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The urban advantage: Do informal science collaborations improve teacher retention?

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PRELIMINARY REPORT
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ABSTRACT

This study reports findings from an evaluation of New York City's Urban Advantage (UA) program, a collaboration between the New York City (NYC) Department of Education and eight informal science education institutions intended to improve science education in middle schools and provide high quality professional development to science teachers. We conduct the first evaluation of whether UA has led to increases in science teacher retention in NYC middle schools. Using detailed teacher-level data on all teaching personnel in NYC public schools, preliminary results suggest that teachers who participate in UA are roughly 3 percentage points more likely to remain teaching at their school the following academic year (from an average of 84% to 87%), compared to non-UA teachers. This gain varies significantly by teaching experience with the largest benefits for teacher with 3-5 years of teaching experience. As informal partnerships between schools and external institutions become more common, evaluations such as this can be used to guide changes in program implementation and education policy.

I. Introduction

In 2008, the American Museum of Natural History contacted researchers at New York University's Steinhardt School of Culture, Education, and Human Development to conduct an initial evaluation of the Urban Advantage program, which at that point was about four years old. Urban Advantage (UA) is a formal-informal partnership that began in the 2004-05 school year (hereafter 2005) after meetings between NYC's science institutions, the Department of Education (DOE), and the City Council to investigate the poor performance of NYC students in science and what could be done to improve it. The UA program brought together the resources of NYC's informal science education institutions (ISEIs) and the NYC public school system to improve instruction in middle school science by providing intensive professional development for participating teachers, materials for science classrooms, and free access to ISEIs for class trips and independent visits. Now in its 14th year of operation, the UA program has grown and become institutionalized in NYC's approach to science instruction. In the latest year of our current analysis, 2015, more than 50% of NYC middle schools were actively participating in UA and close to 60% of middle schools had ever participated in UA.[1]

Over the past few years we have conducted multiple analyses on the impact of the UA program on students' science achievement. The most recent analysis, discussed in the UA September 2017 report, uses detailed student-teacher matched data from school years 2013 to 2016 to estimate the impact of having a UA teacher on students' performance on the 8th grade Intermediate Level science (ILS) exam. We found that having a UA teacher improves exam scores by 0.07 standard deviations and increases the likelihood that a student meets the New York State standards for science by 3.4 percentage points.

[1] We define a middle school as any school that has an 8th grade.

Recognizing the importance that professional development and support has on teachers' career decisions, and thus ultimately student performance, we now turn our attention to the first analysis of the impact of the UA program on teacher retention. Schools often struggle to hire qualified teachers, particularly in the fields of math and science, and high-poverty, high-minority, and urban schools are especially hard to staff (e.g. Hanushek et al., 2016; Marinell & Coca, 2013; Clotfelter et al., 2004; Ingersoll & Perda, 2010). While the supply and recruitment of math and science teachers are important to fill the demand for new hires, evidence suggests that teacher retention is especially challenging for schools. Some level of teacher mobility can be beneficial for schools, but high turnover may lead to lower student achievement, increase the number of inexperienced teachers, reduce teacher quality, disturb school-community relationships, and raise costs for schools and districts (Guin, 2004; Ronfeldt et al., 2013; Watlington et al., 2010).

For our analysis we use longitudinal administrative data from the NYCDOE on middle school science teachers from school years 2007-2015. Preliminary results suggest that UA science teachers are on average 3 percentage points more likely than non-UA science teachers to remain teaching at their school the following year. This impact is substantially higher for teachers with 3 to 5 years of teaching experience (16 percentage points).

The remainder of this paper is organized as follows. Section II describes the teacher data and corresponding descriptive statistics. Section III describes our methodology. We present preliminary findings in section IV and conclude with next steps in section V.

II. Data

We use two data sources provided by the NYCDOE. The first is longitudinal administrative data on all teaching personnel employed by the NYCDOE from school years 2007

to 2015.[2] These data contain indicators for race/ethnicity, gender, job title, licensing, subject(s) taught, salary, absences, teaching experience, and tenure with the NYCDOE. A unique person and school identifier allow us to track individual teachers across schools and over time.[3] All analyses exclude charter schools and special education only schools (District 75 in NYC).[4] We combine these data with UA administrative records that identify teachers participating in UA and their participating school from 2007-2016. Our analysis sample includes roughly 3,600 NYC public school science teachers in over 550 schools, including 640 teachers participating in UA, from 2007-2015.[5]

We construct the outcome of interest, teacher retention, by identifying teachers who remain teaching in the same school the following school year.[6] Table 1 illustrates that UA and non-UA science teachers are different on several observable characteristics, which we adjust for in our empirical strategy. For example, UA teachers are more likely to be women, Asian, and Hispanic, compared to non-UA teachers. They have fewer absences and are less than half as likely to be new teachers with less than one year of teaching experience. Lastly, school and district retention is relatively higher among UA teachers. Our methodology below describes how we account for selection into the program to tease out a causal impact of UA on teacher retention.

[2] We recently received teacher data going back to school year 2003, which we will incorporate into our future analyses. More recent data through school year 2016 is also available.
[3] All teacher files are de-identified since NYCDOE provided us with scrambled identification numbers.
[4] We do not include charter schools because we do not have teacher-student match data; District 75 schools are also excluded because of differences in resources available to students in those schools.
[5] There are also 317 UA teachers who teach subjects other than science, such as math, English, and special education. We will examine the impact for these teachers in future work.
[6] In future work, we will also examine two additional outcomes: transferring to other UA schools and exiting the NYC public school district entirely.

III. Methodology

Participation in the UA program is not random and could depend on teacher and school-level characteristics. To participate in UA, principals must first apply for their school to participate. Once the school is accepted into the UA program, individual teachers may apply to participate. All 6th, 7th, or 8th grade teachers are eligible, regardless of the grade configuration of the school. While most participating teachers are from the science department, there are a number of teachers who are certified in other fields, in particular, special education and bilingual education. Participating schools run the gamut from high performing to low performing and low poverty to high poverty schools. While principal buy-in starts the process, reasons why individual teachers choose to participate vary. UA professional development sessions are more likely to be held on the weekends, during professional development days, or after school, therefore teachers who participate must be willing to devote their own time. Teaching experience, student achievement, and demographics can all predict UA participation. Thus, it is important to adjust for the selection of schools and teachers into the UA program. Our methodology is described below.

For this first set of analyses, we estimate the impact of UA on teacher retention using a two-step process. First, we use propensity score matching to match schools on the following school-level observable characteristics that can influence their decision to participate in UA and their likelihood of retaining teachers: student achievement, teaching experience, spending, teacher engagement, class size, and demographic composition.[7] We have strong common support (see appendix Figure A1) and achieve balance across treatment and control schools (see

[7] Specifically we use the following school-level measures: student math & science proficiency, student attendance, teachers without a certificate, teachers with less than three years of teacher experience, per pupil spending, teacher absences, school size, teacher pupil ratio, race/ethnicity , English language learners, immigrant, students with disabilities, free/reduced lunch eligible students.

appendix Table A1).[8,9]

Second, to estimate the impact of UA on teacher retention on these matched schools, we use a fixed effects methodology that exploits the timing of when a teacher joins UA and compares UA teachers to themselves before and after they join, and to teachers who are not in UA. This allows us to control for both fixed observable and unobservable characteristics of teachers, such as gender and motivation, which could influence their decision to leave a school and to participate in UA. We also adjust for time effects and teacher characteristics that vary over time. Specifically, we estimate the following equation:

$$Stay_{itm} = \beta_0 + \delta\, Post\ UA + \boldsymbol{Z}'_{it}\boldsymbol{\beta} + \alpha_i + \tau_t + \theta_m + \varepsilon_{its} \quad (1)$$

where *Stay* is the outcome equal to 1 if teacher *i*, in year *t*, in matched school *m* remains teaching at the same school the following year; *Post UA* equals 1 in the year that a teacher joins UA and each year thereafter; α_i, τ_t, θ_m are teacher, year, and matched school pair fixed effects, respectively; *Z* is a vector of *time-varying* teacher characteristics (annual salary, teaching experience, experience squared, total NYCDOE years (proxy for age), and days absent).

It is important to note that that while the teacher fixed effects model has strong internal validity, the implications are different from a model without teacher fixed effects. In the current model, for example, teachers who never leave their schools and thus have an outcome that does not vary do not contribute to the estimate. This model is estimated off teachers who move, who are likely the policy relevant group but are nonetheless are a unique set of teachers. In future work we will replicate the analysis using different specifications, including ones without teacher

[8] Common support ensures that there is sufficient overlap in the characteristics of control and treatment schools to find adequate matches. Appendix Figure A1 illustrates that there is strong common support.
[9] Appendix Table A1 presents results from a covariate balance test (a standard check for successful matching) in which the treatment, ever UA school, is regressed on several covariates to test that these confounders are not statistically different between the matched treatment and control groups.

fixed effects.

IV. Preliminary Findings

Table 2 presents results on the impact of UA on the probability that a teacher remains in the same school (as detailed in equation 1). On average, UA increases the probability that a science teacher remains teaching at the same school the following year by 3.2 percentage points (column 1). This amounts to improving retention from a base of 84% to roughly 87%. This average, however, masks substantial variation in the impact of UA by teaching experience, presented in columns (2) through (6). The largest effects are for teachers who have been teaching for three or more years. In particular, UA teachers with three to five years of teaching experience are 16 percentage points more likely to remain teaching than similar peers not in the UA program.

UA's impact could also vary by the number of years teachers are exposed to the UA program. About 6% of UA teachers are in the program for only 1 year, 12-17% are in for 2 to 6 years, and roughly 5-7% are in for 7-9 years. Table 3 reveals that more exposure leads to less turnover, with the exception of novice UA teachers. The impact of UA on retention more than doubles between 3 and 8 years of UA exposure, from 6 percentage points to 18 percentage points. Further, when we examine the results above by the number of years a teacher has been teaching in NYC public schools (i.e. teaching experience) we see that the observed decline in new UA teachers' likelihood of staying in the same school is entirely driven by teachers with less than 3 years of experience (results available from authors). One possible explanation is that new teachers may be overwhelmed as they begin their careers in NYC and UA may not be ideal for them at this stage. Indeed, we saw descriptively in Table 2 that only a few UA teachers have less than a year of teaching experience. Qualitative analysis can help shed light on this theory.

V. Next Steps

This report presents the first evaluation of the impact of the UA program on teacher retention in NYC public schools. UA has not only been successful in improving student science achievement but also in retaining teachers in their school, as the preliminary analysis above suggests. Going forward, we will conduct several additional analyses to add context and check the robustness and generalizability of our findings above. First, we will use survival analysis to explore if UA and non-UA teachers exit their school and the NYC school district at different rates. This analysis will also shed light on when teachers are at the highest risk of leaving their jobs. Second, we will update the analysis period through 2016 and add four earlier years of data going back to school year 2003. This is particularly important for the survival analysis and propensity score matching methodologies because we now have years before the start of the UA program in 2004 to adjust for selection into the program with more accuracy. Third, we will estimate several variations of model (1) with and without teacher fixed effects and for different outcomes. Two additional outcomes we will explore are transfers to other UA schools and exits from the NYC public school district. Lastly, we will explore how UA's impact on teacher retention varies by teacher gender and race/ethnicity, particularly given documented benefits if same-race teachers.

Teacher attrition has both financial and academic consequences for schools and districts. NYC, the nation's largest (urban) school district, is an excellent setting to learn best practices for teacher retention. Results from this project will shed light on measures that policymakers and school administrators can take to improve teacher retention, such as content-focused professional development, especially in urban schools that struggle the most with attrition.

References

Clotfelter, C. T., Glennie, E. J., Ladd, H. F., & Vigdor, J. L. (2008). Teacher bonuses and teacher retention in low-performing schools evidence from the North Carolina $1,800 teacher bonus program. *Public Finance Review*, *36*(1), 63-87.

Guin, K. (2004). Chronic teacher turnover in urban elementary schools. *Education Policy Analysis Archives*, *12*(42).

Hanushek, E. A., Rivkin, S. G., & Schiman, J. C. (2016). Dynamic effects of teacher turnover on the quality of instruction. *Economics of Education Review*, *55*, 132-148.

Ingersoll, R. M. and D. Perda (2010). Is the supply of mathematics and science teachers sufficient? *American Educational Research Journal, 47*(3): 563-594.

Marinell, W. H., & Coca, V. M. (2013). *Who stays and who leaves? Findings from a three-part study of teacher turnover in NYC middle schools*. New York, NY: Research Alliance for New York City Schools. Retrieved from http://media. ranycs. org/2013/003.

Ronfeldt, M., Loeb, S., & Wyckoff, J. (2013). How teacher turnover harms student achievement. *American Educational Research Journal*, *50*(1), 4-36.

Weinstein, M. & E. Ruble (2011). "Can Formal–Informal Collaborations Improve Science Literacy in Urban Middle Schools? The Impact of Urban Advantage," IESP Policy Brief 5-11 (June). New York: NYU Institute for Education & Social Policy

Weinstein, M., Whitesell, E. R., & Schwartz, A. E. (2014). Museums, zoos, and gardens: How formal-informal partnerships can impact urban students' performance in science. *Evaluation review*, *38*(6), 514-545.

Watlington, E., Shockley, R., Guglielmino, P., & Felsher, R. (2010). The high cost of leaving: An analysis of the cost of teacher turnover. *Journal of Education Finance*, *36*(1), 22-37.

Tables and Figures

Table 1. Characteristics of NYC middle school science teacher by UA status

	UA	**non-UA**
Unique number of science teachers	*553*	*3,255*
Total number of teacher-year observations	*2,016*	*11,885*
Demographics (%):		
Female	71.4	66.6
White	48.7	53.5
Black	22.4	24.2
Asian	14.2	9.9
Hispanic	12.5	11.2
Discretionary absences (days)	6.5	7.1
Annual salary ($)	67,645	67,347
Teaching Experience (%):		
1 year or less	4.1	10.8
2-3 years	17.6	16.4
4-10 years	53.8	41.6
11-20 years	20.2	22.7
20 years or more	4.4	8.5
Average years teaching	7.2	8.1
Average years as NYCDOE employees (including non-teaching positions)	7.2	8.1
Retention in following year (%):		
Stayed teaching in the same school	87.2	84.5
Transferred to a different school	7.8	4.1
to another UA school	7.8	1.2
to a non-UA school	0.0	2.9
No longer teaching in NYC schools	5.0	11.4
20 or more years of experience	0.4	1.4
Less than 20 years of experience	4.6	10.1

Notes: Retention is defined as remaining in the same school the following academic year. Discretionary absences include self-treated or medically certified sick days, personal days, and grade periods. All UA non-UA differences are statistically significant except for annual salary and the percent of teachers with 2-3 years of teacher experience. Years 2007-2015.

Table 2. Impact of UA on the probability that a science teacher remains in the same school

		Years of teaching experience				
	(1) All teachers	(2) 3 or less	(3) 3 plus to 5	(4) 5 plus to 10	(5) 10 plus to 20	(6) More than 20
UA Teacher	0.032*	0.049	0.160***	0.012	0.083***	0.118
	(0.019)	(0.062)	(0.034)	(0.046)	(0.020)	(0.103)
N	13,123	3,503	1,815	3,815	2,940	1,050

Robust standard errors clustered by school in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Notes: Linear probability models. All models include the following controls: year, teacher, and matched school pair fixed effects, number of days absent, annual salary, teaching experience, experience squared, and total DOE experience (proxy for age). Years 2007-2015.

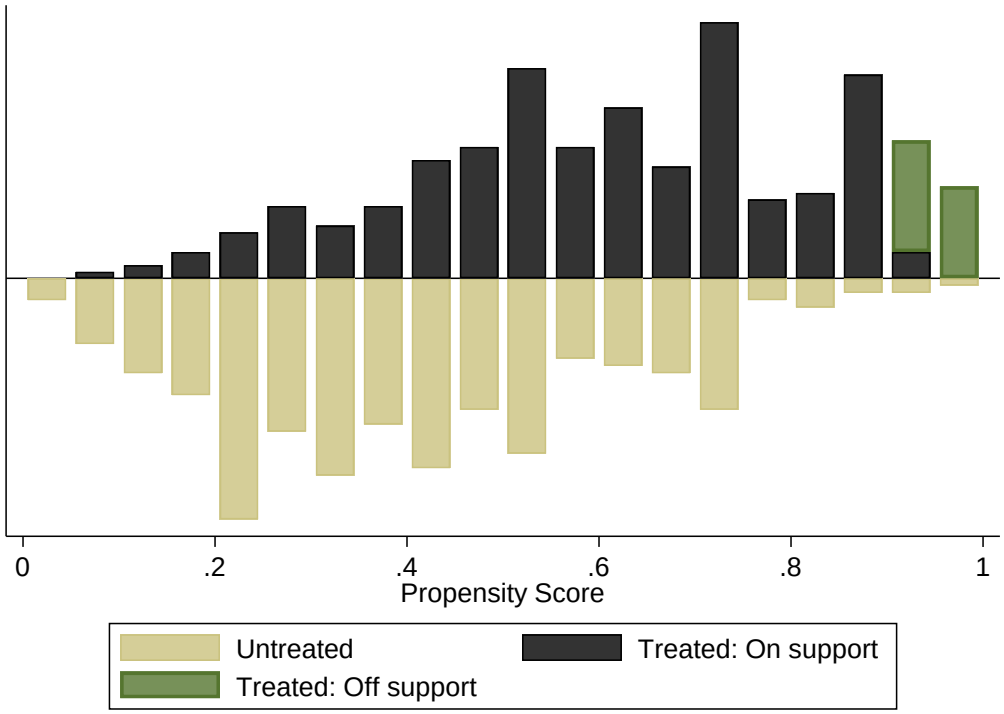
Table 3. Does the impact of UA vary by the number of total years in the program?

	(1)
Years in UA:	
One year	-0.235**
	(0.097)
Two years	0.025
	(0.034)
Three years	0.062*
	(0.032)
Four years	0.046
	(0.031)
Five years	0.106***
	(0.033)
Six years	0.139***
	(0.029)
Seven years	-0.016
	(0.133)
Eight years	0.182***
	(0.029)
N	13,123

Robust standard errors clustered by school in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Notes: Linear probability models. All models include the following controls: year, teacher, and matched school pair fixed effects, number of days absent, annual salary, teaching experience, experience squared, and total DOE experience (proxy for age). Years 2007-2015.

Appendix

Figure 1A. Region of common support, propensity score matching



Notes: *Untreated* are schools who never participated in UA. *Treated* are schools who participated in UA. Figure illustrates strong overlap between treatment and control schools.

Table A1. Balance across UA and non-UA schools from propensity score matching

Dependent variable: ever UA school	(1)
Demographic characteristics:	
Average attendance rate	0.002
	(0.001)
Enrollment	0.000
	(0.000)
Percent Asian	0.012
	(0.033)
Percent Black	0.011
	(0.033)
Percent Hispanic	0.008
	(0.033)
Percent White	0.008
	(0.033)
Percent Female	0.007
	(0.005)
Percent Immigrant	-0.008
	(0.006)
Percent ELL	0.006
	(0.005)
Percent Special Ed.	-0.001
	(0.004)
Percent of students passing math exam	0.001
	(0.003)
Percent of students passing English exam	-0.003
	(0.004)
Percent eligible for free lunch	-0.001
	(0.001)
Percent eligible for reduced price lunch	0.002
	(0.005)
Universal free meal school	0.075
	(0.062)
Percent of students passing science exam	0.014
	(0.181)
Per pupil general ed. spending	-0.000
	(0.000)
Per pupil special ed. spending	-0.000
	(0.000)
Percent of teachers without valid teaching certificate	-0.002
	(0.005)
Percent of teachers with fewer than 3 years of experience	0.001
	(0.002)
Teacher pupil ratio	0.006

	(0.017)
Borough:	
BX	-0.003
	(0.066)
BK	-0.011
	(0.069)
QN	0.017
	(0.083)
SI	0.207
	(0.196)
Constant	-0.773
	(3.345)
N	552

Robust standard errors clustered at the school level in parentheses* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Dependent variable is a binary indicator equal to 1 if a school ever had a teacher who participated in UA (i.e. ever UA school). Linear probability model regression of the treatment (ever UA) on covariates. Estimates show no statistically significant differences between the treatment and control schools on all covariates.