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Examining Spillover Effects from Teach For America Corps Members in Miami-Dade County Public Schools

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WORKING PAPER 113 • JUNE 2014

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Acknowledgements

This work was produced under financial support from the John S. and James L. Knight Foundation. We gratefully acknowledge the cooperation of Miami-Dade County Public Schools, especially Gisela Feild, in providing data access, research support, and allowing us to interview district and school personnel regarding Teach For America. We acknowledge the cooperation of Teach For America's national and Miami regional offices in conducting this research. We thank Jeff Nelson for excellent research assistance, and helpful comments from Raegen Miller, Jason Atwood, Rachel Perera, and participants in presentations of findings at the Knight Foundation and the 2014 AEFP Conference. CALDER working papers have not gone through final formal review and should be cited as working papers. They are intended to encourage discussion and suggestions for revision before final publication.

The views expressed are those of the authors and should not be attributed to the American Institutes for Research, its trustees, or any of the funders or supporting organizations mentioned herein. Any errors are attributable to the authors.

Disclosure: The Knight Foundation funded both the TFA clustering strategy and this external evaluation of that strategy. The Knight Foundation, Teach For America, and Miami-Dade County Public Schools were cooperative in facilitating this evaluation and received early drafts of these findings, but none had editorial privilege over the actual contents or findings presented here. The CALDER Center has a current contract with Teach For America to conduct a separate evaluation of corps member impacts in a different region of the country, which Teach For America procured through a competitive bid process. These evaluations are independent of each other, and TFA has no editorial influence in the presentation of findings in neither the current study nor this separate contract.

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Examining Spillover Effects from Teach For America Corps Members in Miami-Dade County Public Schools

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June 2014

Abstract

Despite a large body of evidence documenting the effectiveness of Teach For America (TFA) corps members at raising the math test scores of their students, little is known about the program's impact at the school level. TFA's recent placement strategy in the Miami-Dade County Public Schools (M-DCPS), where large numbers of TFA corps members are placed as clusters into a targeted set of disadvantaged schools, provides an opportunity to evaluate the impact of the TFA program on broader school performance. This study examines whether the influx of TFA corps members led to a *spillover effect* on other teachers' performance. We find that many of the schools chosen to participate in the cluster strategy experienced large subsequent gains in math achievement. These gains were driven in part by the *composition effect* of having larger numbers of effective TFA corps members. However, we do not find any evidence that the clustering strategy led to any *spillover effect* on school-wide performance. In other words, our estimates suggest that extra student gains for TFA corps members under the clustering strategy would be equivalent to the gains that would result from an alternate placement strategy where corps members were evenly distributed across schools.

I. Motivation and Background

Teach For America (TFA) is an alternative certification program that has demonstrated success in placing intensively selected recent college graduates and mid-career professionals into classrooms serving high-need students. Yet, little is known about the program's impact beyond the classrooms of individual corps members. TFA's recent placement strategy in the Miami-Dade County Public Schools (M-DCPS), where many TFA corps members are placed as clusters into a targeted set of disadvantaged schools, provides a unique research opportunity to evaluate the impact of the TFA program on schools beyond the simple assignment of individual corps members. This paper investigates this clustering strategy to understand the broader influence of TFA corps members on their teacher colleagues and the schools in which they are placed.

TFA operates by recruiting and training graduates from selective colleges or other young professionals to teach for two years in high-need public schools, filling vacancies that are otherwise considered difficult to staff. Several prior evaluations of TFA corps members' classroom performance conclude they outperform comparison teachers in math (and science, where tests are available), but perform at similar levels in reading. These evaluations come from both experimental (Clark, et al., 2013; Glazerman, et al., 2006) and quasi-experimental (Boyd, et al., 2006; Kane, et al., 2008; Xu, et al., 2011) research designs.[1] The increased productivity of TFA corps members is presumed to be driven largely by TFA's ability to select high-quality candidates for placement in the classroom, though TFA's specific role in that selection process is still being examined in the research literature.[2]

[1] An exception to these findings is an early study from Boyd et al. (2006), which examines test scores of New York City grade 4-8 students and finds no significant difference between TFA and traditionally-trained teachers in math. Their only statistically significant finding for TFA teachers is for first-year middle school TFA math teachers relative to other beginning teachers, where students taught by TFA teachers score about 0.05 standard deviations higher.
[2] Xu, et al., (2011) estimate the TFA effect is primarily driven by selecting candidates with high observable characteristics (selective universities, high Praxis scores, etc.), though Clark, et al. (2013) find that the TFA effect cannot be explained by these differences in observables. Dobbie (2011) uses data on TFA rubrics in evaluating

The impact of TFA's placements on the broader school has not previously been examined, though TFA believes the presence of its corps members can be transformational. One can reasonably hypothesize corps members may boost the productivity of the schools in which they are placed through *spillover effects* onto other teachers—both by complementing other TFA corps members and positively impacting non-TFA teachers in the school—which may affect the overall culture and performance of a school. The spillover effects may become more pronounced, in theory, as the number of TFA corps members clustered in a school increases. Evidence that teachers influence other teachers' productivity is found in Jackson and Bruegmann (2009), who find that students perform better when their teachers' peers improve over time. This spillover effect is especially pronounced for inexperienced teachers, which is relevant in our setting since TFA teachers generally have few years of experience.

TFA's clustering placement strategy in the district plays a key role in identifying credible spillover effects. TFA generally targets the highest-need schools in attempting to place their corps members, which implies students' unobservable tendency to score poorly in these schools may bias attempts to identify spillover effects with the use of between-school variation. Yet, using within-school variation of TFA corps members may be endogenously driven in typical circumstances: principals' decisions to hire more or fewer TFA corps members likely depends on their experience in the past, which may in part be a response to corps members' effects on other teachers in the school. Endogenous variation in TFA staffing within schools would likewise be detrimental to these estimates. In recent years, some schools in M-DCPS stopped hiring TFA altogether and others began hiring many more due largely to the new clustering strategy. These changes in TFA levels within schools over a short time period are more plausibly exogenous, and hence lend to more credible estimates of any spillover effects.

This evaluation also relates to research examining school turnaround. Two years after TFA instituted the cluster placement strategy on their own, they formally partnered with M-DCPS's

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corps member applications and finds these measures to be predictive of performance in the classroom, independent of other observable characteristics.

Education Transformation Office (ETO), the office established to oversee school turnaround efforts in the district. The ETO works with low-performing schools to help them implement one of the four federally prescribed turnaround models to improve school performance. One of these models, the *turnaround model*, prescribes low-performing schools to turnover at least 50 percent of the low-performing school's teaching staff. This partnership between TFA and the ETO enabled TFA to channel corps members specifically into schools that were labeled as chronic low performers. While this partnership may aid schools to build committed staffs in short order, prior evidence of success for this strategy is generally weak overall, as described in the Institute of Education Science's Practice Guide on the topic (Herman, et al., 2008). However, a more recent, rigorous study of school turnaround efforts in California point to the *turnaround model* as having the largest associated effect of the four federally prescribed models (Dee, 2012), further supporting the rationale behind these models. How well this strategy of using clusters of TFA corps members to help fill staffing needs in these turnaround schools is an open question that is part of our inquiry here.

II. Research Questions

This evaluation has two guiding research questions:

1. How does the density of TFA-affiliated teachers within a school affect the performance of all other teachers in schools, as measured by test scores of their students?

2. How does increasing the number of TFA-affiliated teachers in a school differentially affect the performance of active TFA corps members in their schools?

To answer these questions, we use administrative data from M-DCPS for the five school years between 2008-2009 and 2012-2013 to estimate spillover effects from TFA teachers to others by exploiting variation in the within-school TFA density inherent in the M-DCPS clustering placement strategy.

In addition to the administrative data primarily used here, the study team also conducted live semi-structured interviews with district personnel who work with the TFA program and school principals or assistant principals in schools where TFA corps members have been placed since the 2009-10 school year. Though an analysis of this qualitative data is beyond the scope of this paper, we supplement the empirical analysis presented here with interview responses where appropriate. A more focused analysis of the qualitative data from this project is forthcoming.

III. TFA Placement in Miami-Dade

TFA has been placing corps members in M-DCPS since 2003, which began with 35 initial placements.[3] During the early period of TFA's presence in the district, the placement of corps members in schools did not adhere to an overarching strategy—aside from the main criterion of placing corps members in schools with high levels of student poverty (student bodies exceeding 70 percent eligibility for free or reduced-price lunch), teachers were placed wherever TFA could establish sufficient rapport with school principals as to allow TFA candidates to be considered for vacancies. This approach to placement resulted in TFA corps members being spread thinly across many schools in the district. By the summer of 2008, TFA's yearly cohort size was approaching 50 corps members, resulting in a total presence of 90 active corps members (representing two cohorts) assigned across 48 schools during the following school year.

Beginning with the 2009-10 school year, TFA began a clustering strategy in which new placements were purposely assigned to schools within designated high-need communities. TFA's clustering placement strategy grew out of an interest in accelerating TFA's impact on student outcomes. Based on conversations with those originally involved in the design of the clustering strategy, these accelerated outcomes were presumed to be achieved through several means. First, by placing multiple corps members in the same schools TFA expected to increase corps members' satisfaction and sense of support from the program, which was hoped to lead to better outcomes among active corps members

[3] This section draws heavily on conversations with the TFA Miami regional office, as well as personnel in the M-DCPS central office. We thank them for generously providing details of the program.

and higher retention after their two-year commitment ended. Second, students in these schools were expected to now have multiple opportunities for being exposed to TFA corps members, thus potentially making a cumulative effect on the high-need student populations in targeted schools.[4] And third, TFA believed a critical mass of young, energetic corps members would possibly spillover into non-TFA teachers' classrooms, and potentially affect the whole school (the primary focus of this paper). Beyond these benefits to students, TFA also expected that higher concentrations of corps members in fewer schools was beneficial from a management perspective: by virtue of working in fewer sites, TFA could better manage and build deeper relationships with building-level administrators as well as provide in-person support to corps members more efficiently. The new placement strategy was conceived by the regional TFA office located in Miami, endorsed by M-DCPS, and encouraged with external funding. Since being implemented in M-DCPS, this placement strategy has been loosely replicated in other, mostly rural, TFA regions.

The TFA clustering strategy soon became one piece in a larger school turnaround effort of M-DCPS's ETO, which was developed in 2010, and designed to serve those schools designated as the "persistently lowest-achieving." Due to the natural overlap in the targeted schools for both TFA and the ETO, they partnered to start placing TFA teachers in select ETO schools starting in the 2011-12 school year. Both entities viewed this as a mutually beneficial partnership—the ETO valued the flow of corps members to vacancies that are otherwise difficult to staff,[5] while TFA viewed this as a way to strategically target their efforts in the highest need schools, which was expected to maximize their

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[4] Follow-up studies in this project intend to evaluate the success of the clustering strategy in retaining corps members after their two-year commitment, and the cumulative effective of exposure to multiple TFA-affiliated teachers on student achievement over time.

[5] TFA placements under the clustering strategy are still heavily dependent upon position vacancies and principal buy-in. Neither schools nor the district made explicit decisions to fill a certain number of vacancies with TFA teachers, but rather considered the pool of eligible incoming TFA candidates to fill vacancies. The ultimate decision to hire a TFA corps member was left to school principals, though under the clustering strategy principals had to begin to accept at least two TFA corps members in the same school. Thus, the density of TFA corps members in a school was determined by available vacancies, principals' selection of corps members to fill vacancies, and the size of the TFA corps cohort, rather than TFA strategically targeting a certain threshold of TFA corps members in each school.

impact on students. This partnership further accelerated the growth of the total number of corps members working in the district.

The growth of the TFA corps and its density is readily apparent in the placement numbers during the five school years of the data used for this analysis. Table 1 presents TFA corps member assignment figures over time. In the 2008-09 school year, the year immediately preceding the clustering strategy, there was an average of slightly less than two TFA corps members in each school where they were placed. In the years following, the number of schools containing any TFA dropped by about half and the number of active TFA corps members in the district more than tripled, resulting in an average of nearly 10 corps members per school where there was any presence.[6] The net result was a jump in the proportion of TFA corps members in placement schools, going from 2-4% in 2008-09 to 14-18% in 2012-13.

IV. Theory of Action

With its clustering strategy, TFA corps members might affect the overall performance of the school in at least two distinct ways: through a *composition effect* and a *spillover effect*. The *composition effect* relies on the makeup of the teacher workforce to determine the school's overall productivity—if TFA corps members are more effective than the prior teachers whom they replace, then the school improves simply as a mechanical result of getting better teachers. Given prior evidence of TFA corps members' classroom performance—in math (and science), at least—this composition effect is likely, but is not our primary focus in this paper. Our interest here is in the possible spillover effect.

The *spillover effect* is less direct. It presumes that all teachers affect each other: more effective peers will promote effectiveness in colleagues. Jackson and Bruegmann (2009) present convincing

[6] When conducting interviews with school and district administrators, one concern we heard about the large increase in TFA placements was a potential dilution of the quality of the TFA pool due to the district filling about three times as many placements with TFA corps members. Any decrease in quality could also be a confounding factor in our attempt to identify spillover effects. We address this issue further in Section VII below.

evidence of productivity spillovers among elementary school teachers in North Carolina, presumably arising through sharing instructional resources, coaching each other, or simply motivating each other. The authors find novice teachers are particularly responsive to the arrival of effective colleagues, but it's not clear that novices are particularly influential in their ability to shape others' performance. Applying these findings to TFA, where almost all of these corps members are novices, one may suspect that the density of TFA corps members likely has the strongest effect on other TFA corps members, and only a moderate effect on more experienced non-TFA teachers. Consequently, as we look for evidence of spillover effects from TFA corps members, we attempt to differentially identify spillover that may affect these two groups.

There are important reasons spillover may be particularly influential for other TFA corps members, aside from the experience differential just described. In this case, spillover effects may be the result of having greater access to a support group of peers from similar backgrounds going through a shared experience in the TFA program. This support group may plausibly affect TFA corps members through traditional means of on-the-job performance (e.g., instruction or classroom management), or may additionally provide non-traditional spillover through off-the-job support (e.g., orienting them to a new city, socializing, or housing). Providing corps members with a group of other supportive corps members in the same school was one of TFA's stated objectives of the clustering placement strategy to begin with; whether this support translates to increased classroom performance for these teachers is an empirical question that we investigate here.

Expectations of TFA spillover onto more experienced, non-TFA colleagues, however, may seem unrealistic on the surface, given the corps members' relative inexperience. Yet, during in-person interviews, multiple school principals expressed opportunity for TFA corps members to influence their colleagues' practice, suggesting spillover could be plausible. The most common opportunity principals cited for TFA corps members to affect others' practice was during common planning, a district-wide effort to organize teachers of the same grade (in elementary grades) or subject (in secondary grades) in a regular shared planning period to coordinate efforts and promote mutual learning. One elementary school principal related, "Through common planning, the sharing of best practices, through our data checks, TFA corps members will show what worked—their determination spread, it's contagious." In addition, clustered TFA corps members may also influence other teachers across the school more broadly, which was confirmed by a district administrator, "When you have a few corps members in the same school, they tend to feed off of each other and often times there's a big change in the school culture." Several principals participating in the interviews indicated specific mechanisms through which these cultural changes may occur, including TFA corps members' high energy levels, high expectations, and outreach to parents, all of which they cited as being noticed and modeled by other teachers. Thus, if these behavioral spillovers translate into student achievement, a TFA spillover effect among all teachers broadly may be plausible, in spite of TFA corps members' relative inexperience.[7]

Considering how the spillover and composition effects interact in the context of a school turnaround is also relevant, given TFA's partnership with the ETO, even though the clustering strategy was not originally designed to be a turnaround intervention. The literature on school turnaround recommends teacher workforce strategies that work through both managing the composition and improving the stock of teachers in the schools (and spillover may be one way these teachers improve). For instance, the IES School Turnaround Practice Guide (Herman, et al., 2008) identifies strategies such as building a committed staff (working through the composition effect) and signaling the need for dramatic change to change the school culture (which could feasibly spillover onto other teachers' performance). Supporting evidence for these approaches is found in Hansen (2013), who concludes there is evidence of both better composition and improvements among the pre-existing stock of teachers that play a role in dramatically improving student achievement in low-performing schools. Both

[7] Using Australian data, Bradley, et al. (2007) find evidence of behavioral spillovers in teacher absences associated with the arrival of teacher colleagues that show prior patterns of high or low absences. The authors do not provide any evidence of this behavior's effect on student achievement.

of these elements may plausibly be activated with the arrival of a cluster of TFA corps members to a struggling school, and hence may potentially play a vital role in achieving a successful transformation.

V. Data

To address the study's research questions, we use detailed student-level administrative data that cover M-DCPS students linked to their teachers for five school years (2008-09 through 2012-13). M-DCPS is the largest school district in Florida and the fourth largest in the United States. The district has large minority and disadvantaged student populations, typical of regions TFA has historically targeted; about 60% of its students are Hispanic, 30% black, and 10% white, and over 60% of students qualify for free or reduced price lunch.

The student-level longitudinal data we use in the analysis contain reading and math scores on the Florida Comprehensive Achievement Test (FCAT).[8] Students' FCAT scale scores are converted to z-scores based on the mean and standard deviation for that particular subject-grade test in the M-DCPS sample. Test scores in each year are outcomes, and prior-year test scores are used as controlling covariates in the value-added approach when estimating student outcomes used in the analysis (described further below). In addition to standardized test scores, we observe a variety of student characteristics: race, gender, free- or reduced-price lunch eligibility, limited English proficiency (LEP) status, whether a student is flagged as having a mental, physical, or emotional disability, attendance, and disciplinary incidents. In addition, all students are linked to teachers through data files that contain information on course membership.[9]

[8] From the 2008-09 school year through the 2010-2011 school year, all students between grades 3-10 took the FCAT in both math and reading. However, with the introduction of End-of-Course (EOC) exams in 2011-12, the mathematics portion of the FCAT will only be administered to grades 3-8 from 2011-2012 forward. For students taking an EOC exam in 2011-2012 and 2012-2013 (for example, Algebra I), we consider their previous year's FCAT score to be their lagged test score. See Appendix I for more information.

[9] Teachers of record in students' core math and reading courses are linked to them for the analysis. Student observations linked to multiple teachers (e.g., due to co-teaching, student mobility) are weighted in proportion to

Teacher personnel files in the M-DCPS data contain information on teachers' experience levels, education attainment, demographics, and other supplemental background variables. These will likewise be used as covariates for various models in the analysis that follows. One variable included in the data is a flag on TFA corps members; given the importance of this variable in the analysis, we externally validated this variable with corps member lists from TFA.[10]

The samples used for this analysis of TFA corps members' spillover effects on student learning outcomes are, of necessity, limited to grades and subjects in which standardized tests are administered to students. Hence, the few schools in which all TFA corps members are placed outside of these grades and subjects are dropped from the sample. Table 2 presents descriptive statistics of the two samples utilized for the study (one for each subject: math and reading). The table groups schools within each sample separately by TFA cluster status, which we define as any school in which two or more corps members from the same cohort are placed starting in the summer of 2009 and after.

As shown in Table 2, the cluster schools where TFA corps members have been placed since 2009 tend to be very observationally dissimilar to the rest of the district. While about two-thirds of students in non-cluster schools are Hispanic, over three-fourths of cluster schools are black (based on student characteristics in the analysis sample in tested grades and subjects). In addition, the share of FRL eligible students is about 20 percentage points higher in placement schools. This is consistent with TFA placement patterns of choosing high needs schools in which to place its corps members. In addition, student achievement on the FCAT in cluster schools is about 0.6 and 0.5 standard deviations lower in reading and math, respectively.

Differences also emerge with observable teacher characteristics, although not as stark as the differences between students. Teachers in non-cluster schools are about five percentage points more likely to have at least a Master's degree, and average an additional 2-3 years of experience. By

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the amount of time spent with each teacher, based on available enrollment data. Please see Appendix I for more information.

[10] Please see Appendix II for details on the matching process to validate this TFA flag.

construction, the share of TFA teachers is much higher in the cluster sample.[11] Also, teachers in placement schools are significantly more likely to be black and less likely to be Hispanic, relative to the non-placement schools.

As TFA corps members and alumni are the primary focus of this study, it is helpful to examine descriptive statistics of these placements over time for those appearing in the analysis sample. Table 3 reports corps member placements over time included in the analysis sample (reporting information parallel to Table 1), and also presents descriptive statistics of the classrooms TFA teachers are leading. Note that the TFA proportion values and descriptive statistics include only active corps members; however, given the high attrition of TFA corps members out of the classroom after two years, these figures only slightly vary when reporting on active corps members and TFA alumni combined. For instance, cluster schools averaged less than one TFA alumni remaining in the school beyond the initial two-year commitment.

Three particular elements of this Table 3 are worth highlighting. First, the schools with any TFA corps members that are included in the analysis sample tend to have even higher percentages of TFA in them (comparing against the percentages reported in the entire district in Table 1 above). This figures show TFA corps members are over-represented among tested grades and subjects, which is unsurprising as TFA teachers are most commonly granted a provisional license to teach in core academic subjects (math, science, and English/language arts) rather than untested subjects (e.g., history, art) that are omitted from the analysis sample. When conducting interviews, we did not find any evidence of principals systematically sorting TFA corps members to a teaching assignment that would be tested (conditional on the corps members' license area). Principal responses were mixed, with some describing an inclination to staff TFA corps members specifically in tested grade/subject assignments, others

[11] There are some TFA corps members and TFA alumni in the non-cluster sample due to residual TFA corps members left over from before the cluster period.

describing a strategy that kept TFA out of these assignments for at least a year, and a third group reporting no particular strategy.

The second pattern to note is a slight tendency for the classroom demographics of TFA teachers to become increasingly disadvantaged as the clustering strategy progressed over time, as measured by higher shares of black or FRL-eligible students. On the other hand, TFA teachers in the most recent three years received students whose previous reading test scores were better than in 2009-10 (-0.25 standard deviations in 2012-13 compared to -0.49 in 2009-10). Prior math scores also increase over time, though the increase is considerably smaller.

And third, the table shows a large and notable jump in math test scores among students taught by TFA corps members. These post-test scores jump considerably in the last two years of data, an increase of 0.35 sd of student achievement, while the increase in pre-test scores during that period is only 0.03 sd. This jump in performance during these last two years is particularly noteworthy for two reasons: first, this jump in performance coincides with the largest single year-to-year increase in the total number of TFA corps members in the district (84 corps members, see Table 1); and second, it also coincides with the initiation of TFA's formal partnership with the district's ETO to help turnaround low-performing schools. These two coincident events could potentially cloud our ability to identify a TFA spillover effect, as concurrent school-wide turnaround interventions will be confounded with the spillover effect if they are correlated with high-dosage TFA schools.

This possible bias prompts us to plot the performance trajectories of TFA cluster schools with those of non-cluster, ETO schools; these are presented in Figure 1. This figure shows this large increase in math test scores appears to be common among both groups of schools; however, the surge in math test scores for TFA cluster schools appears to begin one year earlier in the cluster schools and is larger in magnitude than that observed among the remaining ETO schools. No apparent improvement is observed in reading test scores in either group; both groups showed declines relative to their 2008-09 performance. Note that most (26), but not all (29), TFA cluster schools are ETO schools, while the non-cluster, ETO group contains 39 schools.[12] Hence, to avoid attributing this rise in achievement solely to the TFA clustering strategy, we will control for year-specific ETO effects in our analysis.[13]

VI. Empirical Strategy

To address the study's research question regarding the influence of TFA's clustering strategy on overall school performance, we begin with a straightforward value-added regression predicting student achievement for student *i* in school *s* in classroom *c* at time *t* on test scores (A_{ist}) as a function of prior student achievement (A_{it-1}), student characteristics (X_{it}), classroom characteristics (X_{ct}), and a school fixed effect (γ_s).[14] Studies of TFA effectiveness generally estimate an equation similar to the following:[15]

$$A_{ist} = \alpha A_{it-1} + \beta_1 X_{it} + \beta_2 X_{ct} + \gamma_s + \beta_3 TFA_{it} + \varepsilon_{ist}. \quad (1)$$

Yet, the spillover effects of interest for this paper deal with TFA teachers affecting others, but how is that best empirically modeled? In order to address this question, we need to determine how to quantify the density of TFA teachers in schools. There are two dimensions to this measurement that must be considered: a) through what group are spillover effects transmitted? and b) how is the

[12] The list of schools considered ETO by the district changes has grown over the last several years; we identify a school as ETO if it is ever considered an ETO. The TFA Cluster group in Figure 1 includes all 29 TFA Cluster schools, regardless of ETO status.

[13] When not controlling for ETO time trends, some estimates find a positive and significant effect on math test scores associated with increasing the TFA density within a school. As shown below, the regressions including ETO controls generally do not find TFA density to have a statistically significant effect on achievement.

[14] The vector of prior-year test scores contains cubic functions of prior test scores in both reading and math. The vector of student characteristics includes the following: race, gender, free- or reduced-price lunch (FRL) eligibility, limited English proficiency (LEP) status, and mental, physical, or emotional disability status. The vector of classroom characteristics includes class size, classroom-level averages of prior-year test scores, and classroom-level averages of each of the student characteristics listed above. Teacher controls include teacher race, gender, experience, and whether the race of the teacher matches that of the student. The student characteristic, class average, and teacher demographic controls are interacted with grade indicator variables to allow differences in the influence of these variables across grades. The estimating equation additionally includes indicator variables on grades and years.

[15] Studies using this approach include Boyd, et al., (2006); Clark, et al., (2013); Glazerman, et al., (2006); and Kane, et al., (2008).

composition of TFA teachers measured in the peer group? Both of these dimensions are discussed in turn below.

First, how are spillover effects transmitted? The clustering strategy, as implemented in M-DCPS, focused on increasing the presence of TFA corps members in schools generally, so considering all teachers within a school as the relevant peer group would be a natural way to approach this problem. Yet, defining the peer group this way implies that TFA corps members' influence is broad, potentially reaching others who do not share similar grade or subject assignments. If clusters of TFA affect the school culture in such a way as to promote greater productivity overall (e.g., due to higher student expectations or motivating other teachers to exert more effort), then a parameterization that defines a teacher's peers broadly should pick up this type of spillover. Alternatively, spillover effects may be more concentrated. In select schools, TFA has worked with principals to stack a particular department (typically math or science) with TFA corps members. Learning between teachers during common planning may constitute the most tangible places for TFA corps members to affect others' practices. In these cases, we would expect a parameterization that defines the peer group more narrowly would be more likely to identify the spillover effect.[16] In the analysis that follows, we estimate models using two separate definitions of the relevant peer group—the first defines peers as any colleague within the school, the second defines peers as any colleague within the same grade (for elementary school teachers) or same subject (for middle and high school teachers). As shown below, results are mostly similar across these two definitions.

Second, how is the composition of TFA teachers measured in the peer group? Again, there is no clear answer as to how to measure the density of TFA peer members for a given teacher—one could either directly count all TFA teachers with the peer group or convert that number to represent the proportion of peer teachers who are affiliated with TFA. Given the ambiguity on how to quantify this

[16] Jackson and Bruegmann's (2009) analysis of productivity spillovers in elementary schools measures teacher peer productivity at the grade level, looking at how variations in teacher peer quality in a teacher's grade affects a given teacher's productivity.

variable, we present the results from several different specifications. We separately run regressions with counts and percentage as the relevant measures; also, because spillover may affect peers in non-linear ways, we use various threshold values (both values in counts and proportions) to quantify differences in the composition of TFA teachers in the peer group.

Next, we include these various measures of the TFA corps members' concentration in a school ($TFA\_DENSITY_{st}$) interacted with the indicator for TFA corps member, as shown below:

$$A_{ist} = \alpha A_{it-1} + \beta_1 X_{it} + \beta_2 X_{ct} + \gamma_s + \beta_3 TFA_{it}$$
$$+\beta_4 TFA\_DENSITY_{st} + \beta_5 TFA\_DENSITY_{st} * TFA_{it} + \varepsilon_{ist}. \text{ (2)}$$

In the above equation, *TFA_DENSITY* is a measure of TFA density. These measures of the TFA corps members are one of the various parameterizations just described (combining the relevant peer group with various measures of density). Theses parameters are intended to capture any differential in outcomes that may be associated with differences in the composition of the corps members within the implementation of the cluster strategy. The extent to which the point estimate on the baseline density variable ($\widehat{\beta_4}$) remains statistically significant provides evidence of spillover among all non-TFA teachers generally, rather than changes in performance that are simply associated with the infusion of corps members. Finally, $\widehat{\beta_5}$ captures the extent to which the spillover effects differentially accrue to TFA teachers.[17]

Estimation of these equations above will provide a descriptive picture of the associations between the cluster strategy in a school and the school's value-added performance. Yet, because the clustering strategy is implemented non-randomly across schools in the district (at minimum, we know selected schools had at least 70 percent of its students eligible for free or reduced-price lunch; other characteristics may have also played into the selection decision), the point estimates associated with the

[17] To allow for students with multiple teachers, regressions are run using the Full Roster Method (Hock and Isenberg, 2012), where observations are at the student-teacher link level, and are weighted differentially by teacher dosage. Please see Appendix I for more details.

clustering effect may be downward biased because targeted schools were likely targeted precisely because they were likely to have lower performance absent the intervention. As a result, we include both school fixed effects and controls for time-varying averages within classrooms such as student demographic characteristics and test scores. The inclusion of school fixed effects implies that the variation in schools' densities of TFA teachers over time is driving the resulting estimates—differences in TFA densities across schools are ruled out in the resulting estimates.

Finally, as shown above in Figure 1, there was a substantial increase in the average math test scores at schools involved with the ETO in recent years: both cluster and non-cluster. To avoid attributing this increase in performance to TFA's clustering strategy, we control for a common ETO effect by including an interaction term between ETO and school year in our estimates of school spillover effects.

VII. Results

Estimating the Effects of TFA Corps Members on their Students

To compare the TFA corps members in our study with previously-published research, we display the results of the basic teacher value-added regression represented by Equation (1) in Table 4. In all of the results that follow, all grades are combined into a single regression, with grade-specific intercepts and slopes for relevant control variables. Controls include cubic terms in a student's previous math and reading scores, race, gender, FRL status (all interacted with grade level). In addition, we take class averages of these demographic variables and interact them with grade level. These estimates, therefore, can be interpreted to represent the contributions of TFA teachers over and above the average teacher with similar student backgrounds and test scores. Also interacted with grade level are teacher demographics (race, race-matching with students, gender, and degree attainment) and class size.[18] Finally, we cluster standard errors at the school level.

The first column shows a basic OLS regression while controlling for TFA and teacher experience separately. For math, consistent with previous papers, the TFA effect is positive and statistically significant. We also find a null effect for reading scores in our basic OLS regression shown in column 5. We next investigate whether TFA corps members have differential returns to experience by interacting TFA and years of experience (columns 2 and 6), and generally do not find a differential effect by experience. In other words, both TFA and non-TFA teachers become more effective over time at similar rates. Columns 3-4 (math) and 7-8 (reading) add school fixed effects, and find similar results, although the gain in math test scores associated with being taught by a TFA teacher becomes somewhat larger. This is presumably due to the TFA teacher coefficient being downwardly biased in OLS as corps members are placed in relatively disadvantaged schools; failing to add the school fixed effects attributes the school's low performance trajectory to the corps members rather than to school-specific unobservable performance.[19]

The magnitude of our TFA math effect – about 10% of a standard deviation of student learning on standardized test scores – falls roughly in the middle of previous studies. Relative to the papers discussed earlier, our estimate is somewhat smaller than Glazerman et al. (.15) and Xu et al. (.13), and larger than Clark et al. (.07), Kane et al. (.02), and Boyd et al. (no effect). The null effect we find in reading is expected, and is consistent with these prior studies finding no differential effect in reading. Because the impact of a 0.10 standard deviation improvement in test scores varies across school grades (representing approximately 20% of a school year in grade 4 and 40% of a school year in grade 10), we

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[18] Teachers with missing values for experience are coded as 0 and are flagged with a missing experience indicator variable, which is included as a control in the regressions.

[19] When not including any controls for experience, the TFA effect falls from 0.10 to 0.07 standard deviations. This drop is not surprising since TFA teachers tend to have fewer years of experience than the average non-TFA teacher. When allowing the TFA coefficient to vary over time without including experience controls, the TFA effect is 0.05 for a corps member's first year, 0.07 in the second year, and 0.11 beyond the second year.

convert grade-specific TFA effects to months of student learning using the average annual gain estimates reported in Hill, et al. (2008).[20] After converting, the weighted average TFA effects equate to a 34% boost in learning beyond average annual student gains in math, or a non-significant 3% increase over annual learning gains in reading. In math, this effect is equivalent to 3.4 months of learning, based off of a 10-month school year, relative to the average student assigned to a non-TFA teacher in the same school.

Estimating the Spillover Effects of TFA onto Colleagues' Students

We next turn to the main research questions of this paper: whether the density of TFA members in a school leads to a measureable change in other teachers' performance beyond any composition effect. Regression results incorporating the parameters capturing spillover are presented in Table 5 (for math) and Table 6 (for reading). Panel A of each table shows results in which the peer group is defined as all colleagues within the school. Each column uses a different method of quantifying TFA density. The first column, "Count", simply counts the number of TFA peers within a school. For example, in a school with five TFA corps members, the non-TFA teachers would be considered to have five TFA peers, while the TFA teachers would have four TFA peers (since we do not count a teacher as his or her own peer). The TFA effect continues to be statistically significant and positive. However, neither the density (measured as the count of TFA teachers in a school) nor the TFA * TFA Density interaction are statistically significant. In other words, although TFA corps members are, on average, more productive than non-TFA members, in this specification there are no additional measureable differences in student achievement associated with increasing the number of TFA teachers in a school, other than on those TFA teachers' own students.

The remaining columns of Panel A show the results from different specifications of TFA density. The second column, "Percent", defines the TFA density to be the percent of other teachers in a school

[20] When estimating grade-specific coefficients for the TFA variable, the standard errors increase substantially, and most are not statistically distinguishable from other grades' coefficients or zero. For brevity, we do not report them here.

that are TFA corps members, with similar effects. The remaining columns define a "TFA-dense" school to be one which has TFA density passing certain thresholds. For example, the third column tests whether there is a difference in student achievement associated with increasing the number of TFA teachers in a school to at least five. Finally, columns 5-8 explore whether there is an effect when the percentage of TFA teachers in a school passes a given threshold. In general, there is no evidence of spillovers to non-TFA teachers from increased densities of TFA teachers, as measured by the Density coefficient. This is also true for the impact of TFA density on other TFA corps members.

Panel B of both tables considers the same methods of defining TFA density, but rather than measuring density at the school level, we look at a more targeted peer group. For elementary schools, we consider a teacher's peers to be those teachers in the same grade, and for secondary schools, in the same subject. Results are broadly similar to those in Panel A, and continue to be sensitive to how density is defined. Further complicating our ability to make statistical inference are the standard errors in columns 4-8.

For reading achievement, presented in Table 6, results continue to be sensitive to specification. Point estimates of the TFA effect are positive, though not consistently statistically significant. The TFA spillover effect estimates, both onto TFA and non-TFA teachers, are generally negative, although few of these are statistically significant.

In sum, the results do not find a consistent pattern of TFA density affecting student achievement. When simply using the number or percent of TFA teachers in a school or in a grade/subject as the relevant density measure among the peer group, we do not find that increasing the concentration of TFA teachers has any detectable effect on the productivity of either other TFA or other non-TFA members. However, in other models, the sign of the TFA interaction effect is sensitive to specification and not precisely estimated.

Examining the Potential Tradeoff between Quality and Quantity in Clustering

As a final analysis, we investigate whether the increase in the quantity of TFA corps members placed in the clustering strategy was accompanied by a decrease in the classroom productivity of these corps members. This inquiry is motivated by the concern that the increase in TFA density over time (which we are using to identify spillover effects), if concurrent with a decrease in quality, may understate actual spillover, since the empirical model estimates a single TFA effect over the entire period.

Not only is this possible drop in quality an empirical concern, but it is also a practical concern: when conducting interviews with district administrators, this was the primary concern voiced about the clustering program. One district administrator states, "I would revisit the way they are recruiting TFA; I think everyone recognizes that when you [have grown this much], there is obviously a danger in loss of quality."

Table 7 presents the results of our investigation into changes in TFA effect estimates over time. These results are produced by re-estimating the main TFA effects as detailed in Equation 1, and then adding either cohort-specific (on the left) or year-specific (on the right) interaction terms with the TFA indicator variable. If quality is declining with more recent placements, we expect to see a trend of negative point estimates on the interaction variables representing these placements. The cohort-specific point estimates show a moderate level of fluctuation over time, but no clear downward trend with later cohorts.[21] The year-specific point estimates fluctuate less (as more corps members are included in each grouping), but again do not demonstrate a downward trend. These interaction estimates are not statistically significant in any of these regression models. Based on these results, we conclude the spillover effects estimated in Tables 5 and 6 are likely not tainted a concurrent drop in productivity among TFA estimates.[22]

[21] For the 2007 cohort, the data do not include their first year of teaching and there are very few observations, likely leading to the imprecise estimates found.
[22] Though we do not find any clear empirical evidence of lower classroom productivity among more recent placements, this does not necessarily imply all TFA placements in the district are of the same quality over time. In

VIII. Discussions of Findings and Limitations

There are a number of reasons that, even if there were a spillover effect associated with increasing the density of TFA corps members in a school, we may not be able to find it using our data. The first is due to the relatively short time horizon. It was only in 2010-2011 and especially 2011-2012 and 2012-2013 when the share of TFA teachers within placement schools grew substantially. Since 2012-2013 is the final year of our sample, we are only able to estimate the impact of TFA density on student performance in the short term. If TFA were to change teacher effectiveness over the course of multiple years, we would not yet be able to observe that process. The relatively short time period also limits the observed variation in TFA density, since there is a small sample of cluster schools (only 29) where TFA densities showed any meaningful variation and the rollout only happened in the most recent three years, likely leading to low precision in the estimates.

The second limitation is the exclusive focus on student test scores in this study. Spillover effects from TFA corps members onto other teachers may be transmitted through a variety of behaviors, which may affect students, other teachers, or the school culture in many ways. In subsequent investigations with updated data, we will investigate other outcomes, such as student absences, the persistence of teacher effects among TFA corps members, and teacher retention. Further, our forthcoming analysis of the qualitative data collected during our semi-structured interviews with school and district administrators will provide additional nuance to the influence and the limitations of TFA corps members in these schools.

Finally, previous literature has found that the magnitude of productivity spillovers across teachers is relatively small. Jackson and Bruegmann (2009) find that a one-standard-deviation increase

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order to be included in the analysis sample, a teacher must be assigned to a tested grade and subject, and teach in this assignment for the full school year. If selection into these tested classroom assignments or the premature attrition of TFA corps members has changed during this period, the analysis in Table 7 will not detect them. Hence, while we use the results of Table 7 to remove the possibility of lower productivity clouding our spillover estimates, it should not be interpreted as definite evidence on the health of the TFA corps in the district overall.

in the mean estimated value-added of a teacher's peers is associated with an increase of 0.0398 standard deviations in math test scores. In our data, the average TFA teacher is about 40% of a standard deviation more effective than the average replacement teacher in teacher value added (authors' calculation), so the expected increase in student test scores associated with replacing an average teacher with a TFA teacher would be

$$\frac{1}{n}(0.0398)(0.40),$$

where *n* represents the number of teachers in the relevant peer group (Jackson and Bruegmann use teachers within a grade and school in a sample of elementary school students). Thus, for a grade with five teachers, the expected increase in other students' test scores due to adding a TFA teacher would be 0.003 standard deviations. If an entire grade of average teachers were replaced with TFA teachers, the expected increase would be 0.016 standard deviations, an effect that is too small to detect given the standard errors in most specifications using the available data. However, the results produced here rule out the possibility of TFA corps members producing large spillover effects on both TFA and non-TFA teacher colleagues.

IX. Conclusion

The research questions motivating this study ask whether TFA corps members affect other teachers in their school—both non-TFA teachers and other TFA corps members—through spillover effects. We exploit the variation in TFA corps member densities within schools over time, which occurred due to the implementation of the TFA clustering placement strategy in M-DCPS, to investigate these questions. With student-teacher linked administrative data from M-DCPS, we estimate changes in teacher effectiveness in reading and math that are associated with changes in TFA teacher densities using a school fixed effects model.

In summary, we find little evidence of spillover effects from TFA corps members on student test scores in the short term—neither on non-TFA teachers nor on TFA corps members in the same schools. In spite of the finding of no spillover effect, we do find robust evidence of TFA effects on math test scores in the range of 10 percent of a standard deviation of student achievement, or averaging over 3 months of learning. And, as discussed above, the lack of significant spillover effects on learning does not necessarily imply TFA has no effect on schools beyond their assigned classrooms. Rather, this finding invites further examination on whether TFA corps members affect peers' or their schools' performance in other ways, or over longer time periods.

Was the cluster placement strategy a success in M-DCPS? It may be, in spite of the lack of spillover. TFA stated two primary objectives in designing and implementing the cluster placement strategy: a) to accelerate TFA's influence in student outcomes in particularly disadvantaged settings, and b) to provide more support for TFA corps members through an increased presence in schools and in the district overall. While spillover was an expected result of the strategy, it was not a primary objective. Given the observed patterns of corps member placement in recent years, it is clear that TFA's presence in the district has substantially increased, and the presence of TFA in some of the highest-need schools in the district has likewise increased. Thus, the composition effect alone—where vacancies in high-need schools are filled with relatively effective TFA corps members in math—implies that TFA's increased presence has made a significant difference on student math outcomes in the district. In this way, the clustering strategy has at least partially achieved its objectives. Furthermore, we do not find any evidence that the large increase in the number of TFA placements in recent years was associated with a reduction in TFA effectiveness.

The results here, however, provide no evidence of spillover on student test scores in the short term. In other words, there is no reason to expect that the extra student gains for TFA corps members under the clustering strategy would be any different (in the aggregate) than the gains that could result from an alternate placement strategy where corps members were more evenly distributed across schools. Yet, even if the placement strategy does not affect teacher spillover, how teachers are placed across schools will affect district-wide achievement gaps—broad placement of TFA corps members will boost many students' math performance slightly, while focusing on high-need schools boosts student achievement in math in a more targeted way. By focusing these placement efforts in some of the most disadvantaged and low-performing schools in the district, rather than spreading corps members broadly across many schools, the clustering strategy has accelerated growth in schools that are in greatest need, and within-district achievement gaps are likely reduced as a result.

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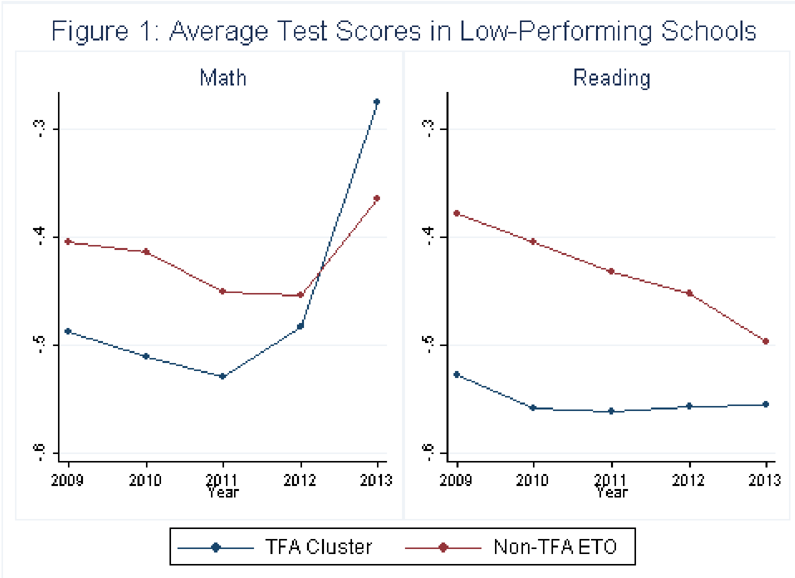
Tables and Figures



Note: Graphs show trajectories of average student achievement (standardized to a mean of zero, with a sd of 1) among TFA cluster schools and non-cluster, ETO schools.

Table 1. Active TFA Corps Member Assignments

	2008-09	2009-10	2010-11	2011-12	2012-13
Total TFA Corps Members	92	93	140	224	285
Total schools containing any TFA Corps Members	49	36	25	25	32
TFA as proportion of school teachers by school type, conditional on containing TFA					
Elementary	3.8%	4.3%	9.0%	19.3%	14.9%
Middle	3.7%	8.2%	8.3%	17.2%	17.5%
High	2.0%	2.9%	10.7%	13.3%	13.6%

Note: Proportions of schools teachers by school type are calculated among any schools containing any TFA corps members during that school year.

Table 2. Descriptive Statistics of the Analysis Samples

	Reading		Math	
	Non-TFA Cluster School	TFA Cluster schools	Non-TFA Cluster School	TFA Cluster schools
Student-level Variables				
Black	19.17%	77.54%	20.62%	77.19%
Hispanic	68.65%	21.19%	68.83%	21.71%
FRL Eligible	68.04%	87.92%	71.67%	88.93%
Math Achievement			0.036	-0.462
			(0.991)	(0.987)
Reading Achievement	0.209	-0.392		
	(0.953)	(0.911)		
Unexcused Absences	4.25	8.52	4.29	8.55
	(6.13)	(9.59)	(6.17)	(9.54)
Out-of-School Suspension Absences	0.44	1.51	0.49	1.70
	(2.43)	(4.50)	(2.59)	(4.87)
Total student-year observations	834,054	63,825	755,114	54,351
Teacher-level variables				
MA Degree or higher	36.69%	32.14%	34.09%	29.06%
Years of Experience	13.0	10.2	12.8	9.6
	(9.7)	(9.0)	(9.7)	(8.9)
TFA Corps Member	0.14%	11.60%	0.15%	13.79%
Black	21.19%	56.62%	21.08%	51.22%
Hispanic	42.57%	13.67%	42.86%	18.75%
Total teacher-year observations	23,561	1,895	18,778	1,552
Total unique schools	431	29	435	29

Note: TFA cluster schools are schools in which 2 or more new TFA corps members were placed in the same cohort for any cohort during or after the summer of 2009. Standard deviations are reported in parentheses for outcome variables.

Table 3. Corps Members Assignments in the Analysis Sample

		2008-09	2009-10	2010-11	2011-12	2012-13
Total TFA Corps Members		43	48	72	108	145
Total schools containing any TFA Corps Members		32	25	22	22	25
TFA as proportion of school teachers by school type, conditional on containing any TFA						
	Elementary	12.0%	12.8%	17.6%	22.2%	30.0%
	Middle	5.6%	10.1%	10.6%	22.3%	30.7%
	High	3.3%	5.7%	17.2%	20.0%	22.0%
Average classroom characteristics for TFA teachers						
	Percent Black	69.7%	72.4%	78.3%	79.3%	77.80%
	Percent Hispanic	28.6%	26.3%	21.1%	19.6%	21.10%
	Percent FRL	87.0%	92.6%	92.1%	93.5%	91.70%
	Reading Achievement	-0.26	-0.52	-0.33	-0.31	-0.29
		(0.84)	(0.89)	(0.83)	(0.80)	(0.82)
	Math Achievement	-0.42	-0.44	-0.48	-0.28	-0.13
		(0.89)	(0.92)	(0.96)	(0.92)	(0.94)
	Lagged Reading Achievement	-	-0.49	-0.22	-0.2	-0.25
		-	(0.85)	(0.8)	(0.79)	(0.81)
	Lagged Math Achievement	-	-0.43	-0.42	-0.33	-0.39
		-	(0.89)	(0.88)	(0.91)	(0.86)

Note: Proportions of schools teachers by school type are calculated among any schools containing any TFA corps members during that school year.

Table 4. Establishing Baseline TFA Estimates

	Math				Reading			
	1	2	3	4	5	6	7	8
TFA	0.083***	0.089***	0.100***	0.103***	0.007	-0.005	0.012	0.007
	(0.021)	(0.028)	(0.020)	(0.025)	(0.012)	(0.016)	(0.012)	(0.015)
TFA * 1 years experience		-0.016		-0.010		0.004		-0.009
		(0.030)		(0.028)		(0.020)		(0.020)
TFA * 2 years experience		-0.005		-0.010		0.032		0.017
		(0.038)		(0.039)		(0.031)		(0.029)
TFA * 3-4 years experience		0.032		0.060		0.060		0.042
		(0.083)		(0.104)		(0.038)		(0.036)
1 year experience	0.039**	0.046**	0.032**	0.036	-0.007	-0.011	-0.006	-0.005
	(0.015)	(0.023)	(0.015)	(0.022)	(0.009)	(0.013)	(0.009)	(0.012)
2 years experience	0.052***	0.055**	0.065***	0.067***	0.021*	0.013	0.008	0.005
	(0.019)	(0.023)	(0.020)	(0.024)	(0.011)	(0.012)	(0.011)	(0.012)
3-4 years experience	0.047***	0.050**	0.065***	0.066***	0.025**	0.019*	0.014	0.012
	(0.017)	(0.020)	(0.017)	(0.020)	(0.010)	(0.010)	(0.010)	(0.010)
5-9 years experience	0.053***	0.056***	0.069***	0.071***	0.030***	0.024**	0.018*	0.016
	(0.016)	(0.020)	(0.016)	(0.019)	(0.010)	(0.011)	(0.010)	(0.010)
10+ years experience	0.037**	0.040**	0.059***	0.061***	0.032***	0.026**	0.017*	0.015
	(0.016)	(0.020)	(0.016)	(0.019)	(0.010)	(0.011)	(0.010)	(0.011)
Observations	740680	740680	740680	740680	1156648	1156648	1156648	1156648
R-squared	0.644	0.644	0.651	0.651	0.698	0.698	0.701	0.701
OLS	✓	✓			✓	✓		
School Fixed Effects			✓	✓			✓	✓

Note: School fixed effects models, with indicator variables on grade and year. Regression controls for student-level and class average demographics and cubic previous test scores, and their interactions with grade. Other controls include class size and teacher race and their interactions with grade.

Table 5. Estimates of Spillover Effects From TFA Teachers on Student Outcomes in Math

Peer Group		Count	Percent	Count >= 5	Pct. >=5	Pct. >= 10	Pct. >= 15	Pct. >= 20	Pct. >= 30
		1	2	3	4	5	6	7	8
Panel A: Peers defined as school colleagues									
School	TFA	0.075***	0.114***	0.127***	0.131***	0.121***	0.098***	0.100***	0.100***
		(0.024)	(0.030)	(0.027)	(0.035)	(0.027)	(0.024)	(0.022)	(0.019)
	Density	0.002	0.001	0.013	0.050	0.013	0.002	-0.015	0.014
		(0.002)	(0.001)	(0.023)	(0.033)	(0.027)	(0.027)	(0.031)	(0.043)
	TFA * TFA Density	0.001	-0.002	-0.056*	-0.061	-0.051*	-0.016	-0.017	-0.081***
		(0.001)	(0.002)	(0.031)	(0.039)	(0.031)	(0.035)	(0.025)	(0.026)
	Observations	740680	740680	740680	740680	740680	740680	740680	740680
	R-squared	0.651	0.651	0.651	0.651	0.651	0.651	0.651	0.651
Panel B: Peers defined as grade colleagues (in elementary grades) or subject colleagues (in middle / high grades)									
Grade (elementary) / Subject (middle/high)	TFA	0.094***	0.116***	0.092***	0.136***	0.113***	0.096***	0.092***	0.086***
		(0.026)	(0.030)	(0.023)	(0.038)	(0.028)	(0.027)	(0.026)	(0.023)
	Density	0.007	0.001	0.038	0.046**	0.030	-0.014	-0.032	-0.023
		(0.007)	(0.001)	(0.038)	(0.018)	(0.026)	(0.024)	(0.024)	(0.031)
	TFA * TFA Density	-0.002	-0.002	0.010	-0.065	-0.039	-0.009	-0.000	0.028
		(0.006)	(0.001)	(0.033)	(0.042)	(0.034)	(0.034)	(0.037)	(0.048)
	Observations	740680	740680	740680	740680	740680	740680	740680	740680
	R-squared	0.651	0.651	0.651	0.651	0.651	0.651	0.651	0.651

Note: School fixed effects models, with indicator variables on grade and year. Regression controls for student-level and class average demographics and cubic previous test scores, and their interactions with grade. Other controls include class size and teacher race and their interactions with grade.

Table 6. Estimates of Spillover Effects From TFA Teachers on Student Outcomes in Reading

Peer Group		**Count**	**Percent**	**Count >= 5**	**Pct. >=5**	**Pct. >= 10**	**Pct. >= 15**	**Pct. >= 20**	**Pct. >= 30**
		1	2	3	4	5	6	7	8
Panel A: Peers defined as school colleagues									
School	TFA	0.037**	0.036*	0.030	0.050***	0.038**	0.027	0.026*	0.012
		(0.016)	(0.020)	(0.022)	(0.018)	(0.018)	(0.017)	(0.014)	(0.013)
	Density	-0.000	-0.000	0.009	0.013	-0.002	-0.017	-0.011	-0.012
		(0.001)	(0.001)	(0.014)	(0.016)	(0.016)	(0.016)	(0.015)	(0.026)
	TFA * TFA Density	-0.002***	-0.001	-0.026	-0.053**	-0.040*	-0.022	-0.027	0.007
		(0.001)	(0.001)	(0.023)	(0.021)	(0.021)	(0.020)	(0.021)	(0.028)
	Observations	1156648	1156648	1156648	1156648	1156648	1156648	1156648	1156648
	R-squared	0.701	0.701	0.701	0.701	0.701	0.701	0.701	0.701
Panel B: Peers defined as grade colleagues (in elementary grades) or subject colleagues (in middle / high grades)									
Grade (elementary) / Subject (middle/high)	TFA	0.029*	0.027	0.024*	0.048**	0.011	0.020	0.019	0.014
		(0.015)	(0.017)	(0.013)	(0.020)	(0.019)	(0.016)	(0.015)	(0.014)
	Density	-0.001	0.000	-0.015	0.022*	-0.002	-0.005	-0.009	-0.027
		(0.002)	(0.001)	(0.015)	(0.011)	(0.015)	(0.015)	(0.015)	(0.022)
	TFA * TFA Density	-0.005**	-0.001	-0.036**	-0.055**	0.004	-0.014	-0.015	0.005
		(0.003)	(0.001)	(0.018)	(0.026)	(0.025)	(0.023)	(0.022)	(0.027)
	Observations	1156648	1156648	1156648	1156648	1156648	1156648	1156648	1156648
	R-squared	0.701	0.701	0.701	0.701	0.701	0.701	0.701	0.701

Note: School fixed effects models, with indicator variables on grade and year. Regression controls for student-level and class average demographics and cubic previous test scores, and their interactions with grade. Other controls include class size and teacher race and their interactions with grade.

Appendix I. Data Cleaning Rules for Analysis

Various processes were undertaken during the course of the data analysis to create credible estimates of the TFA clustering effects. This appendix documents these various considerations and processes.

Tests Included in the Sample

Our final analysis sample spans grades 4-10 and contains FCAT Reading, FCAT Mathematics, and Algebra EOC test scores. Each test score is standardized (z-scores) within year, grade, subject, and test type, relative to the district sample. Because pre-test scores are needed as covariates in the regression, FCAT scores for 3rd grade (the first tested grade) are used as pre-test scores only (i.e., 3rd grade observations do not appear in the analysis).

Up through the 2010-11 school year, it is possible for students in later grades to have taken two different mathematics tests in a year, the FCAT Math and the Algebra EOC exam. For those students, we only use their FCAT Math score. Starting in 2011-12, FCAT Math is no longer tested in grades 9 and 10, though the Algebra EOC exam continues to be tested at the conclusion of the Algebra course (which some students may take for the first time as early as 7th grade or as late as 10th grade). In this case, Algebra EOC exam scores are only used when a student would otherwise be missing a math test score in the current year (i.e., in grades 9 and 10). For students taking Algebra in 7th or 8th grade, the FCAT Math score is used in those years, and those students' 9th and 10th grade math observations are not included in the analysis.

Linking Students with Teacher

Course membership files in the data are used to identify the classes in which students receive instruction and the teachers to whom they are assigned. Students may be linked with multiple teachers in their course membership files (because of either switching classes mid-year, taking multiple classes in the same subject, or due to co-teaching arrangements).

Core Courses

When estimating value-added we want to distribute student learning across all teachers in courses relevant to the tested subjects. As a result, it is important to distinguish between courses that focus on developing skills in tested subjects rather than elective courses that may only be tangentially related to a tested subject. For example, for math value added we want to include an Algebra course but exclude a computer science course that may be offered through the mathematics department and thus labeled in the data under a math course code. We call courses focused on tested subjects core courses (CCs).

We developed the following rules to help identify core courses for all students in the sample.

1) A course is flagged as a CC if 50% or more of the students in the district in that grade and year are enrolled in that same course (defined by the course code).
2) Any course that enrolls 10 or more students without a CC (as determined by the first condition) is flagged as a CC for all students in that year and grade.

All non-CC student-teacher links are discarded. Teacher dosages (detailed below) are calculated based off of the remaining student-teacher links in CCs.

Estimating Regressions with Teacher Dosage

To properly attribute each teacher's contribution to a particular student's learning, we employ the Full Roster Method, developed by Hock and Isenberg (2012) of Mathematica Policy Research. This method retains all student-teacher-course links labeled as core courses, and calculates a "teacher dosage" for each student-teacher link.

The M-DCPS data used for the analysis reports course membership for students and teachers by terms, where each term represents half of the total exposure to a subject a student receives in a particular year (i.e., semesters). For each term we distribute the term-subject dosage (.5) across each of the student-teacher-course links observed. The term weights are added together to get the share of the total student-subject exposure that can be attributed to that student-teacher-course link such that the sum across all student-teacher-course links within a subject is 1. If a student leaves the sample at some point in the year, their student-subject exposure may be less than 1.

Consider the example presented in Appendix Table 1 below. Student A has four student-teacher-course links in ELA for the 2011-12 school year. Three of these courses take place in the first term, the column labeled "# tchs in term 1" illustrates this value. Term 1's total student-subject exposure is .5 which is distributed across all three of these student-teacher-course links, the column labeled "tch dos t1" represents the share of the term 1 dosage attributed to that student-teacher-course link. The same situation is true for term 2. Two of these courses are half year courses and the other two are full year courses; summing the dosage for each term gives more weight to the full year courses and less weight to the half year courses.

Appendix Table 1: Example of Assigning Teacher Dosages

student	year	classid	tchid	Tch term1	Tch term2	# tchs in term1	# tchs in term2	Tch dose t1	Tch dose t2	tch_dosage
A	2012	843611	α	1	0	3		0.166667	0	0.1666667
A	2012	843421	β	1	1	3	3	0.166667	0.1666667	0.3333333
A	2012	843495	β	1	1	3	3	0.166667	0.1666667	0.3333333
A	2012	843623	δ	0	1		3	0	0.1666667	0.1666667

These full-year teacher dosages are incorporated into the value added estimations as a student level analysis weight in Stata. Regressions are run using the areg command, which estimates dummy variables for each school fixed effect included in the model.

Appendix II. Identifying TFA Corps Members in the M-DCPS Administrative Data

The clustering strategy evaluation requires the accurate identification of TFA corps members in the M-DCPS administrative data. M-DCPS maintains its own TFA flag in the data, but based on prior studies' experiences identifying TFA corps members in other administrative data systems, matching a list of actual TFA corps members supplied by TFA to externally validate the TFA variable in the M-DCPS data was desirable. This appendix documents the reconciliation between the M-DCPS variable and the TFA-supplied lists.

M-DCPS Variable

The TFA indicator variable maintained in M-DCPS's administrative data is intended to flag active corps members in M-DCPS only. In total, 379 unique teachers are flagged as TFA in the M-DCPS data. TFA alumni that stay in the classroom beyond the two-year TFA commitment are not flagged in the data. This indicator variable flags specific teacher IDs only—this list must then be merged onto teacher personnel data in the M-DCPS data to determine teachers' identities. Not all teachers' personnel data is accurate or complete, and some have missing names—the key matching variable with the TFA lists.

TFA Lists

Teach For America maintains databases of corps members' placements both regionally and nationally, and these separate data sources are not necessarily synchronized. TFA provided three separate lists for the purpose of validating the TFA flag in the M-DCPS data:

1. A corps member list from the TFA National Office (date: 5/2013)
2. A corps member list from the TFA Miami Regional Office (date: 5/2013)
3. A corps member list from the TFA Miami Regional Office (date: 8/2013)

All of these lists are to represent corps members placed in Miami since the summer of 2007 to current. To facilitate matching on other characteristics, these lists detail the school and year of initial placement (when known) in addition to teachers' names. None of these three TFA lists overlap perfectly – though the National list (list 1) and the August Regional list (list 3) have the most names in common between them; all three lists have names that are unique to each of them.

Also, the Miami Regional Office supplied lists twice (lists 2 and 3 above), though the August Regional (list 3 above) is considered the best representation of actual teachers in M-DCPS schools. The May Regional list (list 2 above) was apparently a comprehensive list of all corps members assigned to the TFA region during the study period, though this includes persons who 1) never actually showed up to begin TFA's summer training institute, or 2) left the program before the school year officially began. The updated August Regional list identified and removed these persons, which is why it is preferred.

Reconciliation

To reconcile these lists, we merged all lists from TFA against the M-DCPS list of teachers (both those flagged as TFA and those not flagged as TFA). Note that this was done only for placements up through the 2012-13 school year, because this is the extent of the M-DCPS data. Matching was done primarily with exact matches on names. Where names did not have an exact match but only an approximate match, initial placement school and year was used to corroborate the match.

Appendix Table 2 below accounts for all unique teachers by source.

Appendix Table 2: Reconciling TFA Corps Member Lists for Analysis

Panel A: Reconciliation by Source of Match		
TFA Lists Corresponding with M-DCPS TFA Variable		
	National list & M-DCPS	4
	August Regional & M-DCPS	2
	May Regional & M-DCPS	6
	National list, August Regional & M-DCPS	30
	National list, May Regional & M-DCPS	1
	National list, May Regional, August Regional & M-DCPS	320
A)	Total flagged in at least one TFA list & M-DCPS	363
TFA Lists Matched with Unflagged M-DCPS Teacher		
	National list & Unflagged in M-DCPS	1
	National list, May Regional, August Regional & Unflagged in M-DCPS	161
B)	Total matched from TFA lists but Unflagged in M-DCPS	162
TFA Lists Not Matched with M-DCPS Teachers		
	National list	72
	May Regional list	3
	National list & August Regional	6
	National list, May Regional & August Regional	10
C)	Total Not Matched with M-DCPS Teachers	91
Flagged M-DCPS Teachers Not Matched with TFA Lists		
D)	Total Only Identified in M-DCPS	16
Panel B: Final Counts of TFA Teachers for Analysis		
Total Unique Teachers on TFA Lists (A+B+C)		616
Total Unique Teachers Flagged as TFA in M-DCPS (A+D)		379
Total Unique Teachers (A+B+C+D)		632
Total Unique Teachers Identified as TFA for Analysis (A+B+D)		541

In total, 541 unique teachers were matched across the TFA lists and the M-DCPS administrative data. For 363 of these cases, we are highly confident in this match, as both M-DCPS and TFA agree on the TFA designation. The remaining 178 unique TFA-flagged teachers that are used in the analysis were identified as TFA in only one data source (B+D).

The 91 persons appearing on the TFA lists but not in the M-DCPS data (C) are larger than anticipated, yet the majority of these come from either the National or May Regional lists, which are the less-preferred lists. The most-preferred August Regional list only includes 16 unique persons that cannot be matched with the M-DCPS data. It is possible that some of these 91 cases are actually included in the M-DCPS data and flagged as TFA teachers, but cannot be matched because of name discrepancies or missing values.

Overall, we feel highly confident the TFA indicators created for this analysis credibly identify real TFA corps members.