Abstract Title Page
Not included in page count.

Title: Explaining Charter School Effectiveness

Authors and Affiliations:

Joshua D. Angrist
MIT Department of Economics and National Bureau of Economic Research
angrist@mit.edu

Parag A. Pathak
MIT Department of Economics and National Bureau of Economic Research
ppathak@mit.edu

Christopher R. Walters
MIT Department of Economics
crwalt@mit.edu

Abstract Body

Limit 4 pages single-spaced.

Background / Context:

Description of prior research and its intellectual context.

Charter schools are publicly funded schools that are given more freedom than traditional public schools to set their curricula, control staffing, and manage day to day operations. A growing body of evidence suggests that urban charter schools have the potential to generate impressive achievement gains for minority students living in high-poverty areas. A series of recent studies using admissions lotteries to identify causal effects reports large gains for charter schools located in Boston and other urban areas of Massachusetts, as well as the Harlem Children's Zone and Washington, DC (Abdulkadiroglu et al., 2011; Angrist et al., 2010a, 2010b; Dobbie and Fryer, 2011; Curto and Fryer, 2011). Studies of Chicago and New York charter schools also report positive effects (Hoxby and Rockoff, 2004; Hoxby, Murarka and Kang, 2009).

While these results are encouraging, results for more diverse sets of charter schools are more mixed. A recent report evaluating roughly two dozen Massachusetts charter finds little evidence of achievement gains at schools outside of high-poverty urban areas (Angrist et al., 2011). Some of the estimates for non-urban Massachusetts charters show significant negative effects. These results echo findings from a multi-state study of 36 charter middle schools using admissions lotteries (Gleason et al., 2010). Here too, charter schools outside of urban areas seem to do little for achievement, though urban schools with high-minority, high-poverty enrollment generate some gains. The source of these striking differences in charter school effectiveness across settings is an open question.

Purpose / Objective / Research Question / Focus of Study:

Description of the focus of the research.

This study uses entrance lotteries to explore heterogeneity in the achievement effects of charter schools across demographic groups and between urban and non-urban areas in Massachusetts. We develop a framework for interpreting this heterogeneity using both student- and school-level explanatory variables.

Setting:

Description of the research location.

Our sample includes 16 middle schools and six high schools from Massachusetts. Nine of the middle schools are in urban areas; seven are in Boston. The other seven are in non-urban areas. Four participating high schools are in Boston, and the other two are in non-urban areas.

Population / Participants / Subjects:

Description of the participants in the study: who, how many, key features, or characteristics.

The set of applicants to charter schools in our lottery sample includes 6,214 middle school students and 4,207 high school students. Table 1 reports pre-lottery demographic characteristics for these students. Urban charter schools serve large fractions of minority students -- 71 percent

and 87 percent of applicants are black or Hispanic in middle and high school, respectively. Urban applicants are also poor (more than 65 percent are eligible for subsidized lunch), and low-achieving; their pre-lottery test scores are more than 0.3 standard deviations below the state average in both math and English language arts (ELA).

In contrast, non-urban charter schools serve a mostly white, high-achieving population. Less than three percent of non-urban applicants are black or Hispanic, and just over 10 percent are eligible for subsidized lunch. Non-urban students also enter with high baseline achievement levels; they score more than 0.3 standard deviations above the state average for each subject in middle school, and baseline achievement for non-urban high school applicants is even higher. The sharp disparities between the characteristics of urban and non-urban charter applicants provide useful variation for studying heterogeneity in the effects of charter schools.

Intervention / Program / Practice:

Description of the intervention, program, or practice, including details of administration and duration.

Educational practices differ dramatically across urban and non-urban charter schools. Table 2 reports information from a survey of school administrators. Urban charter schools run a longer school day and year than do non-urban schools, and spend more time on math and reading instruction. Urban charters are also more likely to require parent and student contracts, are much more likely to use formal reward and punishment systems, and have slightly higher per-pupil expenditures. The survey reveals a sharp division between urban and non-urban charters with respect to the *No Excuses* approach to education. As discussed by Thernstrom and Thernstrom (2003) and Carter (2000), *No Excuses* principles include a strict disciplinary environment, an emphasis on student behavior and comportment, extended time in school, and an intensive focus on traditional reading and math skills. Seventy-one percent of urban charter administrators identify somewhat or fully with *No Excuses*, while no non-urban charter identifies with this approach.

Research Design:

Description of the research design.

Our research design identifies the causal effects of attending charter schools by comparing students who win entrance lotteries to students who lose. Since these lotteries are random, any systematic difference between winners and losers must be due to the lottery outcome. This approach eliminates the selection bias that plagues observational studies of charter school effectiveness.

Formally, we estimate causal effects at charter schools with available lottery records using two-stage least squares (2SLS). The second-stage equation in this context is

$$y_{igt} = \alpha_{2t} + \beta_{2g} + \tau s_{igt} + X_i'\gamma + \sum \delta_j d_{ij} + \epsilon_{igt},$$

where y_{igt} is a test score for student i in grade g in year t, α_{2t} and β_{2g} are year and grade effects, X_i is a vector of pre-lottery demographic characteristics (race, special education, limited English proficiency, subsidized lunch status, and a female-minority interaction), and ϵ_{igt} represents

random fluctuations in test scores. The set of d_{ij} includes a separate dummy variable for every combination of observed charter school lotteries (indexed by *j*) entered by students in the lottery sample. The variable of interest, s_{igt}, measures years spent in charter schools between application and test dates. The parameter τ captures the causal effect of charter school attendance.

Ordinary Least Squares (OLS) estimates of this equation may be biased because students do not choose to attend charter schools randomly. We therefore use a dummy variable, Z_i, indicating lottery offers as an instrument for time spent in charter school. This procedure isolates the random variation in charter school attendance produced by entrance lotteries and generates unbiased estimates of the causal effect of interest. We produce 2SLS estimates separately for urban and non-urban schools.

Given estimates of the causal effect of charter school attendance, we decompose differences in the effects of urban and non-urban schools into student-level and school-level factors. First, we examine levels of test scores in and out of charter schools for urban and non-urban charter applicants. Second, we perform a Blinder-Oaxaca (1973) decomposition of the urban charter advantage to determine the portion of the difference in effectiveness due to student demographics. Finally, we analyze the relationship between school-level causal effects and policies. For this analysis, we produce estimates using observational methods, which allows us to compare lottery and non-lottery charter schools in addition to urban and non-urban ones. The school-level analysis uses equations of the form

$$\hat{\tau}_s = \psi_0 + C_s'\psi_1 + \xi_s$$

Here $\hat{\tau}_s$ is an estimate of the causal effect of school s and C_s is a vector of school characteristics and policies measured in our survey of administrators. The results of this analysis reveal the policies that are most strongly associated with charter school effectiveness.

Data Collection and Analysis:

Description of the methods for collecting and analyzing data.

We attempted to collect lottery data for the set of Massachusetts charter schools serving middle and high school grades with entrance lotteries in grades 4 through 10. We collected lists of lottery applicants, winners, and losers from each charter school with available records. These records were matched by name, grade, and year of application to an administrative database of student demographics, enrollment, and test scores from Massachusetts' Student Information Management System (SIMS) and Comprehensive Assessment System (MCAS). These databases were obtained through a data-use agreement with the Massachusetts Department of Elementary and Secondary Education (DESE). The match rates from the lottery data to the administrative data were 92 percent for middle school and 94 percent for high school.

Findings / Results:

Description of the main findings with specific details.

Our results suggest that urban charter schools in Massachusetts have much larger effects on student test scores than non-urban charter schools. Table 3 shows 2SLS estimates of the per-year effects of charter school. The estimates, which are in standard deviation units (σ), are reported separately by urban status and school level. In middle school, urban charter attendance increases ELA scores by 0.14σ per year and math scores by 0.34σ per year. In contrast, attendance at non-urban charter middle schools reduces both ELA and math scores by 0.16σ per year. All of the middle school estimates are highly statistically significant. The estimates for high school are similar, though results for non-urban high schools are imprecise due to small sample sizes.

Our analysis of charter school effect heterogeneity shows that the striking difference between the achievement effects of urban and non-urban charter schools is only partially explained by student-level factors. Compared to non-urban students, urban charter students start out at low levels of achievement, though their non-charter scores are typical of the general population of urban students. Charter attendance raises the scores of urban students to levels comparable to their non-urban counterparts, while scores for non-urban students are largely unchanged or slightly reduced by charter attendance. Our Blinder-Oaxaca analysis shows that student demographics explain some of the urban advantage, as urban schools are most effective for low-achieving minority students (which are overrepresented in urban areas), but differences in effectiveness within demographic groups are large as well.

Finally, our school-level analysis suggests that the *No Excuses* instructional approach can explain the effectiveness of urban schools relative to non-urban ones, as well as the difference in effectiveness between schools with and without entrance lotteries. As shown in Table 4, controlling for *No Excuses* status accounts for both the urban and lottery advantages; these differences are small and statistically insignificant in our school-level regressions conditional on *No Excuses*. Other important characteristics, like time in school and per-pupil expenditure, are not individually associated with charter school effectiveness and do not explain the *No Excuses* advantage.

Conclusions:

Description of conclusions, recommendations, and limitations based on findings.

Our analysis demonstrates that urban charter schools in Massachusetts dramatically increase student test scores, while non-urban charter schools appear to be largely ineffective and may reduce achievement for some. Candidate explanations for this constellation of findings include the fact that urban charter schools serve larger shares of minority students in districts where the surrounding achievement level is generally low, keep their students in school longer, spend more money per-pupil, and are much more likely to identify with the *No Excuses* instructional approach than are non-urban schools. Our analysis examines the contribution of these student- and school-level factors to the urban charter advantage. The results suggest that student-level factors only partially explain our findings, while adherence to the *No Excuses* approach accounts for the urban and lottery-sample advantages. In ongoing work, we're looking at a variety of post-secondary outcomes in an effort to determine whether the heterogeneous findings for achievement have longer-term consequences. We also hope to investigate the effectiveness of *No Excuses* education for non-urban students by drawing new samples of students and schools from other states.

Appendices

Not included in page count.

Appendix A. References

References are to be in APA version 6 format.

Abdulkadiroglu, A., Angrist, J., Dynarski, S., Kane, T., and Pathak, P. (2011). Accountability and flexibility in public schools: Evidence from Boston's charters and pilots. *The Quarterly Journal of Economics,* forthcoming.

Angrist, J., Cohodes, C., Dynarski, S., Fullerton, J., Kane, T., Pathak, P., and Walters, C. (2011). Student achievement in Massachusetts' charter schools. Harvard Center for Education Policy Research Working Paper.

Angrist, J., Dynarski, S., Kane, T., Pathak, P., and Walters, C. (2010a). Inputs and impacts in charter schools: KIPP Lynn. *American Economic Review*, 100(2), 239-243.

Angrist, J., Dynarski, S., Kane, T., Pathak, P., and Walters, C. (2010b). Who benefits from KIPP? NBER Working Paper 15740.

Blinder, A. (1973). Wage discrimination: Reduced form and structural variables. *Journal of Human Resources*, 8, 436-455.

Carter, S. (2000). *No Excuses: Lessons from 21 high-performing, high-poverty schools.* Washington, DC: Heritage Foundation.

Dobbie, W., and Fryer, R. (2011). Are high quality schools enough to close the achievement gap? Evidence from the Harlem Children's Zone. *American Economic Journal: Applied Economics*, 3(3), 158-187.

Curto, V., and Fryer, R. (2011). Estimating the returns to urban boarding schools: Evidence from SEED. NBER Working Paper 16746.

Hoxby, C., Murarka, S., and Kang, J. (2009). How New York City's charter schools affect achievement. New York City Charter Schools Evaluation Project.

Hoxby, C., and Rockoff, J. (2004). The impact of charter schools on student achievement. Harvard Institute of Economic Research Working Paper.

Oaxaca, R. (1973). Male-female wage differentials in urban labor markets. *International Economic Review,* 14, 673-709.

Thernstrom, A., and Thernstrom, S. (2003). *No Excuses: Closing the racial gap in learning*. New York: Simon and Schuster.

Appendix B. Tables and Figures

Not included in page count.

Table 1: Descriptive Statistics

	Regular Public Schools		Charter schools (eligible)		Charter applicants (lottery)	
	Urban	Non-urban	Urban	Non-urban	Urban	Non-urban
	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A. Middle Schools (5th-8th grade)			
Female	0.486	0.488	0.498	0.476	0.496	0.510
Black	0.185	0.027	0.407	0.036	0.479	0.022
Hispanic	0.314	0.036	0.237	0.048	0.234	0.025
Special education	0.190	0.163	0.166	0.160	0.176	0.184
Subsidized lunch	0.681	0.141	0.650	0.216	0.686	0.102
Limited English proficiency	0.150	0.016	0.077	0.025	0.086	0.008
Baseline Math score	-0.430	0.213	-0.339	0.239	-0.352	0.306
Baseline ELA score	-0.464	0.234	-0.330	0.261	-0.373	0.392
Years in charter	0.000	0.000	2.027	1.960	1.341	1.002
N (students)	153374	369866	6625	8316	4126	1693
N (schools)	262	390	16	11	9	7
			Panel B. High Schools (10th grade)			
Female	0.500	0.494	0.555	0.549	0.549	0.539
Black	0.190	0.028	0.535	0.020	0.615	0.029
Hispanic	0.272	0.032	0.176	0.010	0.256	0.017
Special education	0.169	0.155	0.160	0.105	0.174	0.115
Subsidized lunch	0.606	0.122	0.600	0.146	0.716	0.120
Limited English proficiency	0.093	0.009	0.022	0.005	0.035	0.003
Baseline Math score	-0.420	0.271	-0.413	0.322	-0.315	0.445
Baseline ELA score	-0.387	0.282	-0.325	0.413	-0.306	0.562
Years in charter	0.000	0.000	1.765	1.797	0.627	1.292
N (students)	116593	313366	2198	783	2973	349
N (schools)	101	304	8	2	4	2

Notes: This table reports descriptive statistics for the sample of public school students (columns 1 and 2), the sample of students in eligible charter schools (columns 3 and 4), and the sample of charter applicants (columns 5 and 6) from 2002-2010. The sample is restricted to students in Massachusetts public schools at baseline with at least one followup test score. The number of schools in columns (1) and (2) is counted in 6th grade for middle school and 10th grade for high school. Years in charter school is measured through 8th grade for middle school and 10th grade for high school.

Table 2: Characteristics of Charter Schools

Characteristic	Statewide (1)	Urban (2)	Non-urban (3)
Years open	9.43	8.18	11.36
Days per year	186.18	188.53	182.55
Average minutes per day	447.86	464.35	422.36
Have Saturday school	0.321	0.471	0.091
Avg. math instruction (min)	80.93	94.56	59.86
Avg. reading instruction (min)	84.00	99.62	59.86
CMO or Network Affiliation	0.357	0.294	0.455
Fully or somewhat "No excuses"	0.429	0.706	0.000
Parent contract	0.679	0.824	0.455
Student contract	0.643	0.706	0.545
Uniforms	0.821	0.882	0.727
Reward and punishment system	0.464	0.647	0.182
Avg. per-pupil expenditure	12824.19	14095.53	11090.55
Title I eligible	0.857	1.000	0.636
Number of teachers	25.736	22.735	30.373
Student/teacher ratio	11.614	11.565	11.691
Licensed teachers	51.146	51.853	50.055
Proportion 32 and younger	0.577	0.709	0.384
Proportion 49 and older	0.129	0.058	0.233
Left voluntarily	2.278	1.969	2.727
Left involuntarily	1.296	1.500	1.000
Require staff to take calls after hours	0.071	0.059	0.091
Unpaid tutors/volunteers	0.786	0.706	0.909
Paid tutors	0.143	0.235	0.000
N (schools)	28	17	11

Notes: This table reports results from a survey of Massachusetts charter schools with entry in middle (4th-7th) or high school (9th) grades. The survey sample excludes schools closed prior to 2010, schools that were not open before Fall 2010, and schools serving non-traditional student populations. Twenty-eight of 32 eligible schools responded to the survey.

Table 3: Lottery Results for Urban and Non-urban Charter Schools

			Urban			Non-urban		
			First Stage	Reduced Form	2SLS	First Stage	Reduced Form	2SLS
School level	Subject		(1)	(2)	(3)	(4)	(5)	(6)
Middle	ELA		1.001***	0.141***	0.140***	0.978***	-0.155***	-0.156***
			(0.055)	(0.035)	(0.033)	(0.081)	(0.045)	(0.045)
		N		8762			3364	
	Math		0.990***	0.333***	0.336***	0.996***	-0.159***	-0.155***
			(0.054)	(0.038)	(0.036)	(0.081)	(0.050)	(0.051)
		N		9015			3331	
High	ELA		0.494***	0.117**	0.236***	1.082***	-0.014	-0.009
			(0.105)	(0.051)	(0.079)	(0.153)	(0.116)	(0.105)
		N		2954			349	
	Math		0.495***	0.178***	0.359***	1.088***	-0.274*	-0.246*
			(0.105)	(0.066)	(0.092)	(0.158)	(0.162)	(0.148)
		N		2910			345	
	Writing Topic		0.500***	0.166***	0.332***	1.082***	-0.157	-0.139
			(0.105)	(0.058)	(0.090)	(0.153)	(0.222)	(0.204)
		N		2920			348	
	Writing Composition		0.500***	0.149**	0.298***	1.082***	-0.155	-0.137
			(0.105)	(0.060)	(0.096)	(0.153)	(0.213)	(0.196)
		N		2920			348	

Notes: This table reports estimates of the effects of years in urban and non-urban charter schools on test scores. The sample is restricted to students with baseline demographic characteristics who attended a Massachusetts public school when tested, and excludes students with sibling priority and late applicants. Estimates are produced by a 2SLS procedure using urban and non-urban lottery offers as instruments for attendance at urban and non-urban charter schools. All models control for race, sex, special education, limited English proficiency, subsidized lunch status, and a female by minority dummy. Year of birth, year of test, and risk set dummies are also included. Middle school regressions pool post-lottery outcomes from 4th through 8th grade and cluster by student identifier as well as school-grade-year. High school regressions include only scores for 10th grade, and cluster by school-grade-year.

*significant at 10%; **significant at 5%; ***significant at 1%

Table 4: Effects of School Characteristics

	Math				ELA			
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Urban	0.198***	0.072	0.008	-0.041	0.120***	0.062*	0.011	0.014
	(0.057)	(0.082)	(0.062)	(0.053)	(0.036)	(0.037)	(0.033)	(0.042)
Total minutes per day/100	-	0.154*		0.095	-	0.080*	-	0.055
		(0.090)		(0.078)		(0.042)		(0.038)
Minutes in relevant subject/100	-	0.203	-	0.207	-	0.023	-	0.007
		(0.211)		(0.168)		(0.075)		(0.068)
Per-pupil expenditure/1000	-	-0.002	-	-0.009	-	0.004	-	-0.001
		(0.014)		(0.010)		(0.008)		(0.009)
School is No Excuses	-	-	0.306***	0.231***	-	-	0.169***	0.117**
			(0.082)	(0.060)			(0.045)	(0.048)
Lottery	0.154**	0.086*	0.051	0.038	0.101**	0.055	0.047	0.033
	(0.069)	(0.050)	(0.052)	(0.041)	(0.043)	(0.035)	(0.036)	(0.033)
High School	0.039	0.078	0.035	0.087	0.069*	0.076*	0.062*	0.078*
	(0.071)	(0.065)	(0.052)	(0.057)	(0.036)	(0.040)	(0.032)	(0.040)
Constant	-0.131*	-0.835**	-0.064	-0.490	-0.085*	-0.445**	-0.047	-0.267
	(0.067)	(0.375)	(0.043)	(0.299)	(0.045)	(0.176)	(0.033)	(0.183)
N	30	28	30	28	30	28	30	28

Notes: This table reports regressions of school-specific treatment effects on school characteristics. The sample includes only schools that completed the charter survey. Regressions weight by the inverse of the standard error of the coefficient estimates and cluster at the school level.

*significant at 10%; **significant at 5%; ***significant at 1%