiatives promising to dramatically improve student achievement often rely on interventions that help low-performing schools to recruit effective teachers (Dragoset et al., 2017; Malen et al., 2002; Malen & Rice, 2004). These staff replacement policies in turnaround schools have received substantial resource investments and policy attention, but evaluations report mixed results on student achievement even when the reforms successfully bring high-performing teachers into low-performing schools (Carlson & Lavertu, 2018; Glazerman et al., 2013; Henry et al., 2020). Mixed results in some reform models despite an influx of effective teachers calls into question the assumption that effective teachers will perform equally well after transferring into a turnaround school.

To test this assumption, I examine the stability of teacher effectiveness after they transfer into turnaround schools in Tennessee. The Tennessee context is highly informative for this study because the state has been implementing two active turnaround models that have both recruited effective teachers into their schools (Henry et al., 2020): the Achievement School District (ASD) and local Innovation Zones (iZones). I describe the ASD and iZone reforms in detail below, but while both models recruited effective teachers, prior research finds that ASD schools did not improve student achievement, while iZone schools produced significantly positive effects (Pham et al., 2020; Zimmer et al., 2017). Therefore, comparing changes in the effectiveness of teachers who transfer into ASD schools relative to teachers who transfer into iZone schools provides

important new insights to explain whether the mixed impact of turnaround reforms can be at least partially explained by changes in teacher effectiveness after they transfer.

Additionally, this study makes important contributions to our understanding of contextual influences on teacher effectiveness. While a couple of studies have examined differences in teacher effectiveness after transferring across schools serving different poverty levels or schools with different levels of academic performance (Xu et al., 2012, 2015), researchers have generally focused on comparing low-performing schools with their higher-performing counterparts, with very little attention to differentiating turnaround schools from other low-performing schools. Specifically focusing on teacher effectiveness in the turnaround context is important because these schools have the most resources to recruit teachers, so a large proportion of teachers transferring into low-performing schools are likely moving into a turnaround setting (Papay & Hannon, 2018; Springer et al., 2015; Strunk, Marsh, Hashim, & Bush-Mecenas, 2016; Zimmer et al., 2017). Moreover, teacher effectiveness in turnaround schools will likely differ from other low-performing schools because of the high-pressure environment and expectation for rapid change that is unique to turnaround. For example, after transferring to a turnaround school, teachers may improve their instructional practice because of the increased resources and unifying goal of dramatic improvement, or they may have difficulty maintaining a consistent level of effectiveness given strong pressure to quickly improve test scores. Also, turnaround interventions can affect the culture and climate in schools, and reforms that create a more orderly learning environment or provide more opportunities for collaboration may help teachers improve, whereas disruptive reforms that leave teachers without consistent administrative support could result in lower teacher effectiveness.

Using statewide administrative data from Tennessee, this study contributes more nuanced evidence at the intersection of research on school reform and teacher effectiveness by examining teachers before and after they transfer into turnaround schools. I use difference-in-differences models with teacher and school fixed effects to estimate within-teacher changes in effectiveness after transferring to a turnaround school relative to teachers transferring into low-performing but non-turnaround schools. Given these goals, this study answers the question: To what extent does transferring into a turnaround school change teachers' effectiveness?

My results suggest that teachers who move into iZone schools perform significantly better in both reading and math, relative to teachers who move into low-performing comparison schools. These increases in teacher effectiveness align with previous research finding that iZone reforms improved the schools' professional environment and suggests that turnaround reforms should focus on both recruiting teachers and creating a professional environment where they can be effective (Strunk, Marsh, Hashim, & Bush-Mecenas, 2016). In contrast, I find that after moving into ASD schools, teachers perform worse in reading, relative to teachers who move into low-performing but non-turnaround schools. In math, the difference is not statistically significant. These results suggest that ASD reforms may have failed to improve student achievement partly because teacher effectiveness declined after they moved into ASD schools. Moreover, when examining the heterogeneity of effects, I find that positive effects in reading for teachers who transfer into iZone schools are larger for Black teachers. The same effect for Black teachers transferring into ASD schools is not significant. Overall, my results indicate that teachers who transfer into turnaround schools face a different environment from other low-performing school settings, and successful reforms should attend to helping teachers adjust after they move while also carefully considering how the reforms themselves affect the schools'

culture and climate. That is, hiring effective teachers does not, on its own, explain the positive effect of reforms, and a professional environment conducive to effective instruction is likely also necessary.

Review of the Literature

Many models for school reform, including the most prominent turnaround initiatives, rely to some extent on recruiting effective teachers (Carlson & Lavertu, 2018; Gill et al., 2007; Papay & Hannon, 2018; Schueler et al., 2017; Strunk, Marsh, Hashim, & Bush-Mecenas, 2016). The focus on teacher recruitment has been largely influenced by two consistent findings in the research literature. First, teachers are the single most important school-based contributor to student achievement (Aaronson et al., 2007; Chetty et al., 2011; Rivkin et al., 2005; Rothstein, 2014; Sanders & Rivers, 1996). Second, high-performing teachers are unevenly distributed across schools, because more effective and more experienced teachers tend to transfer into higher-performing schools in lower-poverty communities (Clotfelter, 2001; Feng & Sass, 2017; Hanushek et al., 2004; Imazeki, 2005; Lankford et al., 2002; Scafidi et al., 2007). Together, these two findings support a course of action where low-performing schools are given resources and either encouraged or required to recruit effective teachers. Under No Child Left Behind (NCLB), this theory of action was operationalized through the four turnaround models federally mandated for schools receiving School Improvement Grants (SIGs): restart, turnaround, transformation, or closure. In order to avoid closure, schools could opt to restart, which involves closing and re-opening under new management. Besides restarting, schools could also choose turnaround or transformation. Turnaround requires replacement of the school leader and at least 50 percent of the instructional staff, while transformation requires replacement of the school leader in addition

to other interventions. Collectively referred to as turnaround, these four models have been heavily influential in shaping school reform efforts in recent years.

Under the current Every Student Succeeds Act (ESSA), efforts to support low-performing schools have become more diverse, with states given more autonomy over how to support these schools. Although states are no longer limited to one of the four SIG-prescribed turnaround models, current school reform initiatives continue to prioritize attracting high-performing teachers into low-performing schools using strategies like recruitment bonuses (Glazerman et al., 2013; Springer et al., 2015), involuntary transfer policies (Grissom et al., 2014), academies taught by the highest performing teachers in the district (Schueler et al., 2017), and residency programs that place promising new teachers into high-need schools. The practice of recruiting effective teachers appears to be well supported by existing research on the impact of teachers, but these staffing interventions all assume that teacher effectiveness is largely stable across different school settings, and existing literature provides evidence that contextual factors can influence teachers (Jackson, 2013).

Both organizational theory and empirical evidence suggest that school climate, culture, and context all shape teachers' motivation, sense of self-efficacy, and satisfaction (Johnson et al., 2012; Kraft & Papay, 2014; Ladd, 2011; Loeb et al., 2005). For example, researchers find evidence that peer effects can alter teacher performance through productivity norms (Mas & Moretti, 2009) and informal learning networks (Jackson & Bruegmann, 2009). In addition to peers, multiple factors could potentially influence teacher effectiveness across schools, including level of administrative support (Boyd et al., 2011), availability of instructional resources (Horng, 2010), opportunities for in-service professional learning (Henry, Bastian, & Fortner, 2011; Kraft, Blazar, & Hogan, 2016), and orientation activities that help new teachers acclimate to the

school (Ingersoll & Strong, 2011). These contextual features are especially influential in the turnaround context, because reforms can affect schools' professional environment. For example, turnaround interventions that invest in recruiting and supporting effective school leaders will likely give rise to a professional environment where disciplinary expectations are consistent schoolwide and teachers receive reliable administrative support. Thus, the effect of reforms on school culture and climate are distinct features that can affect teachers' performance once they transfer.

Given evidence that school context matters, a few studies have investigated the stability of teacher effectiveness across schools (Jackson, 2013; Xu et al., 2012, 2015), but the thin literature on this topic generally examines teacher effectiveness when they move from lower-poverty/lower-performing to higher-poverty/higher-performing schools, without attention to the distinct environment in turnaround schools. For example, Xu and colleagues (2012) find that teacher value-added scores are not impacted when they transfer from schools serving fewer economically disadvantaged students to schools with more disadvantaged students. However, Jackson (2013) finds that within-teacher variation in value-added scores varies substantially between schools. Mixed findings from the few studies on this topic suggest that teacher effectiveness can change when switching schools, but not always, and the direction of that change remains unclear, depending perhaps on the teacher's new school, her individual characteristics, or some combination of both. Thus, by focusing on a policy-relevant but unexamined school context (turnaround schools), this paper adds nuance to research on the stability teacher effectiveness by studying the distinct environment of schools undergoing mandated reforms.

Within the school turnaround literature, research on the stability of teacher effectiveness is especially important given mixed results from impact evaluations that investigate the relationship between teacher recruitment and student achievement. Some researchers find that the positive effect of turnaround can be partly attributed to the recruitment of high-performing teachers (Carlson & Lavertu, 2018; Dee, 2012; Henry et al., 2020; Papay & Hannon, 2018; Strunk, Marsh, Hashim, Bush-Mecenas, et al., 2016). Other researchers find that even when turnaround schools bring in effective teachers, student test scores do not improve (Heissel & Ladd, 2017; Henry et al., 2020; Zimmer et al., 2017). This study provides a potential explanation for these disparate findings by examining whether teacher effectiveness may change after they transfer into a turnaround school.

Situated at the intersection of research on school turnaround and teacher effectiveness, this paper makes several contributions. First, it contributes to literature on the stability of teacher effectiveness by examining turnaround schools as a unique context among low-performing schools. Second, this analysis allows me to examine an important theoretical assumption that has received very little attention in the school reform literature: that teachers recruited into turnaround schools will remain similarly effective after they transfer. Third, as states continue to evaluate and refine school improvement plans under ESSA, this research makes a practical policy contribution by helping educational authorities to better understand the extent to which teacher effectiveness changes across schools. Finally, this study contributes new information to help reconcile mixed findings from the turnaround literature over the effect of teacher recruitment on student achievement, because simply recruiting effective teachers may not be enough to improve low-performing schools. Rather, improving school performance also requires attention to how the school's professional environment affects teachers' performance.

Background on School Turnaround in Tennessee

Tennessee's turnaround approach required its Department of Education (TDOE) to identify the lowest-performing five percent of schools in the state, called priority schools. Priority schools are then eligible for one of two turnaround interventions: the ASD and local iZones. As Tennessee's boldest school reform model, the ASD is a statewide school district that removes priority schools from their local district to either directly manage them or convert them into charter schools managed by charter management organizations (CMOs). The ASD approach is similar to many restart models across the country that use state takeover in partnership with external management organizations to dislodge chronically performing schools from the governance and management structures that have led to years of low-performance (Gill et al., 2007; Schueler et al., 2017). In contrast, the iZones are a less dramatic model where schools remain part of their local district but are managed as part of a specialized network that is supported by full-time district staff. The iZone model has grown in popularity across the country as a way for states to give schools and districts more flexibility in implementing improvement strategies that are free from the burden of administrative regulations (Patrick et al., 2018).

From 2012-13 (the first year of Tennessee's turnaround efforts) through 2017-18 (the last year of data available for this study), Tennessee designated 116 schools as priority, most of which were located in Memphis, Nashville, Chattanooga, or Knoxville. Since priority schools could be placed into either the ASD or an iZone, the decision of which new schools would be targeted for turnaround was made annually in meetings between TDOE and district leaders. My communications with TDOE and district leadership suggest that priority schools were not systematically chosen for ASD or iZone reforms. The only commonly used criteria was a desire

to select schools within the same feeder pattern. Thus, both the ASD and iZones first targeted elementary schools and subsequently added middle and high schools in the same feeder pattern. Because of this desire to select schools in the same feeder pattern, many ASD and iZone schools were located relatively close to each other. By 2017-18, 25 of the 116 priority schools had joined the ASD, 40 joined an iZone, 25 were closed, and 26 were still operating without any turnaround interventions (i.e., business-as-usual). Thus, in this study, I use teachers who transfer into non-turnaround priority schools as a comparison group for teachers who transfer into ASD and iZone schools and show in Appendix Table 1 that ASD, iZone, and non-turnaround priority schools have similar achievement levels and demographic characteristics in the years before turnaround.

Although the ASD and iZone governance and management models differ markedly (i.e., the state-led ASD versus district-led iZones), the two models share a few similarities. First, both models focused on replacing teachers in the first year of turnaround as part of a bold push to recruit effective educators. To aid in recruitment, TDOE implemented a bonus pay program that provided turnaround schools with US$7,000 bonuses to recruit teachers with effectiveness ratings of five, the highest possible score on Tennessee's value-added assessment system (TVAAS). Thus, in the first year after beginning turnaround reforms, ASD and iZone schools recruited more teachers with high value-added scores than non-turnaround priority schools (Henry et al., 2014). Also, both models required schools to continue enrolling students from the school's local catchment area, including ASD schools managed by CMOs. This meant that neither the ASD nor iZone could choose what students attended their schools.

Besides different management structures, the ASD and iZones also implemented different reforms. After initial efforts to replace the principal and teachers, the ASD gave school leaders and operators wide autonomy over day-to-day management, while the ASD central leadership

mostly monitored progress. This approach reflects a theory of action that relies on recruiting effective educators then removing bureaucratic obstacles so these educators can focus on improving student achievement. In contrast, iZone schools were given ongoing attention and resources from their districts. Thus, iZone schools hired additional instructional coaches, expanded professional learning communities, and offered performance bonuses for effective teachers (Iyengar et al., 2017). Additionally, the different ASD and iZone management structures and reform practices led to differing levels of support from local communities around these turnaround schools (Glazer & Egan, 2018).

Research evaluating the overall impact of the ASD and iZones finds that ASD schools did not perform better or worse than priority schools receiving no turnaround interventions, while iZone schools produced positive and significant student achievement gains (Pham et al., 2020; Zimmer et al., 2017). To help explain these results, research examining mediating mechanisms finds that ASD schools experienced high teacher turnover rates every year, which suppressed potentially positive ASD effects (Henry et al., 2020). However, one notable finding from Henry and colleagues (2020) is that both ASD and iZone schools hired effective teachers. Therefore, Tennessee's turnaround schools are a highly informative setting for examining the stability of teacher effectiveness, because differences in the overall effect of reforms may be partly explained by changes in teacher effectiveness after they transfer into ASD versus iZone schools.

Methods

Data and Measures

Data for this analysis are provided by TDOE and managed by the Tennessee Education Research Alliance. These administrative data contain characteristics of student (e.g., test scores),

teachers (e.g., value-added score), and schools (e.g., addresses) for all public schools throughout the state, between 2006-07 and 2017-18.[5] The student-level data contain student test scores in reading and math, which I use as my primary outcome of interest. Since Tennessee's state tests consist of end-of-grade (EOG) exams in grades 3-8 and end-of-course exams (EOC) in high school grades, these test score data are standardized at the year-subject-grade level for EOGs and at the year-subject-semester level for EOCs. The student data also include demographic characteristics such as gender, race/ethnicity, and English language learner status (ELL), free-or-reduced price meals eligibility (FRPM), and special education eligibility (SPED). Additionally, I create an indicator for whether the student is new to the school after making a nonstructural move. This new-to-school indicator does not count students as mobile in years where they make structural moves due to changing school levels (e.g., moving to a middle school after completing the final grade offered at an elementary school).

The teacher-level datasets contain demographic variables (e.g., gender, race/ethnicity, age), professional characteristics (e.g., salary, highest degree earned, years of experience), and performance ratings (e.g., observation scores). Tennessee's teacher evaluation system provide teachers with observation scores that range from 1 (Not Effective) to 5 (Highly Effective). Additionally, the data include TVAAS (value-added) scores for teachers in tested grades and subjects, which I standardize statewide within each year.

Finally, the school-level data include total enrollment, school level (elementary, middle, high), and school performance ratings, and I can aggregate relevant student and teacher characteristics up to the school level. Teachers and students can be linked to individual schools and with each other in each academic year, so I can identify when teachers move and link them

[5] Tennessee is missing test score data for grades 3-8 in 2015-16 because these scores were invalidated when technological malfunctions from a new version of the state test caused complications during the test administration.

to both the sending and receiving schools. With the ability to identify sending and receiving schools, I also use school addresses to calculate the geodetic distance (as the crow flies), travel distance, and travel time between sending and receiving schools. The travel distance and travel time are calculated using the *Here* application program interface, which estimates driving distance and time based on *Here*'s proprietary database of average traffic conditions. I calculate these distances using the *geodist* (Picard, 2012) and *georoute* (Weber & Péclat, 2017) commands in Stata.

Given these data, my analytic sample is composed of all teachers in tested grades and subjects in Tennessee public schools who transfer into an ASD, iZone, or comparison priority school. Schools are considered part of the ASD or iZone only in years after they undergo reform.[6] Although I have the full sample of all public-school teachers, my main focus is on comparing the effectiveness of teachers who move into ASD or iZone schools with teachers who move into comparison priority schools, so the sample does not include teachers who transfer into non-priority schools or teachers who never transfer schools. Using only teachers who transfer between schools allows me to compare teacher effectiveness, net the influence of moving itself, and I use only teachers who transfer to non-turnaround priority schools as a comparison group to align with my theory that turnaround schools are a unique environment relative to other low-performing schools.

In addition to examining only teachers who move into priority schools, I make two additional restrictions. First, I restrict the sample to only the observations in the sending and receiving schools before and after the first time a teacher moves from a non-priority school into a

[6] Schools that will eventually become priority schools are categorized non-priority schools in the years before they are designated as priority. Priority schools that will eventually be taken over by the ASD or iZone are categorized as part of the comparison group in the years before they actually join the ASD or an iZone.

priority school. This restriction provides a cleaner interpretation because it does not include any instances where teachers make multiple moves from one priority school to another. However, in practical terms, this restriction is unlikely to affect my results because less than one percent of the total teacher-year observations are cases where teachers move into multiple priority schools. Also, there are some cases of teachers who move into a priority school then stay as that school transitions to being part of the ASD or an iZone, and I do not include these teachers in the sample. While these teachers do experience some changes in school environment when the school begins turnaround, they differ from teachers who move between schools because they continue to work with the same population of students even after turnaround interventions are put into place. This restriction removes about four percent of all teachers who ever move into priority schools.

Thus, my sample of teachers who move into priority schools can be divided into three mutually exclusive groups: (1) those who ever move into an ASD priority school, (2) those who ever move into an iZone priority school, and (3) those who ever move into a non-ASD, non-iZone priority school. For each of these three groups, I examine teachers' effects on student test scores in the sending school before they move with the receiving school after they move.[7] Appendix Table 2 provides counts for the number of unique teachers in each category who can be linked with student test scores in reading and math. The table shows that my sample consists of 1,965 unique teachers in reading and 1,908 teachers in math.

[7] Note that it is possible for some of these teachers to move from a sending school that will later be designated as priority but were not yet priority schools when the teacher was working there. When I remove these teachers (keeping only teachers who come from sending schools that have never been designated as priority), my results are similar, see Appendix Table 3.

Analytic Strategy

To examine the stability of teacher effectiveness, I use a quasi-experimental difference-in-differences (DID) model with teacher and school fixed effects similar to models used in prior research to examine teacher effectiveness across schools (Jackson, 2013). The DID model uses within-teacher differences in effectiveness before and after transferring into turnaround schools relative to the same before-after difference for teachers who transfer into comparison schools, all while controlling for time-invariant school effects. The DID model relies on the assumption that in the absence of the treatment (i.e., transferring into a turnaround school) the teachers who transfer into turnaround schools would have similar changes in effectiveness as teachers who transfer into comparison schools. After describing the analytic strategy, I show evidence that the assumption of parallel trends holds in my data. I also outline a series of alternative specifications and robustness checks which I use to provide additional evidence supporting estimates from the DID model as a plausibly causal effect of transferring into turnaround schools.

Thus, I estimate the following model, where y is the test score for student i in grade g with teacher j in school s at time t.

$$y_{igjst} = \beta_0 + \beta_1 Postmove_{jt} + \beta_2 PostMove_{jt} * MovetoASD_j + \beta_3 PostMove_{jt} * MovetoiZone_j + \beta_4 y_{igst-1} + X'_{igjst}\alpha + J'_{jt}\pi + \theta_j + \delta_s + \phi_g + \varepsilon_{igjst} \quad \text{(Equation 1)}$$

Equation 1 includes $PostMove$, an indicator that equals one in all years after teachers move into a priority school. Thus, β_1 estimates the average difference in student achievement for teachers before and after moving into a comparison priority school. $MovetoASD$ and $MovetoiZone$ are indicators for teachers who ever move into either ASD or iZone schools,

respectively.[8] Thus, the interaction terms allow me to estimate the coefficients of interest β_2 and β_3, which represent the difference in student achievement before and after moving for teachers who move into ASD or iZone schools relative to the same difference for teachers who move into comparison priority schools. Equation 1 also includes prior year test scores (y_{igst-1}), meaning that effects are on student achievement gains rather than levels. In Appendix Table 4, I also test models that include quadratic prior-year achievement terms and models that include prior year achievement in both math and reading at the same time. The results are robust to these various specifications, so I primarily report results using only the linear prior year test score. X_{igjst} is a vector of student characteristics used as control variables: gender, race, ELL, FRPM, SPED, and new-to-school. J_{jt} is a vector of teacher characteristics including whether the teacher has a graduate degree and years of experience. Since teacher, year, and experience effects cannot be estimated simultaneously, I follow recommendations in previous literature to include indicators for experience bins (1-3, 4-9, 10-24, and 25 or more), with 25 or more as the reference category (Papay & Kraft, 2015). Equation 1 also includes teacher (θ_j), school (δ_s), and grade (ϕ_g) fixed effects. I estimate Equation 1 on reading and math test scores separately, with robust standard errors clustered at the teacher level. In Appendix Table 5, I also test and find similar results when using standard errors clustered at the school level and bootstrap standard errors calculated from randomly sampling the data 1,000 times, with replacement.

The teacher and school fixed effects in Equation 1 are especially important because they allow me to disentangle school-specific teacher effects from the overall effect of the school and

[8] *MovetoASD* and *MovetoiZone* are not included separately because they are perfectly collinear with the teacher fixed effect.

the general effect of the teacher.[9] The school effect includes any features that affect all teachers and students equally at a school (e.g., a strong leadership team, access to high quality instructional resources). Similarly, any teacher specific factors that equally affect all of her students (across all of her schools) would be part of general teacher effect (e.g., content expertise). Controlling for the school and general teacher effect allows me to leverage variation in teacher effectiveness across different school settings (i.e., complementarities between specific teachers in specific schools). Heterogeneity across different teacher-school combinations is exactly the variation I want to capture to examine the stability of teacher effectiveness.

While the school fixed effect allows me to control for average levels of school-specific student achievement by removing mean differences across schools, the school fixed effect does not account for time-varying school characteristics that may simultaneously influence teacher effectiveness and the likelihood that she will transfer schools. For example, losing an effective principal could simultaneously decrease student achievement and increase the probability that teachers will leave. I examine this possibility using two approaches. First, I estimate Equation 1 with the addition of multiple time-varying school characteristics. Second, I replace the school fixed-effect with a school-by-year fixed effect. I discuss results from both approaches below, but generally find that my results are robust to both specifications, suggesting that time-varying school characteristics are unlikely to bias my results. Thus, I primarily present results from the more parsimonious model containing teacher and school fixed effects.

In addition to estimating to the overall effect of moving, I also estimate trends in teacher effectiveness over time using an event history model:

[9] As a supplementary analysis in Appendix Table 11, I also examine a model with student-by-school fixed effects to control for potential systematic assignment of the high scoring students to teachers who transfer from turnaround schools. Conclusions from this analysis are the same.

$$y_{igjst} = \beta_0 + \sum_{\kappa=-5}^{\kappa=3} \beta_{1\kappa} MoveYear_{j\kappa} + \sum_{\kappa=-5}^{\kappa=3} \beta_{2\kappa} MoveYear_{j\kappa} * MovetoASD_j + \sum_{\kappa=-5}^{\kappa=3} \beta_{3\kappa} MoveYear_{j\kappa} * MovetoiZone_j + \beta_4 y_{igst-1} + X'_{igjst}\alpha + J'_{jt}\pi + \theta_j + \delta_s + \phi_g + \varepsilon_{igjst}$$

(Equation 2)

Equation 2 replaces the $PostMove$ indicator with a vector of indicators for the number of years before and after teachers transfer into the priority school ($MoveYear$), where zero is the year immediately prior to moving and one is the first year after teachers move into the priority school. Since turnaround began in 2012-13, it is possible for teachers to move into a priority school in 2012-13 and have six years of post-move outcomes through 2017-18; however, the number of teachers who have more than three years of post-move data is extremely limited, especially after separating into ASD, iZone, and comparison priority schools (see Appendix Table 2). Therefore, I estimate Equation 2 using indicators for one, two, and three or more years after moving.[10] Interactions between the year indicators and $MovetoASD$ and $MovetoiZone$ allow me to estimate the cumulative effect for each year before and after moving, with year zero as the reference category. For example, $\beta_{2\kappa=2}$ is the cumulative effect for a teacher who is in her second year after moving into an ASD school relative to the year just before she moves, all compared with a teacher in her second year after transferring to a non-turnaround priority school. Equation 2 is also estimated for reading and math separately with standard errors clustered at the teacher level.

[10] Following a similar logic, the year indicators start at -5, representing 6 or more years before the move.

Finally, in order to better understand whether teacher characteristics have a moderating influence on the effect of transferring into a turnaround school, I estimate Equation 1 with the addition of individual teacher characteristics interacted with the post-move indicators and the indicators for moving into ASD and iZone schools. Specifically, the teacher characteristics I examine include: (1) whether the teacher is female, (2) whether the teacher is Black,[11] (3) whether the teacher has a graduate degree, (4) whether the teacher had a TVAAS score of four of greater in the year before moving, (5) whether the teacher has more years of experience that the median for all movers, in the year before moving, (6) whether the teacher's tenure in the sending school is above median in the year before moving,[12] and (7) whether the teacher came from a nonpriority sending school. Thus, the three way interactions for each characteristic ($Teacher\ Characteristic * PostMove * MovetoASD$ and $Teacher\ Characteristic * PostMove * MovetoiZone$) allow me to estimate heterogeneous effects of moving into ASD or iZone schools for different groups of teachers.

Results

Descriptive Results

Before discussing the DID results, Table 1 below shows descriptive characteristics of all teachers who move into priority schools, in the baseline year before they move. Most teachers who move to a priority school are female (74-81 percent) and Black (61-68 percent), and the vast

[11] The reference category here is non-Black teachers, but the vast majority of non-Black teachers in this context are white, because only about 1 percent of teachers are not Black or white.
[12] I use median years for experience and tenure, because both of these variables are right skewed due to a few teachers who have many years of experience in one school. Using the mean does not change my conclusions. The median years of experience for movers in the year before moving is six years. The median tenure length is two years.

majority of non-Black teachers are white (31-38 percent), with fewer than 1 percent who are a different race/ethnicity. Table 1 shows substantive differences between the characteristics of teachers who move into ASD, iZone, and comparison priority schools. Both the ASD and iZone schools were able to hire teachers with higher TVAAS and observations scores than comparison schools, with the most effective teachers moving into iZone schools. For example, teachers moving into iZone schools had an average observation score of 3.74 relative to 3.67 and 3.57 for teachers moving into ASD and comparison schools, respectively.[13] Teachers moving into ASD schools also tended to be younger and have fewer years of experience than teachers moving into iZone and comparison schools. The modal group of teachers moving into ASD schools have 1-3 years of experience (about 47 percent), whereas the modal group of teachers moving into iZone (36 percent) and comparison schools (40 percent) have 10-24 years of experience. Previous research has shown that these differences in the effectiveness and experience of teachers moving into ASD and iZone schools help to partly explain positive iZone effects (Henry et al., 2020).

In addition to describing characteristics of teachers, Table 1 also shows that, depending on whether they move to ASD, iZone, or comparison schools, about 73 to 80 percent of teachers who move into priority schools are coming from other schools in the same district, with an average geodetic distance of 16.4 to 18.9 miles between schools. Travel distances are similar, translating to an average travel time of nearly 30 minutes between sending and receiving schools. These times suggest that teachers who move into priority schools are coming from sending schools that are not very far away.

[13] Note that all teachers in this sample have prior year observation scores because all were observed in a sending school before transferring.

Table 1. Descriptive Characteristics Movers in the Year Prior to Moving

	Teachers who Move to Comparison Schools	Teachers who Move to ASD School	Teachers who Move to iZone School
Characteristics of Teachers			
Female	0.74	0.81	0.81
Age (Years)	42.51	35.77	40.68
White	0.31	0.33	0.38
Black	0.68	0.66	0.61
Other Race	0.01	0.01	0.01
Standardized TVAAS Index	-0.33	-0.18	-0.11
Observation Score (1-5)	3.57	3.67	3.74
Teacher Salary ($1000)	52.56	47.28	50.70
Tenure	3.35	2.66	3.53
Experience: 1-3 Years	0.25	0.47	0.29
Experience: 4-9 Years	0.24	0.29	0.26
Experience: 10-24 Years	0.40	0.20	0.36
Experience: 25 Plus Years	0.11	0.04	0.09
MA Degree or Higher	0.64	0.55	0.66
Characteristics of Move			
Within District Move	0.78	0.73	0.80
Geodetic Distance (miles)	16.43	18.94	17.52
Travel Distance (miles)	20.49	23.29	21.74
Travel Time (minutes)	27.27	29.51	28.54

Note. Only teachers who move into ASD, iZone, or comparison priority schools are included in the sample.

To better describe changes in teachers' school setting before and after they move, Table 2 shows average characteristics of sending and receiving schools for teachers who move into ASD, iZone, and comparison schools. The table shows that, on average, teachers in the sample are moving between low-performing schools with below-average standardized test scores. However, teachers who move into priority schools tend to be coming from somewhat higher performing sending schools, reflecting the status of priority schools as the lowest-performing schools in the state. Moreover, sending schools tend to serve larger proportions of white students, fewer FRPM eligible students, and fewer new-to-school students. Also, students in sending schools tend to

have somewhat higher attendance rates. For example, teachers move from sending schools where 77 percent of students are FRPM eligible on average to receiving iZone schools where 89 percent of students are FRPM eligible. Overall, these results show that teachers who transfer into priority schools are coming from sending schools that are modestly higher performing and serving slightly fewer disadvantaged students.

Although all teachers moving into priority schools tend to come from sending schools with higher proportions of white teachers and teachers with more years of experience, descriptive teacher characteristics between sending and receiving schools reveal different patterns between ASD and iZone schools. For example, teachers who move into ASD schools are coming from sending schools that average 10.37 years of teacher experience to arrive in ASD schools where average teacher experience is 5.71 years. The parallel values for teachers moving to iZone schools is 12.05 years to 9.47 years of experience. Comparing average teacher TVAAS and observation scores for ASD and iZone schools reveals further differences. Teacher who move into ASD schools are coming from sending schools with average standardized TVAAS scores of -0.17 to an average of -0.48 in the receiving ASD school (a decrease in average effectiveness). However, teachers are moving from sending schools with average teacher TVAAS scores of -0.09 to iZone schools with average teacher TVAAS scores of -0.05 (an increase in average effectiveness). Teacher observation scores follow a similar pattern – decreasing for teachers who move into ASD schools and increasing for teachers who move into iZone schools.

Table 2. Descriptive Characteristics of Sending and Receiving Schools

	Comparison		ASD		iZone	
	Sending	Receiving	Sending	Receiving	Sending	Receiving
Student Test Scores						
Average Reading	-0.62	-0.95***	-0.64	-0.98***	-0.50	-0.89***
	(0.59)	(0.56)	(0.59)	(0.46)	(0.62)	(0.52)

Average Math	-0.56	-0.89***	-0.58	-0.97***	-0.44	-0.74***
	(0.61)	(0.55)	(0.59)	(0.54)	(0.61)	(0.51)
Student Body Characteristics						
Proportion Female	0.49	0.49	0.49	0.48**	0.49	0.48***
	(0.05)	(0.09)	(0.04)	(0.03)	(0.04)	(0.02)
Proportion White	0.13	0.03***	0.09	0.02***	0.21	0.05***
	(0.23)	(0.05)	(0.17)	(0.03)	(0.28)	(0.06)
Proportion Black	0.80	0.88***	0.81	0.93***	0.70	0.87***
	(0.27)	(0.15)	(0.23)	(0.10)	(0.32)	(0.14)
Proportion Other Race	0.07	0.10***	0.10	0.05***	0.09	0.08**
	(0.10)	(0.12)	(0.13)	(0.07)	(0.11)	(0.11)
Proportion ELL	0.03	0.05***	0.05	0.03***	0.04	0.04*
	(0.06)	(0.08)	(0.08)	(0.04)	(0.07)	(0.07)
Proportion FRPM	0.81	0.87***	0.82	0.84**	0.77	0.89***
	(0.18)	(0.13)	(0.18)	(0.14)	(0.23)	(0.08)
Proportion SPED	0.15	0.16***	0.13	0.16***	0.15	0.18***
	(0.05)	(0.05)	(0.05)	(0.04)	(0.06)	(0.04)
Proportion New-to-School	0.31	0.36***	0.32	0.35***	0.29	0.36***
	(0.15)	(0.15)	(0.16)	(0.14)	(0.13)	(0.12)
Average Attendance Rate	93.51	91.91***	93.58	91.76***	93.61	91.70***
	(3.10)	(4.96)	(3.38)	(3.33)	(2.68)	(2.46)
Total Enrollment	654.37	521.10***	616.37	424.02***	604.95	486.91***
	(425.03)	(218.32)	(360.02)	(169.48)	(328.62)	(144.85)
Teacher Characteristics						
Proportion Female	0.77	0.75**	0.77	0.79***	0.78	0.77***
	(0.14)	(0.12)	(0.13)	(0.11)	(0.13)	(0.11)
Proportion White	0.41	0.33***	0.39	0.34***	0.51	0.36***
	(0.26)	(0.18)	(0.21)	(0.16)	(0.30)	(0.21)
Proportion Black	0.58	0.66***	0.60	0.64***	0.48	0.62***
	(0.26)	(0.19)	(0.22)	(0.16)	(0.30)	(0.22)
Proportion Other Race	0.01	0.01***	0.01	0.02***	0.01	0.02***
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
Average Experience (Years)	12.58	10.81***	10.37	5.71***	12.05	9.47***
	(3.59)	(3.22)	(4.14)	(1.67)	(3.25)	(2.39)
Proportion MA Degree or Higher	0.57	0.57	0.56	0.50***	0.59	0.61***
	(0.12)	(0.11)	(0.13)	(0.13)	(0.11)	(0.13)
Average Standardized TVAAS Index	-0.23	-0.40***	-0.17	-0.48***	-0.09	-0.05
	(0.58)	(0.65)	(0.65)	(0.66)	(0.51)	(0.58)
Average Observation Score (1-5)	3.78	3.72***	3.83	3.41***	3.73	3.84***
	(0.37)	(0.33)	(0.35)	(0.42)	(0.42)	(0.40)

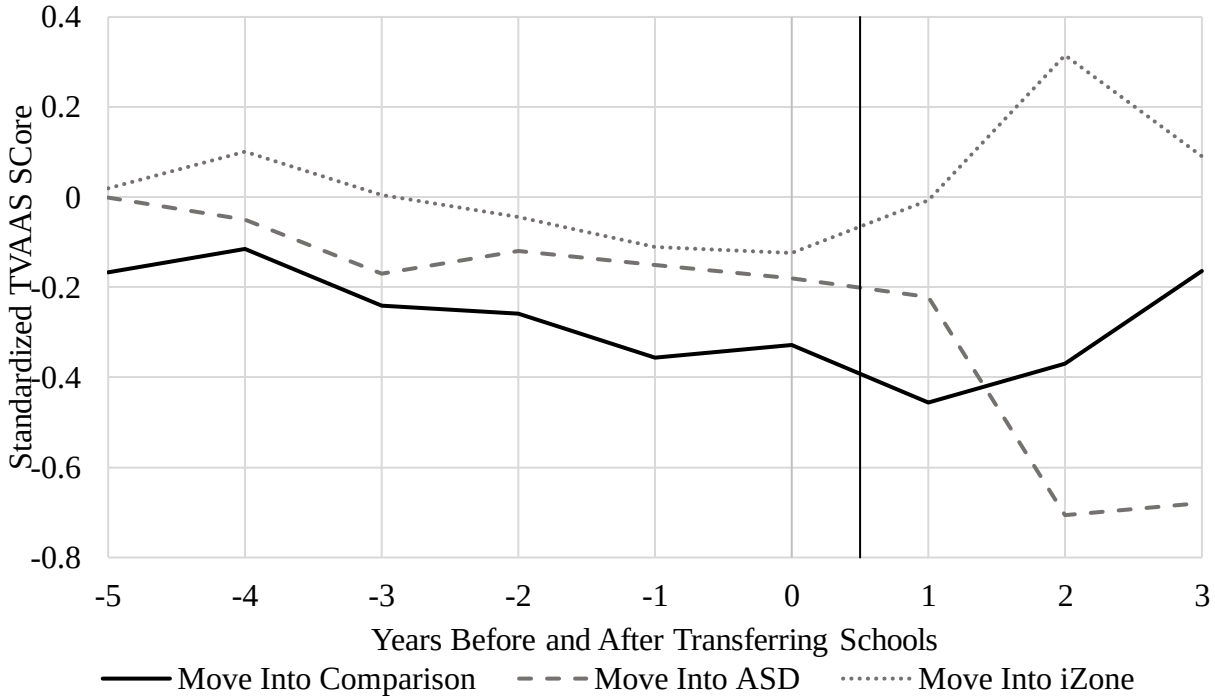
Notes. Standard deviations in parentheses. ASD = Achievement School District; iZone: Innovation Zone; FRPM: free and reduced price meals; SPED: special education; ELL: English language learners; New-to-School includes only student who make a non-structural move. Stars show significance levels from *t*-tests comparing characteristics of sending and receiving schools. + p<0.10 * p<0.05 ** p<0.01 *** p<0.001

Parallel Trends

To examine trends in teacher effectiveness, I plot average standardized TVAAS scores for teachers in each of year before and after she transfers into a priority school in Figure 1. Figure 1 shows that, prior to moving, teachers who move into ASD, iZone, and comparison

schools have effectiveness trends that are reasonably similar, suggesting that teachers moving into comparison priority schools are a valid counterfactual for teachers moving into turnaround schools. After moving, Figure 1 shows noticeable drops in average teacher TVAAS for ASD teachers, whereas teachers who move into iZone schools had increased TVAAS scores. Appendix Figure 1 shows similar patterns when using observation scores to measure teacher effectiveness.

Figure 1. Average TVAAS Scores in the Years Before and After Transferring Schools for Teachers Moving into ASD, iZone, and Comparison Priority Schools



Difference-in-Differences Results

Table 3 shows results from estimating Equation 1. All results include the full list of student and teacher control variables described above. Column 1 shows results for reading with a teacher fixed effect while column 2 shows the preferred model including both the teacher and

school fixed effects. Columns 3-4 show the parallel results for math. The coefficients on $PostMove$ show that the average change in student test scores after teachers move into comparison priority schools is not statistically significant, except a marginally significant difference of 0.06 standard deviation units (SDUs) in reading when including both teacher and school fixed effects. Focusing on the preferred results in columns 2 and 4, I find that the average postmove – premove difference in reading is 0.07 SDUs lower for teachers who move into the ASD than the same difference for teachers who move into comparison schools. The effect is not statistically significant in math. In contrast, the effect for teachers who move into iZone schools is positive and significant for both reading (0.09 SDUs) and math (0.21 SDUs), suggesting improvements in effectiveness for iZone teachers. Finally, the effect estimates for teachers who move into ASD schools and for teacher who move into iZone schools are significantly different from each other across all models and subjects.

Table 3. DID Effects Before and After Teachers Move into ASD and iZone Schools Relative to Non-turnaround Priority Schools

	(1) Reading	(2) Reading	(3) Math	(4) Math
Post Move	0.009	0.055+	-0.033	0.014
	(0.015)	(0.028)	(0.025)	(0.028)
Ever Move to ASD*Post Move	-0.053*	-0.072*	0.000	0.020
	(0.024)	(0.030)	(0.041)	(0.053)
Ever Move to iZone*Post Move	0.066***	0.087**	0.163***	0.210***
	(0.020)	(0.029)	(0.031)	(0.056)
Teacher FE	Yes	Yes	Yes	Yes
School FE	No	Yes	No	Yes
$p_{\text{Move to ASD= Move to iZone}}$	0.00	0.00	0.00	0.01
R Squared	0.60	0.60	0.54	0.55
Observations	291700	291697	264460	264455

Note. Robust standard errors in parentheses clustered at the teacher level. Sample includes only teachers who transfer schools and not teachers who stay when priority school begins turnaround reforms. All models include grade fixed effects and the full set of covariates. Student level covariates include gender, race, ell, FRPM, SPED, mobility. Teacher covariates include graduate degree attainment, and experience (with 25+ years as the reference category). + p<0.10 * p<0.05 ** p<0.01 *** p<0.001

Figure 2 shows results from the event history analysis that includes indicators for years before and after teachers move into a priority school (see Equation 2). The figure plots coefficients from the interaction between moving to the ASD or iZones and each of the year indicators. For full results, see Appendix Table 6. For teachers who will move into ASD schools, Figure 2 shows that average student achievement does not differ significantly between the baseline year and each year before. The F-test of joint significance for all pre-move years is also insignificant ($p_{pre=0} = 0.69$). Then, teachers who transfer into an ASD school experience a negative -0.08 SDU effect in year one after the move. The effect of moving into an ASD school is not statistically significant after year one in reading or in any post-move year for math. Turning to the iZones, coefficients for the pre-move years are also not individually or jointly different from the baseline year ($p_{pre=0} = 0.57$). After teachers transfer into iZone schools, Figure 2 shows positive effects in both reading (0.08 SDUs) and math (0.23 SDUs) in the first post-move year. Also, teachers transferring into iZone schools experience a positive effect in reading for years 3 and after (0.10 SDUs) and in math for year two (0.19 SDUs).

Figure 2. Average TVAAS Scores in the Years Before and After Transferring Schools for Teachers Moving into ASD, iZone, and Comparison Priority Schools

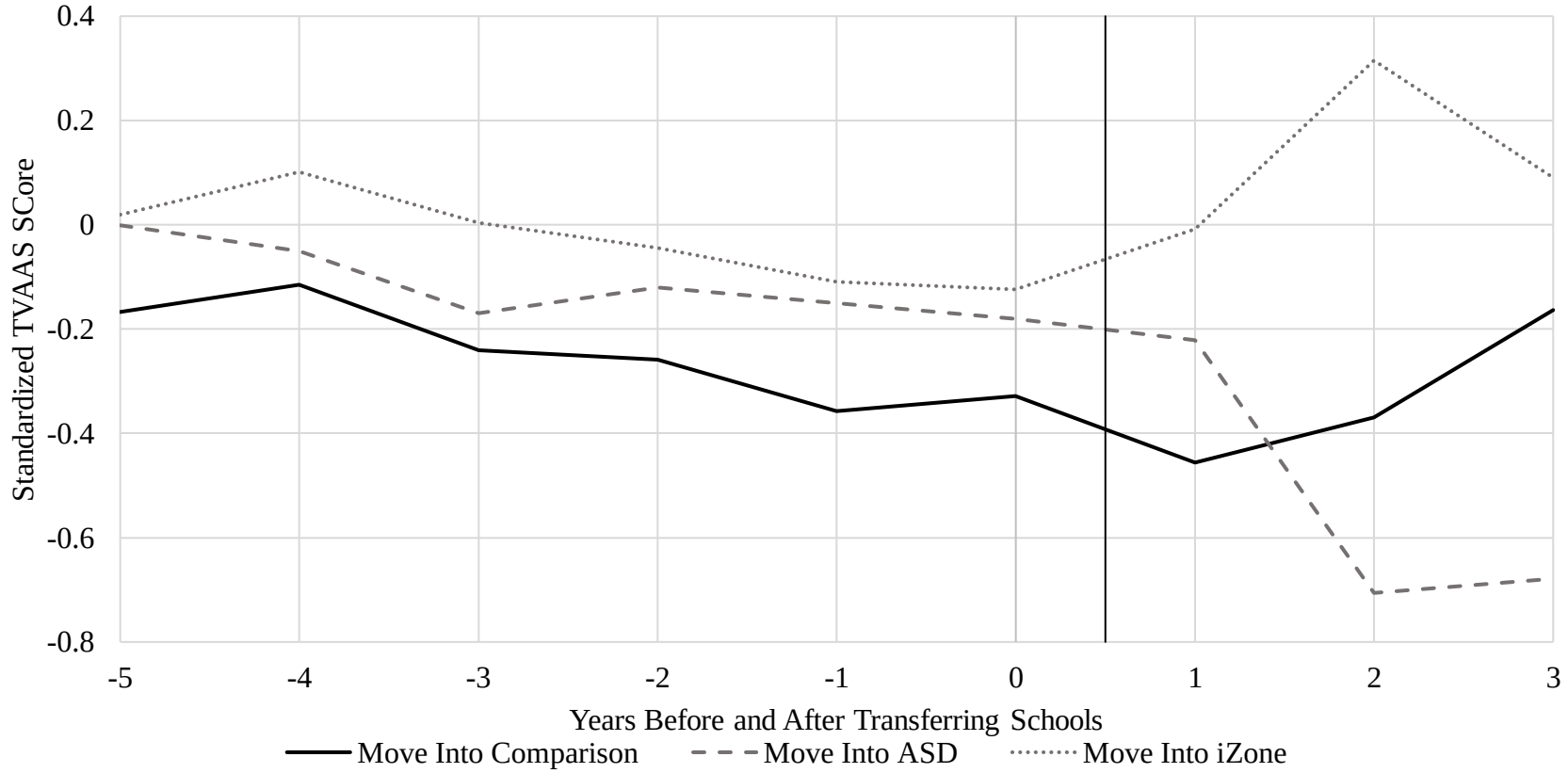


Table 4 shows heterogeneous effects for different groups of teachers in reading (Panel A) and math (Panel B). The first column replicates the main results from Table 3. Then, columns 2-8 each adds a different teacher characteristic as a moderator, with the coefficients of interest shown in the three way interactions between the teacher characteristic, $PostMove$, and the indicators for teachers who move into ASD or iZone schools. I find that most of the teacher characteristics in Table 4 do not have a significant influence on the effect of moving into either ASD or iZone schools. The only statistically significant moderating effect is for Black teachers in reading. The positive effect in reading for teachers who transfer into an iZone school is 0.11 SDUs higher among Black teachers.

Table 4. Heterogeneous Results by Characteristics of Teachers who Transfer Schools

Teacher Characteristics:	(1) Overall Results	(2) Female	(3) Black	(4) Masters and Above	(5) TVAAS >= 4	(6) Experience > Median	(7) Tenure > Median	(8) Non-Priority Sending School
Panel A: Reading								
Post Move	0.055+	0.056+	0.104***	0.053*	0.056**	0.040+	0.039	0.072*
	(0.028)	(0.030)	(0.029)	(0.026)	(0.020)	(0.022)	(0.024)	(0.029)
Ever Move to ASD*Post Move	-0.072*	-0.051	-0.109*	-0.070+	-0.059+	-0.082*	-0.033	-0.104+
	(0.030)	(0.054)	(0.056)	(0.040)	(0.035)	(0.035)	(0.040)	(0.060)
Ever Move to iZone*Post Move	0.087**	0.081*	-0.005	0.105**	0.085**	0.107**	0.112**	0.079+
	(0.029)	(0.041)	(0.040)	(0.039)	(0.033)	(0.034)	(0.039)	(0.043)
Teacher Characteristics								
Teacher Characteristic*Post Move		0.001	-0.057*	0.003	-0.004	0.028	0.023	-0.029
		(0.031)	(0.029)	(0.029)	(0.026)	(0.026)	(0.027)	(0.032)
Teacher Characteristic*Post Move*Move to ASD		-0.024	0.047	-0.003	-0.027	0.018	-0.066	0.045
		(0.055)	(0.061)	(0.045)	(0.051)	(0.046)	(0.049)	(0.065)
Teacher Characteristic*Post Move*Move to iZone		0.012	0.109**	-0.026	0.004	-0.032	-0.034	0.002
		(0.040)	(0.037)	(0.036)	(0.035)	(0.033)	(0.036)	(0.041)
Observations	291697	289827	291697	291697	291697	291697	291697	291697
Panel B: Math								
Post Move	0.014	-0.015	0.010	0.044	0.010	0.042	0.066	-0.010
	(0.028)	(0.054)	(0.060)	(0.048)	(0.038)	(0.039)	(0.045)	(0.046)
Ever Move to ASD*Post Move	0.020	0.079	0.138	0.017	0.054	0.016	0.064	0.046
	(0.053)	(0.092)	(0.107)	(0.071)	(0.069)	(0.068)	(0.076)	(0.073)
Ever Move to iZone*Post Move	0.210***	0.242**	0.154+	0.234**	0.252***	0.194**	0.153+	0.220**
	(0.056)	(0.081)	(0.091)	(0.072)	(0.065)	(0.073)	(0.080)	(0.076)
Teacher Characteristics								
Teacher Characteristic*Post Move		0.044	0.006	-0.046	0.005	-0.049	-0.086	0.043
		(0.063)	(0.062)	(0.053)	(0.059)	(0.049)	(0.052)	(0.057)
Teacher Characteristic*Post Move*Move to ASD		-0.069	-0.143	0.009	-0.043	0.012	-0.099	-0.035
		(0.104)	(0.116)	(0.081)	(0.092)	(0.087)	(0.086)	(0.089)
Teacher Characteristic*Post Move*Move to iZone		-0.044	0.067	-0.028	-0.083	0.025	0.075	0.006
		(0.076)	(0.080)	(0.066)	(0.074)	(0.065)	(0.071)	(0.074)
Observations	264455	263047	264455	264455	264455	264455	264455	264455

Note. Robust standard errors in parentheses clustered at the teacher level. Sample includes only teachers who transfer schools and not teachers who stay when priority school begins turnaround reforms. All models include grade fixed effects and the full set of covariates. Student level covariates include gender, race, ell, FRPM, SPED, mobility. Teacher covariates include graduate degree attainment, and experience (with 25+ years as the reference category). + p<0.10 * p<0.05 ** p<0.01 *** p<0.001

Robustness Checks

The trends shown in Figure 1 and Appendix Figure 1 show evidence of parallel trends in effectiveness among teachers who move into ASD, iZone, and comparison priority schools in the years before they move, suggesting that teachers who move into comparison priority schools are a valid counterfactual. However, I also test whether my results are robust to this choice of comparison group by comparing teachers who transfer into ASD or iZone schools with teachers who transfer in low-performing schools in the bottom 6-10 percent of schools in Tennessee. Appendix Table 7 shows that using this alternative comparison group leads to similar conclusions: positive effects for teachers transferring into iZone schools and null or negative effects for teachers moving into ASD schools.

Additionally, there is a concern that teacher effectiveness is endogenous with whether teachers move in the first place. For example, teachers may know that they will move the following year and therefore be less motivated. In this case, one would expect a dip in performance in the year just prior to moving. To test for this possibility, I conduct a placebo test where I construct a post-move indicator that equals one in the baseline year before teachers move into a priority school. Appendix Table 8 shows results from this placebo test. The table shows that the effect on student achievement is substantively small and not significant for teachers moving into the ASD, iZone, or comparison priority schools. This suggests that my results are not driven by uncharacteristic dips in teacher performance in the year before they move.

Also, significant effects from the DID model may be driven by unobserved factors that influence teachers' decision to transfer to an ASD or iZone school while also affecting student achievement. For example, the positive iZone results may be driven by teachers who choose iZone schools because they already know they will perform well in a results-driven school

environment. To test for these potential omitted factors driving teachers to move, I use an instrumental variable approach where I predict the likelihood that teachers will transfer schools based on the distance between the sending and receiving schools. Then, I estimate changes in student test scores based on the predicted likelihood that teachers will transfer. Intuitively, the distance between schools should influence the likelihood that teachers will transfer because teachers are less likely to move further away,[14] but the distance between schools is unlikely to affect student achievement. Thus, I use the geodetic distance between sending and receiving schools as an instrument, though results using travel distance and travel time are similar. I conduct this analysis on three groups of teachers separately: those who move into ASD, iZone, and comparison priority schools; therefore, the results do not have a DID interpretation, but should instead be interpreted as the difference in student achievement before and after teachers move. Results shown in Appendix Table 9 are not statistically significant, but do follow the same patterns observed in the DID results. That is, teachers who move into ASD schools experience decreases in student achievement relative to teachers who move into comparison schools, whereas teachers who move into iZone schools experience an increase in student test scores for both reading and math.

Another way that teacher mobility and effectiveness may be endogenous is if principals are able to identify and hire teachers who will do especially well in their school. For example, the positive iZone effect may be driven by experienced principals who use informal social networks to find teachers who work well under pressure. Also, principals with more experience in the district may have greater knowledge about individual teachers who will likely be a good fit in the turnaround school. To test for this possibility, I include characteristics of receiving school

[14] The first stage equation does indeed show that the distance between sending and receiving schools has a negative effect on whether teachers will transfer.

principals as a moderating variable to test whether teacher effectiveness changes more when they move into an school with a principal who is more experienced (overall and in the district) or more effective.[15] Results in Appendix Table 10 shows results for iZone principals who (1) have more experience, (2) have higher observation scores, and (3) have more experience working in the district. Teachers who move into schools led by these types of iZone principals do not experience increases in effectiveness that are higher than teachers moving into iZone schools with less experienced principals, less effective principals, or principals with less experience in the district. Also, results in Appendix Table 10 show that teachers transferring into ASD schools with more experienced or more effective principals do not experience significant changes in effectiveness relative to teachers transferring into ASD schools led by less experienced or less effective principals.

Finally, a potential alternative explanation for changes in teacher effectiveness after transferring into ASD or iZone schools may be that the DID models are capturing direct effects of the ASD or iZone interventions and not only differences in teacher effectiveness across different school settings. However, direct effects of turnaround interventions are unlikely to bias my results because any factors that affect all teachers and students at the school-level (including turnaround reforms) are captured by the school fixed effect. The school fixed effect may not fully capture the effect of reforms because it includes pre-intervention years, but models using school-by-year fixed effects find similar results (see Appendix Table 11), so I mainly report results from the more parsimonious model with school fixed effects. I also test models that include a number of time-varying school characteristics and again find that my results are robust (see Appendix Table 4). However, outside teacher effectiveness, changes in student test scores

[15] Principal effectiveness is measured using their observation scores. For more information on Tennessee's principal evaluation system, see Grissom et al. (2018).

may affected by other aspects of the turnaround reforms that are not captured by the school or school-by-year fixed effect. Thus, to more directly test for changes in teacher effectiveness, I estimate DID models using teacher observation scores and TVAAS scores as the outcome. Although observation scores and TVAAS scores are both imperfect measures of effectiveness, they are directly measured for teachers. That is, although test scores may be influenced by turnaround reforms that operate outside of changes in teacher effectiveness, any changes in teacher observation and TVAAS scores are more likely the direct result of the organizational climate and culture that teachers experience when they transfer into the turnaround school. Table 5 below shows that both teacher observation and TVAAS scores increase at statistically significant levels after moving into iZone school relative to changes for teachers who move into non-turnaround priority schools. The effects on teacher observation and TVAAS scores are not significant for teachers who transfer into ASD schools.

Table 5. DID Effects on Teacher Observation Scores and TVAAS Scores

	(1) Observation Score (1-5)_	(2) Standardized TVAAS
Post Move	0.004	0.003
	(0.036)	(0.159)
Ever Move to ASD*Post Move	0.132	0.092
	(0.149)	(0.363)
Ever Move to iZone*Post Move	0.113*	0.523*
	(0.045)	(0.264)
R Squared	0.71	0.86
Observations	5129	2249

Note. Robust standard errors in parentheses clustered at the teacher level. Sample includes only teachers who transfer schools and not teachers who stay when priority school begins turnaround reforms. All models include grade fixed effects and the full set of covariates. Student level covariates include gender, race, ell, FRPM, SPED, mobility. Teacher covariates include graduate degree attainment, and experience (with 25+ years as the reference category). + p<0.10 * p<0.05 ** p<0.01 *** p<0.001

Discussion

In this study, I examine the stability of teacher effectiveness before and after transferring into turnaround schools, relative to teachers who transfer into comparison priority schools. I find that teachers who transfer into iZone schools experience significant positive increases in student achievement. The parallel effects for teachers transferring into ASD schools are inconsistent: negative in reading and null in math. Separating these effects into the number of years before and after transferring, I find that the positive effects for teachers transferring into iZone schools appear in both subjects for multiple post-move years, whereas the negative effect for ASD teachers in reading is significant in the first year and marginally significant in year two after teachers move. These results are robust to multiple alternative explanations and do not generally differ by characteristics of the teachers themselves, except the positive effects in reading are larger for Black teachers who move into iZone schools than for white teachers.

Contributing to the literature on school turnaround, this paper provides compelling evidence to help reconcile mixed results from previous studies of turnaround which find that bringing effective teachers into turnaround schools only sometimes leads to improvements in student achievement. My results suggest that existing estimates of turnaround effects may be mixed because teacher effectiveness can change after transferring into a turnaround school. Although both ASD and iZone schools recruited more effective teachers relative to non-turnaround priority schools, average student achievement increased significantly for teachers who moved into iZone schools, whereas teachers in ASD schools experienced either declines or no changes (Pham et al., 2020; Zimmer et al., 2017). Improvements in teacher effectiveness in iZone schools help to explain positive overall effects of the iZone reforms and support an expanded theory of action for turnaround which goes beyond simply recruiting effective

teachers. One way to do this is to invest in strategies that help teachers adjust to their new school. Previous research suggests that robust teacher induction (Carver & Feiman-Nemser, 2009), strong collaborative instructional teams (Goddard et al., 2007), and support from more experienced mentors (Davis & Higdon, 2008) are potentially effective strategies to support teachers who transfer into a new school, and future reform plans under ESSA would do well to consider these strategies to follow-up after initial recruitment efforts.

Results from this study also corroborate prior research finding that a component of teachers' effectiveness stems from differences in the marginal effectiveness of school inputs across teachers (Jackson, 2013; Strunk, Marsh, Hashim, & Bush-Mecenas, 2016). That is, teachers' performance is partly influenced by how well teachers work within the particular culture and climate at their school, and the work culture within a turnaround school is likely distinct from other low-performing schools that do not have the same accountability pressures. In addition to recruiting new teachers, prior research finds that iZone reforms gave rise to a more orderly learning environment, greater teacher collaboration, and more opportunities for professional learning (Pham, 2019). These advances in the professional environment in iZone schools help to potentially explain improvements in teacher effectiveness, and future reform efforts should invest in building school environments that are conducive to effective teaching so that teachers can remain effective after they transfer. In ASD schools, prior research found that an ongoing barrier to improvement was high principal turnover (Henry et al., 2020). Without effective leadership to maintain consistent expectations throughout the school, the unstable ASD environment likely hindered teachers' ability to maintain high levels of effectiveness after they transferred.

Contributing to the broader literature on teacher effectiveness, this study adds nuance to existing research on teacher effectiveness across schools by focusing on turnaround schools, a subset of low-performing schools where the stability of teacher effectiveness has not been previously examined. Understanding teacher effectiveness in turnaround schools is important because a large number of teachers who transfer into low-performing schools are likely moving into turnaround schools in response to recruitment efforts in these schools. My communications with district leaders suggest that this was the case in the Memphis iZone, where supports for iZone schools (e.g., recruitment bonuses) helped them to attract more teachers than other low-performing schools in the district. I find that teacher effectiveness does indeed change after teachers transfer into turnaround schools in ways that differ from teachers who transfer into low-performing but non-turnaround schools. Thus, ongoing research on teacher effectiveness should consider distinct features of turnaround schools that make them different from other low-performing schools.

Comparing the iZone and ASD experience also points to complementarities between teacher effectiveness and retention, both of which appears to have helped produce positive results. After recruiting teachers, this study finds evidence that iZone schools were able to support and develop them, leading to higher levels of effectiveness relative to the years before they transferred. Moreover, iZone schools have been shown to have high levels of teacher retention; higher than comparison priority schools and much higher than ASD schools (Henry et al., 2020). Taken together, these findings suggest that the supports teachers received in iZone schools (e.g., instructional coaches, professional learning communities) had a dual impact on increasing both their effectiveness and retention rates. In contrast, the ASD approach focused on teacher recruitment without clear strategies to support them after they transferred, leading to

some negative effects on teacher effectiveness and significantly lower retention rates relative to comparison schools. Together, the ASD and iZone experience suggest that strategies to develop and retain teachers may need to go hand-in-hand in order to successfully support school improvement.

Also, the finding that Black teachers experience greater increases in student achievement after transferring into iZone schools deserves further attention. Since iZone schools serve primarily Black students, this finding aligns with previous research which finds academic benefits for students who are assigned to racially congruent teachers (Joshi et al., 2018). Although an exploration of why Black teachers tend to do better after transferring into iZone schools is beyond the scope of this study, it will be important in future research to further examine the experiences of minority race teachers in turnaround schools.

This study finds convincing evidence that successful school reforms must go beyond recruiting effective teachers by investing in efforts to create a school environment in which teachers can continue to improve. However, it leaves open the question of what mechanisms lead to these improvements in school environment. One important route for future research is to examine features of reforms that tend to influence teacher effectiveness. For example, what role does the leader of a turnaround school play in helping teachers to adjust after they move so that they do not experience declines in effectiveness? Further illuminating strategies to help build teachers' capacity will be important next steps in the ongoing effort to support our lowest-performing schools.

Appendix

Appendix Table 1. Comparisons of the ASD, iZone, and Comparison Priority Schools in the Year Before Turnarounds

	ASD		iZone	
	Non-ASD Non-iZone Priority	Ever Treated	Non-ASD Non-iZone Priority	Ever Treated
Student Test Scores				
Average reading score	-.943	-1	-.943	-.988
Average math score	-.944	-.92	-.944	-.938
Average science score	-1.1	-1.15	-1.1	-1.14
Student Characteristics				
Proportion Female	.488	.493	.488	.486
Proportion Minority	.988	.985	.988	.967*
Proportion FRPM	.881	.886	.881	.921
Proportion SPED	.15	.153	.15	.172
Proportion ELL	.0261	.0166	.0261	.0208

Note. * $p < 0.05$ ** $p < 0.01$ *** $p<0.001$ FRPM: Eligibility for free or reduced priced meals; ELL: English Language Learner; SPED: special education status

Appendix Table 2. Number of Teachers in Sample who Move into Comparison, ASD, and iZone Schools – Pooled Across All Years and By Each Post Move Year

	Comparison	ASD	iZone	Total
Reading				
Reading - All Years	716	464	785	1965
Reading - Year 1	392	185	375	952
Reading - Year 2	118	77	200	395
Reading - Year 3	47	20	64	131
Reading - Year 4	14	6	19	39
Reading - Year 5	6	3	24	33
Reading - Year 6	2	1	12	15
Math				
Math - All Years	694	456	758	1908
Math - Year 1	376	184	370	930
Math - Year 2	118	77	199	394
Math - Year 3	46	21	64	131
Math - Year 4	14	6	19	39
Math - Year 5	6	3	24	33
Math - Year 6	2	1	12	15

Note. Numbers are of unique teachers.

Appendix Table 3. Teacher Effects Before and After Moving - Restricting to Teachers who Come from Nonpriority Sending Schools

	(1) Reading	(2) Reading	(3) Math	(4) Math
Post Move	-0.018	0.030	-0.056+	-0.010
	(0.017)	(0.022)	(0.029)	(0.038)
Ever Move to ASD*Post Move	-0.041	-0.098**	0.024	-0.016
	(0.027)	(0.034)	(0.049)	(0.072)
Ever Move to iZone*Post Move	0.073**	0.132***	0.169***	0.393***
	(0.023)	(0.037)	(0.037)	(0.076)
Teacher FE	Yes	Yes	Yes	Yes
School FE	No	Yes	No	Yes
R Squared	0.62	0.62	0.55	0.56
Observations	224370	224367	203313	203307

Note. Robust standard errors in parentheses clustered at the teacher level. Sample includes only teachers who transfer schools and not teachers who stay when priority school begins turnaround reforms. All models include grade fixed effects and the full set of covariates. Student level covariates include gender, race, ell, FRPM, SPED, mobility. Teacher covariates include graduate degree attainment, and experience (with 25+ years as the reference category). + $p<0.10$ * $p<0.05$ ** $p<0.01$ *** $p<0.001$

Appendix Table 4. DID Effects Before and After Teachers Move into ASD and iZone Schools Relative to Non-turnaround Priority Schools - Additional Covariates

	(1) Reading	(2) Reading	(3) Reading	(4) Reading	(5) Reading	(6) Math	(7) Math	(8) Math	(9) Math	(10) Math
Post Move	0.055+	0.062***	0.072***	0.043*	0.042*	0.014	0.016	0.019	0.009	0.008
	(0.028)	(0.017)	(0.018)	(0.017)	(0.017)	(0.028)	(0.028)	(0.029)	(0.029)	(0.029)
Ever Move to ASD*Post Move	-0.072*	-0.074*	-0.084**	-0.054+	-0.062+	0.020	0.021	0.016	0.012	0.019
	(0.030)	(0.030)	(0.030)	(0.031)	(0.032)	(0.053)	(0.053)	(0.053)	(0.054)	(0.058)
Ever Move to iZone*Post Move	0.087**	0.079**	0.071*	0.087**	0.081**	0.210***	0.209***	0.194***	0.198***	0.189**
	(0.029)	(0.028)	(0.029)	(0.028)	(0.028)	(0.056)	(0.056)	(0.056)	(0.057)	(0.058)
Student Characteristics										
Female	0.061***	0.060***	0.069***	0.061***	0.061***	0.041***	0.048***	0.002	0.040***	0.040***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Black	-0.146***	-0.099***	-0.112***	-0.146***	-0.146***	-0.146***	-0.115***	-0.098***	-0.145***	-0.145***
	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.007)	(0.007)
Hispanic	-0.010	0.023***	-0.011+	-0.011+	-0.011+	-0.012	0.005	-0.001	-0.012	-0.012
	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Asian	0.082***	0.070***	0.030*	0.082***	0.081***	0.188***	0.141***	0.211***	0.186***	0.186***
	(0.012)	(0.014)	(0.012)	(0.012)	(0.012)	(0.017)	(0.016)	(0.016)	(0.017)	(0.017)
Other Race	-0.025	-0.002	-0.001	-0.025	-0.025	-0.172***	-0.165***	-0.157***	-0.166***	-0.165***
	(0.032)	(0.031)	(0.030)	(0.032)	(0.032)	(0.044)	(0.043)	(0.042)	(0.044)	(0.044)
ELL	-0.222***	-0.218***	-0.197***	-0.222***	-0.221***	-0.163***	-0.147***	-0.026*	-0.162***	-0.162***
	(0.011)	(0.011)	(0.010)	(0.011)	(0.011)	(0.012)	(0.011)	(0.012)	(0.012)	(0.012)
FRPM	-0.071***	-0.049***	-0.062***	-0.073***	-0.073***	-0.073***	-0.059***	-0.044***	-0.073***	-0.073***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
SPED	-0.276***	-0.299***	-0.197***	-0.278***	-0.278***	-0.229***	-0.249***	-0.174***	-0.230***	-0.229***
	(0.009)	(0.009)	(0.008)	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Student is New to School	-0.043***	-0.042***	-0.030***	-0.044***	-0.044***	-0.072***	-0.072***	-0.064***	-0.069***	-0.070***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Teacher Characteristics										
MA Degree or Higher	0.019	0.014	0.015	0.016	0.013	0.057*	0.055*	0.063**	0.056*	0.047*
	(0.014)	(0.014)	(0.015)	(0.014)	(0.014)	(0.024)	(0.024)	(0.024)	(0.024)	(0.023)
Experience: 1-3 Years	0.004	-0.004	-0.023	0.017	0.015	0.042	0.044	0.015	0.043	0.038
	(0.043)	(0.042)	(0.046)	(0.044)	(0.044)	(0.066)	(0.067)	(0.064)	(0.066)	(0.067)
Experience: 4-9 Years	-0.008	-0.017	-0.024	0.002	-0.000	0.061	0.057	0.036	0.058	0.052
	(0.044)	(0.043)	(0.046)	(0.045)	(0.045)	(0.064)	(0.066)	(0.064)	(0.065)	(0.065)
Experience: 10-24 Years	-0.019	-0.023	-0.029	-0.016	-0.019	0.014	0.009	-0.002	0.007	-0.002
	(0.045)	(0.044)	(0.047)	(0.045)	(0.045)	(0.063)	(0.065)	(0.063)	(0.063)	(0.064)
Prior Year Student Test Scores										
Prior Year Reading	0.667***	0.795***	0.570***	0.667***	0.667***			0.236***		

	(0.003)	(0.006)	(0.003)	(0.003)	(0.003)			(0.003)		
Prior Year Reading Squared		0.071***								
		(0.002)								
Prior Year Math			0.194***			0.613***	0.712***	0.470***	0.613***	0.614***
			(0.002)			(0.003)	(0.006)	(0.003)	(0.003)	(0.003)
Prior Year Math Squared							0.064***			
							(0.003)			
Characteristics of Students in the School										
Proportion Female				0.141	0.145				0.141	0.133
				(0.182)	(0.182)				(0.323)	(0.319)
Proportion Black				-0.125	-0.128				-0.683+	-0.696+
				(0.184)	(0.183)				(0.362)	(0.357)
Proportion Hispanic				0.239	0.210				-0.440	-0.496
				(0.255)	(0.251)				(0.444)	(0.438)
Proportion Asian				1.165	1.114				4.431*	4.516*
				(0.846)	(0.848)				(1.869)	(1.861)
Proportion Other Race				1.811	1.695				-6.716*	-6.918*
				(2.246)	(2.248)				(3.347)	(3.327)
Proportion ELL				0.140	0.163				0.317	0.342
				(0.318)	(0.314)				(0.532)	(0.529)
Proportion FRPM				0.063+	0.058+				0.008	-0.011
				(0.035)	(0.035)				(0.087)	(0.088)
Proportion SPED				0.453**	0.447**				0.379	0.340
				(0.151)	(0.152)				(0.257)	(0.255)
Proportion Student is New to School				0.041	0.039				-0.071	-0.071
				(0.038)	(0.038)				(0.073)	(0.073)
Characteristics Teachers in the School										
Proportion MA Degree or Higher					0.059					0.203*
					(0.048)					(0.085)
Average Experience (Years)					-0.003					-0.003
					(0.003)					(0.005)
R Squared	0.60	0.62	0.64	0.60	0.60	0.55	0.56	0.57	0.55	0.55
N Teachers	1965	1965	1903	1965	1965	1908	1908	1903	1908	1908
N Schools	487	487	473	487	487	473	473	473	473	473
Observations	291697	291697	262177	291697	291697	264455	264455	262177	264455	264455

Note. Robust standard errors in parentheses clustered at the teacher level. Sample includes only teachers who transfer schools and not teachers who stay when priority school begins turnaround reforms. All models include teacher, school, and grade fixed effects and the full set of covariates. Student level covariates include gender, race, ell, FRPM, SPED, mobility. Teacher covariates include graduate degree attainment, and experience (with 25+ years as the reference category). + p<0.10 * p<0.05 ** p<0.01 *** p<0.001

Appendix Table 5. Teacher Effects Before and After Moving - Alternative Standard Errors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Reading - SE Clustered at School Level	Reading - SE Clustered at School Level	Reading - Bootstrap SE	Reading - Bootstrap SE	Math - SE Clustered at School Level	Math - SE Clustered at School Level	Math - Bootstrap SE	Math - Bootstrap SE
Post Move	0.009	0.055*	0.009	0.055*	-0.033	0.014	-0.033	0.014
	(0.015)	(0.024)	(0.015)	(0.023)	(0.021)	(0.022)	(0.023)	(0.039)
Ever Move to ASD*Post Move	-0.053*	-0.072**	-0.053*	-0.072+	0.000	0.020	0.000	0.020
	(0.025)	(0.028)	(0.024)	(0.041)	(0.036)	(0.046)	(0.040)	(0.073)
Ever Move to iZone*Post Move	0.066**	0.087***	0.066***	0.087*	0.163***	0.210***	0.163***	0.210**
	(0.021)	(0.020)	(0.020)	(0.040)	(0.033)	(0.040)	(0.030)	(0.080)
Teacher FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School FE	No	Yes	No	Yes	No	Yes	No	Yes
R Squared	0.60	0.60	0.60	0.60	0.54	0.55	0.54	0.55
Observations	291700	291697	291700	291697	264460	264455	264460	264455

Note. Robust standard errors (SE) in parentheses clustered at the teacher level. Sample includes only teachers who transfer schools and not teachers who stay when priority school begins turnaround reforms. All models include teacher, school, and grade fixed effects and the full set of covariates. Student level covariates include gender, race, ell, FRPM, SPED, mobility. Teacher covariates include graduate degree attainment, and experience (with 25+ years as the reference category). + p<0.10 * p<0.05 ** p<0.01 *** p<0.001

Appendix Table 6. Event History Model for Each Year Before and After Moving

	(1) Reading	(2) Reading	(3) Math	(4) Math
Years Before and After Move				
Year -5 and Before	-0.030	-0.035	-0.061	-0.058
	(0.024)	(0.024)	(0.046)	(0.047)
Year -4	-0.034+	-0.031	-0.044	-0.045
	(0.020)	(0.020)	(0.035)	(0.035)
Year -3	-0.019	-0.014	-0.028	-0.025
	(0.018)	(0.018)	(0.030)	(0.030)
Year -2	-0.026	-0.029	-0.037	-0.039
	(0.018)	(0.018)	(0.028)	(0.028)
Year -1	-0.038	-0.038	-0.022	-0.018
	(0.022)	(0.022)	(0.026)	(0.027)
Year 1	-0.029+	0.035+	-0.024	0.000
	(0.017)	(0.019)	(0.032)	(0.033)
Year 2	0.030	0.035	-0.039	0.017
	(0.027)	(0.028)	(0.046)	(0.045)
Year 3 and After	0.032	0.026	-0.021	-0.017
	(0.026)	(0.030)	(0.048)	(0.053)
Ever Move to ASD*Year -5 and Before	-0.043	-0.055	0.022	0.017
	(0.039)	(0.039)	(0.065)	(0.065)
Ever Move to ASD*Year -4	-0.014	-0.015	0.010	0.010
	(0.038)	(0.037)	(0.059)	(0.059)
Ever Move to ASD*Year -3	0.021	0.018	0.060	0.045
	(0.032)	(0.032)	(0.053)	(0.054)
Ever Move to ASD*Year -2	-0.017	-0.016	0.068	0.055
	(0.030)	(0.030)	(0.047)	(0.046)
Ever Move to ASD*Year -1	0.021	0.017	0.018	0.004
	(0.024)	(0.025)	(0.041)	(0.040)
Ever Move to ASD*Year 1	-0.046	-0.084*	0.008	-0.009
	(0.030)	(0.034)	(0.056)	(0.068)
Ever Move to ASD*Year 2	-0.049	-0.081+	0.076	0.118
	(0.043)	(0.048)	(0.085)	(0.089)
Ever Move to ASD*Year 3 and After	-0.087+	-0.036	-0.038	0.014
	(0.049)	(0.053)	(0.080)	(0.096)
Ever Move to iZone*Year -5 and Before	-0.013	-0.030	0.014	-0.003
	(0.031)	(0.031)	(0.059)	(0.060)
Ever Move to iZone*Year -4	-0.009	-0.015	0.074	0.056
	(0.028)	(0.027)	(0.047)	(0.047)
Ever Move to iZone*Year -3	0.009	0.002	-0.012	-0.033
	(0.023)	(0.023)	(0.043)	(0.043)
Ever Move to iZone*Year -2	-0.019	-0.028	-0.020	-0.038
	(0.023)	(0.023)	(0.039)	(0.040)
Ever Move to iZone*Year -1	0.020	0.018	0.013	0.003
	(0.020)	(0.019)	(0.037)	(0.037)

Ever Move to iZone*Year 1	0.074**	0.078*	0.202***	0.231***
	(0.023)	(0.032)	(0.044)	(0.066)
Ever Move to iZone*Year 2	0.041	0.054	0.163**	0.193**
	(0.033)	(0.037)	(0.056)	(0.070)
Ever Move to iZone*Year 3 and After	0.038	0.096*	0.058	0.106
	(0.034)	(0.042)	(0.060)	(0.079)
Teacher FE	Yes	Yes	Yes	Yes
School FE	No	Yes	No	Yes
R Squared	0.60	0.60	0.54	0.55
Observations	291700	291697	264460	264455
Probability Pre-ASD = 0	0.80	0.69	0.38	0.51
Probability Post-ASD = 0	0.04	0.06	0.77	0.51
Probability Pre-iZone = 0	0.90	0.57	0.69	0.93
Probability Post-iZone = 0	0.03	0.02	0.00	0.01

Note. Robust standard errors in parentheses clustered at the teacher level. Sample includes only teachers who transfer schools and not teachers who stay when priority school begins turnaround reforms. All models include teacher, school, and grade fixed effects and the full set of covariates. Student level covariates include gender, race, ell, FRPM, SPED, mobility. Teacher covariates include graduate degree attainment, and experience (with 25+ years as the reference category). + $p<0.10$ * $p<0.05$ ** $p<0.01$ *** $p<0.001$

Appendix Table 7. DID Models Using the Bottom 6-10 Percent of Schools as a Comparison Group

	(1) Reading	(2) Reading	(3) Math	(4) Math
Post Move	-0.020*	-0.002	-0.035**	-0.009
	(0.009)	(0.011)	(0.012)	(0.017)
Ever Move to ASD*Post Move	-0.018	0.035	0.021	0.027
	(0.022)	(0.025)	(0.030)	(0.041)
Ever Move to iZone*Post Move	0.064***	0.090***	0.150***	0.176***
	(0.017)	(0.019)	(0.025)	(0.027)
R Squared	0.59	0.59	0.54	0.55
Observations	528645	528638	482433	482425

Note. Robust standard errors in parentheses clustered at the teacher level. Sample includes only teachers who transfer schools and not teachers who stay when priority school begins turnaround reforms. All models include teacher, school, and grade fixed effects and the full set of covariates. Student level covariates include gender, race, ell, FRPM, SPED, mobility. Teacher covariates include graduate degree attainment, and experience (with 25+ years as the reference category). + $p<0.10$ * $p<0.05$ ** $p<0.01$ *** $p<0.001$

Appendix Table 8. Placebo Test for Year Before Moving

	(1) Reading	(2) Math
Post Move	0.019	0.017
	(0.015)	(0.024)
Ever Move to ASD*Post Move	0.002	0.000
	(0.025)	(0.037)
Ever Move to iZone*Post Move	0.009	-0.005
	(0.019)	(0.034)
N Schools	484	470
Observations	208862	184904

Note. Robust standard errors in parentheses clustered at the teacher level. Sample includes only teachers who transfer schools and not teachers who stay when priority school begins turnaround reforms. All models include teacher, school, and grade fixed effects and the full set of covariates. Student level covariates include gender, race, ell, FRPM, SPED, mobility. Teacher covariates include graduate degree attainment, and experience (with 25+ years as the reference category). + $p<0.10$ * $p<0.05$ ** $p<0.01$ *** $p<0.001$

Appendix Table 9. Teacher Effects Before and After Moving Using Geodetic Distance Between Sending and Receiving Schools as an Instrument

	Reading			Math		
	(1) Comparison	(2) ASD	(3) iZone	(4) Comparison	(5) ASD	(6) iZone
Post Move	-0.206	-0.600+	0.094	-0.263	-1.008	0.944
	(0.222)	(0.362)	(0.195)	(0.262)	(1.116)	(0.620)
Student Characteristics						
Prior Year Test Score	0.660***	0.672***	0.674***	0.603***	0.603***	0.612***
	(0.007)	(0.010)	(0.007)	(0.011)	(0.011)	(0.009)
Female	0.062***	0.069***	0.057***	0.046***	0.067***	0.027***
	(0.006)	(0.007)	(0.005)	(0.006)	(0.010)	(0.005)
Black	-0.149***	-0.153***	-0.143***	-0.143***	-0.177***	-0.148***
	(0.012)	(0.013)	(0.012)	(0.014)	(0.017)	(0.015)
Hispanic	-0.006	-0.003	-0.006	-0.003	0.010	-0.008
	(0.015)	(0.016)	(0.011)	(0.017)	(0.021)	(0.018)
Asian	0.116***	0.062+	0.083***	0.197***	0.188**	0.205***
	(0.022)	(0.035)	(0.018)	(0.031)	(0.059)	(0.026)
Other Race	-0.026	0.017	-0.044	-0.220	-0.271*	-0.115+
	(0.064)	(0.074)	(0.057)	(0.142)	(0.113)	(0.066)
ELL	-0.221***	-0.231***	-0.222***	-0.198***	-0.192***	-0.120***
	(0.024)	(0.022)	(0.021)	(0.037)	(0.034)	(0.030)
FRPL	-0.057***	-0.086***	-0.090***	-0.061***	-0.094***	-0.111***
	(0.008)	(0.013)	(0.009)	(0.011)	(0.021)	(0.016)
SPED	-0.274***	-0.273***	-0.294***	-0.217***	-0.274***	-0.202***
	(0.021)	(0.029)	(0.016)	(0.023)	(0.033)	(0.028)
Student is New to School	-0.046***	-0.038***	-0.030**	-0.070***	-0.040+	-0.064***
	(0.008)	(0.011)	(0.010)	(0.015)	(0.021)	(0.013)
Teacher Characteristics						
MA Degree or Higher	0.018	0.028	0.016	0.053	0.064*	0.035
	(0.016)	(0.021)	(0.013)	(0.037)	(0.031)	(0.034)
Experience: 1-3 Years	0.078*	0.075	0.043	0.035	0.212	-0.023
	(0.033)	(0.093)	(0.026)	(0.065)	(0.215)	(0.070)
Experience: 4-9 Years	0.078*	0.109	0.026	0.046	0.298	0.038
	(0.036)	(0.106)	(0.024)	(0.073)	(0.264)	(0.060)
Experience: 10-24 Years	0.068*	0.131	0.021	0.037	0.262	0.001
	(0.029)	(0.106)	(0.026)	(0.055)	(0.291)	(0.063)
N Teachers	718	473	790	704	464	768
N Schools	298	206	329	286	203	317
Observations	104875	59679	123410	92412	54765	114070

Note. Robust standard errors in parentheses clustered at the teacher level. Sample includes only teachers who transfer schools and not teachers who stay when priority school begins turnaround reforms. All models include teacher, school, and grade fixed effects and the full set of covariates. Student level covariates include gender, race, ell, FRPM, SPED, mobility. Teacher covariates include graduate degree attainment, and experience (with 25+ years as the reference category). + p<0.10 * p<0.05 ** p<0.01 *** p<0.001

Appendix Table 10. Teacher Effects Before and After Moving - Characteristics of Principals in Receiving School

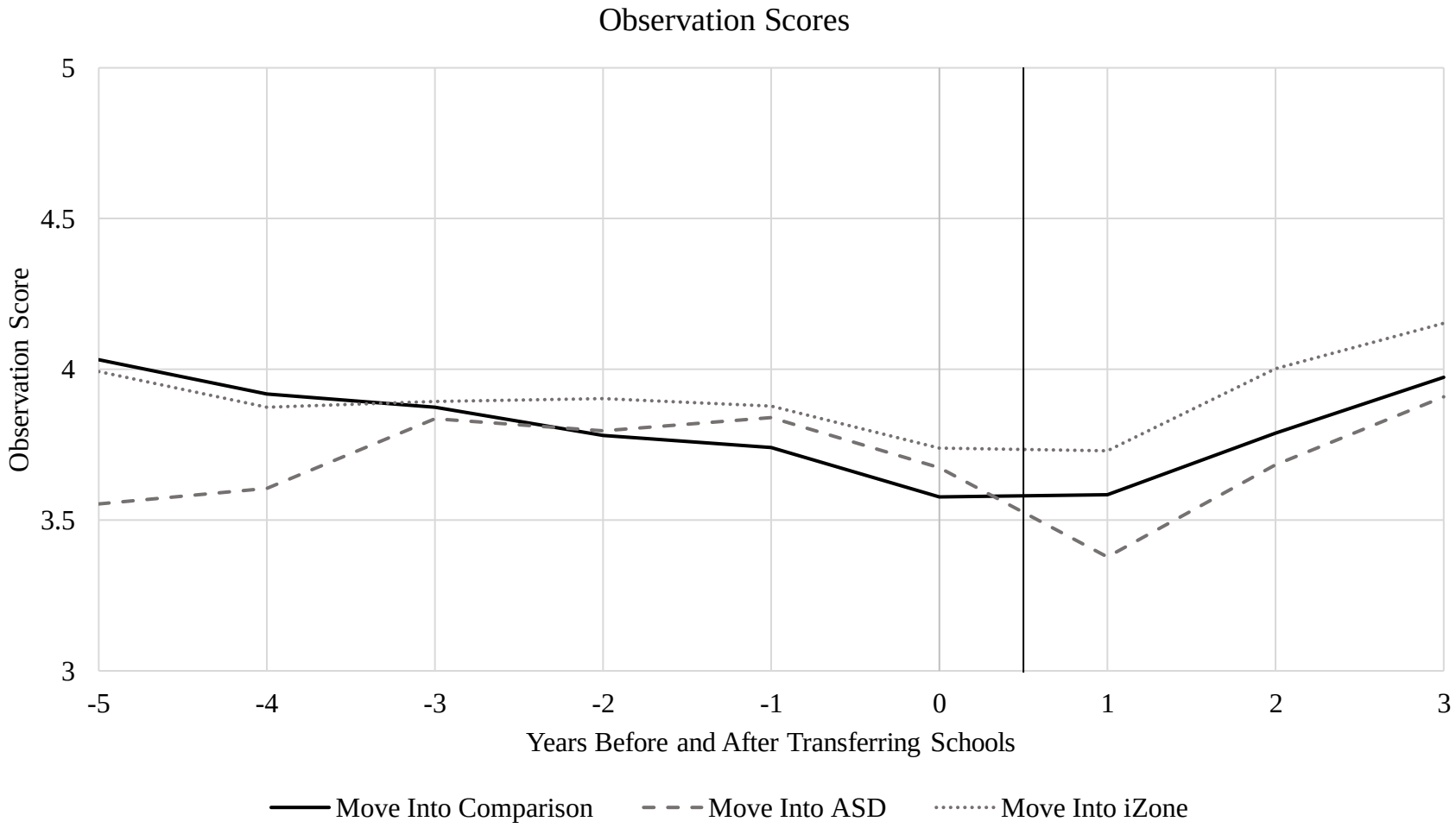
Principal Characteristics:	(1) All Principals	(2) Principal Observation Score Above Median	(3) Principal Experience Above Median	(4) Principal District Tenure Above Median
	Reading			
Post Move	0.055+	0.032	0.076***	0.075***
	(0.028)	(0.025)	(0.021)	(0.022)
Ever Move to ASD*Post Move	-0.072*	0.054	-0.077*	-0.091*
	(0.030)	(0.074)	(0.035)	(0.036)
Ever Move to iZone*Post Move	0.087**	0.110**	0.065+	0.059
	(0.029)	(0.038)	(0.037)	(0.037)
Principal Characteristics				
Principal Characteristic*Post Move		0.040	-0.033	-0.033
		(0.031)	(0.025)	(0.025)
Principal Characteristic*Post Move*Move to ASD		-0.150	-0.015	0.026
		(0.083)	(0.052)	(0.050)
Principal Characteristic*Post Move*Move to iZone		-0.044	0.039	0.050
		(0.047)	(0.041)	(0.040)
Observations	291697	291697	291697	291697
	Math			
Post Move	0.014	-0.022	0.010	0.009
	(0.028)	(0.043)	(0.044)	(0.044)
Ever Move to ASD*Post Move	0.020	0.506***	0.047	0.027
	(0.053)	(0.143)	(0.070)	(0.070)
Ever Move to iZone*Post Move	0.210***	0.186**	0.197*	0.196*
	(0.056)	(0.072)	(0.079)	(0.077)
Principal Characteristics				
Principal Characteristic*Post Move		0.062	0.010	0.009
		(0.056)	(0.050)	(0.050)
Principal Characteristic*Post Move*Move to ASD		-0.165	-0.064	-0.011
		(0.151)	(0.087)	(0.082)
Principal Characteristic*Post Move*Move to iZone		0.022	0.021	0.024
		(0.074)	(0.082)	(0.081)
Observations	264455	264455	264455	264455

Note. Robust standard errors in parentheses clustered at the teacher level. Sample includes only teachers who transfer schools and not teachers who stay when priority school begins turnaround reforms. All models include teacher, school, and grade fixed effects and the full set of covariates. Student level covariates include gender, race, ell, FRPM, SPED, mobility. Teacher covariates include graduate degree attainment, and experience (with 25+ years as the reference category). + p<0.10 * p<0.05 ** p<0.01 *** p<0.001

Appendix Table 11. Teacher Effects Before and After Moving - Teacher, School, and School-by-Year Fixed Effects

	(1) Reading	(2) Reading	(3) Reading	(4) Reading	(5) Math	(6) Math	(7) Math	(8) Math
Post Move	0.009	0.055+	0.012	0.054**	-0.033	0.014	-0.038	0.033
	(0.015)	(0.028)	(0.017)	(0.018)	(0.025)	(0.028)	(0.030)	(0.033)
Ever Move to ASD*Post Move	-0.053*	-0.072*	-0.054+	-0.073*	0.000	0.020	0.082	0.128+
	(0.024)	(0.030)	(0.030)	(0.036)	(0.041)	(0.053)	(0.054)	(0.069)
Ever Move to iZone*Post Move	0.066***	0.087**	0.092***	0.066+	0.163***	0.210***	0.316***	0.284***
	(0.020)	(0.029)	(0.027)	(0.038)	(0.031)	(0.056)	(0.057)	(0.080)
Teacher FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School FE	No	Yes	No	No	No	Yes	No	No
School x Year FE	No	No	Yes	No	No	No	Yes	No
Student x School FE	No	No	No	Yes	No	No	No	Yes
R Squared	0.60	0.60	0.61	0.94	0.54	0.55	0.55	0.92
Observations	291700	291697	291664	186640	264460	264455	264455	173341

Note. Robust standard errors in parentheses clustered at the teacher level. Sample includes only teachers who transfer schools and not teachers who stay when priority school begins turnaround reforms. All models include teacher, school, and grade fixed effects and the full set of covariates. Student level covariates include gender, race, ell, FRPM, SPED, mobility. Teacher covariates include graduate degree attainment, and experience (with 25+ years as the reference category). + $p<0.10$ * $p<0.05$ ** $p<0.01$ *** $p<0.001$



Appendix Figure 1. Average Observation Scores in the Years Before and After Transferring Schools for Teachers Moving into ASD, iZone, and Comparison Priority Schools

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CHAPTER 3

ESTIMATING THE EFFECT OF TEACHERS WHO LEAVE TURNAROUND SCHOOLS ON THE SCHOOLS THAT RECEIVE THEM

Introduction

Supported by federal initiatives such as Race to the Top and school improvement grants, turnaround reforms targeting low-performing schools have grown dramatically nationwide. Although specific interventions vary across states and districts, turnaround models share a common underlying theory that improving chronically low-performing schools requires bold interventions that can include radically changing the school's culture or governance structure and replacing most if not all of the teaching staff. Research evaluating these reforms have focused on how they affect the turnaround school (Carlson & Lavertu, 2018; Dee, 2012; Dragoset et al., 2017; Heissel & Ladd, 2017; Henry & Harbatkin, 2018; Papay & Hannon, 2018; Pham et al., 2020; Strunk et al., 2016; Sun et al., 2017; Zimmer et al., 2017), but very little attention has been paid to spillover effects of turnaround reforms on non-turnaround schools. In this paper, I address one aspect of these understudied spillover effects by examining the characteristics of teachers who transfer away from turnaround *sending* schools and how these teachers affect student achievement after they transfer into non-turnaround schools, which I call *receiving* schools.

Previous research has shown that reforms often result in large numbers of teachers transferring away from the turnaround school, either because the school is required to replace most of its current staff (Dragoset et al., 2017) or because teachers choose to avoid the high pressure turnaround environment (Rice & Malen, 2010; Viano et al., 2018). Furthermore, the broader literature on teacher collective bargaining agreements and tenure policies finds that

teachers who leave one school are often rehired at a different school, usually in the same district (Goldhaber & Hansen, 2010; Loeb et al., 2015). Thus, turnaround reforms could have negative spillover effects on student achievement in receiving schools if the teachers who leave turnaround schools are the school's least effective instructors, who may have even been barriers to improvement in the turnaround school. However, teachers who leave turnaround schools are not necessarily low-performing, and they may improve after leaving the turnaround school, which could result in null or positive effects on receiving schools.

To examine these transferring teachers, I use statewide administrative data from Tennessee. First, I describe the characteristics of teachers who transfer from turnaround schools. Then, I examine the characteristics of schools that receive them. Third, I use difference-in-differences (DID) models to examine the effects of teachers coming from turnaround schools on student achievement in receiving schools. A challenge to estimating the effects of teachers who transfer out of turnaround schools is that the data do not identify teachers who would have left regardless of the turnaround interventions. Below, I describe how the DID model addresses this issue by estimating the average effect of teachers who transfer from turnaround schools after reforms were put into place relative to teachers who came from these same schools before the reforms began. Thus, this model allows me to estimate a plausibly causal spillover effect of turnaround using teachers who left prior to the reforms as a counterfactual.

Tennessee provides a highly informative context for this study because replacing teachers is a major component of the state's turnaround models, and this emphasis on staff replacement mirrors many other reform initiatives across the nation (Dragoset et al., 2017). These teacher replacement policies mean that many teachers transferred into different schools when the turnaround reforms were put into place. Also, prior research has estimated the effect of

Tennessee's reforms on student achievement in turnaround schools (Pham et al., 2020; Zimmer et al., 2017) and examined a different spillover effect – on schools that lose teachers who are recruited to transfer *into* turnaround schools (Kho et al., 2018). I add to this literature by examining the reciprocal effects of teachers who transfer *away* from turnaround schools. Together with previous work on school reform in Tennessee (Henry et al., 2020; Kho et al., 2018; Zimmer et al., 2017), this study contributes a more nuanced understanding of turnaround effects by highlighting spillover into non-turnaround, receiving schools. My analysis answers three questions:

RQ1: What are the characteristics of teachers who transfer away from turnaround schools?

RQ2: What are the characteristics of schools that receive teachers from turnaround schools?

RQ3: To what extent do turnaround reforms affect transferring teachers' impact on student achievement in receiving schools?

In addition to filling a gap in the research literature, answering these questions also informs future school reform policies. Accounting for effects in receiving schools would help policymakers to better understand how these reforms affect all students, not just students in turnaround schools. Potential negative effects in receiving schools would help policymakers avoid interventions that support some schools at the expense of others; whereas, positive effects in receiving schools would mitigate concerns that some students must lose for others to gain.

Consistent with prior research, my results suggest that teachers transfer out of turnaround schools at higher rates after reforms are put into place (Henry et al., 2020), which, for receiving schools, means an increase in the proportion of incoming teachers coming from turnaround schools. Also, I find that less-effective teachers are more likely to transfer out of turnaround schools when reforms are put into place. When examining characteristics of receiving schools, I

find that they are only somewhat higher-performing than the turnaround schools themselves and tend to serve high proportions of Black students and students eligible for free-or-reduced-price meals. This suggests that teachers who leave turnaround schools are transferring into receiving schools that face similar challenges. Finally, I estimate the unintended effects of turnaround reforms on non-turnaround receiving schools and find a positive effect on student achievement. Also, average teacher value-added and observation scores increase after teachers transfer into non-turnaround receiving schools. These results suggest positive spillover effects of turnaround reforms because dislodging low-performing teachers from turnaround schools leads them to transfer into new environments where their performance improves.

Review of the Literature

Characterized by dramatic interventions targeting persistently low-performing schools (Herman et al., 2008), school turnaround efforts have grown rapidly across the country with support from considerable federal investments such as the $4.35 billion dollar Race to the Top program (US Department of Education, 2009) and $3 billion of funding for School Improvement Grants (SIGs) through the American Recovery and Reinvestment Act (Dragoset et al., 2017). Currently, under the Every Students Succeeds Act (ESSA), school reform continues to be a major policy focus because state ESSA plans must include an approach for identifying and targeting the state's lowest-performing schools for "comprehensive support and improvement" (Klein, 2016). These previous and ongoing investments suggest that school reform models will continue to expand, but in order to fully understand the effects of these high-cost turnaround interventions, more research is needed to examine spillover effects of turnaround reforms on non-turnaround schools.

Although interventions vary across different models, turnaround initiatives often feature policies that both directly and indirectly increase the number of teachers who transfer away from the turnaround school. For example, a well-known characteristic of the federal SIG program was the direct requirement for teachers in turnaround schools to reapply for their jobs with the stipulation that fewer than 50 percent would be rehired. Given common staffing policies that directly require turnaround schools to replace teachers, research evaluating turnaround reforms often examines the proportion of teachers who transfer away, the characteristics of teachers who replace them, and how these reforms affect student outcomes in the turnaround school (Hamilton et al., 2014; Henry et al., 2020; Hess, 2003; Rice & Malen, 2010; Strunk et al., 2016).

Turnaround interventions that directly mandate teacher replacements generally assume that school leaders will use the opportunity to remove the school's least effective teachers; those who are most likely a barrier to school improvement. However, there is scant research documenting characteristics of teachers who transfer when reforms are put into place, so the assumption that low-performing teachers will transfer out may not hold in practice. Many turnaround schools also replace their principal, so the new principal may not know which teachers are low-performing. Moreover, under models where schools are required to replace a sizeable proportion of teachers, school leaders may be letting more effective teachers go in an effort to meet the reform requirements. Thus, attention to the characteristics of teachers who transfer away will shed light on whether intentional teacher replacement interventions are functioning as expected.

In addition to intentional teacher replacement efforts, turnaround interventions can also indirectly increase teacher transfer rates if the dramatic interventions induce some teachers to voluntarily seek other opportunities. Turnaround reforms can include state takeover of schools or

districts (Gill et al., 2007; Schueler et al., 2017), restarting schools under new management organizations (Harris & Larsen, 2016; Strunk et al., 2016; Zimmer et al., 2017), or implementing schoolwide changes such as longer school days, new curricula, and stronger accountability systems (Dougherty & Weiner, 2017; Papay & Hannon, 2018). These disruptive interventions could push some teachers to voluntarily transfer in order to avoid the high-pressure environment or increased workload in turnaround schools (Viano et al., 2018). Moreover, turnaround interventions that require all teachers to reapply for their jobs may induce some high-performing teachers to apply for a position in different schools, and even if these teachers are eventually rehired in the turnaround school, they may choose to move because they have already found a new position that they perceive as being more advantageous. Thus, the teachers who choose to avoid working in a turnaround environment are not necessarily lower-performing, and these voluntary transfers cast doubt on the assumption that low-performing teachers will be the ones to move away from turnaround schools.

Since reforms focus on improving the turnaround school, existing effect estimates for these interventions do not account for any effects of teachers who transfer out. Teachers who transfer no longer influence students in the turnaround schools, but displacing these teachers from a turnaround school can affect the performance of their new students after they transfer. Previous research finds that tenure protections (i.e., continuing or permanent contract status) and collective bargaining agreements allow most teachers who leave one school to move into another school in the district (Goldhaber & Hansen, 2010; Jacob, 2011; Loeb et al., 2015). Thus, turnaround reforms that dislodge large numbers of teachers from one school may have non-negligible spillover effects on receiving schools.

If low-performing teachers are transferring away from turnaround schools, they could negatively affect receiving schools, especially if these receiving schools were themselves also low-performing. This scenario indicates that any potential positive effects in turnaround schools must be down-weighted by potential negative spillover into receiving schools. However, the influx of teachers from turnaround schools could have a positive effect on receiving schools if transferring teachers are already high-performing or if they improve after making the move. For example, teachers may improve if they move into higher-performing receiving schools where they can learn from more effective peers (Jackson & Bruegmann, 2009). Moreover, research finds that low-performing teachers do improve after transferring into new schools if they find a school where the culture and expectations are better aligned with their personal preferences (Jackson, 2013). This perspective aligns with a rich literature finding that the school context can strongly influence teachers' sense of self efficacy, satisfaction, and returns to experience (Johnson et al., 2012; Kraft & Papay, 2014).

Turnaround reforms can also have spillover effects on receiving schools after the reforms are put into place if these reforms affect teachers' long-term performance. For example, reforms that focus on coaching and developing teachers could have positive spillover effects if they help teachers to improve and these teachers then take what they learn with them when they move into receiving schools. Conversely, high-pressure reforms that negatively affect teachers' sense of self-efficacy could have lasting negative effects on their performance, even after they move into new schools. Reforms that potentially change teachers' effectiveness highlight an important distinction between teachers who transfer just before reforms begin (either because they were not rehired or because they want to avoid ever working in a turnaround school) and teachers who transfer later, after having experienced the reforms. To help illuminate potential differences

between these two groups of teachers, I first examine the combined effect of teachers who transfer just before and teachers who transfer after reforms are put into place. Then, I examine separate effects for teachers who transfer just before year one of the reforms and teachers who transfer in later years.

These various scenarios suggest a complex array of potential outcomes from turnaround reforms that dislodge teachers from low-performing schools. Spillover effects could vary depending on the characteristics of transferring teachers, characteristics of the receiving schools, how the reforms affect teachers, and how teachers fare in their new schools. By examining these factors together, this paper helps educational authorities and policymakers to better understand how reforms affect students outside of the turnaround school.

School Turnaround in Tennessee

Tennessee's turnaround reforms have been in continuous operation since 2012-13, providing a long window of time (relative to reforms in other states) to examine spillover effects on non-turnaround schools. Tennessee uses two primary models to support its lowest-performing schools: the state-led Achievement School District (ASD) and district-level Innovation Zones (iZones). After seven years of operation, both models have taken over five cohorts of schools, with a total of 26 ASD schools and 42 iZone schools. Since the purpose of this paper is not to estimate the impact of ASD or iZone reforms on the schools they manage, I group the 68 ASD and iZone schools together and report results on teachers who transfer from turnaround schools in either model. Results that examine teachers transferring from ASD and iZone schools separately are quite similar to the overall effects and can be found in Appendix Tables 5-10.

Tennessee is an informative context to examine spillover effects in receiving schools because both the ASD and iZones required schools to replace teachers, and previous research has found that both models did indeed replace the vast majority of teachers in the first year after they take over a school (Henry et al., 2020). This policy context allows me to compare both teachers who transferred just before the first year of reforms with teachers who transfer after year one. Moreover, both the ASD and iZones implemented schoolwide interventions that radically changed the day-to-day operations at the schools they manage. ASD schools were removed from their local district, required to replace teachers and principals, and restarted under new management, which usually meant management by a charter management organization (CMO). CMOs then had wide autonomy to change the daily operations at the school, such as adopting new curricula and changing the schedule. Schools that were placed into a district-led iZone remained part of their local district, but were managed as part of an intra-district network overseen by a separate office of full-time district staff. Besides replacing teachers and principals, iZone schools were required to extend their school day, hire additional staff (e.g., instructional coaches), and were closely monitored by the district iZone office. These bold interventions meant that Tennessee's turnaround reforms both directly required teacher replacements and likely encouraged many teachers to voluntarily transfer. For more detailed descriptions of ASD and iZone reforms along with their effects on student achievement in turnaround schools see Henry et al. (2020), Pham et al. (2020), and Zimmer et al. (2017).

Methods

Data and Measures

This study uses data provided by Tennessee's Department of Education and housed by the Tennessee Education Research Alliance. These datasets include school, principal, teacher, and student-level variables for all public schools in Tennessee from 2006-07 through 2018-19. Since both the ASD and iZones began reforms in 2012-13, these datasets capture student and teacher data for up to seven years after reforms were put into place. The student-level datasets include test scores, demographic variables (e.g., race, gender), and student characteristics (e.g., free-or-reduced-priced meal or FRPM eligibility, English language learner or ELL status, and special education or SPED status). Student test scores in Tennessee include results from end-of-grade (EOG) exams in grades 3-8 and end-of-course (EOC) exams for high school subjects. For EOC test scores, I standardize the statewide data by subject, year, and grade, and the EOG scores are standardized by subject, year, and semester.[16]

The staff-level datasets contain demographic variables (e.g., gender, race), professional characteristics (e.g., years of experience, highest degree attained), and performance ratings (e.g., observation and value-added scores) for all public school teachers and principals in the state. Following prior research on attrition among early-career teachers (Henry et al., 2011), I use the available data on teacher experience to create an indicator for novice teachers who have three or fewer years of experience.[17] Also, it is important to note that the effectiveness of tested subject

[16] Note that Tennessee changed to a new assessment system in 2015-16 (called TNReady), but administration of the new test in that first year was burdened by numerous technological problems resulting in legislative action that barred all scores in grades 3-8 from being reported. Therefore, my analyses only include student scores from EOC exams in 2015-16.

[17] Results are robust when the novice indicator identifies teachers with five or fewer years of experience.

teachers in Tennessee is measured by value-added scores on Tennessee's value-added assessment system (TVAAS), which range from one (not effective) to five (highly effective). Additionally, the data contain teacher and principal observation scores that also range from one to five. Principal observation scores are supervisor ratings given to school leaders from a rubric based on the Tennessee Instructional Leadership Standards or TILS. Scores on the TILS rubric are given by the district superintendent or her designee (usually the principal's supervisor), and previous research has found that these observation scores are internally consistent, stable over time, and predictive of other performance measures, such as student achievement growth and teachers' ratings of their school leadership (Grissom et al., 2018).

The school-level datasets include characteristics of schools such as total enrollment and address, and I can aggregate student and teacher characteristics to the school-level. Using school addresses, I can estimate the distance between sending and receiving schools using the *geodist* (Picard, 2012) package in Stata.[18] Finally, I augment Tennessee's school-level data with the Common Core of Data to obtain indicators for grade levels served in the school (elementary, middle, high, or other school level) and indicators that describe the school's location (urban, suburban, town, or rural).

Besides demographic characteristics, the data allow me to link students and educators to specific schools in each year. I use these linkages to identify students, teachers, and principals who transfer across schools. For students, I create a new-to-school indicator that equals one when the student makes a non-structural move. Nonstructural moves do not include planned school changes that occur after students complete the final grade offered at a school and therefore must move into a new school serving the next grade. For teachers and principals, I

[18] Travel distances calculated from the *geodist* package rely on proprietary data from the *Here* application program interface (Picard, 2012).

create new-to-school indicators that equal one if their current school is different from their school in the prior year. Finally, by linking teachers to specific schools, I can identify when they transfer from turnaround sending schools into non-turnaround receiving schools. In receiving schools, this means that I can identify teachers who transferred in from a turnaround sending school (both before and after reforms are put into place) and compare them to teachers who transferred in from a non-turnaround school.

Sample

To answer each of the three research questions, I use somewhat different sub-samples. First, to examine the characteristics of teachers who leave turnaround schools (either to transfer into another school or to leave Tennessee public schools completely), I restrict the sample to only teachers in turnaround schools, either before or after the reforms are put into place. Second, to examine characteristics of receiving schools, I use a sample of only non-turnaround schools that have received at least one teacher from a turnaround sending school. Third, to estimate the spillover effect of turnaround reforms, I further restrict this subsample to only include teachers who have *transferred* into a school that has received at least one teacher from a turnaround school. That is, I remove teachers who have never previously worked in another school. This allows me to compare only (1) teachers who transferred in from a turnaround sending school with (2) teachers who transferred in from a non-turnaround sending school.

Analytic Strategy

To answer the first research question, I limit the analytic sample to teachers in turnaround schools and use a multinomial logit model to predict the likelihood that they either transfer into

another school or leave the Tennessee public education system, relative to staying in the turnaround school. I use stayers as the reference category because these are teachers that could have left turnaround schools, but did not. These models allow me to examine whether certain teacher, principal, or school characteristics predict the likelihood that teachers will either transfer or leave the turnaround school, after controlling for other relevant contributing factors. I estimate the following model for teacher j in school s and year t:

$$P_{jst}(transfer\ status = N) = \frac{e^f}{1+\sum_{j=2}^{N} e^f} \ ,$$

(Equation 1)

where

$$f = \beta_0 + \beta_1 PostReforms_{st} + \alpha\, T_{jst} + \delta P_{st} + \pi S_{st} + \alpha'(PostReforms_{st} * T_{jst}) + \delta'(PostReforms_{st} * P_{st}) + \pi'(PostReforms_{st} * S_{st}) + \theta_t + \varepsilon_{jst}$$

In equation one, teacher transfer status (N) is categorized as either staying at the turnaround school, transferring into a receiving school, or leaving Tennessee public schools. The likelihood that a teacher will either stay, transfer, or leave in each year is a function of (an indicator for years after reforms are implemented teacher characteristics (T_{jst}), principal characteristics (P_{st}), school characteristics (S_{st}), a set year of year indicators (θ_t), and a random error term (ε_{jst}). The teacher, principal, and school time-varying characteristics are all from the year before teachers transfer. The interactions between and the teacher, principal, and school characteristics allow me to examine whether turnaround reforms changed the relationship between these characteristics and the likelihood of teachers transferring or leaving. Teacher

characteristics include indicators for whether the teacher is female, Black,[19] or new to the school, and whether she has three or fewer years of experience or three or fewer years of tenure in the school. also includes the teacher's prior year value-added score and whether she holds a graduate degree. Principal characteristics include indicators for female, Black, new to school, 1-3 years of experience a principal, and 1-3 years of tenure in the school. Additionally, includes principals' observation score along with whether the principal holds a doctoral degree. School characteristics includes indicators for whether the school is a middle or high school (relative to elementary schools),[20] whether the school is located in an urban area (relative to non-urban areas), and total enrollment. Standard errors are clustered at the school level.

To answer the second research question, I limit the analytic sample to non-turnaround receiving schools and model the proportion of incoming teachers who came from a turnaround school ($FromTuraround$) for school s in time t such that:

$$FromTurnaround_{st} = \beta_0 + \beta_1 PostReforms_{st} + \delta P_{st} + \pi S_{st} + \delta'(PostReforms_{st} * P_{st}) + \pi'(PostReforms_{st} * S_{st}) + \theta_t + \varepsilon_{st}$$

(Equation 2)

Equation two models the proportion of incoming teachers who transferred from a turnaround school as a function of the $PostReforms$ indicator, prior-year school characteristics (S_{st}), prior-year principal characteristics (P_{st}), a year fixed effect (θ_t), and interactions between $PostReforms$ and the school/principal characteristics. The school characteristics include average test scores and the proportion of students who are female, Black, or new to the school

[19] Given the extremely small number of minority race teachers who are non-Black in the sample, all models including teacher characteristics compare Black with non-Black teachers where the vast majority of non-Black teachers are White.

[20] This sample includes only turnaround schools, none of which are categorized as serving an "other" grade level.

(all from the prior year).[21] School characteristics in Equation 2 also includes travel distance to the closest turnaround school, total enrollment, indicators for middle, high, or other school level (relative to elementary), and indicators for urban, suburban, or town (relative to rural locations). Prior-year principal characteristics in Equation 2 are the same as in Equation 1, and standard errors are clustered the school level.

To answer the third research question, my preferred analytic strategy is a DID model with a school-by-grade-by-year fixed effect. Although I cannot observe whether a teacher who left the turnaround school post-reform would have done so regardless of the reforms, this DID model allows me to estimate whether teachers coming from these turnaround schools post-reforms have different effects on students in receiving schools compared to teachers coming from these same schools before reforms were put into place I model student test scores y for student i in grade g with teacher j in school s and year t, using:

$$y_{igjst} = \beta_0 + \beta_1 FromEverTurnaround_{jt} + \beta_2 FromAfter_{jt} + \beta_3 FromEverTurnaround_{jt} * FromAfter_{jt} + \gamma X_{it} + \theta_{gst} + \varepsilon_{igjst}$$

(Equation 3)

Equation three includes three indicators that characterize teachers' previous school. $FromEverTurnaround$ is an indicator for whether the teacher's previous school is a turnaround school. Thus, $FromEverTuranround$ is one for teachers who transferred into her current school from a sending school that either will or have already implemented turnaround reforms, and β_1 is the average difference in student achievement between teachers who came from a pre-reform turnaround school relative to teachers who did not.

[21] Other characteristics that capture the school's student body such as proportion FRPL eligible or proportion ELL status are not included because they are highly collinear with variables included in the model (e.g., urban and proportion Black).

$FromAfter$ is an indicator for whether the teacher left her previous school in the years after turnaround reforms had already been put into place. For teachers who came from a turnaround sending school, $FromAfter$ is one in the years after reforms are implemented. For teachers who came from non-turnaround sending schools, $FromAfter$ is one if that teacher left after the 2011-12 school year because Tennessee's turnaround efforts began in the summer of 2012. Thus, β_2 is the average difference in student achievement for teachers who transferred from a non-turnaround sending school after 2011-12 relative to teachers who transferred from a non-turnaround sending school before 2011-12.

The interaction between $FromEverTuranround$ and $FromAfter$ yields the coefficient of interest, β_3, interpreted as the pre-post difference in test score gains for teachers transferring from turnaround sending schools relative to the same difference for teachers transferring from non-turnaround sending schools. Adding the β_1 and β_3 coefficients yields the average difference in student achievement gains between teachers who transferred from turnaround schools and teachers who transferred from non-turnarounds schools, all in the post-reform years. The sum of β_1 and β_3 shows whether teachers transferring from the post-reform turnaround schools were more or less effective than teachers transferring from non-turnaround schools. Additionally, adding β_2 and β_3 yields the average difference between teachers who transferred from turnaround schools post-reforms and teachers who transferred from these same schools before reforms began. By comparing the effectiveness of teachers who transferred from turnaround schools before and after the reforms began, I can assess whether the reforms led to changes in the effects of teachers coming from these schools.

Equation 3 also includes a vector of student characteristics as control variables (X_{it}) including prior year test score, gender, race, FRPM eligibility, SPED status, ELL status, whether

the student is new to the school after making a nonstructural move, and the student's attendance rate. Equation 3 includes a school-by-grade-by-year fixed effect (θ_{gst}), which compares only teachers and students in the same school, grade, and year combination. I estimate equation three for student test scores in reading and math separately, and account for nonindependence between teachers in the same school-grade cell over time by clustering standard errors at the school-grade-year level.

The school-by-grade-by-year fixed effect is important because it controls for any sorting of teachers to schools and any cohort effects. For example, potential positive effects of teachers transferring from turnaround schools could be the result of them choosing to leave their turnaround school for a higher-performing receiving school where they know that they will be more successful. Restricting my inferences to within the same school-grade-year cells largely eliminates these potential threats because any influences from the receiving school itself will likely be the same for teachers in the same school, grade, and year. This approach does have a drawback in that it does not allow for any interdependent effects across grades and years (e.g., teachers coming from turnaround schools could have an effect on teachers in other grades). Although such interdependencies are most likely to occur between teachers within the same school-grade-year combination, my results will be understated to the extent that they occur with teachers in other grades or years.

To better understand potential threats to the validity of my results, I also fit less restrictive models and examine the extent to which my results change, following methods used in previous studies of teacher turnover (Ronfeldt et al., 2013). First, I replace the school-by-grade-by-year fixed effect with a school-by-grade fixed effect and add controls school characteristics, including all student-level covariates aggregated to the school level, total enrollment, and

indicators for location (urban, suburban, town) and school level (middle, high, other). The school-by-grade fixed effect uses variation across time within each school-grade cell. This specification controls for any influences in the receiving school that do not vary across the time period of this study, such as the demographic characteristics of the local community served by the school. However, it does not control for time varying influences such as changes in the effectiveness of the school's leadership. Second, I exchange the school-by-grade-by-year fixed effect with a school-by-year fixed effect. This model uses variation across grades within the same school-year cell and controls for changes across time (such as the aforementioned changes in leadership), but it does not control for differences across grades within the same school (e.g., more effective peers in some grades than others). If these less restrictive models produce similar results to my preferred model, it would suggest that I have successfully controlled for potential bias due to the sorting of teachers to particular receiving schools after they transfer away from a turnaround school. Below, I also describe additional robustness checks and alternative specifications to rule out other potential threats to validity, such as nonrandom student sorting.

Finally, in order to differentiate between the effect of teachers who transfer just before year one of reforms and teachers who transfer after the reforms had already begun, I estimate an event history model where I model test scores y for student i in grade g with teacher j in school s and year t, using:

$$y_{igjst} = \beta_0 + \beta_1 FromEverTurnaround_{jt} + \sum_{-4}^{7} \beta_{2\kappa} ReformYear_{\kappa} + \sum_{-4}^{7} \beta_{3\kappa} FromEverTurnaround_{jt} * ReformYear_{\kappa} + \gamma X_{it} + \theta_{gst} + \varepsilon_{igjst}$$

(Equation 4)

Equation 4 is similar to Equation 3, except $ReformYear_{\kappa}$ is a set of indicators for each year before and after reforms began in the sending school. For example, $ReformYear_{\kappa=1}$ is an indicator for teachers who transfer just before the first year of reforms are scheduled to begin in their sending school. These teachers are either not rehired or choose to transfer and do not experience any of the interventions. Likewise, $ReformYear_{\kappa=2}$ is an indicator for teachers who transfer just before the second year of reforms in their sending school and therefore experienced interventions that occurred that first year. The coefficients of interest ($\beta_{3\kappa}$) allow me to compare spillover effects from teachers who left because reforms were beginning but never experience them ($\beta_{3\kappa=1}$) with spillover effects from teachers who transferred later so their effectiveness may have been influenced by the turnaround interventions ($\beta_{3\kappa=2-7}$).

Results

Descriptive Characteristics of Turnaround Schools and Non-turnaround Receiving Schools

Descriptive statistics for both turnaround sending schools and non-turnaround receiving schools are summarized in Table 1. The table shows that turnaround schools are low-performing, with average standardized test scores of -0.89 standard deviation units (SDUs) in reading and -0.80 SDUs in math. Furthermore, turnaround schools primarily serve Black students (89 percent) and students who are FRPM-eligible (89 percent), and the vast majority are located in an urban area (98 percent). Most teachers in turnaround schools are female (77 percent) and Black (59 percent Black and 40 percent White), and about 38 percent are novice teachers with three or fewer years of experience. TVAAS scores for teachers in turnaround schools average about 2.75 out of five. Turnaround school principals are also primarily female (64 percent) and Black (75

percent), with average observations scores of about 3.56 out of five, and about 52 percent have three or fewer years of experience as a principal.

Table 1 also shows average characteristics of non-turnaround receiving schools with results from *t*-tests for differences between sending and receiving schools. The table shows that receiving schools have average student test scores that are somewhat higher than turnaround schools, though still below the state average (about -0.38 SDUs in reading and math). Moreover, receiving schools also serve high proportions of minority race (63 percent Black and 15 percent Hispanic/LatinX) and FRPM-eligible students (70 percent). Relative to turnaround schools, teachers in receiving schools are more likely to be White (54 percent) and less likely to be a novice (28 percent), with somewhat higher TVAAS scores (2.92 out five). Likewise, receiving school principals are more likely to be White (40 percent) and have higher observation scores (3.77 out of five) than principals in turnaround schools. Overall, these descriptive characteristics suggest that teachers who transfer from turnaround sending schools are moving to non-turnaround receiving schools that are only somewhat higher-performing. Although receiving schools serve fewer minority race and low-income students than turnaround sending schools, student populations in these receiving schools are still mostly non-White and low-income.

Table 1. Descriptive Statistics for Turnaround Sending Schools and Non-turnaround Receiving Schools

	Turnaround Sending Schools	Non-turnaround Receiving Schools	Difference
Test Scores			
Reading	-0.89	-0.38	-0.51***
Math	-0.80	-0.38	-0.42***
School Characteristics			
Elementary School Level	0.44	0.46	-0.02
Middle School Level	0.39	0.26	0.13***
High School Level	0.16	0.21	-0.05***

Other School Level	0.01	0.07	-0.05***
Urban	0.98	0.77	0.21***
Suburban	0.00	0.13	-0.13***
Town	0.00	0.02	-0.02***
Rural	0.02	0.08	-0.06***
Total Enrollment (100s)	4.77	6.79	-2.01***
Student Body Characteristics			
Proportion Female	0.48	0.49	-0.01***
Proportion Asian	0.00	0.02	-0.01***
Proportion Black	0.89	0.63	0.26***
Proportion Hispanic	0.06	0.15	-0.08***
Proportion White	0.05	0.20	-0.16***
Proportion Other Race	0.00	0.00	-0.00***
Proportion FRPM	0.89	0.70	0.19***
Proportion ELL	0.04	0.08	-0.04***
Proportion SPED	0.17	0.14	0.04***
Average Attendance Rate	0.92	0.94	-0.02***
Proportion Students New to School	0.35	0.28	0.06***
Teacher Characteristics			
Proportion Female	0.77	0.77	0.00
Proportion Asian	0.01	0.01	-0.00*
Proportion Black	0.59	0.44	0.14***
Proportion Hispanic/LatinX	0.01	0.01	-0.00
Proportion White	0.40	0.54	-0.14***
Proportion Other Race	0.00	0.00	0.00
Proportion with 1-3 Years of Experience	0.38	0.28	0.10***
Proportion with 1-3 Years of Tenure in the School	0.73	0.60	0.12***
Proportion with Graduate Degree	0.54	0.51	0.04***
Average TVAAS Score (1-5)	2.75	2.92	-0.17***
Principal Characteristics			
Proportion Female	0.64	0.58	0.06***
Proportion Asian	0.00	0.00	-0.00
Proportion Black	0.75	0.60	0.15***
Proportion Hispanic/LatinX	0.00	0.00	0.00
Proportion White	0.25	0.40	-0.15***
Proportion Other Race	0.00	0.00	0.00
Proportion with 1-3 Years of Principal Experience	0.52	0.40	0.13***
Proportion with 1-3 Years of Tenure in the School	0.79	0.60	0.18***
Proportion with Doctorate	0.38	0.41	-0.03*
Average Observation Score (1-5)	3.56	3.77	-0.21***

Notes. FRPM: free and reduced price meals; SPED: special education eligible; ELL: English language learners * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

What are the characteristics of teachers who leave turnaround schools?

Table 2 shows results from Equation 1 estimated on only teachers in turnaround schools, with coefficients expressed as relative risk ratios.[22] Model 1 includes only teacher characteristics.

[22] Similar results separating teachers in ASD and iZone schools can be found in Appendix Tables 6 and 7.

Model 2 adds principal characteristics, and Model 3 adds school characteristics. Each model shows results for teachers who transferred and teachers who leave Tennessee public schools, and relative risk ratios for each characteristic are shown next to results for the same characteristic interacted with the post-reform indicator. Across all three models, the relative risk ratio for the post-reform indicator is statistically significant and above one, suggesting that teachers are more likely to either transfer or leave than they are to stay after turnaround reforms are put into place. Focusing on Model 3 with the full set of covariates, the results suggest that, before the reforms began, the odds of Black teachers leaving are 0.65 times the odds that they will stay in their turnaround school. This relationship is not significantly different post-reforms. Model 3 also shows marginally significant evidence that teachers with higher prior-year TVAAS scores are less like to transfer after reforms begin, whereas teachers who are new to the school and novice teachers are less likely to leave after reforms are put into place. Turning to principal characteristics, Model 3 suggests that teachers in post-reform turnaround schools led by Black principals are less likely to transfer the next year. Also, teachers in schools led by novice principals are more likely to leave than to stay, but less so after reforms are implemented. Finally, post-reforms, teachers are more likely to leave turnaround middle schools than elementary schools and less likely to transfer away from larger schools than smaller schools.

To help put the magnitude of these results into perspective, Appendix Table 1 shows the average marginal effects for each teacher and principal characteristic on the probability that a teacher stays, transfers, or leaves (holding all other covariates at their observed values). For example, Appendix Table 1 shows that being Black reduces the probability that a teacher would leave by 5 percentage points, while a having a Black principal reduces teachers' probability of transferring by 9 percentage points.

Table 2. Relative Risk Ratios for Transferring From and Leaving Turnaround Schools

	(1)				(2)				(3)			
	Transfer		Leave		Transfer		Leave		Transfer		Leave	
Post Reforms	6.99***		4.13**		25.69**		21.87**		50.03***		15.05*	
	(2.55)		(2.23)		(26.36)		(24.78)		(56.53)		(17.98)	
		Interacted with Post Reforms		Interacted with Post Reforms		Interacted with Post Reforms		Interacted with Post Reforms		Interacted with Post Reforms		Interacted with Post Reforms
Teacher Characteristics												
Female	1.28	0.80	1.04	0.67	1.25	0.81	0.96	0.72	1.19	0.82	0.93	0.77
	(0.37)	(0.23)	(0.24)	(0.17)	(0.36)	(0.24)	(0.23)	(0.20)	(0.36)	(0.25)	(0.21)	(0.21)
Black	0.73*	1.28	0.59**	1.00	0.76	1.29	0.67+	0.91	0.79	1.23	0.65*	0.92
	(0.11)	(0.23)	(0.12)	(0.26)	(0.13)	(0.27)	(0.14)	(0.26)	(0.13)	(0.26)	(0.14)	(0.27)
Graduate Degree	1.04	0.87	0.86	1.00	1.00	0.90	0.80	1.05	0.96	0.94	0.79	1.07
	(0.20)	(0.23)	(0.25)	(0.32)	(0.21)	(0.25)	(0.24)	(0.34)	(0.20)	(0.25)	(0.24)	(0.35)
Prior Year TVAAS Score (1-5)	1.02	0.88+	0.97	0.93	1.03	0.89+	0.99	0.93	1.03	0.89+	0.99	0.93
	(0.05)	(0.06)	(0.10)	(0.11)	(0.06)	(0.06)	(0.10)	(0.11)	(0.06)	(0.06)	(0.10)	(0.11)
New to School	1.23	0.89	1.38	0.42*	1.22	0.84	1.46	0.38*	1.29	0.79	1.46	0.37*
	(0.21)	(0.18)	(0.44)	(0.16)	(0.22)	(0.19)	(0.49)	(0.15)	(0.24)	(0.17)	(0.52)	(0.16)
Experience: 1-3 Years	0.95	0.96	2.74***	0.45*	0.92	0.93	2.76***	0.43*	0.92	0.96	2.65***	0.44*
	(0.27)	(0.27)	(0.74)	(0.16)	(0.27)	(0.27)	(0.76)	(0.15)	(0.26)	(0.27)	(0.73)	(0.16)
Tenure: 1-3 Years	1.16	0.87	0.80	1.36	1.17	0.94	0.74	1.55+	1.14	0.96	0.79	1.47
	(0.21)	(0.19)	(0.20)	(0.40)	(0.22)	(0.22)	(0.18)	(0.41)	(0.24)	(0.24)	(0.19)	(0.39)
Principal Characteristics												
Female					1.06	1.38	0.94	1.27	1.05	1.31	0.97	1.23
					(0.24)	(0.42)	(0.23)	(0.40)	(0.23)	(0.39)	(0.24)	(0.40)
Black					1.17	0.59+	0.86	0.94	1.28	0.57+	0.75	0.99
					(0.23)	(0.19)	(0.25)	(0.34)	(0.27)	(0.19)	(0.23)	(0.38)
Doctorate					0.91	0.89	1.27	0.76	0.82	0.99	1.19	0.78
					(0.21)	(0.25)	(0.34)	(0.26)	(0.21)	(0.31)	(0.33)	(0.26)
Observation Score					0.96	0.82	1.09	0.68	1.10	0.72	1.08	0.67
					(0.18)	(0.19)	(0.29)	(0.18)	(0.23)	(0.19)	(0.31)	(0.20)
New to School					1.30	1.01	1.10	1.16	1.42	0.93	1.22	1.04
					(0.29)	(0.27)	(0.32)	(0.39)	(0.33)	(0.26)	(0.36)	(0.35)
Principal Experience: 1-3 Years					1.50	0.71	2.48*	0.32*	1.77+	0.61	2.51*	0.31*
					(0.44)	(0.27)	(0.90)	(0.15)	(0.54)	(0.24)	(0.93)	(0.14)
Principal Tenure: 1-3 Years					0.84	0.73	0.63	1.19	0.72	0.83	0.63	1.27
					(0.22)	(0.25)	(0.19)	(0.43)	(0.20)	(0.28)	(0.20)	(0.48)
School Characteristics												
Middle									0.87	1.05	0.50*	2.00*
									(0.28)	(0.41)	(0.16)	(0.69)
High									0.53+	1.64	0.63	2.01+
									(0.19)	(0.67)	(0.24)	(0.79)

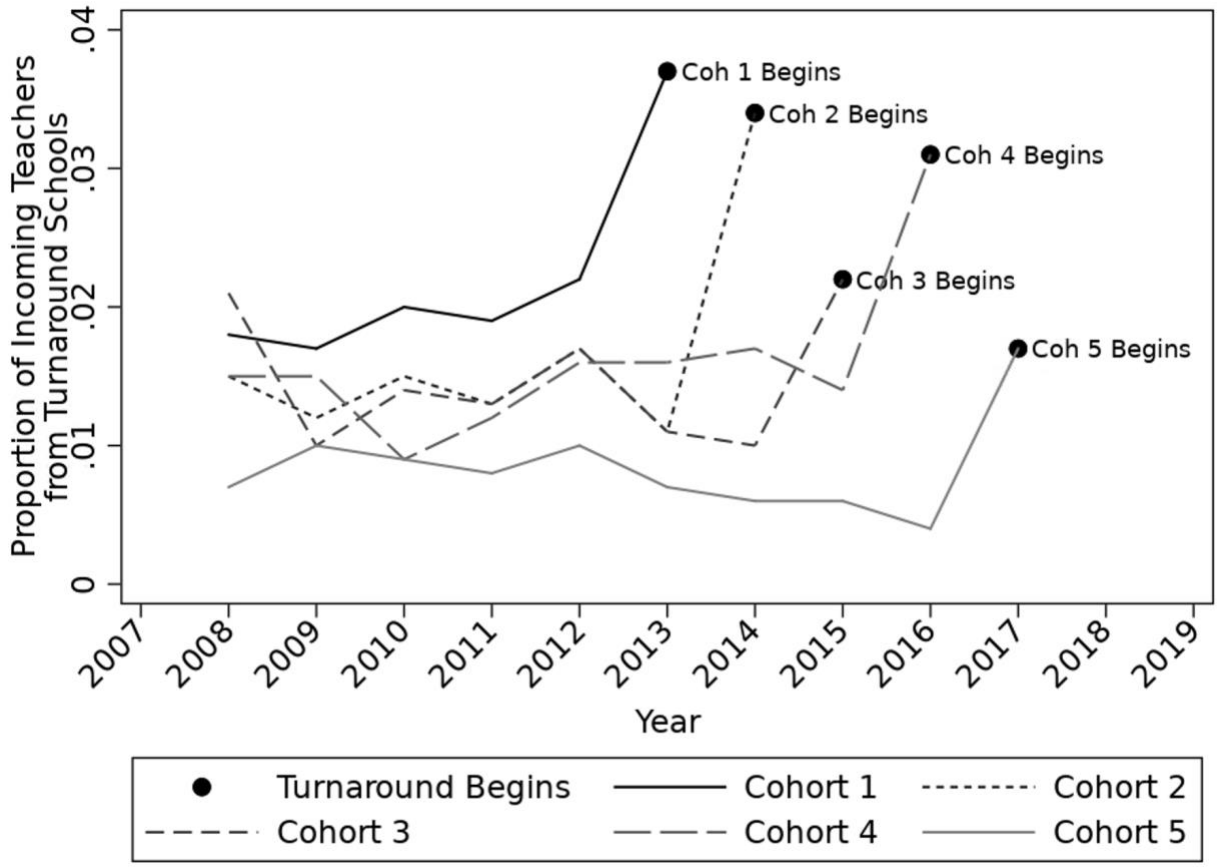
Urban			0.40*	2.36	1.08	2.59+
			(0.16)	(1.26)	(0.46)	(1.30)
Total Enrollment (100s)			1.17*	0.80*	1.17*	0.84+
			(0.08)	(0.07)	(0.08)	(0.08)
Observations	3529	3529	3529			
Pseudo R-Squared	0.06	0.07	0.08			

Note: Standard errors in parentheses are clustered at the school level. Black teachers and principals are relative to being non-Black. The vast majority of non-Black educators in Tennessee are White (less than 1 percent other race). + p<.1; * p<0.05; ** p<0.01; *** p<0.001

What are the characteristics of schools that receive teachers who transfer from turnaround schools?

In order to answer to the second research question, I examine the characteristics of non-turnaround receiving schools. Most schools in Tennessee (about 57 percent) have never received any teachers from a turnaround school in any year. However, among schools that ever receive a teacher from a turnaround school, an average of 8.5 percent of incoming teachers come from a turnaround school before reforms began, which amounts to about 4.4 teachers on average per school. After reforms are put into place, about 10.3 percent of incoming teachers are from a turnaround school, an average of 5.2 teachers per school. To help illustrate how turnaround reforms lead to increases in the number of teachers who transfer into receiving schools, Figure 1 below graphs the average proportion of teachers moving into receiving schools whose sending school is a turnaround school in each of Tennessee's five turnaround cohorts. For example, the graph shows that about 1.8 percent of incoming teachers in receiving schools come from a cohort 1 turnaround school in 2008 (before the turnaround sending school began any reforms). By 2012-13 (the first year of turnaround for cohort one schools), the number doubles such that about 3.7 percent of teachers transferring into receiving schools are coming from cohort one turnaround schools. These percentages are low because the number of schools in each turnaround cohort are small relative to the number of receiving schools; nevertheless, Figure 1 shows a clear increase in teachers transferring into new schools when turnaround sending schools begin implementing reforms.

Figure 1. Average Proportion of Teachers Moving into Non-turnaround Receiving Schools from Turnaround Sending Schools Separated by Cohort



Before turning to results from estimating Equation two, in Table 3, I present descriptive student and principal characteristics for schools with different proportions of incoming teachers from turnaround schools. I separate the results for schools that do not hire any teachers from turnaround schools, and use *t*-tests to compare them with schools that hire progressively more teachers from turnaround schools. Overall, comparing the first column in Table 3 with columns 2-5 suggests that schools not hiring any teachers from turnaround schools are higher-performing, less likely to be an in urban setting, less likely to serve historically disadvantaged students and more likely to be led by effective principals than schools that do hire teachers from turnaround schools. Even when comparing only schools that receive at least one teacher from a turnaround school, the results in Table 3 suggest that schools hiring the most teachers from turnaround

schools (top quartile) serve more Black, Hispanic, and FRPM eligible students, and they are led by principals with relatively lower observation scores and less experience than schools hiring the fewest teachers from turnaround schools. Receiving schools that hire the most teachers from turnaround schools are also more likely to be located in an urban setting and are within a shorter driving distance to turnaround schools. Finally, schools with the fewest incoming teachers from turnaround schools post average tests scores of about -0.30 SDUs, while schools hiring the most teachers from turnaround schools have average reading and math scores of -0.51 and -0.47 SDUs, respectively.

Table 3. Characteristics of Schools By the Proportion of Incoming Teachers who are from a Turnaround School

	(1) No Incoming Teachers from Turnaround School	(2) Q1 (Fewest Incoming Teachers from Turnaround	(3) Q2	(4) Q3	(5) Q4 (Most Incoming Teachers from Turnaround)
Test Scores					
Reading	-0.04	-0.29*	-0.37*	-0.45*	-0.51*
Math	-0.05	-0.30*	-0.35*	-0.44*	-0.47*
School Characteristics					
Elementary School Level	0.56	0.40*	0.50*	0.53	0.59
Middle School Level	0.20	0.27*	0.28*	0.28*	0.24*
High School Level	0.20	0.28*	0.16	0.14*	0.12*
Other School Level	0.04	0.05	0.05	0.05	0.04
Urban	0.29	0.67*	0.76*	0.80*	0.85*
Suburban	0.17	0.15	0.13*	0.11*	0.09*
Town	0.17	0.04*	0.03*	0.01*	0.01*
Rural	0.37	0.13*	0.07*	0.08*	0.06*
Total Enrollment (100s)	5.91	7.98*	6.18	5.21*	4.66*
Travel Distance to Closest Turnaround School (miles)	-	14.59*	9.06*	10.75*	8.38*
Student Body Characteristics					
Proportion Female	0.48	0.49*	0.49*	0.48	0.49
Proportion Asian	0.02	0.03*	0.02*	0.01	0.01*
Proportion Black	0.23	0.53*	0.62*	0.66*	0.72*
Proportion Hispanic	0.07	0.14*	0.14*	0.13*	0.11*
Proportion White	0.68	0.30*	0.23*	0.19*	0.16*
Proportion Other Race	0.00	0.00*	0.00*	0.00*	0.00*

Proportion FRPM	0.54	0.62*	0.69*	0.72*	0.77*
Proportion ELL	0.03	0.08*	0.08*	0.08*	0.06*
Proportion SPED	0.15	0.14*	0.14*	0.14*	0.15*
Average Attendance Rate	0.94	0.94*	0.94*	0.94*	0.93*
Proportion Students New to School	0.23	0.26*	0.28*	0.27*	0.31*
Principal Characteristics					
Female	0.56	0.56	0.58	0.63*	0.63*
Asian	0.00	0.00	0.00	0.00	0.00
Black	0.16	0.50*	0.56*	0.61*	0.66*
Hispanic/LatinX	0.00	0.00	0.00	0.00	0.00*
White	0.83	0.50*	0.44*	0.38*	0.33*
Other Race	0.00	0.00	0.00	0.01	0.00
Experience: 1-3 Years	0.48	0.40*	0.36*	0.47	0.42*
Tenure: 1-3 Years	0.60	0.64*	0.55*	0.60	0.61
Doctorate	0.43	0.42	0.41	0.43	0.31*
Observation Score (1-5)	3.92	3.79*	3.77*	3.74*	3.76*
Number of Schools	17335	590	488	369	450

Notes. * $p < 0.05$ Asterisks denote significant differences between each quartile and schools with no incoming teachers from a turnaround school. FRPM: free and reduced price meals; SPED: special education eligible; ELL: English language learners

To examine whether teachers who transfer from post-reform turnaround schools are moving to different receiving schools from the teachers who transferred before reforms began, results from estimating equation two are shown in Table 4.[23] Model 1 of Table 4 shows results that only control for average school characteristics, and Model 2 adds principal characteristics. Aligning with results from Table 3, Table 4 suggests that receiving schools post lower test scores (-0.06 SDUs), serve more Black students, and are more likely to be in urban areas, but these characteristics of receiving schools are not significantly different after reforms are put into place. Insignificant coefficients on all of the interactions between the post-reform indicator and every school/principal characteristic suggest that teachers who transferred pre-reforms and teachers who transferred post-reforms are moving into similar types of receiving schools.

[23] Results separated by ASD and iZone schools can be found in Appendix Table 8.

Table 4. Relationship between School Characteristics and the Proportion of Incoming Teachers Transferring from Turnaround Schools

Outcome:	(1) Proportion of Incoming Teachers Transferring from a Turnaround School		(2) Proportion of Incoming Teachers Transferring from a Turnaround School	
Post Reforms	0.13		0.17	
	(0.13)		(0.15)	
		Interacted with Post Reforms		Interacted with Post Reforms
School Characteristics				
Average Test Scores	-0.06*	0.04	-0.06*	0.04
	(0.03)	(0.03)	(0.03)	(0.03)
Proportion Female	0.28	-0.24	0.29	-0.25
	(0.26)	(0.27)	(0.26)	(0.27)
Proportion Black	0.17***	0.02	0.15**	-0.00
	(0.04)	(0.05)	(0.05)	(0.05)
Proportion Students New to School	-0.04	0.08	-0.04	0.08
	(0.09)	(0.10)	(0.09)	(0.10)
Total Enrollment (100s)	-0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Middle School Level	0.03	-0.02	0.03	-0.02
	(0.02)	(0.02)	(0.02)	(0.02)
High School Level	-0.01	-0.00	-0.02	0.00
	(0.03)	(0.03)	(0.03)	(0.03)
Other School Level	0.02	-0.05	0.01	-0.04
	(0.04)	(0.04)	(0.04)	(0.04)
Urban	0.05*	-0.03	0.05*	-0.03
	(0.02)	(0.02)	(0.02)	(0.02)
Suburban	0.02	-0.02	0.03	-0.02
	(0.02)	(0.02)	(0.02)	(0.02)
Town	0.01	-0.04	0.01	-0.04
	(0.03)	(0.03)	(0.03)	(0.03)
Travel Distance to Closest Turnaround School (miles)	0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Principal Characteristics				
Female			-0.01	0.01
			(0.02)	(0.02)
Black			0.01	0.03
			(0.02)	(0.03)
Doctorate			-0.02	0.01
			(0.02)	(0.02)
Observation Score (1-5)			0.01	-0.01
			(0.01)	(0.02)
New to School			0.01	-0.01
			(0.02)	(0.02)
Principal Experience: 1-3 Years			-0.00	0.01
			(0.03)	(0.03)
Principal Tenure: 1-3 Years			-0.00	-0.01
			(0.03)	(0.03)
Observations	4291		4291	
R Squared	0.17		0.18	

Note. Standard errors clustered at school level. + p<.1; * p<0.05; ** p<0.01; *** p<0.001

To what extent do turnaround reforms affect transferring teachers' impact on student achievement in receiving schools?

Before presenting results from estimating Equation 3, Figure 2 below graphs average student achievement in receiving schools for teachers who transferred from turnaround sending schools and teachers from non-turnaround sending schools. Panel A graphs average reading scores, and panel B graphs math scores. For both panels, the x-axis depicts the year when a teacher left her sending school, centered on when reforms began in that sending school. For teachers whose came from a turnaround sending school, the year is centered on zero as the year before the sending school began turnaround reforms, and one is the first year after reforms. For example, teachers who left their sending school just before year one of reforms are part of the year one average. For teachers who came from a non-turnaround sending school, the year is centered on zero as the 2011-12 school year, and one is 2012-13. The y-axis in Figure 2 graphs average student test scores in the first year after teachers arrive in their non-turnaround receiving school.

Figure 2 shows a number of important trends. First, in the years prior to reforms, student achievement trends between teachers coming from turnaround sending schools are similar to trends for teachers coming from non-turnaround sending schools. Below, I show formal evidence for parallel trends from an event history model where I find no statistically significant differences between teachers from turnaround schools and teachers from non-turnaround schools in the pre-reform years. I also reach similar conclusions when I use a comparative interrupted time series model that includes the pre-reform trend (see Appendix Table 11). These results support the validity of the DID model, because similar trends between these two groups of

teachers in the pre-turnaround period suggest that any changes in the trend after turnaround began is likely due to different types of teachers leaving in the post-reform period.

Figure 2 also shows that in the first year after teachers arrive in their receiving school, average student test scores for teachers from turnaround schools are lower than test scores posted by teachers from non-turnaround schools. These trends suggest that teachers coming from turnaround schools are generally lower-performing than teachers from non-turnaround schools in the first year after they transfer. Third, Figure 2 shows that average test scores for teachers from turnaround schools are descriptively higher for teachers who leave after their sending school initiates reforms than for teachers who leave before their sending school initiates reforms. This increase suggests that teachers who transfer from their post-reform sending school perform better in receiving schools than teachers who left these same schools pre-reforms. Thus, the gap between teachers from turnaround schools and teachers from non-turnaround schools diminishes after reforms are put into place in the sending school.

Figure 2. Average Student Test Scores in Receiving Schools for Teachers who Transferred from Turnaround Sending Schools and Non-turnaround Sending Schools

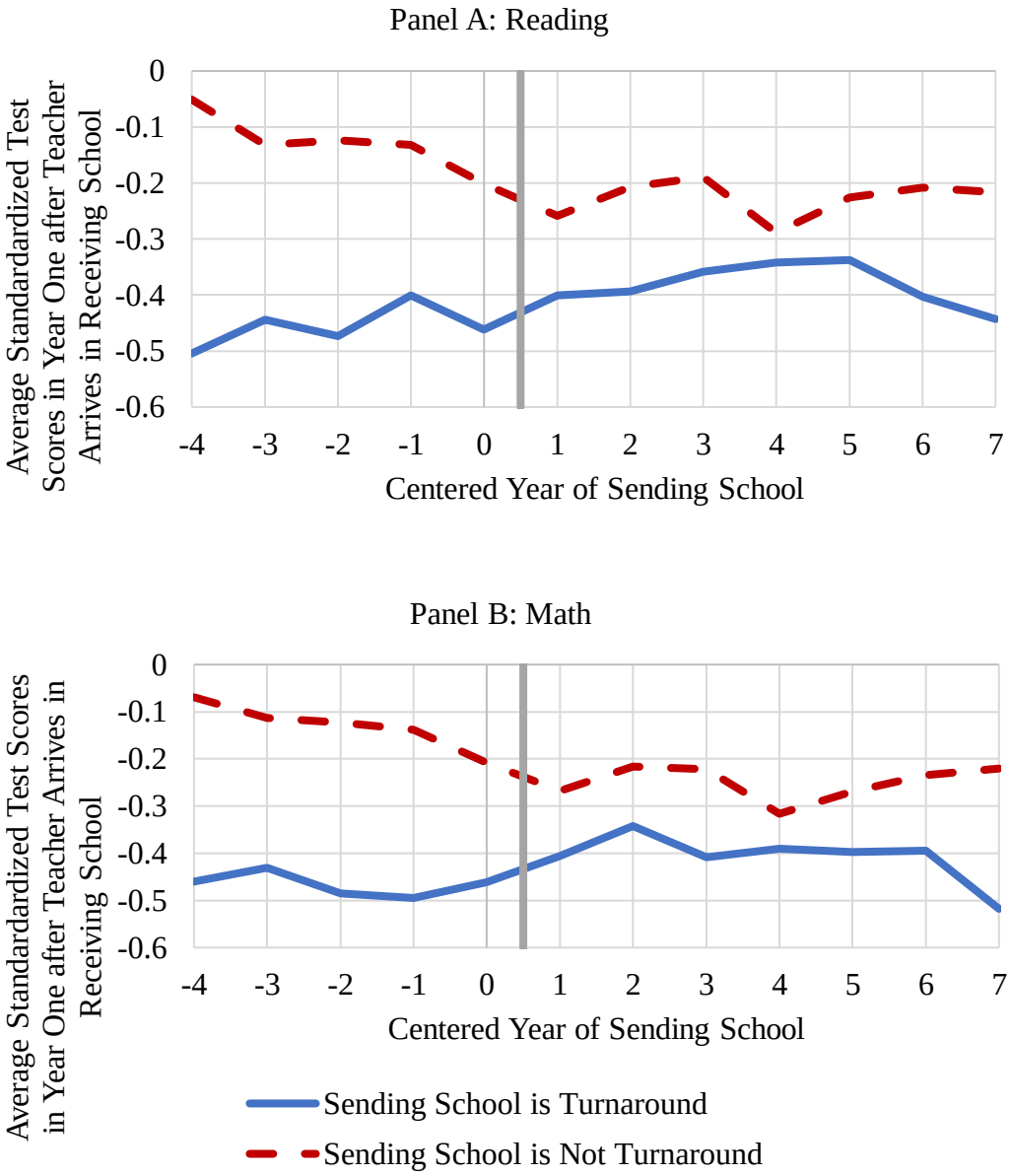


Table 5 show results from estimating Equation 3 on reading and math test scores.[24] The first two columns show results from the preferred model with a school-grade-year fixed effect. Columns 3 and 4 use a school-grade fixed effect, and columns 5 and 6 use a school-year fixed effect. All models include the full set of student control variables, but for brevity, Table 5 only shows the coefficients comparing teachers from turnaround and non-turnaround sending schools (in equation three). The coefficient of interest is the DID effect from interacting the indicator for transferring from a turnaround school with the indicator for transferring after reforms began (). Results from the preferred model in Table 5 suggest that the DID effect is positive and significant in math and positive and marginally significant at the 10 percent level in reading. That is, the average post-reform – pre-reform difference for teachers who transfer from turnaround schools is 0.02 SDUs higher than the same difference for teachers transferring from non-turnaround schools. Adding and , yields the average difference between teachers who transferred from a turnaround school and teachers who transferred from a non-turnaround school post-reforms. This difference is positive in math (0.01 SDU), but the *F*-test for is not statistically significant (. Additionally, adding and shows that the average difference between teachers who transferred from a post-reform turnaround school and teachers who transferred from a pre-reform turnaround school is 0.01 SDUs, though again the result is not statistically significant ().

Looking across Table 5, I find that the results are largely similar in the less restrictive models. The DID estimate is largest in magnitude and statistically significant in both reading and math in the model using a school-by-grade fixed effect, whereas the DID estimate is only marginally significant for both models when using the school-by-year fixed effect. Although the effect estimate is not always significant at the five percent level, the coefficient across all the

[24] Appendix Tables 9 and 10 show parallel results for teachers from ASD and iZone schools separately.

different models are always positive and of similar magnitude, providing evidence to suggest that the teachers who leave post-turnaround tend to produce better results in their receiving schools than teachers who left these same schools before turnaround began.

Table 5. DID Effect of Teachers from Turnaround Sending Schools on Reading and Math Test Scores in Receiving Schools

Fixed Effect:	School-by-Grade-by-Year Fixed Effect		School-by-Grade Fixed Effect		School-by-Year Fixed Effect	
	(1)	(2)	(3)	(4)	(5)	(6)
Outcome:	Reading	Math	Reading	Math	Reading	Math
Characteristics of Sending School						
Sending School was Ever Turnaround ()	-0.01***	-0.01**	-0.05***	-0.05***	-0.05***	-0.05***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
Left Sending School After Turnaround Reforms ()	-0.01	-0.01	-0.01	-0.03	-0.02	-0.03
	(0.01)	(0.01)	(0.01)	(0.03)	(0.02)	(0.03)
Sending School was Ever Turnaround * After ()	0.01+	0.02*	0.03*	0.03*	0.02+	0.03+
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
Student Covariates	Yes	Yes	Yes	Yes	Yes	Yes
School Covariates	No	No	Yes	Yes	No	No
N Observations	3480661	3084361	4330872	4108195	4455565	4234193
R Squared	0.57	0.53	0.36	0.34	0.37	0.35

Note. Student characteristics included as covariates include prior year test score, gender, race, FRPM eligibility, SPED status, ELL status, whether the student is new to the school after making a nonstructural move, and the student's attendance rate. School characteristics included as covariates include total enrollment, proportion female, proportion Asian, proportion Black, proportion Hispanic/LatinX, proportion other race, proportion SPED status, proportion FRPL eligible, proportion ELL, proportion new to school, and indicators for urban, suburban, town, middle school, high school, and other school level. Standard errors are clustered at the same level as the fixed effect. + $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

To examine the effect of teachers who transferred just before reforms began from teachers who transferred after experiencing the reforms, Table 6 shows results from estimating Equation 4. The results in the pre-reform years show that none of the coefficients for the pre-reform years are significantly different from zero. An *F*-test for whether the pre-reform coefficients are jointly different from zero was also not statistically significant in both reading (and math (). These results provide formal evidence to support the parallel trends assumption. For teachers who transferred just before year one of reforms, Table 6 shows positive coefficients, but the estimate is only marginally significant in math (0.021 SDU. Among teachers who transferred after reforms were already put into place, the results suggest some positive effects in year five (0.022 SDU) for reading and years two (0.033 SDU) and three (0.027 SDU) for math. Overall, these results provide some evidence to suggest that both teachers who were forced to reapply for their jobs and teachers who chose to leave after experiencing the reforms began may have positive effects on student achievement in receiving schools, though the effect appears larger among teachers who experienced the reforms.

Table 6. Effect of Teachers from Turnaround Schools on Reading and Math Test Scores, Separated by Teachers Leaving in the First Year and Teachers Transferring in Later Years

	(1) Reading	(2) Math
Characteristics of Previous School		
From Ever Turnaround * Year -4	0.005	0.014
	(0.007)	(0.012)
From Ever Turnaround * Year -3	0.006	0.033
	(0.008)	(0.024)
From Ever Turnaround * Year -2	0.006	-0.002
	(0.009)	(0.014)
From Ever Turnaround * Year -1	0.005	0.009
	(0.009)	(0.015)
From Ever Turnaround * Year 1	0.005	0.021+

	(0.008)	(0.013)
From Ever Turnaround * Year 2	0.009	0.033*
	(0.010)	(0.014)
From Ever Turnaround * Year 3	-0.002	0.027*
	(0.009)	(0.014)
From Ever Turnaround * Year 4	0.011	0.018
	(0.010)	(0.014)
From Ever Turnaround * Year 5	0.022*	0.023
	(0.010)	(0.014)
From Ever Turnaround * Year 6	0.004	0.021
	(0.011)	(0.014)
From Ever Turnaround * Year 7	0.031	-0.015
	(0.027)	(0.033)
Student Covariates	Yes	Yes
School-Grade-Year Fixed Effect	Yes	Yes
$p_{pre-reform=0}$	0.40	0.22
N Observations	3486445	3088961
R Squared	0.57	0.53

Note. Student characteristics included as covariates include prior year test score, gender, race, FRPM eligibility, SPED status, ELL status, whether the student is new to the school after making a nonstructural move, and the student's attendance rate. Standard errors clustered at the same level as the fixed effect. + p < 0.10; * p < 0.05; ** p < 0.01; *** p < 0.001

Robustness Checks

In addition to using multiple fixed effect models to account for potential teacher sorting, I also conduct a series of robustness checks to examine several alternative explanations. One potential threat to the validity of the DID model is a violation of the parallel trends assumption. Although I find no evidence of statistically significant differences in any year prior to reforms, one way to address this issue is to model the pre-reform trends using a comparative interrupted time series (CITS) model. In Appendix Table 11, I show results from a CITS model where I include a linear year trend and interact it with the indicator for transferring from ever turnaround schools and the indicator for transferring after reforms had been in place. The CITS model yields conclusions that are similar to those from the DID model. That is, relative to teachers from non-turnaround schools, the deviation from the baseline trend for teachers who transfer post-reforms is 0.032 SDU in math. The same result is positive but not statistically significant in reading.

Similar conclusions from the CITS suggests that is the parallel trends assumption holds in this study.

Another potential threat is that my preferred model does fully capture the sorting of students to teachers. For example, teachers who choose to transfer post-reforms may be moving to schools where they know they will be assigned to higher performing students. I address this issue using two strategies. First, I replace the student-level covariates in Equation three with a student fixed effect to control for any omitted time invariant student characteristics that could be driving the results. Also, I estimate a model similar to Equation three where I regress students' prior year test scores on an indicator for whether her current teacher transferred from a post-reform turnaround school. Any effect of the teacher on her students' prior year test scores (before they were assigned to her) would suggest that students are systematically assigned to teachers. Appendix Table 2 shows that the student fixed effect model yields similar results as the preferred model, and Appendix Table 3 shows that having a teacher who transferred from a turnaround school does not predict students' prior year test scores.

Besides addressing primary concerns with teacher and student sorting, I also estimate a number of alternative specifications where I add quadratic terms for students' prior year test score, include both reading and math prior year scores, remove all student-level covariates, and add a set of principal characteristics to a model that uses the school-by-grade fixed effect. Appendix Table 2 contains results from these alternative specifications and shows that, as before, the DID effect estimate is always positive (though sometimes marginally significant at the 10 percent level) and of a similar magnitude to my preferred model. Finally, I test whether my results are robust to my choice of standard errors by testing alternative standard errors clustered at the school level (instead of the school-grade-year level) and using bootstrap standard errors

based on 1,000 replications with replacement. These alternative standard errors lead to the same conclusions (see Appendix Table 4).

Discussion

Given the ongoing expansion of school reform efforts across the nation, it is important to understand the effect of these interventions outside of the turnaround school. Turnaround reforms can either directly cause teachers to transfer by not rehiring them or indirectly induce teachers to voluntarily transfer in order to avoid the high-stakes turnaround environment. Working in a turnaround environment may also affect teachers' long-term effectiveness after they transfer away from the turnaround school. Thus, turnaround reforms can have unintended spillover effects when teachers transfer from turnaround sending schools into non-turnaround receiving schools. This paper contributes new knowledge on these unintended effects by examining the characteristics of teachers who transfer or leave when their school implements reforms, describing the characteristics of receiving schools, and estimating how reforms affect the impact of teachers in receiving schools. I find that less-effective teachers are more likely to transfer than they are to stay after the school undergoes reforms. When teachers transfer away from turnaround schools, the schools that receive them tend to be nearby and are themselves low-performing (but not as low-performing as the turnaround sending school).

Once these teachers arrive in receiving schools, I find a positive effect on student achievement. Teachers who transferred from pre-reform turnaround schools produce lower average student achievement gains than teachers transferring from non-turnaround schools; however, average test score gains for teachers who came from post-reform turnaround schools are higher than for teachers who came from the same schools before reforms began. The

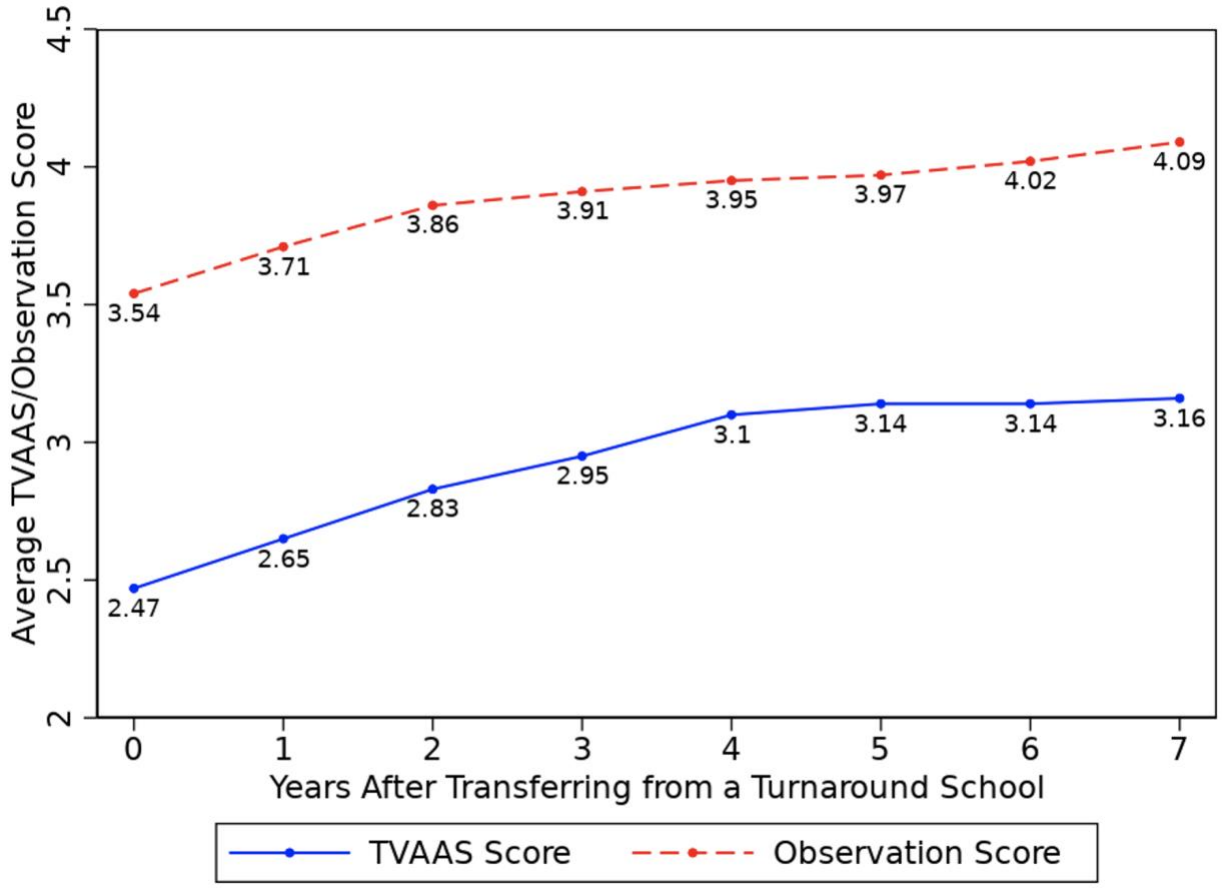
estimates also suggest that teachers from post-reform turnaround schools may be more effective than teachers from non-turnaround schools, but this relationship was not statistically significant. Finally, I find that teachers who transfer just before reforms begin have marginally positive effects in math, while teachers who transfer later produced significant gains in both reading and math in various years. Overall, these results suggest that teachers who transfer while their schools undergo reform are not negatively affecting receiving schools.

The finding that less-effective teachers are more likely to transfer after reforms were put into place indicate that Tennessee's interventions may be allowing turnaround schools to push out their lower-performing teachers or perhaps less-effective teachers are choosing to avoid the high-pressure turnaround environment. Moreover, I find that after the reforms are put into place, teachers in turnaround schools (who are mostly Black) are less likely to transfer than to stay when they have a Black principal in the prior year. Though purely descriptive, this result aligns with previous research finding that turnover is lower when teachers share a similar racial background as their principal (Grissom & Keiser, 2011). To test for potential racial-congruence effects, Appendix Table 5 includes principal-teacher racial congruence as a predictor of transferring or leaving and shows that teachers are less likely to transfer from the turnaround school when they share the racial background of their principal.

When examining characteristics of receiving schools, I find that they tend to also be low-performing and are often located near the turnaround school. This finding suggests that policy makers and educational authorities should recognize that interventions which require turnaround schools to replace teachers are not completely removing teachers from the system; they are likely moving these teachers into nearby schools. However, my results also suggest that the teachers who transfer from post-reform sending schools are more effective in receiving schools than those

teachers who transferred before their sending schools began reforms. One potential explanation for this pattern may be that the teachers who are encouraged by the reforms to transfer tend to perform somewhat better in a new school environment. To provide evidence that this is the case, Figure 3 below graphs average observation and TVAAS scores for teachers one year before (year 0) and each year after they transfer from their turnaround school into a non-turnaround receiving school. The graph shows a clear trend in which teachers who transfer from a turnaround school tend to receive higher effectiveness ratings in their new school over time. Though descriptive, this trend aligns with previous literature suggesting that low-performing teachers tend to improve after moving to a different school setting because they will likely move into new schools where the culture and expectations are better aligned with their preferences (Jackson, 2013). Thus, turnaround reforms may have positive spillover effects if they encourage teachers who otherwise would not leave their current school to find a new school that better matches their skills and preferences.

Figure 3. Average Observation and TVAAS Scores for Teachers in One Year Before and Each Year After they Transfer from their Turnaround School into a Non-turnaround Receiving School



Another potential part of reason for positive effects in receiving schools may be because turnaround reforms are improving teachers' effectiveness. Estimating effects for teachers who transfer just before year one of reforms and effects for teachers who transfer later shows that both groups are producing positive results, though only marginally so for teachers who transfer just as reforms are starting. Positive effects from teachers who transfer after reforms are put into place suggests that perhaps reforms aimed at teacher development, such as professional learning communities and instructional coaches, may have long-term positive effects through increasing

teacher effectiveness even after they transfer into different schools. Future research should directly examine the long-term effects of school reform on teacher effectiveness.

My results provide evidence that teachers who are encouraged to transfer by turnaround reforms are better for receiving schools than the teachers who would have transferred in the absence of reforms. However, this leaves open the question of whether receiving schools would fare even better if the teachers who transferred from a turnaround school had completely left the profession. One the one hand, encouraging large numbers of teachers to leave teaching may create shortages, especially because these are teachers who have shown a willingness to work in low-performing schools. One the other hand, if these teachers left instead of transferring, the schools that would have received them may then be able to hire more effective teachers from elsewhere. This outcome may be unlikely given prior research suggesting that teachers tend to sort into higher-performing schools (Feng & Sass, 2017; Goldhaber et al., 2011; Guarino et al., 2011; Lankford et al., 2002), but future research should further examine the unintended effects of turnaround reforms through teachers who leave the profession.

Although these results come from particular turnaround efforts in Tennessee, the reform models in Tennessee share many similarities with school reforms nationwide that utilize similarly dramatic staff replacement policies coupled with bold changes to schoolwide operations. Thus, the lessons from Tennessee will likely apply to reforms in other states, but future research should examine whether the patterns uncovered here will hold in different contexts. In the meantime, the Tennessee example provides some heartening evidence to suggest that teacher transferring from turnaround schools may have positive spillover effects on receiving schools.

Appendix

Appendix Table 1. Average Marginal Effects for Transferring From and Leaving Turnaround Schools

	Before Turnaround			After Turnaround		
	(1) Stay	(2) Transfer	(3) Leave	(4) Stay	(5) Transfer	(6) Leave
Teacher Characteristics						
Female	-0.02	0.03	-0.01	0.02	0.02	-0.04**
	(0.04)	(0.04)	(0.02)	(0.02)	(0.02)	(0.02)
Black	0.05+	-0.02	-0.03*	0.04	0.01	-0.05**
	(0.03)	(0.02)	(0.01)	(0.02)	(0.03)	(0.02)
Graduate Degree	0.01	0.01	-0.02	0.03	-0.01	-0.01
	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.01)
Prior Year TVAAS Score	-0.0012	0.0000	0.001	0.02+	-0.01+	-0.01
	(0.0100)	(0.0082)	(0.007)	(0.01)	(0.01)	(0.01)
New to School	-0.02	0.02	0.00	-0.02	0.05	-0.03
	(0.06)	(0.05)	(0.04)	(0.04)	(0.04)	(0.03)
Years of Experience	0.003	0.0003	-0.003+	0.0002	0.004*	-0.005**
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Tenure in School (Years)	0.01	-0.00	-0.01	-0.02	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Principal Characteristics						
Female	0.01	-0.02	0.01	-0.08*	0.07*	0.01
	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.01)
Black	0.01	0.01	-0.01	0.10*	-0.09+	-0.01
	(0.03)	(0.03)	(0.02)	(0.05)	(0.05)	(0.02)
Doctorate	0.00	-0.01	0.00	0.04	-0.04	-0.00
	(0.05)	(0.04)	(0.02)	(0.03)	(0.03)	(0.01)
Observation Score	0.01	0.01	-0.02	0.06*	-0.04	-0.03*
	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.01)
New to School	-0.09	0.05	0.04	-0.06	0.04	0.02
	(0.09)	(0.08)	(0.06)	(0.05)	(0.05)	(0.03)
Years of Experience	0.002	-0.0006	-0.001	0.004	-0.003	-0.001
	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.0009)
Tenure in School (Years)	-0.02	0.01	0.02	-0.03	0.01	0.01
	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)	(0.01)
Observations	1017	1017	1017	2532	2532	2532

Note. Standard errors in parentheses. All models include year indicators. + p<.1; * p<0.05; ** p<0.01; *** p<0.001

Appendix Table 2. Robustness Checks and Alternative Specifications

	Preferred Model		Student Fixed Effect		Prior Year for Both Subjects		Prior Year Test Score Squared		No Covariates		School-Grade Fixed Effect and Principal Covariates	
	(1) Reading	(2) Math	(3) Reading	(4) Math	(5) Reading	(6) Math	(7) Reading	(8) Math	(9) Reading	(10) Math	(11) Reading	(12) Math
Characteristics of Sending School												
Sending School was Ever Turnaround	-0.01***	-0.01**	-0.01***	0.00	-0.01**	-0.01*	-0.01***	-0.01**	-0.04***	-0.04***	-0.01+	-0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)
Left Sending School After Reforms	-0.01	-0.01	-0.02*	-0.01*	-0.01	-0.01	-0.01	-0.01	-0.01*	-0.01*	-0.00	-0.02+
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
Sending School was Ever Turnaround * After	0.01+	0.02*	0.01***	0.01*	0.01*	0.01+	0.01	0.02*	0.03+	0.03	0.01	0.03+
	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)
Prior Year Scores												
Prior Year Reading	0.68***				0.56***	0.23***	0.70***				0.67***	
	(0.00)				(0.00)	(0.00)	(0.00)				(0.00)	
Prior Year Math		0.65***			0.21***	0.52***		0.67***				0.64***
		(0.00)			(0.00)	(0.00)		(0.00)				(0.00)
Prior Year Reading Squared							0.04***					
							(0.00)					
Prior Year Math Squared								0.04***				
								(0.00)				
Student Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes
School Covariates	No	No	No	No	No	No	No	No	No	No	Yes	Yes
Principal Covariates	No	No	No	No	No	No	No	No	No	No	Yes	Yes
N	3486445	3088961	4669921	4442160	3011403	3011403	3486445	3088961	4722560	4495672	2250472	1982856
R Squared	0.57	0.53	0.01	0.01	0.61	0.56	0.57	0.54	0.00	0.00	0.57	0.52

Note. Models 1-10 include a school-by-grade-by-year fixed effect. $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Appendix Table 3. Effects on Students' Prior Year Test Score

	(1) Prior Year Reading	(2) Prior Year Math
Sending School was Turnaround (Post-Reforms)	-0.00	-0.01
	(0.00)	(0.01)
Student Covariates		
Prior Year Test Score	0.69***	0.67***
	(0.00)	(0.00)
Female	0.06***	0.03***
	(0.00)	(0.00)
Asian	0.05***	0.15***
	(0.01)	(0.01)
Black	-0.14***	-0.14***
	(0.00)	(0.00)
Hispanic	-0.05***	-0.03***
	(0.00)	(0.00)
Other Race	-0.02	-0.01
	(0.01)	(0.02)
SPED	-0.24***	-0.22***
	(0.01)	(0.01)
FRPM	-0.09***	-0.08***
	(0.00)	(0.00)
ELL	-0.27***	-0.18***
	(0.01)	(0.01)
Student is New to School	-0.04***	-0.05***
	(0.00)	(0.01)
Attendance Rate	0.78***	1.18***
	(0.02)	(0.02)
Student Covariates	Yes	Yes
School-by-Grade-by-Year Fixed Effect	Yes	Yes
N	2397490	2042567
R Squared	0.58	0.53

Note. $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Appendix Table 4. Effect of Teachers from Turnaround Schools on Reading and Math Test Scores - Different Standard Errors

	Standard Errors Clustered at School-Grade-Year		Standard Errors Clustered at School		Bootstrap Standard Errors	
	(1) Reading	(2) Math	(3) Reading	(4) Math	(5) Reading	(6) Math
Characteristics of Sending School						
Sending School was Ever Turnaround	-0.01***	-0.01**	-0.01**	-0.01	-0.01***	-0.01**
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
Left Sending School After Turnaround Reforms	-0.01	-0.01	-0.01	-0.01+	-0.01	-0.01+
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Sending School was Ever Turnaround * After	0.01+	0.02*	0.01	0.02+	0.01	0.02*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Student Covariates	Yes	Yes	Yes	Yes	Yes	Yes
School-Grade-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N Observations	3486445	3088961	3486445	3088961	3486445	3088961
R Squared	0.57	0.53	0.57	0.53	0.57	0.53

Note. $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Appendix Table 5. Relative Risk Ratios for Transferring From and Leaving Turnaround Schools with Gender and Racial Congruence

	(1)				(2)			
	Transfer		Leave		Transfer		Leave	
Post Reforms	50.03***		15.05*		67.77***		15.64*	
	(56.53)		(17.98)		(76.83)		(18.47)	
		Interacted with Post Reforms		Interacted with Post Reforms		Interacted with Post Reforms		Interacted with Post Reforms
Teacher Characteristics								
Female	1.19	0.82	0.93	0.77	1.20	0.83	0.93	0.78
	(0.36)	(0.25)	(0.21)	(0.21)	(0.37)	(0.26)	(0.21)	(0.21)
Black	0.79	1.23	0.65*	0.92	0.74+	1.54*	0.70	0.94
	(0.13)	(0.26)	(0.14)	(0.27)	(0.12)	(0.32)	(0.21)	(0.37)
Graduate Degree	0.96	0.94	0.79	1.07	0.96	0.94	0.79	1.08
	(0.20)	(0.25)	(0.24)	(0.35)	(0.19)	(0.25)	(0.24)	(0.35)
Prior Year TVAAS Score	1.03	0.89+	0.99	0.93	1.03	0.89+	0.99	0.93
	(0.06)	(0.06)	(0.10)	(0.11)	(0.06)	(0.06)	(0.10)	(0.11)
New to School	1.29	0.79	1.46	0.37*	1.29	0.79	1.46	0.37*
	(0.24)	(0.17)	(0.52)	(0.16)	(0.25)	(0.18)	(0.51)	(0.16)
Experience: 1-3 Years	0.92	0.96	2.65***	0.44*	0.92	0.95	2.66***	0.44*
	(0.26)	(0.27)	(0.73)	(0.16)	(0.26)	(0.27)	(0.76)	(0.16)
Tenure: 1-3 Years	1.14	0.96	0.79	1.47	1.15	0.96	0.79	1.47
	(0.24)	(0.24)	(0.19)	(0.39)	(0.24)	(0.24)	(0.18)	(0.39)
Principal Characteristics								
Female	1.05	1.31	0.97	1.23	0.96	1.48	1.01	1.25
	(0.23)	(0.39)	(0.24)	(0.40)	(0.24)	(0.49)	(0.28)	(0.41)
Black	1.28	0.57+	0.75	0.99	1.31	0.56+	0.73	1.02
	(0.27)	(0.19)	(0.23)	(0.38)	(0.27)	(0.19)	(0.22)	(0.40)
Doctorate	0.82	0.99	1.19	0.78	0.83	0.99	1.19	0.78
	(0.21)	(0.31)	(0.33)	(0.26)	(0.22)	(0.32)	(0.32)	(0.25)
Observation Score	1.10	0.72	1.08	0.67	1.09	0.72	1.10	0.66
	(0.23)	(0.19)	(0.31)	(0.20)	(0.23)	(0.19)	(0.31)	(0.19)
New to School	1.42	0.93	1.22	1.04	1.43	0.92	1.22	1.03
	(0.33)	(0.26)	(0.36)	(0.35)	(0.33)	(0.25)	(0.35)	(0.35)
Principal Experience: 1-3 Years	1.77+	0.61	2.51*	0.31*	1.78+	0.60	2.51*	0.31*
	(0.54)	(0.24)	(0.93)	(0.14)	(0.55)	(0.24)	(0.93)	(0.14)
Principal Tenure: 1-3 Years	0.72	0.83	0.63	1.27	0.72	0.85	0.62	1.30
	(0.20)	(0.28)	(0.20)	(0.48)	(0.20)	(0.29)	(0.20)	(0.50)
School Characteristics								
Middle	0.87	1.05	0.50*	2.00*	0.88	1.01	0.49*	2.02*
	(0.28)	(0.41)	(0.16)	(0.69)	(0.28)	(0.40)	(0.16)	(0.70)
High	0.53+	1.64	0.63	2.01+	0.54+	1.54	0.60	2.07+
	(0.19)	(0.67)	(0.24)	(0.79)	(0.19)	(0.62)	(0.23)	(0.81)
Urban	0.40*	2.36	1.08	2.59+	0.41*	2.15	1.03	2.61+
	(0.16)	(1.26)	(0.46)	(1.30)	(0.16)	(1.11)	(0.46)	(1.31)
Avg Total Enrollment (100s)	1.17*	0.80*	1.17*	0.84+	1.17*	0.80*	1.18*	0.84+
	(0.08)	(0.07)	(0.08)	(0.08)	(0.08)	(0.07)	(0.08)	(0.08)
Teacher-Principal Gender Congruence					1.15	0.83	0.95	0.94
					(0.30)	(0.22)	(0.29)	(0.31)
Teacher-Principal Race Congruence					1.14	0.65*	0.88	1.00
					(0.16)	(0.12)	(0.25)	(0.35)
Observations	3529				3529			
Pseudo R Squared	0.08				0.08			

Note. All models include year indicators. Standard errors in parentheses are clustered at the school level. + p<.1; * p<0.05; ** p<0.01; *** p<0.001

Appendix Table 6. Relative Risk Ratios for Transferring From and Leaving ASD Schools

	(1)				(2)				(3)			
	Transfer		Leave		Transfer		Leave		Transfer		Leave	
Post Reforms	13.47***		12.20**		232.72+		1104.98*		870.85*		6688.24**	
	(10.26)		(9.56)		(681.68)		(3131.19)		(2386.51)		(22768.73)	
		Interacted with Post Reforms		Interacted with Post Reforms		Interacted with Post Reforms		Interacted with Post Reforms		Interacted with Post Reforms		Interacted with Post Reforms
Teacher Characteristics												
Female	0.81	0.87	1.19	0.72	0.83	0.88	1.13	0.84	0.84	0.68	1.20	0.63
	(0.35)	(0.56)	(0.47)	(0.49)	(0.35)	(0.62)	(0.45)	(0.61)	(0.37)	(0.48)	(0.47)	(0.45)
Black	0.45+	2.87**	0.41+	1.91	0.41**	2.66*	0.39*	1.67	0.41**	2.21+	0.37*	1.48
	(0.18)	(0.99)	(0.22)	(1.22)	(0.13)	(1.15)	(0.17)	(0.93)	(0.13)	(0.98)	(0.17)	(0.90)
Graduate Degree	1.09	1.08	0.66	0.94	1.02	1.14	0.55	1.15	0.95	1.10	0.55	1.05
	(0.32)	(0.39)	(0.35)	(0.65)	(0.34)	(0.45)	(0.28)	(0.68)	(0.32)	(0.47)	(0.28)	(0.64)
Prior Year TVAAS Score (1-5)	1.13+	0.97	1.04	1.00	1.15+	1.00	1.14	0.97	1.09	1.03	1.18	0.92
	(0.07)	(0.14)	(0.15)	(0.17)	(0.09)	(0.13)	(0.13)	(0.15)	(0.08)	(0.15)	(0.15)	(0.14)
New to School	0.93	0.45+	0.48	0.73	0.82	0.56	0.46	0.81	0.77	0.61	0.47	0.92
	(0.36)	(0.20)	(0.24)	(0.47)	(0.32)	(0.29)	(0.25)	(0.60)	(0.31)	(0.33)	(0.27)	(0.73)
Experience: 1-3 Years	0.40*	1.73	2.69	0.30+	0.39*	1.56	2.56	0.31+	0.36*	1.84	2.54	0.33
	(0.18)	(0.84)	(1.68)	(0.21)	(0.19)	(0.73)	(1.60)	(0.22)	(0.17)	(0.95)	(1.60)	(0.26)
Tenure: 1-3 Years	1.16	0.58+	0.88	0.93	1.13	0.72	0.93	1.19	1.12	0.82	1.00	1.26
	(0.22)	(0.19)	(0.28)	(0.42)	(0.26)	(0.23)	(0.37)	(0.51)	(0.25)	(0.30)	(0.41)	(0.59)
Principal Characteristics												
Female					1.16	0.80	0.49+	2.22	1.19	0.18**	0.58	0.26
					(0.31)	(0.40)	(0.20)	(2.24)	(0.36)	(0.10)	(0.25)	(0.27)
Black					1.70+	1.34	1.93+	0.51	1.36	1.23	1.82+	0.44
					(0.52)	(1.04)	(0.73)	(0.45)	(0.33)	(1.14)	(0.58)	(0.37)
Doctorate					0.80	1.01	0.74	1.22	0.58+	1.67	0.65	1.70
					(0.29)	(0.57)	(0.39)	(1.07)	(0.18)	(0.85)	(0.34)	(1.37)
Observation Score					1.13	0.40+	0.94	0.31	0.98	0.27*	0.91	0.25+
					(0.30)	(0.20)	(0.45)	(0.24)	(0.30)	(0.16)	(0.41)	(0.21)
New to School					1.46	0.14***	1.45	0.54	1.21	0.24*	1.59	0.68
					(0.48)	(0.08)	(0.63)	(0.54)	(0.64)	(0.17)	(0.59)	(0.57)
Principal Experience: 1-3 Years					2.39**	0.14**	4.04*	0.06**	1.95*	0.38	4.17*	0.16
					(0.72)	(0.09)	(2.55)	(0.06)	(0.53)	(0.27)	(2.62)	(0.20)
Principal Tenure: 1-3 Years					0.59	11.44***	0.94	4.84	1.04	2.58	0.77	1.70
					(0.26)	(8.38)	(0.91)	(6.73)	(0.30)	(1.67)	(0.89)	(2.68)
School Characteristics												
Middle									1.89	0.05**	1.17	0.06*
									(1.27)	(0.05)	(0.98)	(0.07)
High									0.53	0.08+	1.35	0.02**
									(0.44)	(0.12)	(1.00)	(0.03)
Total Enrollment (100s)									0.85	2.15**	1.18	2.08+
									(0.11)	(0.58)	(0.23)	(0.79)
Observations	791				791				791			
Pseudo R-Squared	0.24				0.27				0.29			

Note. All models include year indicators. Standard errors in parentheses are clustered at the school level. + p<.1; * p<0.05; ** p<0.01; *** p<0.001

Appendix Table 7. Relative Risk Ratios for Transferring From and Leaving iZone Schools

	(1)				(2)				(3)			
	Transfer		Leave		Transfer		Leave		Transfer		Leave	
Post Reforms	6.83***		2.95		20.42*		49.72*		109.45***		23.69*	
	(3.39)		(2.02)		(24.84)		(82.54)		(127.83)		(35.94)	
		Interacted with Post Reforms		Interacted with Post Reforms		Interacted with Post Reforms		Interacted with Post Reforms		Interacted with Post Reforms		Interacted with Post Reforms
Teacher Characteristics												
Female	1.83+	0.58	1.04	0.62	1.77	0.58	0.87	0.73	1.64	0.61	0.86	0.76
	(0.65)	(0.20)	(0.30)	(0.19)	(0.65)	(0.21)	(0.27)	(0.24)	(0.66)	(0.24)	(0.26)	(0.25)
Black	0.90	0.91	0.82	0.64	0.93	0.95	0.94	0.60	1.02	0.87	0.96	0.58
	(0.17)	(0.21)	(0.20)	(0.20)	(0.18)	(0.24)	(0.24)	(0.20)	(0.19)	(0.22)	(0.26)	(0.20)
Graduate Degree	1.01	0.88	0.95	1.04	0.99	0.88	0.94	1.02	0.89	0.99	0.89	1.09
	(0.23)	(0.27)	(0.35)	(0.42)	(0.23)	(0.28)	(0.38)	(0.45)	(0.20)	(0.31)	(0.38)	(0.49)
Prior Year TVAAS Score (1-5)	0.95	0.95	0.91	1.01	0.94	0.99	0.85	1.09	0.95	0.97	0.86	1.09
	(0.07)	(0.09)	(0.13)	(0.17)	(0.08)	(0.09)	(0.14)	(0.20)	(0.08)	(0.09)	(0.14)	(0.20)
New to School	1.24	0.96	1.82	0.31**	1.23	0.92	2.09+	0.27**	1.48+	0.75	2.24+	0.24**
	(0.24)	(0.22)	(0.69)	(0.14)	(0.26)	(0.22)	(0.89)	(0.13)	(0.31)	(0.18)	(1.00)	(0.12)
Experience: 1-3 Years	1.40	0.67	2.54**	0.49+	1.36	0.64	2.65**	0.46+	1.26	0.71	2.42*	0.50
	(0.46)	(0.21)	(0.85)	(0.21)	(0.47)	(0.21)	(0.90)	(0.20)	(0.44)	(0.24)	(0.87)	(0.22)
Tenure: 1-3 Years	1.15	0.98	0.70	1.65	1.19	1.03	0.57+	2.12*	1.02	1.22	0.59	2.10*
	(0.29)	(0.29)	(0.23)	(0.62)	(0.31)	(0.32)	(0.18)	(0.68)	(0.33)	(0.44)	(0.19)	(0.71)
Principal Characteristics												
Female					1.00	1.39	1.94*	0.54	1.17	1.12	2.45*	0.41*
					(0.34)	(0.51)	(0.62)	(0.21)	(0.29)	(0.29)	(0.97)	(0.17)
Black					1.17	0.56+	1.92*	0.38**	1.48	0.48	1.50	0.45+
					(0.33)	(0.19)	(0.62)	(0.14)	(0.57)	(0.22)	(0.68)	(0.22)
Doctorate					1.20	0.71	3.48***	0.30***	1.08	0.78	3.01*	0.33*
					(0.34)	(0.23)	(1.02)	(0.10)	(0.45)	(0.36)	(1.32)	(0.15)
Observation Score					1.00	0.88	1.34	0.66	1.19	0.77	1.24	0.72
					(0.24)	(0.23)	(0.39)	(0.23)	(0.35)	(0.24)	(0.44)	(0.29)
New to School					1.43	0.97	1.12	0.85	1.26	1.10	1.11	0.82
					(0.42)	(0.34)	(0.39)	(0.32)	(0.39)	(0.41)	(0.40)	(0.33)
Principal Experience: 1-3 Years					1.09	1.07	1.45	0.68	1.15	1.05	1.36	0.73
					(0.39)	(0.43)	(0.69)	(0.37)	(0.42)	(0.44)	(0.64)	(0.38)
Principal Tenure: 1-3 Years					0.94	0.61	0.76	1.05	1.16	0.49+	0.83	1.03
					(0.37)	(0.28)	(0.33)	(0.49)	(0.40)	(0.20)	(0.36)	(0.49)
School Characteristics												
Middle									0.91	0.96	0.55	1.67
									(0.26)	(0.35)	(0.27)	(0.83)
High									0.50+	1.95	0.85	1.62
									(0.18)	(0.81)	(0.44)	(0.87)
Urban									0.27*	2.55	0.53	4.16*
									(0.15)	(1.65)	(0.37)	(2.87)
Total Enrollment (100s)									1.31***	0.70***	1.14	0.81+
									(0.10)	(0.06)	(0.11)	(0.09)
Observations	2738				2738				2738			
Pseudo R-Squared	0.05				0.06				0.07			

Note. All models include year indicators. Standard errors in parentheses are clustered at the school level. + p<.1; * p<0.05; ** p<0.01; *** p<0.001

Appendix Table 8. Regression Outcome: Ever Receiving Teachers from an ASD or iZone School

	ASD				iZone			
	(1)		(2)		(3)		(4)	
Post Turnaround	0.09		0.10		0.04		0.07	
	(0.09)		(0.09)		(0.13)		(0.14)	
		Interacted with Post Reforms		Interacted with Post Reforms		Interacted with Post Reforms		Interacted with Post Reforms
School Characteristics								
Avg Test Scores	-0.03*	0.04*	-0.03*	0.04*	-0.03	0.00	-0.03	0.00
	(0.01)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)
Proportion Female	0.16	-0.20	0.12	-0.17	0.12	-0.04	0.17	-0.09
	(0.16)	(0.18)	(0.16)	(0.17)	(0.26)	(0.26)	(0.25)	(0.25)
Proportion Black	0.09***	0.03	0.08**	0.02	0.07+	-0.01	0.07	-0.03
	(0.02)	(0.02)	(0.03)	(0.03)	(0.04)	(0.04)	(0.05)	(0.05)
Proportion Students New to School	-0.02	0.05	-0.03	0.05	-0.02	0.03	-0.02	0.03
	(0.04)	(0.04)	(0.04)	(0.04)	(0.09)	(0.10)	(0.09)	(0.10)
Total Enrollment (100s)	0.00*	-0.00	0.00*	-0.00+	-0.00+	0.00	-0.00+	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Middle School Level	-0.01	0.01	-0.01	0.01	0.03	-0.03	0.03	-0.03
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
High School Level	-0.03*	0.01	-0.03+	0.01	0.02	-0.02	0.01	-0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
Other School Level	0.04	-0.05	0.04	-0.05	-0.02	-0.00	-0.03	0.01
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Urban	0.01	-0.02	0.01	-0.02	0.04*	-0.01	0.04*	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Suburban	-0.01	-0.00	-0.00	-0.00	0.03	-0.02	0.03	-0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Town	0.00	-0.02	0.00	-0.02	0.01	-0.02	0.01	-0.02
	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Travel Distance to Closest Turnaround School	0.00	-0.00	0.00	-0.00	-0.00	-0.00+	-0.00	-0.00+
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Principal Characteristics								
Female			0.01	-0.01			-0.02	0.01
			(0.01)	(0.01)			(0.02)	(0.02)
Black			0.01	0.01			0.00	0.02
			(0.02)	(0.02)			(0.02)	(0.02)
Doctorate			0.01	-0.02			-0.03*	0.03+
			(0.01)	(0.01)			(0.01)	(0.02)
Observation Score			0.01	-0.00			0.00	-0.00
			(0.01)	(0.01)			(0.01)	(0.01)
New to School			0.02	-0.02			-0.01	0.01
			(0.02)	(0.02)			(0.02)	(0.02)
Principal Experience: 1-3 Years			0.02	-0.01			-0.02	0.02

		(0.01)	(0.01)		(0.02)	(0.02)
Principal Tenure: 1-3 Years		-0.03*	0.02		0.03	-0.04
		(0.01)	(0.01)		(0.03)	(0.03)
Observations	4294	4294		4294	4294	
R Squared	0.11	0.12		0.09	0.09	

Note. Standard errors clustered at school level. + p<.1; * p<0.05; ** p<0.01; *** p<0.001

Appendix Table 9. Effect of Teachers from ASD Schools on Reading and Math Test Scores

	School-by-Grade-by-Year Fixed Effect		School-by-Grade Fixed Effect		School-by-Year Fixed Effect	
	(1)	(2)	(3)	(4)	(5)	(6)
	Reading	Math	Reading	Math	Reading	Math
Characteristics of Sending School						
Sending School was Ever ASD ()	-0.01**	-0.01*	-0.06***	-0.05**	-0.06***	-0.06***
	(0.00)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
Left Sending School After Turnaround Reforms ()	-0.01	-0.01	-0.01	-0.04	-0.02	-0.03
	(0.01)	(0.01)	(0.01)	(0.04)	(0.03)	(0.04)
Sending School was Ever ASD * After ()	0.01+	0.02*	0.04*	0.03	0.04*	0.04*
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Student Covariates	Yes	Yes	Yes	Yes	Yes	Yes
School Covariates	No	No	Yes	Yes	No	No
N Observations	3480661	3084361	4453621	4226927	4578907	4353488
R Squared	0.57	0.53	0.36	0.34	0.37	0.35

Note. Standard errors clustered at the school-grade-year level. $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Appendix Table 10. Effect of Teachers from iZone Schools on Reading and Math Test Scores

	School-by-Grade-by-Year Fixed Effect		School-by-Grade Fixed Effect		School-by-Year Fixed Effect	
	(1)	(2)	(3)	(4)	(5)	(6)
	Reading	Math	Reading	Math	Reading	Math
Characteristics of Sending School						
Sending School was Ever iZone ()	-0.01**	-0.01	-0.04***	-0.04**	-0.04***	-0.04***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
Left Sending School After Turnaround Reforms ()	-0.01	-0.01	-0.01	-0.04	-0.02	-0.03
	(0.01)	(0.02)	(0.02)	(0.04)	(0.02)	(0.04)
Sending School was Ever iZone * After ()	0.01	0.01	0.03+	0.04*	0.02	0.02
	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)
Student Covariates	Yes	Yes	Yes	Yes	Yes	Yes
School Covariates	No	No	Yes	Yes	No	No
N Observations	3480661	3084361	4414139	4189617	4540090	4317004
R Squared	0.57	0.53	0.36	0.34	0.37	0.35

Note. Standard errors clustered at the school-grade-year level. $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Appendix Table 11. CITS: Effect of Teachers from Turnaround Schools on Reading and Math Test Scores

	(1) Reading	(2) Math
Sending School was Ever Turnaround * After	0.008	0.032*
	(0.010)	(0.015)
Sending School was Ever Turnaround	-0.006	-0.020**
	(0.004)	(0.007)
Left Sending School After Turnaround Reforms	-0.006	-0.024*
	(0.008)	(0.012)
Year Trend	-0.003***	-0.003***
	(0.000)	(0.001)
Sending School was Ever Turnaround * Year Trend	0.003	-0.001
	(0.002)	(0.002)
Left Sending School After Turnaround Reforms * Year Trend	-0.001	0.003
	(0.002)	(0.002)
Student Covariates		
Prior Year Test Score	0.671***	0.645***
	(0.002)	(0.002)
Female	0.065***	0.030***
	(0.002)	(0.002)
Asian	0.051***	0.140***
	(0.005)	(0.006)
Black	-0.138***	-0.130***
	(0.003)	(0.003)
Hispanic	-0.050***	-0.044***
	(0.003)	(0.004)
Other Race	-0.010	-0.004
	(0.012)	(0.015)
SPED	-0.277***	-0.247***
	(0.005)	(0.005)
FRPM	-0.080***	-0.071***
	(0.002)	(0.002)
ELL	-0.208***	-0.173***
	(0.007)	(0.006)
Student is New to School	-0.029***	-0.043***
	(0.003)	(0.004)
Attendance Rate	0.968***	1.438***
	(0.021)	(0.025)
Student Covariates	Yes	Yes
School by Grade by Year FE	Yes	Yes
N	1373436	1245973
R Squared	0.56	0.52

Note. Standard error clustered at school-grade-year level. $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

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