Abstract Title Page.

Title:

School Organizational Contexts, Teacher Turnover, and Student Achievement: Evidence from Panel Data

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Context:

Evidence of persistent differences in productivity across firms can be found in almost every sector of the economy (Bloom & Van Reenen, 2011). In education, there is ample evidence that some schools far outperform others at raising student achievement even when accounting for differences in the students they serve and the resources at their disposal. Differences in the human capital stock of teachers across schools cannot fully account for the differential productivity across schools. In teaching, as in any occupation where professionals perform their work in organizational contexts, productivity is influenced by *both* individual and organizational factors (Hackman & Oldman, 1980; Kanter, 1983; Johnson, 1990). A growing body of literature attempts to identify, measure, and evaluate the potential contribution of organizational practices and contexts to overall productivity in schools and in the private sector (Simon & Johnson, forthcoming; Lazear and Oyer, 2009). However, this literature has been largely limited to cross-sectional analyses and longitudinal case studies of individual organizational (Bloom & Van Reenen, 2011).

The proliferation of school surveys administered to teachers, students and/or parents presents a unique opportunity to capture large-scale data on organizational contexts. Although some organizational features, such as school resources, can be readily measured with administrative data, school surveys now allow researchers to characterize the ways in which administrators, teachers and students interact within schools. These surveys provide important data on the organizational culture and context of schools, but their utility to researchers has been constrained by their infrequent administration and low response rates in most districts.

Purpose:

This study is among the first to address the empirical limitations of prior studies on organizational contexts by leveraging one of the largest survey administration efforts ever conducted in the United States outside of the decennial population census. Since 2007, the New York City Department of Education (NYC DOE) has administered an annual school surveys to teachers, parents, and students with consistently high response rates. We identify distinct, malleable dimensions of middle schools' organizational contexts using teachers' responses to the annual School Survey and estimate the relationship between these measures and teacher turnover, and growth in students' academic achievement. Our panel data allows us to identify these estimates using within-school variation over time by accounting for any time-invariant differences across schools and unobserved time-shocks through school and year fixed effects.

Setting & Sample:

We focus our analyses on NYC middle schools for several reasons. First, the middle grade years are crucial in students' academic and social-emotional development and play a critical role in influencing students' high school and post-secondary outcomes (Balfanz, 2009). Despite this, middle schools have uncommonly high rates of teacher turnover (Marinell & Coca, 2013), teachers often consider middle school assignments as less desirable than comparable elementary or high school assignments, and middle school teachers may receive less tailored preparation than elementary and high school teachers (Neild, Farley-Ripple & Byrnes, 2009).

We create three primary analytic datasets to conduct our analyses of NYC middle schools. First, we construct a teacher-year level panel dataset that contains teachers' responses to the School Survey. Our analytics sample spans five years from 2007-08 and 2011-12. As shown in Table 1, response rates were 63 percent in 2007-08 and rose incrementally each

following year to 83 percent by 2011-12. Using a teacher-year level panel dataset built from human resources files, we create school-level averages of teacher turnover and teacher characteristics. Importantly, this panel includes data through 2012-13 which allow us to create measures of teacher turnover for the 2011-12 academic year. We restrict this dataset to include only full-time middle school classroom or special education teachers using the NYC DOE's approach to identifying active teachers, resulting in 54,050 teacher-year observations and 16,408 unique teachers. Our primary analytic dataset is a school-year panel from 2008 to 2012 that contains 1,151 school-year observations for 278 unique middle schools in the NYC DOE. We restrict our sample to include only middle schools with traditional grade 6-8 configurations. In Tables 2 and 3, we present descriptive characteristics of the teachers and schools in our sample.

Measures:

We construct two sets of primary outcomes for our regression analyses described below: school-level average measures of teacher turnover and median student growth percentiles. The average turnover rate among schools in our sample is almost 18% annually, with nearly 8% transferring to other schools and 10% taking non-teaching positions or leaving the NYC public school system. We estimate student growth scores in mathematics and ELA following the methods developed by Betenbenner (2009) and operationalized in the Student Growth Percentile (SGP) software package in R (Betebenner, 2011).

We draw upon both theory-driven and data-driven approaches to inform our process of constructing school context measures. We first restricted the pool of items to only those that were included on each survey from 2008 to 2012. We then conducted a principal components analysis on our panel dataset of teachers' responses to the School Survey to identify the number of distinct factors captured by our 33 items. A four factor solution suggested by our visual analyses of the marginal decrement in eigenvalues was further reinforced by applying the Kaiser-Guttman stopping criterion. In order to construct measures of the four factors suggested by our exploratory analysis, we conducted a principal-component factor analysis, followed by an orthogonal (varimax) rotation. We calculate factor scores for each teacher in each year, and then average these scores to the school-year level to obtain our primary predictors. Finally, we standardize each of these school context measures in a school-level dataset to facilitate the comparison of the relative magnitudes of their associated coefficients in our analyses.

Research Design:

We analyze the relationship between our two primary outcomes of interest, teacher turnover and student growth, and measures of school context in a school-year dataset using two classes of Generalized Linear Models (GLMs). This approach best reflects the school-level processes we hope to capture and the level at which our standard errors are most appropriately estimated. Formally, analytic approaches can be expressed using the following general model:

$$(1) \qquad g\{E(Y_{st})\} = \beta' Dimensions_t + \eta' T_{st} + \varphi' S_{st} + \pi_s + \gamma_t$$

where $E(Y_{st})$ is the expected value of the outcome for school s in year t, conditional on observable predictors; $g\{\cdot\}$ is a link function; $Dimensions_{st}$ is the vector of school-context factors described above; T_{st} is a vector of teacher characteristics, averaged within school and year; S_{st} is a vector of school characteristics; and π_s and γ_t are fixed effects specific to school and year, respectively. Average teacher characteristics include controls for gender, race,

experience, and degrees. School characteristics include controls for the proportion of students by gender, race, free/reduced lunch eligibility, special education status, and English language learner status, as well as log enrollment and an indicator for schools that provide free lunch to all students (i.e., universal feeding schools). For teacher turnover, we set $g\{\cdot\}$ to be the logit function. For student growth percentiles, we take Y_{st} to be the median student growth percentile score in mathematics or ELA and set $g\{\cdot\}$ as the identity function. We assume these medians to be approximately normally distributed about their conditional means, resulting in an Ordinary Least Squares model.

Findings:

Four Dimensions of the School Context: We construct four distinct measures of the school context based on our analyses of teachers' responses to the School Survey: leadership & professional development (*Leadership*), high academic expectations for students (*Expectations*), teacher relationships and collaboration (*Relationships*), and school safety & order (*Safety*). These four dimensions aligned closely with the thematic groupings that our research team independently identified prior to conducting our factor analyses. We arrived at these four dimensions by characterizing the dominant items on each factor with rotated factor loadings of 0.6 or higher. As shown in Table 4, the Leadership dimension has the most items with large factor loadings and explains 21 percent of the variance across our panel of teacher responses.

In order to provide readers with intuitive measures of how NYC DOE middle school teachers perceive the school contexts in which they work, we calculate the percentage of teachers who either agree or strongly agree with each survey item in a given school-year. On average, we find that teachers view their school favorably; the mean agreement rate across school-years to each School Survey item asking about positive aspects of the school climate was over 70%. Overall, teachers were most likely to agree with the items that contribute to the academic expectations dimension, followed closely by the teacher relationships & collaboration dimension. Teachers were less readily willing to agree that their school benefited from high quality leadership and professional development and that they taught in safe and orderly schools.

Teacher Turnover: We estimate the relationship between school context measures and our outcomes of interest using models both without and with school fixed effects as well as with all measures included separately and simultaneously. This produces four set of results for each outcome of interest and helps to illustrate important differences across estimation strategies. Our baseline model omits school fixed effects and estimates the relationship between individual dimensions of the school context, entered separately in each model, and a given outcome. We then re-estimate these models that draw on both within- and between-school variation, but include all four school context measures simultaneously. Our third set of analyses returns to estimating school context measures separately, but restricts our identifying variance to within-school variation over time by adding school fixed effects. Finally, we fit our preferred specification which includes all measures simultaneously with school fixed effects.

In Table 5, we present predicted marginal effects of a one standard deviation increase in measures of the school context with teacher turnover. Our Generalized Linear Model relates school context dimensions to teacher turnover via an S-shaped logistic curve, which allows the marginal relationship to differ across the distribution of our predictors. We present estimates of these marginal effects at the 10^{th}, 50^{th}, and 90^{th} percentile of the distribution of each school context measure to characterize this curvilinear relationship. The results we present in Table 5 illustrate four important findings: 1) we replicate previous findings that schools with higher

quality contexts experience lower turnover, 2) we show that improvements in the organizational context within a school over time are associated with corresponding decreases in teacher turnover, 3) we find that increases in school context measures have larger marginal effects on turnover for schools that start at lower levels of school context quality, and 4) we document the independent relationship between multiple dimensions of the school context and teacher turnover.

Student Achievement Growth: In Table 6, we present a parallel set of estimates to those described above but exchange our teacher turnover outcome for measures of the median student growth percentile in mathematics or English language arts. Our results reveal four key findings: 1) we replicate and extend previous research which finds that schools with higher quality school contexts have students who experience greater growth in achievement, 2) we show that improvements in the school context within a school over time are associated with corresponding increases in student achievement growth, 3) we find that the relationship between the school context and the median Student Growth Percentile in at a school is stronger in mathematics than in ELA, and 4) we illustrate that the relationship between the school context and student growth varies considerably across dimensions.

Threats to Validity: The analytic methods discussed above allow us to show clearly that, among NYC middle schools, improvements in the school context within a school over time are associated with corresponding decreases in teacher turnover and increases in student achievement growth. Ultimately, we want to know whether the changes we observe in school-specific turnover rates and student growth are caused by changes in the school context. Our research design does not allow us to estimate this causal relationship conclusively because we lack a source of exogenous variation in our measures of the school context. Recognizing this limitation, we attempt to better understand the underlying relationship we observe between school context dimensions, turnover, and achievement by examining the most plausible alternative explanations for the patterns in our data. Robustness tests on a range of potential threats including common source bias, survey non-response bias, reverse causality, and omitted variable bias reveal no evidence that can explain away the relationships we find.

Conclusions:

While it seems intuitively obvious that an individual's performance is affected by the environment in which she works, policymakers have largely overlooked the central role that schools play in influencing teachers' in their push to overhaul teacher evaluation systems. In instances where aspects of school context—e.g., a principal who is an ineffective instructional leader, a school that lacks a consistent disciplinary code—are partly, or largely, responsible for languishing student performance, efforts to measure and strengthen the performance of individual teachers are unlikely to be adequate remedies in themselves. For teachers who have the misfortune of trying to deliver high-quality instruction and improve their craft amidst organizational dysfunction, continually reshuffling the staff in search of teachers who can be successful in spite of organization limitations is likely be an ineffective strategy to improving instructional quality. To systematically improve student performance, school and district leaders need robust evidence about the strengths and weaknesses of both individual teachers and the school organization as a whole. Equipped with this data, policymakers and practitioners can take steps to address individual as well as organizational strengths and deficiencies.

Appendix A. References

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Appendix B. Tables and Figures

Table 1: Teacher Response Rates to the NYC DOE School Survey

	Average	25th Percentile	75th Percentile
2008	63	48	80
2009	75	62	92
2010	78	68	93
2011	82	72	95
2012	83	75	95

Table 2: New York City Middle School Teacher Characteristics

Female	0.696
Asian	0.053
Hispanic	0.225
African American	0.128
White	0.579
Novice	0.053
2-3 years experience	0.119
4-10 years experience	0.569
11-20 years experience	0.128
> 20 years experience	0.131
Bachelor's Degree	0.149
Master's Degree	0.428
Master's Degree plus 30 Credits	0.420
Transfer	0.062
Leave	0.089
Turnover	0.151

Notes: Sample includes 54,050 teacher-years and 16,408 unique teachers

Table 3: New York City School Characteristics

	mean	Percentile		
		25th	50th	75th
Enrollment	639	280	477	939
% Free/Reduced Price Lunch Eligible	82.64	75.86	88.79	99.43
% Special Education	11.63	8.06	11.17	14.95
% English Lanuge Learner	13.07	4.44	9.23	18.09
% African American	34.66	10.76	26.12	60.08
% Asian	11.31	0.86	2.88	14.61
% Hispanic	43.06	18.83	41.02	65.81
% White	10.55	0.64	1.69	14.77
% Teachers Transfer Schools	7.84	1.75	5.26	11.11
% Teachers Leave Teaching	10.00	5.33	8.70	13.33
% Turnover	17.84	9.59	15.38	23.53
SGP: Math	47.98	39.00	48.00	57.00
SGP: ELA	47.42	41.00	47.50	54.00

Notes: Sample includes 1151 schools years and 278 unique schools

Table 4: Descriptive Statistics for Four School Context Factors

	Number of items with loadings over 0.5	Eigen Value	Proportion of Variance explained
Leadership & Professional Development	11	7.00	0.21
Academic Expectations	6	5.93	0.18
Teacher Relationships & Collaboration	5	4.45	0.14
Safety & Order	5	3.69	0.11

Notes: Eigen values and proportion of variance explained are from exploratory factor analyses with a four factor solution, and a varimax orthogonal rotation.

Table 5: Predicted Marginal Effects of Four Dimensions of the School Context on Teacher Turnover

	Percentile of the school context measure at which the predicted marginal effect is estimated					
	10th	50th	90th	10th	50th	90th
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
	Panel A: Regression estimated for for each factor separately					
Leadership & Professional Development	-0.022**	-0.020***	-.018***	-.019***	-.017***	-.016***
	(0.003)	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)
Academic Expectations	-.021***	-.019***	-.017***	-.009*	-.008*	-.008*
	(0.003)	(0.003)	(0.002)	(0.004)	(0.003)	(0.003)
Teacher Relationships & Collaboration	-.007*	-.006*	-.006*	-.007*	-.006*	-.006*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Safety & Order	-.023***	-.021***	-.018***	-.013**	-.013**	-.012**
	(0.004)	(0.003)	(0.002)	(0.005)	(0.004)	(0.004)
	Panel B: Factors included simultaneously in each regression					
Leadership & Professional Development	-.014***	-.013***	-.012***	-.016***	-.015***	-.014***
	(0.003)	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)
Academic Expectations	-.011***	-.010***	-.010***	-0.005	-0.004	-0.004
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
Teacher Relationships & Collaboration	-.006*	-.006*	-.006*	-.007*	-.007*	-.007*
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
Safety & Order	-.015***	-.014***	-.013***	-.009*	-.008*	-.008*
	(0.003)	(0.003)	(0.002)	(0.004)	(0.004)	(0.004)
Year FE		Yes			Yes	
School FE		-			Yes	
n		1151			1151	

Notes: ***p<0.001, **p<0.01, *p<0.05. Standard errors reported in parentheses are clustered by school. Estimates are derived from generalized linear models with a logit link function. All models include vectors of teacher and student characteristics. Teacher-year level covariates include controls for average teacher gender, race, experience and degrees. School-year level covariates include controls for enrollment (logged) and average student gender, race, free/reduced-price lunch status, special education status, and English language learners.

Table 6: The Relationship between Four Dimensions of the School Context and School Median Student Growth Percentiles in Mathematics and English Language Arts

	Mathematics (SD=12.6)		English Language Arts (SD=8.7)	
	(1)	(2)	(3)	(4)
	Panel A: Regression estimated for each factor separately			
Leadership & Professional Development	1.063*	1.162*	.778**	0.178
	(0.478)	(0.533)	(0.289)	(0.327)
Academic Expectations	2.906***	1.804***	1.637***	0.204
	(0.459)	(0.505)	(0.325)	(0.361)
Teacher Relationships & Collaboration	0.109	0.44	-0.175	-0.111
	(0.471)	(0.517)	(0.313)	(0.449)
Safety & Order	5.208***	3.337***	2.788***	1.137*
	(0.586)	(0.698)	(0.371)	(0.486)
	Panel B: Factors included simultaneously in each regression			
Leadership & Professional Development	-0.619	0.456	-0.136	-0.047
	(0.465)	(0.546)	(0.285)	(0.339)
Academic Expectations	2.187***	1.597**	1.240***	0.186
	(0.437)	(0.520)	(0.304)	(0.365)
Teacher Relationships & Collaboration	0.032	0.539	-0.211	-0.047
	(0.443)	(0.495)	(0.313)	(0.448)
Safety & Order	4.875***	3.189***	2.513***	1.138*
	(0.599)	(0.736)	(0.376)	(0.511)
Year FE	Yes	Yes	Yes	Yes
School FE	-	Yes	-	Yes
n	1151	1151	1148	1148

Notes: ***p<0.001, **p<0.01, *p<0.05. Standard errors reported in parentheses are clustered by school. Estimats are derived from OLS regression models. All models include vectors of teacher and student characteristics. Teacher-year level covariates include controls for average teacher gender, race, experience and degrees. School-year level covariates include controls for enrollment (logged) and average student gender, race, free/reduced-price lunch status, special education status, and English language learners.