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Does Small High School Reform Lift Urban Districts? Evidence from NYC

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The National Center on Scaling Up Effective Schools (NCSU) is a national research and development center that focuses on identifying the combination of essential components and the programs, practices, processes and policies that make some high schools in large urban districts particularly effective with low income students, minority students, and English language learners. The Center's goal is to develop, implement, and test new processes that other districts will be able to use to scale up effective practices within the context of their own goals and unique circumstances. Led by Vanderbilt University's Peabody College, our partners include The University of North Carolina at Chapel Hill, Florida State University, the University of Wisconsin-Madison, Georgia State University, and the Education Development Center.

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Introduction

While numerous policy interventions have been aimed at improving high school outcomes for urban students, "small school reform" (in which large comprehensive high schools are replaced by newly created small schools) is of particular interest for three reasons: first, because it has been adopted in key American cities including New York City, Los Angeles, Chicago, Philadelphia, Oakland, San Diego, and Boston; second because it enjoyed a substantial public and philanthropic funding base, including nearly $600 million each from the Gates foundation and US Department of Education;[1] third -- and perhaps most tantalizing -- because recent research evaluating the new schools in New York City (Bloom et al., 2010 and Schwartz, Stiefel, and Wiswall, 2012) and Chicago (Barrow et al., 2010) suggests that that students attending new small schools achieve better outcomes (including higher graduation rates) than other district schools. Although additional work is needed to externally validate these latter results in other cities, the findings provide only part of the evidence needed to answer to the question we pose in this paper – does the introduction of new small schools (and the corresponding changes in other schools) improve outcomes district-wide?

The underlying logic of small school reform as a district-wide improvement strategy is threefold. First, small schools may be more effective than large comprehensive schools because small learning communities can be more intimate and nurturing, and could attract a different mix of teachers and leaders. Second, creating new small schools builds new capacity, which allows districts to close failing, dysfunctional schools. Third, increasing the number of schools means there will be more competition for students among schools, which could fuel innovations and improvements across the board. Thus, small school reform is not just about building better schools, but about lifting all the boats.

To be clear, the existing literature finds that students attending new small schools fare better than those attending old schools in the same period, but it does not examine changes district-wide. Is the better performance of new small schools gained at the expense of losses elsewhere? If, for example, new small schools succeed by immiserating the old schools – by drawing financial resources or high quality students, for example– then the overall impact on the district's children may well be negative, even while the students in new small schools do better. Does small school reform lift the whole district? This is the question we seek to address.

In this paper we explore the success of New York City's small high school reform in which hundreds of new small high schools were built in less than a decade as part of a series of reforms initiated by New

[1] Over the past decade, the Gates Foundation has invested over $700 million for high school initiatives, including $590 million (80%) on reforms in which small schools are either the centerpiece or essential component of the reform (i.e., early-college high school programs). Likewise, the US Department of Education awarded grants totaling $140 million as part of its Smaller Learning Communities initiative from 2001 to 2002, with an additional $477 million appropriated for 2002-2004. (US Department of Education, 2005).

York City Public Schools Chancellor Joel Klein.[2] Of particular interest is that the New York City Department of Education (NYCDOE) implemented new procedures and regulations governing new small schools established after 2002 (See Cahill and Hughes, 2010; Bloom et al., 2010 for more).[3] To begin, the application process required plans for implementing an academically rigorous curriculum and partnerships with community- based organizations. Not all applications were successful. Almost all of the new small schools were supported by non-profit organizations, such as New Visions for Public Schools, with generous funding from the Gates Foundation or other philanthropies to monitor, aid and network together these new small schools as they were established. Perhaps even more important, new small schools were granted exemptions in their first years from serving some groups of special needs students and following all union rules on hiring teachers.[4,5]

Other key school reforms in NYC included an overhaul of the high school application and admissions process and changes in human resources policies (see Corcoran and Levin, 2011, for a description of some of these reforms).[6] Chancellor Klein enjoyed strong support from Mayor Michael Bloomberg who was granted control over the schools by the New York State Legislature in 2002. The public school budget expanded dramatically, fueled by favorable economic conditions in the city and increased state aid, and Chancellor Klein served extraordinarily long eight year tenure. These simultaneous changes mean that fully isolating the effect of small school reform from the effects of other changes is, ultimately, quite difficult. Nonetheless, in practice, reforms are typically implemented amidst other changes – some inextricably linked to the reform and others merely coincident. The New York City initiatives offer an opportunity to gain insight into the efficacy of small school reform in practice and on a large scale in America's largest school district, providing implications for policymakers and education reform leaders.

In this paper, we use a rich administrative dataset of individual student level data on four cohorts of NYC high school students – two cohorts that were slated to graduate from high school prior to the Mayor

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[2] The investment in new small high schools continues, along with continued investment in new charter schools and new middle schools. In his 2012 State of the City Mayor Bloomberg reported: "The four new schools here at the Morris campus are among the 500 new schools we've created over the past decade, including 139 new charter schools. This year, we'll phase out another 25 schools and open smaller schools in the same buildings. All told, our goal is to open 100 new schools over the next two years – including 50 new charters."

[3] This environment for new small schools may have applied also to new schools that were still adding grades in 2002 and 2003.

[4] Some of these exemptions were slated to sunset within a few years.

[5] The exemptions surrounding hiring were over and above broader reforms aimed at improving teacher recruitment, retention, and evaluation such as the open market transfer system (see, Goertz, Loeb, and Wyckoff, 2011 for more detail on policies aimed at improving the teaching workforce during these years). Moreover, changes in state regulation surrounding teacher certification at the turn of the century meant that the pool of teachers competing for jobs was increasingly more qualified (at least in ways researchers are able to measure).

[6] Changes in the high school application process were introduced in AY 2003-04 via the High School Application Processing System (HSAPS). Under this system, all NYC public school 8th graders are required to submit a ranked list of up to 12 high schools citywide according to their personal preferences. The NYCDOE uses a computerized matching process to assign students to high schools based on their preferences, school selection criteria, and seat availability (Abdulkadiroglu, Pathak, and Roth 2005, 2009).

Bloomberg's takeover of the schools (2001 and 2002) and two that were expected to graduate after the small school reforms were well underway (2007 and 2008). We estimate a model of school outcomes controlling for student characteristics to examine changes over time and explore the differential effects of small schools. We control for potential selection into small schools using an instrumental variables (IV) approach as in Schwartz, Stiefel, and Wiswall (2012). In addition, we explore differences between the schools that were closed, the new schools that opened, and, importantly, the gains made in the continuously operating schools. Did high school outcomes improve across the board? To what extent are observed changes reflective of changes in the student body? Did old schools improve or were gains driven by replacing low performing schools with high performing schools? Are the results robust to selection? We hope to provide a nuanced picture of the effects of the small school reform overall. Our evaluation, therefore, is relevant for policymakers who aim to initiate small high school reform in an environment – like that found in many urban school districts in the U.S. today – where change and reform is ongoing and "business as usual" involves continual change.

We begin in section II by reviewing the current literature on small schools paying particular attention to three recent studies examining the efficacy of small schools in Chicago and NYC. In section III, we turn to describing our data and in section IV we explain our models. In section V, we present results on the overall impact of the school reforms. To do so, we compare the characteristics and performance of NYC high schools and high school students in two pre-reform cohorts – 2001 and 2002 – and two post-reform cohorts – 2007 and 2008. In section VI, we explore the gains made overall and by small schools in particular and examine the robustness of our findings. We end, in section VII, with conclusions that include implications for policymakers and education reformers.

What Do We Know About Small Schools?

Much of the existing literature on small schools is correlational and micro-focused – aimed at understanding how small high schools differ from large high schools or how outcomes vary with school size. Fowler and Walberg (1991), Fowler (1992), and Lee and Smith (1997), for example, find that achievement scores and attendance rates are higher and dropout rates are lower in small schools compared to large schools. Fowler (1992) and Page et al. (2002) suggest that small schools have more student participation in extracurricular activities and better student and teacher attitudes and Shouse (2004) and Powell (1985), among others, find large schools have less personal relationships and more student disengagement due to feelings of anonymity. In an influential study, Lee and Smith (1997) report that an optimal school size with respect to maximizing student achievement ranges between 600 and 900 students, which is larger than that promoted in most current initiatives, including New York City's.[7]

While valuable, this body of research does not offer evidence on the causal relationship between school size and achievement. Schneider, Wyse and Keesler (2007) were among the first to explicitly address the issue of causality, using Hierarchical Linear Modeling (HLM) and propensity score matching to attempt to control for selection into small schools. While the HLM results suggest attending a small high school has little effect on achievement, postsecondary expectations and number and types of college

[7] Howley et al. (2000) observe that studies of outcomes recommend smaller school sizes than those based on inputs, and studies focusing on aspects of community in education recommend smaller sizes than those based on outcomes.

applications, propensity score matching results suggest somewhat more positive impacts of small schools

More recently, three studies have made important strides in obtaining causal estimates of small school efficacy. Barrow et al. (2010) and Schwartz, Stiefel, and Wiswall (2012) use distance between residence and school choices as an instrumental variable to address potential endogeneity in the choice to attend a small school in Chicago and New York City, respectively. Bloom et al (2010) exploit a lottery design to examine the outcomes of randomly assigned lottery winners and losers at oversubscribed small schools of choice in New York City.

As our interest is on the role of small school reform in New York City, the work by Schwartz, Stiefel, and Wiswall (2012) and Bloom et al. (2010) is most relevant. Schwartz, Stiefel, and Wiswall (2012) evaluate the impact of small schools on all first time 9th graders in two cohorts. They find that 121 new small schools (those with graduating classes after 2002) delivered higher graduation outcomes (17.5 percentage points higher) for attending students in 2007 and 2008, compared to 122 large schools operating in that year. Further, they find that the 48 old small schools had significantly worse outcomes with 56 percentage points lower graduate rate relative to large schools. Bloom et al. (2010) examine 105 oversubscribed small schools of choice that held lotteries to allocate places in the school and find positive effects of small school attendance on persistence through high school, but no improvement on student test scores. Specifically, comparing the outcomes of lottery winners and losers for one cohort of students, they find the four year graduation rates for students attending small schools of choice are 6.8 percentage points higher than the students in the control group.

Table 1: Probability of graduating in four years, IV regression results

	Barrow et al	Bloom et al	Schwartz, Stiefel, Wiswall
	(1)	(2)	(3)
Old small			-0.556***
			(0.167)
New small	0.082	0.068**	0.175**
	(0.078)	(0.013)	(0.084)
Observations	31,258	5,363	76,213
# of small schools	11	105	169

Note: In Barrow et al (2010), the majority of the new schools are conversion schools (see Barrow et al (2010), pg 7); in Bloom et al (2010), the new small schools are all oversubscribed small schools of choice; and in Schwartz, Stiefel, and Wiswall (2012), the new small schools are all small schools graduating their first class after 2002.

Column (1) taken from Barrow et al (2010). Table 4c column (4). At the end of the study period, there were 22 new small high schools in Chicago; however, these opened at various times throughout the study period and four and five year high school outcomes are only available for 11 schools.

Column (2) taken from Bloom et al. (2010). Table 3.7.

Column (3) taken from Schwartz, Stiefel, and Wiswall (2012). Table 3 column (4).

To date, however, there is no evidence, whether descriptive or causal, on whether students on average in districts adopting small school reform improve overall. Current literature focuses entirely on whether small schools are better than large schools operating concurrently in the same district. There is very little evidence on whether the large schools suffer in the face of increased attention on their small school counterparts or whether the new small schools replace bad old schools. In this paper, we take a longer perspective by examining changes in high school outcomes over the course of the reform years. Further, we extend the definition of what counts as success in the small schools reform movement by focusing attention not on whether small schools are high performing, but whether all schools – small and large – improved performance on key high school outcomes during this time period.

Data

We use richly detailed student-level administrative data from the New York City Department of Education (NYCDOE) for the four cohorts of public high school students expected to graduate in 2001, 2002, 2007, and 2008. Throughout the paper, we refer to students in cohorts 2001 and 2002 as pre-reform and those in cohorts 2007 and 2008 as post-reform. These student-level data include information on the student's gender, race\ethnicity, poverty (measured as participation in the free lunch program in 8th grade), English proficiency, home language, whether the student is overage for grade, and prior test performance on standardized English language arts and math exams.[8] Additionally, we have data on whether students graduated in four years and data on their test taking and performance on statewide English and Math Regents exams. We define graduation as earning a local, Regents, Honors, or Advanced Regents diploma in four years.[9] Students receiving a GED are not considered graduates. We

[8] Test scores are measured in z-scores, which are standardized to have a mean of zero and a standard deviation of one over all test takers in a grade and year.

[9] The Regents Examinations are a series of tests, aligned with New York State's Learning Standards, which New York students must pass in order to receive high school diplomas. They are designed and administered under the authority of the Board of Regents of the University of The State Of New York (the State governing body for K-16 education) and prepared by teacher examination committees and testing specialists. Examination scores range from 0–100%. To earn a Regents high school diploma, New York students need to obtain appropriate credits in a number of specific subjects by passing year-long or half-year courses, after which they must pass a Regents examination in that subject area. This expectation is in addition to passing the courses themselves, the passing grade of which is based on an individual teacher's or school's own tests and class work. Starting with the cohort entering grade 9 in 2001, and thus including our own cohorts, to receive a Regents high school diploma students need to score a 65 or above in the following five content areas: Integrated Algebra (or Math A), Global History and Geography, U.S.

focus on the English and Math (Math A) Regents as these are the first exams required to be taken by all students before New York State's graduation requirements began to change. Finally, we have data on the student's residence borough and residence zip code, which we use to calculate distances between students' homes and the nearest schools.

We assign each student to his\her 9th grade school following an "intent-to-treat" strategy. We use geocoded addresses of every high school serving students in our sample and classify schools as small if the total enrollment is 550 or fewer in that cohort year. Address and enrollment information is based on data from the *Annual School Reports* and the *School Based Expenditure Reports.* Across the literature on school size and outcomes, there is no universal agreement on a definition of "small." The federal government, through its *Small Schools Initiative,* set a limit of 300 students; the Gates-funded initiative in New York City considered 500 students the upper limit for small high schools; previous research on the costs of small high schools in New York City, as well as the then-current local policy, considered 600 students or fewer small (Stiefel et al., 2000); and Lee and Smith (1997) found schools in the range of 600 to 900 to be most effective for minority students. Recent work in NYC defines small as enrolling 550 or fewer students (Bloom et al, 2010 and Schwartz, Stiefel and Wiswall, 2012) and to remain consistent with these recent studies, we use the 550 definition in our analysis.

We exclude students attending alternative high schools (such as "last chance" high schools or schools for pregnant mothers) and schools designed to serve special education students (that is, schools in District 75, the citywide special education designated district). We also exclude schools and students in Staten Island.[10]

Empirical Methods

We begin by estimating a regression model linking student outcomes to a set of student socio-demographic and educational characteristics and, critically a set of cohort fixed effects:

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Here *HS_outcome* is a student outcome for student *i* in school *s*, in cohort *k*, residing in borough *b*.[11] We explore five main outcomes of interest: graduation rates, English and Math Regents test taking rates, and

History and Government, Comprehensive English, and any one science area. To earn an Advanced Regents diploma, students take additional credits in a foreign language, pass an additional Regents exam in science (at least one in life science and one in physical science), and pass a second Regents exam in math. Students in our cohorts also were allowed to graduate with local (not Regents) diplomas, which required passing any one of five Regents examinations with a score of at least 55%. The math exams offered for the cohorts in our study are Math A and Math B. Topics tested by the Math A Regents exam include equations and inequalities, probability and statistics, and geometry. Math B, which is optional, is taken after the student has passed Math A. Topics that can be tested include concepts from trigonometry and advanced algebra, as well as some pre-calculus and calculus.

[10] While students can (and some do) travel outside Staten Island to attend another high school citywide, this is not common and very few travel outside Staten Island to attend a small high school. Moreover, there are no small high schools in Staten Island.

[11] Since we use cohort, rather than panel data, there is only one observation per student.

passing rates at or above 65 on the English and Math Regents. In our specifications, we include a vector of student characteristics, including gender, race\ethnicity, free lunch eligibility, English proficiency, home language, an indicator for being overage for grade, and a set of 8th grade English language arts and math test scores (each score, each score squared, and interacted). We also include borough fixed effects (□□) and, importantly, cohort fixed effects (□□), which enable us to look at changes in the outcome of interest over time.

We then extend this model to include an indicator variable taking a value of 1 if student *i* in cohort *k* attended a small school in his\her 9th grade year. Here, small is defined as enrolling 550 or fewer students. We interact this variable with cohort indicators, allowing us to estimate cohort specific coefficients on the small schools indicator.

Finally, we address the potential bias that might arise if student selection into small schools is driven by variables unobserved in our data set. To do so, we also estimate the model using distance between student residence and the nearest small and large schools -- credible instrumental variables that exogenously influence student decisions to attend small schools but do not influence student outcomes, following Schwartz, Stiefel and Wiswall (2012).[12] As shown in prior papers, the likelihood of attending any particular school decreases as the distance to the school increases, reflecting higher transportation costs broadly defined, information costs, etc. Using the distance IVs to instrument for small school attendance, should, then, yield consistent estimates of the causal effects of attending small schools. [13]

Results

Before turning to the regression results, we begin by comparing the characteristics and performance of NYC high schools and high school students in two pre-reform cohorts – 2001 and 2002 – and two post-reform cohorts – 2007 and 2008. We next consider the regression results, organized around answering four questions: Are high school outcomes improving? Is the apparent improvement reflecting student population changes? Is the improvement limited to small schools or are all rising? Are the results robust to selection?

New York City high schools and students by the numbers

As shown in Table 2, the small school reform significantly changed the portfolio of schools. In the 2001 cohort, there were only 60 small schools serving roughly 9 percent of the city's first time 9th graders. Six

[12] A similar instrumental variables framework has been used in an educational evaluation of Chicago schools (Cullen et al., 2005), an evaluation of small schools in Chicago (Barrow et al., 2010), an examination of the effect of college attendance on earnings (Card, 1995) and on health behaviors (Currie and Morretti 2003), and, most recently, in an evaluation of the small school reforms in New York City (Schwartz, Stiefel, and Wiswall, 2012).

[13] To be specific, we calculate the minimum Euclidean distance from the centroid of each residence zip to geocoded addresses of small and large schools. We include the minimum distance to small schools, its square, the minimum distance to large schools, and its square. Distances are calculated using the students' 8th grade residence zip code. In our IV analysis, we allow the coefficients on the covariates to differ between the pre- and post-reform cohorts to control for differences in how student characteristics affect performance may have changed over time.

years later, in 2007, the number of small schools had increased over 92 percent: roughly 19 percent of the city's first time 9th graders attended over 100 small schools. And, the growth continued. The number of small schools grew by 41 schools between cohorts 2007 and 2008. Nonetheless, the vast majority of the city's 9th grade students (78%) attended large schools in 2008.

As expected, as new small schools opened, the average minimum distance between student residences and small high schools decreased. Consistent with the notion that distance matters, the change was larger for students attending small schools (roughly 1 mile in the pre-form cohorts to 0.7-0.8 miles in the post-reform cohorts) than for students attending large schools, but the distance to the nearest small school decreased for students attending large schools as well. At the same time, distance to the nearest large high school remained relatively constant, roughly 0.6 miles, throughout the time period and, on average, students in all cohorts had a large school as the nearest one.

Interestingly, this period also saw changes in the characteristics of students served by New York City public high schools. Most notably, the percentage of black and white students declined and the percentage of Hispanic and Asian students increased. The proportion of students who spoke English at home declined, as did the percentage overage for grade.

Small schools serve somewhat different students than large schools. In all years, students in small high schools had lower performance on their 8th grade exams than students in non-small high schools, although the differential with large schools declined over this period. Students who attend small high schools were more likely to be eligible for free lunch, Black or Hispanic students, female, and overage for grade. [14]

[14] To some extent this is a result of the closing of low-performing large schools.

Table 2: Descriptive Statistics of New York City High School Students by Cohort and Size Category

	Cohort 2001			Cohort 2002			Cohort 2007			Cohort 2008		
	all	**small**	**large**	**all**	**small**	**large**	**all**	**small**	**large**	**all**	**small**	**large**
% enrolled small schools	8.81	100	-	8.45	100	-	18.58	100	-	22.01	100	-
# of schools	164	60	104	167	58	109	224	115	109	272	156	116
Distance to nearest small HS	1.38	0.95	1.43	1.45	1.04	1.48	1.36	0.81	1.49	1.21	0.66	1.37
Distance to nearest large HS	0.63	0.62	0.63	0.62	0.61	0.62	0.64	0.63	0.65	0.64	0.56	0.67
Demographic Characteristics												
% Female	52.93	59.00	52.34	53.12	58.36	52.64	53.47	56.59	52.76	53.25	57.25	52.12
% Black	41.62	43.98	41.39	40.96	44.72	40.61	38.16	42.86	37.09	36.31	42.93	34.44
% Hispanic	34.24	45.00	33.20	34.29	43.99	33.39	35.50	40.34	34.40	37.44	43.96	35.61
% Asian	10.56	3.86	11.20	11.38	4.80	11.99	14.20	8.32	15.55	14.74	7.02	16.91
% White	13.58	7.17	14.20	13.37	6.49	14.00	12.02	8.25	12.88	11.46	5.99	13.00
% English is home language	60.36	61.26	60.28	59.11	62.77	58.78	53.77	59.13	52.54	52.14	59.30	50.12
% Overage	18.92	18.33	18.97	17.73	19.36	17.58	16.50	17.62	16.25	16.73	18.00	16.37
% Poor	73.64	77.92	73.23	76.42	82.71	75.84	74.86	74.92	74.85	77.48	80.41	76.65
% LEP	2.16	3.24	2.06	1.33	1.65	1.30	4.37	3.87	4.49	2.09	2.27	2.04
Mean Math 8th Grade z-score	0.00	-0.19	0.02	0.00	-0.26	0.02	0.00	-0.10	0.02	0.00	-0.15	0.04

Mean ELA 8th Grade z-score	0.00	-0.15	0.01	0.00	-0.18	0.02	0.00	-0.07	0.02	0.00	-0.13	0.04
Observations	31,204	2,749	28,455	30,798	2,603	28,195	38,758	7,201	31,557	37,455	8,243	29,212

Note(s): Small is defined as having an enrollment of 550 students or fewer. Cohort is defined as of first enrollment in ninth grade.

In summary, while the prevalence of small schools increased significantly during this time period, the majority of NYC's 9th grade students in cohort 2008 are still served by, and reside near, large schools. In each cohort, the composition of students in small and large high schools differs, with small high schools generally serving less advantaged and lower achieving populations.

Are high school outcomes improving?

In order for small schools reform to work as systemic reform, performance overall citywide needs to increase. We begin to examine this question by analyzing the unadjusted (or raw changes) in five high school outcomes: graduation rates, English and Math Regents test taking, and English and Math Regents scores. As shown in Table 3, graduation rates rose over time city-wide, increasing 16.8 percentage points between 2001 and 2008. Although only 51 percent of NYC students graduated high school in four years in 2001, 64% graduated in four years in 2007 and 68% graduated in four years in 2008. At the same time, we see similar increases over the period in test taking and scores. Roughly 75% of students took each exam in 2001; by 2008 over 85% of students took the English Regents and nearly 86% took the Math Regents. The share passing with a score at or above 65 increased roughly 19 percentage points on both exams between 2001 and 2008. In sum, New York City's students, as a whole, improved on all high school outcomes during this period.

Table 3: Unadjusted regression results, baseline models, all schools

	(1) Graduated	(2) Took English Regents	(3) Took First Math Regents	(4) Eng Regents score >=65	(5) Math Regents score >=65
2002	0.016***	0.016***	-0.014***	0.067***	-0.012***
	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)
2007	0.129***	0.071***	0.058***	0.176***	0.185***
	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)
2008	0.168***	0.113***	0.106***	0.188***	0.189***
	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)
Constant	0.509***	0.740***	0.752***	0.683***	0.651***
	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)
Student controls	N	N	N	N	N

# schools	293	293	293	292	292
Observations	138,215	138,215	138,215	109,826	109,758
R-squared	0.021	0.012	0.014	0.037	0.049

Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Small schools are those with 550 or fewer students in that cohort year. The 2001 cohort is the omitted group and its outcomes are indicated by the constant. The other year coefficients indicate differences from the total graduation rate in 2001.

Is the apparent improvement reflecting student population changes?

As noted earlier, NYC saw changes in its student body that may explain the rise in performance, separate and apart from the reforms. Since the unadjusted results presented in Table 3 above do not control for any student characteristics, the estimates may reflect changing populations not improvements driven by small school reform.

To explore this, we estimate the model controlling for a range of student characteristics. As shown in Table 4, the results are remarkably unchanged. The four year cohort graduation rate increased 16.3 percentage points from a base of 52.6% in 2001 to roughly 66% in 2008. There are similar improvements for Regents test taking and passing: on both exams, the share of students taking the test increased 10 percentage points to approximately 88%, and the share passing with a 65 or above increased 20 percentage points on both exams (roughly 87% passing with a 65 or better on the English Regents in 2008 and 86% passing with a 65 or better on the Math Regents). Again, evidence suggests that performance on key high school outcomes improved during these seven years.

Table 4: Adjusted regression results, baseline models, all schools

	(1) Graduated	(2) Took English Regents	(3) Took First Math Regents	(4) Eng Regents score >=65	(5) Math Regents score >=65
2002	0.015***	0.015***	-0.015***	0.066***	-0.018***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
2007	0.121***	0.062***	0.050***	0.184***	0.194***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
2008	0.163***	0.108***	0.102***	0.204***	0.209***

	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Constant	0.526***	0.775***	0.782***	0.669***	0.648***
	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)
Student controls	Y	Y	Y	Y	Y
# schools	293	293	293	292	292
Observations	138,215	138,215	138,215	109,826	109,758
R-squared	0.254	0.153	0.163	0.263	0.279

Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Small schools are those with 550 or fewer students in that cohort year. All models include controls for gender, race\ethnicity, overage for grade, English proficiency, home language, poverty (measured as eligibility for free lunch), 8^{th} grade test scores on standardized ELA and math exams, and residence borough. The 2001 cohort is the omitted group and its outcomes are indicated by the constant for the group of students defined by the student covariates. The other year coefficients indicate differences from the 2001 graduation rate.

Is the improvement limited to small schools or did the large schools improve as well?

As seen in Table 5, even when we allow for differential effects for the small schools, there are still significant gains across the board: graduation rates for large schools are 14 percentage points higher in 2008 compared to 2001. Compared to their peers in large schools, however, students attending small high schools have higher graduation rates in all cohorts and the differential increased by over five percentage points (7.9% for 2001 to 13.3% for 2008). In the post-reform years (2007 and 2008), students attending small schools are 10-13 percent more likely to graduate in four years than their otherwise similar peers in large schools.

Turning to Regents exams, students attending large schools in 2008 were 8-10 percentage points more likely to take the exams and passing rates at or above 65 were 20 percentage points higher compared to 2001. Students in small schools in the post-reform cohorts are 7-8 percentage points more likely to take these exams relative to their otherwise similar peers attending large schools. Students attending small schools in 2008 are slightly more likely to pass with a 65 on the Math Regents compared to students attending large schools. Their passing rates on the English Regents, however, are not significantly different from the students attending large schools in the post-reform cohorts.

The gap in passing rates between the small and large schools decreased over the time period. In the pre-reform cohorts, students attending small schools were roughly 6 percentage points less likely to pass the English Regents with a 65; by 2008, they were no less likely to pass compared to their large school peers. On the math Regents in 2002 students in small schools are less likely to pass, but by 2008, they are slightly more likely to pass.

Table 5: Adjusted regression results, all schools

	(1) Graduated	(2) Took English Regents	(3) Took First Math Regents	(4) English Regents score >=65	(5) Math Regents score >=65
2002	0.017***	0.015***	-0.017***	0.066***	-0.013**
	(0.004)	(0.004)	(0.007)	(0.007)	(0.006)
2007	0.108***	0.054***	0.029***	0.180***	0.195***
	(0.010)	(0.008)	(0.010)	(0.015)	(0.015)
2008	0.140***	0.097***	0.078***	0.197***	0.201***
	(0.010)	(0.008)	(0.012)	(0.016)	(0.016)
Small:					
2001	0.079***	0.040*	-0.073*	-0.055**	-0.031
	(0.016)	(0.021)	(0.039)	(0.027)	(0.028)
2002	0.049**	0.040***	-0.053	-0.062***	-0.092***
	(0.020)	(0.014)	(0.039)	(0.020)	(0.029)
2007	0.107***	0.066***	0.076***	-0.010	-0.015
	(0.013)	(0.009)	(0.010)	(0.011)	(0.014)
2008	0.133***	0.067***	0.080***	0.011	0.025**
	(0.012)	(0.010)	(0.013)	(0.011)	(0.012)
Constant	0.509***	0.765***	0.783***	0.674***	0.650***
	(0.013)	(0.011)	(0.015)	(0.016)	(0.015)
Stud controls	Y	Y	Y	Y	Y

# schools	293	293	293	292	292
Obs.	138,215	138,215	138,215	109,826	109,758
R-squared	0.260	0.156	0.167	0.264	0.280

Robust standard errors, adjusted for within-school clusters, in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Small schools are those with 550 or fewer students in that cohort year. All models include controls for gender, race\ethnicity, overage for grade, English proficiency, home language, poverty (measured as eligibility for free lunch), 8th grade test scores on standardized ELA and math exams, and residence borough. The 2001 cohort attending large schools form the omitted group and its outcomes are indicated by the constant for the group of students defined by the student covariates. The other year coefficients indicate differences from the 2001 graduation rate for students attending large schools. The small cohort coefficients capture the difference between the graduation rate for students attending small compared to large schools in that cohort year.

Overall, allowing for differential effects for the small schools does not change the finding that there were improvements in the graduation rate and Regents test taking and passing during this time period for the large schools.

Are the results robust to selection?

Table 6 presents the IV estimates for the effect of small school attendance for our five main outcomes of interest. In this specification, we replicate Table 5, but using IV estimation and allowing coefficients on the covariates to differ by early and late cohorts.[15]

Importantly, the IV estimates differ dramatically from the OLS estimates reported in the tables above. There are still significant and large improvements for the students attending large schools – and, actually, there are significant and large improvements for students in small schools. But here we find that in the early cohorts students in small schools are *less* likely to earn a diploma in four years. In the post-reform years, graduation rates are similar for students in small and large schools.[16]

We see similar results in Regents outcomes: students attending small schools in the pre-reform years are less likely to take the English regents and less likely to pass either the English or Math examination. In 2008, we find that students attending small schools are between 7-10 percent more likely to take the English or Math exam. Performance on both the English and Math exam remains significantly worse for students attending small schools compared to large schools in the post-reform cohort years, but better than small schools in earlier cohorts.

[15] The covariates in later cohorts have statistically significant differences in coefficients, form ones in earlier years (prob. < 0.01).

[16] This finding is consistent with the finding in Schwartz, Stiefel and Wiswall (2012) that students in *new* small schools do better but not students in *old* small schools.

Table 6: Instrumental variable regression results, all schools

	(1) Graduated	(2) Took English Regents	(3) Took First Math Regents	(4) English Regents score >=65	(5) Math Regents score >=65
2002	0.012	0.017**	-0.014	0.062***	-0.003
	(0.009)	(0.008)	(0.010)	(0.010)	(0.012)
2007	0.195***	0.069***	0.056**	0.329***	0.287***
	(0.032)	(0.024)	(0.027)	(0.032)	(0.029)
2008	0.224***	0.101***	0.090***	0.333***	0.294***
	(0.033)	(0.023)	(0.027)	(0.032)	(0.029)
Small:					
2001	-0.431**	-0.247*	-0.227	-0.350**	-0.488***
	(0.174)	(0.129)	(0.154)	(0.142)	(0.188)
2002	-0.427**	-0.294**	-0.247	-0.322**	-0.699***
	(0.171)	(0.132)	(0.167)	(0.142)	(0.223)
2007	-0.022	0.006	0.024	-0.285***	-0.144***
	(0.067)	(0.055)	(0.062)	(0.060)	(0.053)
2008	0.043	0.067*	0.099**	-0.180***	-0.098**
	(0.056)	(0.037)	(0.044)	(0.044)	(0.042)
Constant	0.506***	0.778***	0.781***	0.650***	0.635***
	(0.026)	(0.018)	(0.024)	(0.023)	(0.025)
Stud controls	Y	Y	Y	Y	Y
Observations	138,215	138,215	138,215	109,826	109,758
R-squared	0.224	0.137	0.165	0.233	0.239

Robust standard errors, adjusted for within-school clusters, in parentheses (*** p<0.01, ** p<0.05, * p<0.1) Small schools are those with 550 or fewer students in that cohort year. All models include controls for gender, race\ethnicity, overage for grade, English proficiency, home language, poverty (measured as eligibility for free lunch), 8th grade test scores on standardized ELA and math exams, and residence borough. All covariates for the specification in column 5 are also interacted with an indicator for late (2007 and 2008) cohorts. The 2001 cohort attending large schools form the omitted group and its outcomes are indicated by the constant for the group of students defined by the student covariates. The other year coefficients indicate differences from the 2001 graduation rate for students attending large schools. The small cohort coefficients capture the difference between the graduation rate for students attending small compared to large schools in that cohort year.

Probing the Results

Our results suggest that there was real, meaningful improvement in high school outcomes during this time period. A significant component of small school reform in NYC, however, is changing the composition of schools by opening new schools and closing bad schools. As shown in Table 7, less than half of the 293 schools operating in at least one of these cohort years operated continuously though the period: twenty schools that operated in 2001 were no longer operating in 2008 and over 120 schools opened.[17] At the same time, the 144 schools operating continuously throughout this period served a significant portion of the first time 9th graders: four in five students in cohort 2008 attend a school that operated continuously throughout this period. Did these schools improve as well, driven, perhaps by competition, or did they languish?

Table 7: Changing landscape of NYC high schools

	2001	2008
# schools	164	272
# small	60	156
# new	0	128
# new small	0	113

[17] We define schools that closed as schools serving students in cohort 2001, but not 2008. Schools that open are schools serving students in post-reform cohorts, but not in cohort 2001.

# closed	0	20
# continuously operating	144	144

Were there improvements in continuously operating schools? Is this result driven by closing bad schools and opening new ones?

To address this, we replicate our main analyses restricting the sample to the 144 schools operating in all four cohort years. In these models, we include school fixed effects, so the coefficients are identified by variation over time within school. In particular, the estimated gains over time capture gains made *within schools* and not changes in the mix of schools – that is, between schools.

As seen in Table 8, performance improved on all outcomes for the 144 continuously operating schools. In this table, we include school fixed effects in order to assess the average change within continuously operating schools by size and cohort. Students attending large continuously operating schools in the post-reform cohorts had improvements in graduation rates of approximately 8-10 percentage points. In 2008, students attending small continuously operating schools had an additional increase in their graduation rates of approximately 5 percentage points. Regents test taking rates improved 6-7 percentage points for the large schools and passing rates improved 18 percentage points. Small continuously operating schools had significantly higher shares of students taking the Math Regents and passing the English and Math regents.

Table 8: OLS Regression results, continuously operating schools

	(1) Graduated	(2) Took English Regents	(3) Took First Math Regents	(4) English Regents score >=65	(5) Math Regents score >=65
2002	0.012**	0.011**	-0.016**	0.059***	-0.016***
	(0.005)	(0.004)	(0.007)	(0.007)	(0.006)
2007	0.083***	0.037***	0.016	0.166***	0.176***
	(0.009)	(0.007)	(0.010)	(0.015)	(0.014)
2008	0.105***	0.074***	0.057***	0.180***	0.179***
	(0.009)	(0.007)	(0.011)	(0.016)	(0.015)
Small:					

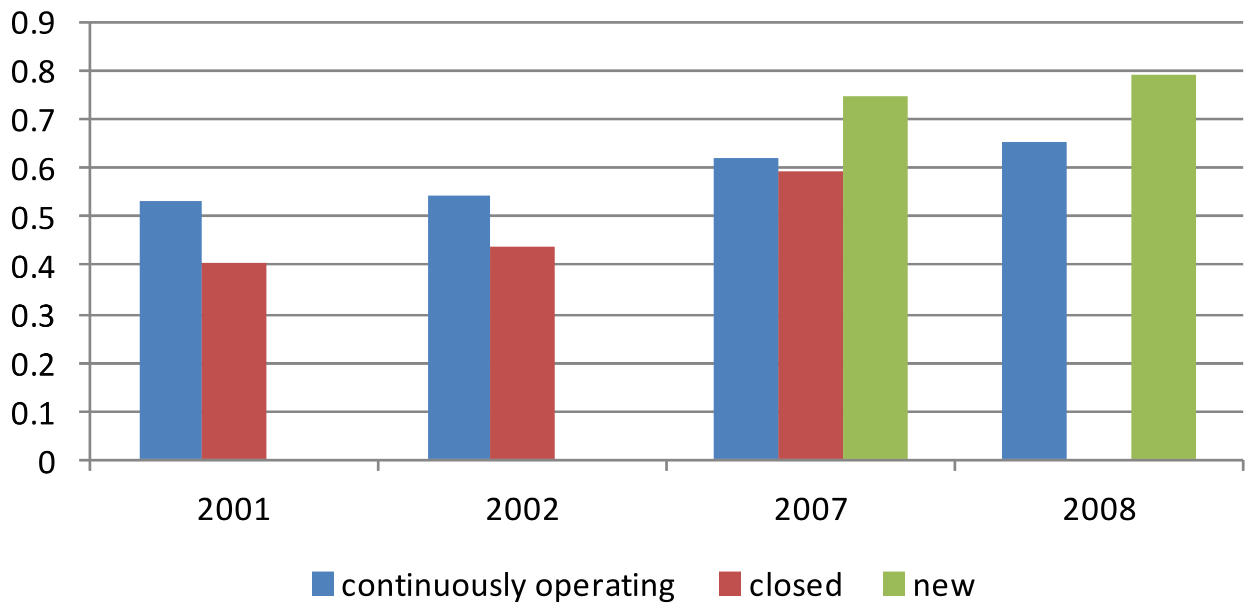
2001	---	---	---	---	---
	---	---	---	---	---
2002	-0.009	0.004	-0.007	0.037	-0.030
	(0.024)	(0.027)	(0.029)	(0.029)	(0.028)
2007	0.036	0.056	0.251***	0.119***	0.096***
	(0.025)	(0.035)	(0.055)	(0.036)	(0.030)
2008	0.054**	0.055	0.240***	0.119***	0.144***
	(0.024)	(0.034)	(0.055)	(0.037)	(0.034)
Constant	0.534***	0.787***	0.785***	0.693***	0.669***
	(0.011)	(0.008)	(0.009)	(0.014)	(0.013)
Student controls	Y	Y	Y	Y	Y
School FX	Y	Y	Y	Y	Y
# schools	144	144	144	144	144
Observations	117,380	117,380	117,380	94,101	93,704
R-squared	0.266	0.161	0.197	0.279	0.295

Robust standard errors, adjusted for within-school clusters, in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Continuously operating small schools are those with 550 or fewer students in all cohort years (and therefore are can be thought of as “always small”). All models include controls for gender, race\ethnicity, overage for grade, English proficiency, home language, poverty (measured as eligibility for free lunch), 8th grade test scores on standardized ELA and math exams, and residence borough. The 2001 cohort is the omitted group and its outcomes are indicated by the constant for the group of students defined by the student covariates. Finally, we examine the performance of the schools that closed – and those that opened. To do so, we examine the regression adjusted differences for these three types of schools in each cohort. For ease of interpretation, the regression adjusted differences for graduation rates are presented graphically below in Figure 1. IV results for our five main high school outcomes are presented in Appendix Table 1.

As seen in Figure 1, continuously operating schools improved their graduation rates across the four cohorts. Schools that closed had significantly lower graduation rates: 12.4 percentage points lower than continuously operating schools in 2001. Schools that were closed still performed below the continuously operating schools in 2002, although the differential in their performance was slightly smaller than that for the 2001 cohort. Schools closing in 2007 had only slightly lower graduation rates compared to continuously operating ones that year. Overall, the schools that closed had lower graduation rates compared to the continuously operating schools in each cohort. The differential decreased over time, suggesting that the district closed the “worst of the worst” schools first.

Consistent with the results seen in Schwartz, Stiefel, and Wiswall (2012), we find new schools have significantly higher graduation and rates than continuously operating schools in the 2007 and 2008 cohorts. Students attending new schools have graduation rates that are roughly 13 percentage points higher than their peers in continuously operating schools in the post-reform cohorts.

Figure 1: Graduation rates, continuously operating, closed, and new schools, all cohorts



Conclusions

Did high school outcomes improve in NYC as the small school reform was implemented? Our results suggest that they did– graduation, Regents test taking, and Regents passing rates have all improved significantly since 2001. Moreover, these improvements occurred in the large schools, in the small schools, in the continuously operating schools, and in the new schools.   Thus, these provide some support for the notion that small school reform works as systemic reform.

Of course, there were many other changes going on – both in New York City and in New York State – and, as noted by Kemple (2011) “Some amount of this improvement is likely an artifact of reforms and trends that were under way before the implementation of Children First reforms, some is likely due to other reform initiatives at the federal and state level, and some is likely due to a growing familiarity with the assessments and testing strategies across the state" (page 288). At the same time, in this period, the unemployment rate in New York City decreased from 5.8% to 5.4%, while unemployment state-wide rose from 4.7% to 5.3%.[18] Thus, economic conditions in NYC were improving absolutely and compared to the state.

Even more important, as reported in Stiefel and Schwartz (2011), spending on education increased dramatically in this period. Per pupil revenues increased over $5,000 in inflation adjusted dollars between 2002 and 2008 compared to an increase of $3,200 in the rest of the state – 58% of this growth was due to a $3,400 increase in local dollars ($5,460 in 2002 to $8,827 in 2008).[19] Pre-reform, NYC spent less per pupil than the rest of the state, but post-reform (in 2008), the city spent roughly $1,500 more per pupil. Between 2002 and 2008, NYC increased per pupil total expenditures almost $4,400 in inflation adjusted dollars.[20]

Additionally, these years witnessed significant changes in practices surrounding teachers. New York State regulations required that as of 2003 all newly hired teachers had to be certified. This, in combination with the growth of alternative certification programs such as the New York City Teaching Fellows and Teach for America, meant the characteristics of the teaching workforce in the 2000s were different than those of the workforce in the 1990s. Moreover, Bloomberg and Klein's push to increase principal authority in exchange for increased school accountability meant that as the decade went on principals had tools and systems, such as the open market transfer system, that theoretically allowed them to "match the needs of their students and schools to the characteristics of teachers, ensuring a better fit that is likely more stable" (Goertz, Loeb, and Wyckoff, 2011 page 174).

Were the gains in NYC merely a reflection of state-wide reforms or macro effects? Kemple (2011) examines student outcomes in NYC and the rest of the state between 2003-2010. He finds NYC increased performance on fourth and eighth grade ELA and math proficiency rates and graduation rates. Even more important, regression adjusted estimates provide evidence the city pulled away from the rest of state on all of these measures during this time period.[21] Thus, it seems likely that the gains in high school outcomes were, at least in part, reflections of changes affecting all students and not just high school students and, in particular, ones that affected earlier grades may have been carried into high school as the students aged.

Bringing small school reform to scale

What would it mean to bring small school reform to scale? It seems implausible to eliminate all large high schools and replace them with small schools in large urban districts. Based on 9th grade enrollments

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[18] Department of Labor Statistics. Retrieved from http://www.bls.gov.lau

[19] All dollars are inflated to 2008 dollars using the Consumer Price Index (CPI) and districts are weighted by their enrollment to reflect differences in size.

[20] Notably, these dollars do not include the support from foundations and philanthropies. While private dollars comprise less than one percent of the NYC Department of Education's annual budget, they may provide flexibility to embark on reform efforts. The small schools reform in NYC was supported by $100 million in funding from the Gates Foundation, with additional funding from the Carnegie Corporation of New York and Open Society Institute.

[21] Only significant difference for the graduation outcomes was for 2005 cohort.

from the NCES Common Core of Data for the four largest school districts, educating all high school students in small schools would require 640 small schools in NYC, 511 in Los Angeles, 256 in Chicago, and 190 in Miami.[22] These are very large numbers of schools to manage and given that they also cost more per pupil (see Schwartz, Stiefel and Wiswall, 2012; Stiefel, Schwartz, Iatarola and Chellman, 2009), they would be expensive.

Instead, one can imagine creating new small schools incrementally. If adding new small schools improves outcomes in large schools as well as small, it is possible that the benefits of adding more schools decreases and, ultimately, there is an efficient portfolio of small and large schools, that takes into account the benefits as well as the costs of running small high schools.

In the end, districts intending to use the creation of small high schools as a systemic reform need to be aware that this strategy involves closing poorly performing large schools and setting up a process to govern how new small schools will be established. Moreover, given the higher costs of small schools and the salutatory effects on continuously operating large schools, the reform's goals could be to establish a portfolio of similarly performing large and small schools. That is, small schools could be created and large poorly performing ones closed until the performance of large and small schools converge.

[22] CCD Build A Table data tool: http://nces.ed.gov/ccd/bat

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Appendix Table 1: Regression results, closed and new schools

	(1) Graduated	(2) Took English Regents	(3) Took First Math Regents	(4) English Regents score >=65	(5) Math Regents score >=65
Year 2002	0.012***	0.012**	-0.016**	0.061***	-0.017***
	(0.005)	(0.004)	(0.007)	(0.007)	(0.006)
Year 2007	0.091***	0.042***	0.032***	0.174***	0.183***
	(0.008)	(0.007)	(0.011)	(0.014)	(0.014)
Year 2008	0.121***	0.083***	0.076***	0.190***	0.192***
	(0.009)	(0.008)	(0.012)	(0.015)	(0.015)
Closed:					
2001	-0.124***	-0.109***	-0.073***	-0.132***	-0.127***
	(0.013)	(0.013)	(0.021)	(0.025)	(0.027)
2002	-0.108***	-0.088***	-0.071***	-0.076***	-0.143***
	(0.016)	(0.013)	(0.025)	(0.023)	(0.021)
2007	-0.030	-0.037	-0.017	-0.140**	-0.079*
	(0.026)	(0.025)	(0.021)	(0.057)	(0.045)
New:					
2007	0.122***	0.060***	0.075***	-0.003	-0.000
	(0.014)	(0.010)	(0.011)	(0.013)	(0.016)
2008	0.136***	0.061***	0.086***	0.007	0.023*
	(0.012)	(0.010)	(0.011)	(0.013)	(0.012)
Constant	0.532***	0.783***	0.786***	0.680***	0.659***
	(0.013)	(0.011)	(0.015)	(0.015)	(0.015)
Student ctrls	Y	Y	Y	Y	Y

Observations	138,215	138,215	138,215	109,826	109,758
R-squared	0.262	0.158	0.168	0.266	0.282

Robust standard errors, adjusted for within-school clusters, in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Small schools are those with 550 or fewer students in that cohort year. All models include controls for gender, race\ethnicity, overage for grade, English proficiency, home language, poverty (measured as eligibility for free lunch), 8th grade test scores on standardized ELA and math exams, and residence borough. Closed schools are those operating in cohort 2001, but not cohort 2008. New schools are those with their first graduating class after 2002. The 2001 cohort is the omitted group and its outcomes are indicated by the constant for the group of students defined by the student covariates.