The Relative Costs of New York City's New Small Public High Schools of Choice

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Abstract

Building on prior research by two of the present authors, which uses lottery-like features in New York City's high school admissions process to rigorously demonstrate that new small public high schools in the district are markedly improving graduation prospects for disadvantaged students, the present paper demonstrates that these graduation benefits do not come at the cost of higher expenditures per graduate. The basis for these findings are two cost comparisons: (1) a "descriptive" comparison of per-pupil operating costs for the new small high schools with those for all other district high schools, and (2) an "experimental" comparison of per-pupil operating costs for the new small high schools with those attended by their control group counterparts. The descriptive comparison demonstrates that the new small schools spend a little more per pupil than the average district high school and a lot more than the largest of these other schools. By contrast, results of the experimental comparisons together with previous findings of two of the present authors about the substantial positive effects of the new small schools on high school graduation rates indicate that *the cost per high school graduate is substantially lower for the small-school enrollees than for their control group counterparts*. This seemingly counterintuitive result occurs because control group counterparts (1) attend high schools with annual per-pupil costs that are about the same as those for the new small schools, (2) are more likely to attend a fifth year of high school because they do not graduate in four years, and (3) are less likely to graduate from high school at all.

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1. Introduction

As opportunities to exploit random assignment to treatments and access to longitudinal, student-level data have expanded in recent years, evaluations of educational interventions have grown in sophistication. Most of this evaluation work has focused on estimating intervention effects on student outcomes — that is, the benefits of interventions. Careful attention to the costs of interventions has occurred much less frequently, and rigorous methods for estimating such costs have rarely been used. The present study takes advantage of a unique opportunity to estimate the costs and benefits of a large-scale educational intervention using the same rigorous methods for both analyses and thereby inform key policy questions.

Specifically, this study examines the costs of newly created, academically nonselective small public high schools of choice (SSCs) in New York City. A previous evaluation of these schools, which exploited randomly assigned high school admissions, found that students who attend an SSC are 9.5 percentage points more likely to graduate from high school than they would have been had they gone to the other New York City public high schools attended by their control group counterparts (Bloom and Unterman, 2014).[1] The existing literature, however, suggests that small high schools might cost more to operate than larger high schools because small schools cannot exploit economies of scale (Andrews, Duncombe, and Yinger, 2002; Stiefel et al., 2009). The present paper helps to complete the evaluation of SSCs by considering the school costs that were incurred to produce the previously estimated graduation benefits, and its analyses help to inform the debate over small schools that has been ongoing for more than a decade (Wasley et al., 2000). The paper also attempts to promote better methods for assessing the costs of educational interventions by presenting a new approach to estimating these costs and identifying the policy questions that such analyses can inform.

The sections that follow present two complementary sets of analyses: The first set (which we call "descriptive" comparisons) compares per-pupil expenditures and other measures of resource use by SSCs with per-pupil expenditures and resource use by other New York City high schools (defined later), on average overall and by school size. These comparisons (1) confirm differences between the costs of small and large high schools that have been reported by other researchers; (2) explore some reasons why SSC costs differ from those of other high schools operated by the New York City Department of Education (NYCDOE); (3) provide insights into the potential cost implications of replacing existing large public high schools in New York City with additional SSCs; and (4) help to contextualize the present

[1] The 9.5 percentage point effect of SSCs on graduation rates reported by Bloom and Unterman (2014) was based on data for three annual cohorts of entering ninth graders. A forthcoming analysis that adds data for another student cohort reports a 9.4 percentage point effect (Unterman, 2014).

findings by enabling other researchers to compare high school costs in New York City with those elsewhere.

The second set of analyses (which we call "experimental" comparisons) employs the experimental/instrumental variables framework used by Bloom and Unterman (2014) to estimate the effect on graduation rates of attending SSCs (relative to the New York City public high schools attended by the control group counterparts of SSC enrollees) in order to estimate the difference in resources devoted to those treatment and control group students. These analyses explicitly compare the costs of SSCs with the corresponding costs of their "counterfactual counterparts." Doing so represents an innovative approach to rigorously addressing the question: How do the differential costs of SSCs compare with their differential effectiveness?

Results of our descriptive comparisons indicate that (1) annual operating expenditures per pupil for SSCs are modestly higher than those for the typical NYCDOE high school and substantially higher than those for especially large NYCDOE high schools (with more than 2,000 students); and (2) this conclusion does not change when operating expenditures are adjusted statistically for school differences in teacher salaries and student composition.

By contrast, results of our experimental comparisons together with previous findings about the substantial positive effects of SSCs on high school graduation rates (Bloom and Unterman, 2014) indicate that *the cost per high school graduate is substantially lower for SSC enrollees than for their control group counterparts*. This seemingly counterintuitive result occurs because their control group counterparts (1) attend high schools with annual per-pupil costs that are about the same as those for SSCs, (2) are more likely to attend a fifth year of high school, and (3) are less likely to graduate from high school.

These findings provide a compelling case that the benefits of existing SSCs — higher graduation rates and fewer students in need of a fifth year of high school — are substantially greater than their costs. Thus from a cost-benefit perspective, New York City's SSCs should be continued. The findings also provide *suggestive* evidence that expanding SSCs in New York City or implementing them in other large urban districts might be a cost-effective way to improve educational opportunities for additional low-income disadvantaged students. However, as discussed later, decisions about expanding small schools in New York City or elsewhere involve additional considerations that are beyond the scope of the present analysis, such as which existing high schools SSCs would replace and which students these new schools would serve.

The remainder of this paper is organized as follows: Section 2 provides background on the New York City small high school reforms and the small high schools that we study. Sections 3 and 4 describe the sample, data, and cost measures that we use. Sections 5 and 6 present the results of the two complementary cost analyses that we conducted. Section 7 considers the

implications of several additional sources of costs that could not be fully accounted for, and Section 8 describes the implications of our analyses for policy.

2. Background on New York City's Small Schools of Choice and Their Likely Costs

As part of sweeping high school reforms, more than 200 new, small public high schools were created in New York City between 2002 and 2008. Although some of these schools screen students based on their academic backgrounds and others focus specifically on students who are overage and/or undercredited, the majority are academically nonselective and provide options for students regardless of their prior academic attainment or achievement. We refer to these schools as New York City's "Small Schools of Choice" (SSCs). Most of these new small schools serve concentrations of disadvantaged students of color and are located in buildings where larger high schools with low levels of student achievement had been closed.

In a recent evaluation of New York City's SSCs, Bloom and Unterman (2014) exploited randomized school admission lotteries created by New York City's high school application processing system to estimate the effects of enrolling in an SSC on a variety of student outcomes, including high school graduation rates. Based on a sample of students who participated in ninth-grade admission lotteries for 84 SSCs in the fall of 2005, 2006, or 2007, these analyses indicate that attending an SSC instead of another New York City public high school increased four-year graduation rates by 9.5 percentage points (from 60.9 percent to 70.4 percent) and five-year graduation rates by 8.9 percentage points (from 64.7 percent to 73.6 percent). Similar gains were documented for a wide range of subgroups, including students with eighth-grade state test scores that were below or above grade-level proficiency, students from low-income families, and students from different demographic groups (Bloom, Levy Thompson, and Unterman, 2010; Bloom and Unterman, 2012; Bloom and Unterman, 2014).

However, a complete assessment of SSCs requires information not only on their benefits, but also on their costs, which the existing literature suggests might be higher than average. SSCs are uniformly small in size, serving roughly 100-120 students per grade, and are considerably smaller on average than other New York City public high schools. One might expect costs to decline as school size increases because fixed costs associated with indivisible inputs such as administrative and student support personnel, teachers in specialized subjects, and gymnasiums, science labs, libraries, auditoriums, and cafeterias can be spread over more students in large schools. Especially large schools, however, might create managerial challenges such that the effectiveness of fixed resources might decline after the number of students exceeds a certain point, thereby increasing costs (Andrews, Duncombe, and Yinger, 2002; Stiefel et al., 2009).

Empirical studies of the relationship between school size and costs have typically tried to estimate the marginal effect of increased enrollment on expenditures, controlling for student outcomes, input prices (particularly teacher wages), and differences between schools in students' educational needs. Challenges in estimating these models include measuring outcomes, input prices, and student needs; accounting for the simultaneous determination of student outcomes and school expenditures; and controlling for efficiency.[2] Because these challenges are not adequately addressed by most early studies, it is difficult to draw strong conclusions from them.[3]

More recent studies, which have addressed some of these empirical challenges, suggest that annual per-student resource use tends to be higher in small schools than in large schools. For example, a study of small New York City high schools that were established before those we evaluate found that costs per graduate for schools with fewer than 600 students were about the same as those for large schools. However, because graduation rates were higher at the small schools, small schools have fewer enrollees than large schools with the same number of graduates. Thus, costs per enrollee were higher in small schools than in large schools (Stiefel et al., 2000). Similarly, a study of exogenous enrollment changes at Indiana elementary schools (Kuziemko, 2006) found that decreased school size was associated with increased math scores and student attendance rates but also increased per-pupil costs. Another study of New York City high schools using data prior to most of the recent wave of high school reforms (Stiefel et al., 2009) is noteworthy because it controls for school fixed effects, which can help to reduce potential bias due to omitted or poorly measured variables and school inefficiency. This study finds that holding student needs and outcomes constant, annual costs per student increase monotonically as school size decreases. However, for themed schools, the analysis finds U-shaped cost curves that imply that costs per enrollee are minimized at a school size of roughly 800 students.

In addition to making descriptive comparisons of resource use in small and large high schools, the present paper takes a new approach to estimating small-school costs. It exploits the random assignment of incoming ninth-graders to SSCs or other high schools operated by the NYCDOE. This design switches the research question from "How do costs vary across different

[2]Efficient schools achieve a given level of outcomes for the least cost possible given their size, the wages they face, and the needs of their students. If a smaller (or larger) share of small schools than large schools are efficient in this sense, or if small schools on average are further away from (closer to) the efficient amount of resource use, then that will make small schools appear to have higher (lower) per-pupil costs than large schools, even if small and large schools can be operated in ways that achieve the same outcomes for the same per-pupil costs. Small schools might be operated more or less efficiently than large schools in a specific context for any number of reasons. For instance, the managerial abilities of principals in small schools may differ systematically from those in large schools.

[3]For a discussion of these issues see Andrews, Duncombe, and Yinger (2002).

schools, holding their outcomes and efficiency constant?" to "How much did a specific intervention cost, relative to a control condition, in order to achieve estimated improvements in student outcomes, given actual levels of efficiency?" This approach avoids the need to statistically control for student outcomes or school efficiency, though it no longer provides a purely large- versus small-school comparison.

This alternative approach to examining the costs of SSCs is particularly appropriate because SSCs are not only smaller than the typical NYCDOE high school, but they also have other distinctive features that could influence both their costs and effects. For example, SSCs were created through a competitive proposal process that was designed to stimulate innovative education practices and ensure that SSCs promoted academic rigor and sustained personal relationships among students and faculty (see Bloom, Levy Thompson, and Unterman, 2010, for details). Also, in accordance with a key tenet of their initial design, SSCs were required to involve community partners as an integral part of their educational programs and often were created and operated with help from intermediary organizations. These intermediaries and partners might well provide staffing, support, and other resources to SSCs that are not generally available to other NYCDOE high schools.

3. Sample and Data

Of the more than 200 new, small high schools opened in New York City between 2002 and 2008, 123 are academically nonselective and, in effect, determine admissions by a lottery if oversubscribed. Based on data for multiple student enrollee cohorts and follow-up outcomes, Bloom and Unterman (2014) report positive SSC effects for up to three cohorts of students that enrolled in oversubscribed SSCs between 2005-2006 and 2007-2008. For the present analysis we use five years of school expenditures data for each of the 8,521 students in the first two of these study cohorts (first-time ninth-graders in the falls of 2005 and 2006). This sample, which represents 84 of the original 123 SSCs, is the same as that used by Bloom and Unterman (2014) to estimate SSC effects on five-year high school graduation rates.

The first set of analyses presented below, which we refer to as our "descriptive" analyses, compare per-pupil expenditures for this sample of 84 SSCs with per-pupil expenditures for a set of schools that we refer to as "other New York City high schools." Since all SSCs begin with ninth grade, their comparison schools include all other NYCDOE schools that begin with ninth grade, except for schools with highly specialized missions (such as serving students who are failing in other high school environments) that differ from those of SSCs, and other

SSCs that were not included in the present sample.[4] This comparison group includes between 225 and 295 schools depending on the school year being examined.

The second set of analyses compares per-pupil expenditures devoted to students who randomly won the opportunity to attend an SSC on their high school choice list and subsequently enrolled in one with the per-pupil expenditures devoted to students who randomly lost the opportunity to attend an SSC and as a result attended another New York City public high school.[5] These students who applied but were denied admission attended a total of 216 to 229 schools depending on the year examined.

Data for our cost analyses were drawn mainly from NYCDOE School-Based Expenditure Reports (SBERs) for the 2005-2006 through 2010-2011 school years. These data include per-pupil expenditure information by several functions for general education and special education students and are drawn from the NYCDOE's accounting system of record. This system assigns all public school expenditures to specific schools, including funds that are spent directly by schools from their own budgets and funds that are spent for schools by district field offices and central offices. There is substantial variation across schools in the amount spent directly through school budgets. This variation reflects school differences in their number of teachers, administrators, and other staff members; school differences in the salaries of these staff members; and school differences in program offerings and compensatory aid. District-level expenditures are allocated to schools by a central cost accounting system. Some of these allocations are based on detailed resource usage information and others are made on a simple per-pupil basis.[6]

We also used data on individual teacher experience levels and salaries obtained from the Personnel Master File (PMF) maintained by the New York State Education Department, data from the NYCDOE School Construction Authority on facility capacity usage, and data on student enrollments and student-staff ratios from New York State School Report Cards.

[4]The following types of schools were excluded: schools that offer evening academic programs for high school students who are behind in credits, considering dropping out, or occupied by adult responsibilities in the daytime; schools devoted primarily to providing GED preparation; schools that exclusively serve special education students; residential programs; and schools that closed or initiated phase-out between 2005-2006 and 2010-2011.

[5]As discussed later, these experimental comparisons were the basis of an instrumental variables analysis that accounted for the fact that not all lottery winners attended an SSC and some lottery losers attended an SSC.

[6]The analysis below demonstrates that there is considerable variation in per-pupil expenditures, that this variation fits expectations, and that differences across schools in expenditures per pupil are similar to those we see in more direct resource measures, such as student-teacher ratios, all of which confirms that the SBERs reflect real differences in resource use across schools.

4. Cost Measures Examined

The cost of SSCs can be divided into two types: start-up costs and ongoing costs. Start-up costs include resources devoted to planning and opening SSCs. Start-up activities were conducted by a wide range of actors both within and outside the NYCDOE. They include development and dissemination of guidelines for small-school proposals, provision of technical assistance to groups who were developing and submitting proposals, assessment and selection of proposals, site and facility planning, selection and hiring of SSC staff, procurement of equipment and supplies, and numerous other activities. The second type of cost involves the annual recurring costs of operating SSCs, which include costs of teachers, instructional support staff, pupil support services, administrative and instructional leadership, ancillary and building services, and the depreciation or lease of capital facilities. A complete accounting of these costs would include the value of ongoing resources provided by intermediary and partner organizations as well as those provided by the NYCDOE.

Because they were drawn from so many different sources and were incurred some time ago, we could not assemble complete data on all SSC start-up costs. Hence the analyses we present focus mainly on the ongoing operating costs of SSCs. We do, however, return to the issue of SSC start-up costs after presenting our primary analysis.

Following Levin and McEwan (2000), we define costs as the value of resources used in their best alternative use. The most comprehensive measure provided by the SBER of the value of resources used by specific schools is "direct service expenditures." This measure includes all expenditures for services that were provided directly to students mainly in the school building during the school day and the school year. These expenditures include those recorded in each school's spending plan plus district-level expenditures for services provided to each school or its students, including food, transportation, and building services. Any spending that is not included in direct service expenditures is allocated by the NYCDOE to schools on a per-pupil basis and thus cannot contribute to per-pupil cost differences among schools.

Assuming that resources are purchased in competitive markets, expenditures for resources are usually good estimates of the value of those resources in their next best use (Levin and McEwan, 2000). The assumption of competitive markets, however, is potentially problematic in the cases of school staff and teachers, which represent the majority of school expenditures. Salaries for most school staff members are determined by collective bargaining agreements and vary substantially for individuals in the same position depending on their experience and education level. Thus, even between schools with the same number of teachers and other staff members, salary expenditures can differ appreciably. If salaries accurately reflect the value that school personnel have in their best alternative use, then salary expenditures plus benefits are an appropriate measure of the cost of these personnel. However, there may be reason to question this presumption. For example, a large literature on teacher effectiveness suggests to

many researchers that experience and education levels, which account for virtually all of the variation in teacher salaries, are only weakly related to teacher quality (Goldhaber, 2008; Rivkin, Hanushek, and Kain, 2005; Rockoff, 2004). Because SSCs tend to employ less experienced teachers who receive lower salaries than teachers in other high schools, per-pupil spending in SSCs may understate the true value of teachers in SSCs and thus their true costs relative to teachers in other high schools.[7]

In order to remove this source of variation from our cross-school cost comparisons, we created a measure of "adjusted direct service expenditures per pupil" that values the time of all teachers at all high schools at the "district-wide" average high school teacher salary for the relevant school year. For details on how these adjustments were made, see Appendix B.

We also developed a measure of direct student service expenditures that adjusts for school differences in student needs *and* teacher salaries. Table A.1 in Appendix A compares the average shares of students eligible for special education services, English language learner services, and free lunches for SSCs and other NYCDOE high schools. These findings indicate that SSCs serve a somewhat smaller share of students with limited English proficiency. However, beginning in the 2007-2008 school year, they served a higher share of special education students. Throughout our analysis period, SSCs served significantly higher shares of free-lunch-eligible students.[8]

As a result of class size and other service requirements associated with special education, more resources are required to serve special education students than are required to serve general education students. For instance, the 2009-2010 SBERs indicate that schools spent more than three times as much per pupil for full-time special education students than for general education students. One consequence of this is that a significant amount of variation in expenditures across schools can be explained by the percentage of their students who are eligible for special education services. More generally, service needs vary for different types of students. In addition to special education students, English language learners and students from low-income families tend to require more services than do other students.

If SSCs tend to serve more or fewer high-need, high-cost students than the typical high school in either of our groups of comparison schools, then simple comparisons of average per-pupil spending will either overstate or understate the relative cost of SSCs. In order to address

[7]Table 3 documents differences in teacher experience and salaries between SSCs and other New York City high schools. It is more likely that SSCs use less experienced, lower-paid teachers because they are new than because they are small.

[8]Different types of special education students have different cost implications. It is possible that although SSCs serve a higher share of special education students, they serve a less costly mix of special education students. Data that we have been able to collect were insufficient to confirm or deny this possibility.

this issue we used regression analyses to estimate the effects of student need differences on expenditures and used the resulting estimates to adjust our measure of per-pupil spending (for details see Appendix B). The difference between the average of this adjusted spending measure for SSCs and other New York City high schools indicates the difference in per-pupil spending, holding student needs and teacher salaries constant.

Although they are the most comprehensive measures of resource use available, the preceding three measures omit two sets of school resources that would be included in a complete accounting of ongoing school operating costs: facility space and resources provided by external partners.[9] We return to this issue later.

In addition to the preceding resource use measures, we compared per-pupil expenditures for SSCs and other NYCDOE high schools with respect to five functions: classroom instruction; instructional support services; leadership, supervision, and support; ancillary support services; and building services. We also compared direct resource measures including student-teacher ratios and student-staff ratios, which were computed from PMF data or obtained from New York State School Report Cards. These comparisons were made to help shed light on why SSC costs differ from those for other NYCDOE schools.

5. Descriptive Comparisons of School Resource Use

Table 1 compares average direct service expenditures per pupil for SSCs and other New York City high schools. Because these averages are *weighted by the student enrollment of each school*, they represent the direct service expenditures for the average SSC student and for the average student in other NYCDOE high schools, respectively, for each of the years examined. Observed differences between SSCs and other high schools range from $678 per pupil in 2007-2008 to $1,411 per pupil in 2010-2011 (from 5.3 percent to 10.2 percent of spending in other NYCDOE high schools). These differences are statistically significant at conventional levels beginning in 2008-2009 and increase in magnitude over time.

One might ask whether SSCs spend more per pupil because they are smaller than other NYCDOE high schools or for other reasons. Table 2 informs this question by comparing direct service expenditures per pupil in high schools with various enrollments. Because findings from these comparisons are similar across all years, we present them only for the most recent school year, 2010-2011. Focusing first on other New York City high schools, we can see that schools

[9]SBERs do report lease payments for schools that lease space and expenditures on debt service. But many schools occupy space owned by the NYCDOE and the value of that space is not reflected in SBERs. Also, debt service is not allocated to schools in a way that accurately reflects differences in the value of the facilities they use. Expenditures for leases and debt service are not reflected in direct service expenditures.

with more than 2,000 pupils have considerably lower per-pupil direct service expenditures than do smaller schools, and schools with 250 or fewer students have considerably higher per-pupil expenditures than do larger schools. SSCs have lower per-pupil direct services expenditures in comparison with other New York City high schools of a similar size, although these differences are not statistically significant. These findings suggest that a primary reason that SSCs spend more per pupil than do other NYCDOE high schools is that SSCs are smaller, and smaller schools have higher per-pupil costs.

Appendix Tables A.2 through A.6 compare per-pupil expenditures for SSCs and other NYCDOE high schools by functional categories that could be affected differently by economies of scale. For example, the literature suggests that high schools may have scale economies in the delivery of classroom instruction because small high schools may have trouble filling specialized classes and thus have smaller than average class sizes for those subjects. Even larger economies of scale are expected for administrative and support functions because small schools often require administrative and leadership staffing that is comparable in size to that of larger schools. Results in the tables largely confirm these expectations. They indicate that SSCs spend slightly more per pupil on classroom instruction (between 0.1 percent and 7.0 percent more) and substantially more per pupil on leadership, supervision, and support (between 18.6 percent and 31.0 percent more) than do other New York City high schools.

In addition to comparing direct expenditures per pupil, we used data from the Personnel Master File (PMF) and New York State School Report Cards to develop more direct measures of personnel resources used. Comparison of these personnel resource measures suggests that much of the additional cost of SSCs — and small schools more generally — is due to higher staff-student ratios. For instance, in 2010-2011, SSCs used 15.9 percent more teaching staff and 32.9 percent more administrative staff per student than other NYCDOE high schools.[10] These differences between SSCs and other NYCDOE high schools are statistically significant and similar in other years.

Teacher experience and salary data from the PMF are presented in Table 3. The comparisons in Table 3 indicate that SSCs have maintained higher teacher-student ratios without spending significantly more on instruction (see Table A.2) because, on average, they hired less experienced (and thus lower-paid) teachers. The findings also indicate that differences in experience and salary are gradually eroding as SSCs age, which helps to explain why the cost disadvantage of SSCs as measured in Table 1 grows over time.

[10]This difference implies that SSCs have about two fewer students per teacher than other NYCDOE high schools.

The top panel of Table 4 presents comparisons of per-pupil direct service expenditures that are adjusted for differences in teacher salaries (as described earlier). As expected, because experience levels and salaries are relatively low in SSCs, adjusting for salary differences increases their observed cost differences from those reported for unadjusted measures in Table 1.

As noted earlier, SSCs serve higher percentages of students who are eligible for special education services and free lunches than do other NYCDOE high schools, although they serve lower percentages of English language learners. Thus findings in Table 1 and the top panel of Table 4 might either overstate or understate the relative costs of SSCs. To address this issue, the bottom panel of Table 4 presents cost comparisons that adjust for differences in teacher salaries *and* student needs (as described earlier). These findings indicate that direct service expenditures per pupil in SSCs exceeded those in other NYCDOE high schools by 7.4 percent in 2005-2006 and 1.8 percent to 6.3 percent in subsequent years.

6. Estimated Costs of Achieving the SSC Graduation Gains

The preceding comparisons suggest that SSCs are more costly to operate than other, larger NYCDOE high schools, although the overall difference narrows when the level of student need or disadvantage is taken into account. However, these comparisons do not indicate the quantity of resources that were used to achieve the estimated effect of SSCs on their students' graduation rates. For this purpose one needs to compare school costs for winners and losers of SSC lotteries, just as similar comparisons of high school graduation rates were used to estimate SSC graduation effects (Bloom and Unterman, 2014).

The present section reports estimates of the value of school resources used for "target SSC enrollees" (defined below) relative to the value of school resources used for their "control group counterparts" (also defined below). The first step in this process was to assign our estimated school-year-specific per-pupil expenditures to each student in the sample that was used to estimate SSC effects on *five-year* high school graduation rates. This assignment of per-pupil expenditures was carried out for each of the five years after sample students entered ninth grade and was based on the high school in which they were enrolled during October of each school year (New York State's enrollment month of record). For sample members who were identified as dropouts or graduates based on NYCDOE discharge codes, a school cost of zero was assigned for each year after the last year in which they were officially enrolled in a NYCDOE high school.

This school cost assignment process resulted in very little missing data. Specifically, for the first, second, third, fourth, or fifth follow-up years, data were missing for only 4.8, 4.8, 4.5, 6.3, and 15.7 percent of sample members, respectively. For the present analysis, these missing values were imputed using a single replication of a multiple-imputation model based on all

existing baseline and follow-up information for sample members. Alternative findings based on a sample that omits students with missing school cost values are very similar to those we report here and can be made available upon request.

We then estimated the effect of SSC enrollment on high school costs per pupil using the statistical model employed by Bloom and Unterman (2014) to estimate the effect of SSC enrollment on high school graduation rates. This model uses lottery-based random assignment to an SSC or some other NYCDOE high school as an instrumental variable that predicts whether a student *ever* enrolled in an SSC during his five-year follow-up period. Predicted SSC enrollment is then used to estimate the causal effect of enrollment in an SSC on per-pupil expenditures. The approach produces an estimate of the average effect on school costs of enrollment in an SSC for students who enrolled because they won an SSC lottery.[11] This type of causal effect is typically referred to as a local average treatment effect on individuals who comply with their lottery assignment (that is, who attend an SSC if they win their SSC lottery and attend some other type of NYCDOE high school if they do not win their SSC lottery).[12]

Our statistical model was implemented using two-stage least squares to estimate the following equations separately for each of five follow-up years and for the entire five-year period:

First stage: SSC enrollment as a function of first SSC lottery assignment

$$E_i = \sum_{j=1}^{J} \pi_j \cdot I_{ji} + \sum_{j=1}^{J} \gamma_j \cdot T_i \cdot I_{ji} + w_i \qquad (1)$$

where:

E_i = one if student *i* enrolled in an SSC at any time during his five-year follow-up period and zero otherwise,

I_{ji} = one if student *i* participated in SSC lottery *j* and zero otherwise,[13]

T_i = one if student *i* won his SSC lottery and zero otherwise, and

w_i = a random error that is distributed independently and identically across students.

[11]See Bloom and Unterman (2014), pages 294-299 and 301-305, for a detailed explanation of the analytic procedures. As they describe, it is based on whether a student won his *first* SSC lottery, because given the way that high school assignment works in New York City, it is possible for a student to be in more than one SSC lottery (that is, for a less preferred SSC as well).

[12]See Angrist, Imbens, and Rubin (1996) for a discussion of compliers and local average treatment effects.

[13]Students participate in separate lotteries defined by the school, the year, and the SSC priority group the student belongs to, where SSC priority groups are defined by students' residence and whether or not they had made themselves "known" to the SSC. As stated above, it is possible for them to be in more than one SSC lottery. For reasons discussed by Bloom and Unterman (2014), we (and they) only include students in their first SSC lottery (typically that for their most preferred SSC).

Second stage: High-school cost as a function of predicted SSC enrollment

$$Y_i = \sum_{j=1}^{J} \alpha_j \cdot I_{ji} + \delta \cdot \hat{E}_i + e_i \quad (2)$$

where:

Y_i = per-pupil expenditures (adjusted or not) at the school attended by student *i*,

$\hat{E}_i$ = the predicted value of SSC enrollment for student *i* from the estimated first-stage equation, and

e_i = a random error that is clustered by the school a student attends.

Since assignment to treatment (T_i) is random only among students participating in the same SSC lottery, including lottery indicators (I_{ji}) is crucial for obtaining unbiased SSC effect estimates. It is also useful to specify a separate instrumental variable (instrument) for each lottery. These instruments were created by interacting the treatment indicator (T_i) with the lottery indicators (I_{ji}). The instruments are valid because they are randomly assigned and strong because they are highly predictive of SSC enrollment.[14] The estimated value of δ is a consistent estimate of how many more (or fewer) school resources were devoted to target SSC enrollees than to their control group counterparts.[15]

Table 5 presents estimates of effects of enrollment in an SSC on direct service expenditures per pupil, with and without adjustments for teacher salaries and student needs. Following Bloom and Unterman (2014), we refer to students who won their SSC lottery and attended an SSC *because* they won this lottery as "target SSC enrollees." We refer to students who lost their SSC lottery and attended some other NYCDOE high school *because* they lost their lottery as "control group counterparts." Column one in the table presents estimated mean expenditures for target SSC enrollees, column two presents these estimates for control group counterparts, and column three presents the difference between these two estimates, which is the estimated effect of enrollment in an SSC.[16]

During each of the first four years of high school, direct service expenditures per pupil were neither substantially nor statistically different for target SSC enrollees and their control group counterparts. This finding holds for all three direct service expenditure measures. During the fifth year of high school, direct service expenditures per entering ninth-grader dropped precipitously for target SSC enrollees and their control group counterparts. This is because only

[14]Bloom and Unterman (2014) provide details on the first-stage results for Equation 1.

[15]Estimates of second-stage standard errors were adjusted to account for uncertainty in predicted SSC enrollment, $\hat{E}_i$.

[16]Appendix C describes how estimates of per-pupil expenditures for target SSC enrollees were obtained.

a fraction of students in each entering-ninth-grade cohort enroll for a fifth year. However, fifth-year expenditures per entering ninth-grader were about one-third *higher* for control group counterparts than for target SSC enrollees ($5,063 versus $3,749). This is because fifth-year enrollment rates were about one-third higher for control group counterparts (26.4 percent versus 19.7 percent).[17] This, in turn, reflects the fact that roughly one-third more control group counterparts were "available" for a fifth year of high school because they did not graduate in their fourth year.

In sum, the quantity of resources devoted to SSC target enrollees is similar to the quantity devoted to their control group counterparts during the first four years of high school. However, because SSCs' target enrollees are more likely to graduate in four years, they are less likely to require additional resources during a fifth year and thus use up fewer resources, on average, than the control group counterparts over the entire course of high school. This finding about average *total* student costs is in contrast to results presented earlier that indicate that average *annual* student costs are higher at SSCs than at other NYCDOE high schools. These results imply that the average control group counterpart attended a high school with annual per-student costs that were also higher than the overall average for non-SSC high schools. Possible reasons for this finding are that control group counterparts were substantially more likely than non-SSC high school students in general to attend high schools that had fewer than 250 students (16.0 percent compared with 1.3 percent) and substantially less likely to attend high schools that had more than 2,000 students (37.8 percent versus 51.9 percent).[18]

Bloom and Unterman (2014) report that five-year graduation rates for target SSC enrollees and their control group counterparts are 74 percent and 65 percent, respectively. Estimates in Table 5 of the present paper indicate that total five-year direct service expenditures for target SSC enrollees and their control group counterparts are $57,246 and $59,818, respectively. Together these results imply that the cost per graduate for target SSC enrollees ($77,780) is 16 percent lower than the cost per graduate for control group counterparts ($92,454). If we use cost measures that were adjusted for teacher salary differences alone or for teacher salary differences and student needs together, corresponding results imply that the cost per graduate is approximately 14 percent lower for target SSC enrollees than for their control group counterparts.

[17]These rates were estimated using the impact model specified by Equations 1 and 2, replacing measures of expenditures as the dependent variable in Equation 2 with an indicator of whether or not a student was enrolled in his fifth year.

[18]The rates for control group counterparts were estimated using the impact model specified by Equations 1 and 2, replacing measures of expenditures as the dependent variable in Equation 2 with an indicator of whether or not a student attended a school of a given size.

7. Additional Considerations

The expenditure measures used in the preceding analyses do not reflect the value of three sets of resources used by SSCs: (1) facility space, (2) the value of human and financial resources contributed to SSCs by their external partners, and (3) the one-time, initial investment of resources devoted to creating each SSC. Although we do not have the data for a complete accounting of these additional costs, the following sections provide rough approximations of how their consideration might influence the conclusions drawn from the preceding analysis.

Facility Utilization

Specialized instructional spaces such as gyms, music rooms, science labs, etc. represent fixed costs that can be optimally utilized only when school enrollments are sufficiently high. An important part of the SSC intervention, however, was to replace large high schools with multiple small high schools that were often located in the same building. The hope was that by sharing specialized instructional spaces in those buildings, small high schools could optimally spread the fixed costs of those spaces (New Visions, 2005). In fact, 73 of the 84 SSCs in our sample shared a building with at least one other high school, 6 shared space with elementary or middle schools, and only 5 were located in stand-alone buildings.[19] A substantial number of New York City high schools other than SSCs share a building with one or more other schools, but a much higher fraction — nearly half — stand alone. So the question is whether sharing school buildings allows SSCs to use facility space as efficiently as schools with larger enrollments.

Comprehensive measures that capture the quality as well as the quantity of space used by schools are not available. However, the NYCDOE School Construction Authority prepares an annual enrollment, capacity, and utilization report that includes a measure of facility capacity used by each school in the district. This measure is based on the number, size, and types of rooms used. For each room, the number of students that can be accommodated is estimated based on its size and function plus an assumption about how many periods per day the room can be used.[20] The resulting measure indicates the number of students that the space used by the school is capable of serving. Dividing this capacity measure for each school by its total enrollment in a given year provides an indication of how much capacity the school uses per student. A value less than one indicates that a school is overcrowded and a value greater than one

[19]These counts were tabulated by the authors using information from the NYCDOE Enrollment, Capacity, and Utilization Report for 2009-2010.

[20]It is assumed that regular classrooms can be used for seven out of eight periods per day and that specialty instructional spaces can be used for five periods per day. Specialty instructional spaces include music rooms, art rooms, computer labs, science labs, weight rooms, dance studios, and gymnasiums.

indicates some degree of underutilization, meaning that the school facility serves fewer students than it is capable of serving.[21]

Comparisons of capacity-enrollment ratios for SSCs and comparison high schools based on the 2010-2011 Enrollment, Capacity, and Utilization Report indicate that schools with small enrollments tend to use more facility capacity per student than do schools with large enrollments. Because SSCs tend to be smaller than comparison group schools, and smaller schools tend to use more capacity per pupil, more facility capacity is devoted to the average SSC student than to the average student in other New York City high schools. Specifically, SSCs use about 26 percent more facility capacity per pupil than other New York City high schools.

Table 6 presents estimates of the difference in per-pupil capacity usage between SSC target enrollees and their control group counterparts (that is, the estimated effect of SSC enrollment on capacity usage per student). These estimates were computed like the corresponding estimates of SSC effects on direct service expenditures per pupil in Table 5 (by specifying capacity per pupil as the dependent variable in Equation 2). During years one, two, three, and four the ratio of school capacity to enrollment is greater than one for both the SSC target enrollees and their control counterparts. These results suggest that both sets of students tend to enroll in schools whose facility capacity is somewhat underutilized relative to NYCDOE standards. The facility capacity usage measures are well below one for both groups of students in year five because the majority of students do not enroll for a fifth year and students who are not enrolled use up zero facility capacity.

Overall, the results in Table 6 suggest that SSC target enrollees use more facility capacity per pupil than do their control group counterparts, but this difference is small. Over the full five years after students first enter ninth grade, SSC target enrollees use up only 6.3 percent more facility capacity per student than their control group counterparts, a difference that is not statistically significant.

Converting these differences in facility capacity usage into dollar terms is not possible. However, facility costs per pupil tend to be a small proportion of total school costs. For example, the 2010-2011 SBER indicates that only about 4.6 percent of expenditures by the NYCDOE were for debt service and leases for facility space. Because school buildings still have economic value even if they are not actively leveraged with debt, this figure is likely a substantial underestimate of the value of school facilities used in New York. Nevertheless, it is also likely that facility space is only a small fraction of annual school costs. Thus, if the small

[21] We were able to obtain data on these measures only for 2008-2009, 2009-2010, and 2010-2011. However, because these findings were similar across years, we assume that levels of capacity use in 2005-2006, 2006-2007, and 2007-2008 were the same as those in 2008-2009.

difference in facility capacity usage between SSCs and control group counterparts were expressed in dollars, it is unlikely that the resulting amount would change the conclusions we reach through our analysis of direct service expenditures.

Resources from External Partners

The best available information about the value of contributions to SSCs from their external partners is a survey of 13 SSC external partners conducted by New Visions for Public Schools. These survey results indicate that during the 2004-2005 school year, on average, external partners contributed financial and in-kind resources that were worth roughly $275,000 per SSC (Soler-McIntosh, Carrion, and Guntan, 2007). For a typical SSC with roughly 440 students, this equals about $625 per student, which is only 5 percent of annual direct service expenditures. Thus adding these "off-the-book" costs for SSCs is unlikely to change conclusions about overall operating costs. Furthermore, since other NYCDOE schools can have external partners, only considering external contributions for SSCs would overstate the difference in this cost component, which makes it even less likely that a full accounting of these costs, if possible, would change our conclusions.

Start-Up Costs

Human and financial resources from multiple sources were devoted to planning and establishing SSCs. For example, the Bill & Melinda Gates Foundation (BMGF) planned to donate roughly $100,000 a year to SSC planning teams for their school planning year and the first four years of their school's operation. Internal BMGF documents suggest that roughly $135 million went to support small schools initiatives in New York City between the fall of 2000 and the fall of 2007. How much of this funding was used either directly or indirectly to support the SSCs examined by the present analysis is hard to say. In addition, other foundations invested in this movement, and the NYCDOE allocated special funds and devoted district personnel to support planning efforts for small schools. Although a full accounting of these costs is not possible, it is important to note that they represent a *one-time cost* for each SSC that should be amortized over many years of its subsequent operation. Thus annualized costs per student are likely to be small. For instance, if we assume that (1) the $135 million from BMGF was split evenly across the 216 small high schools created by the NYCDOE between 2002 and 2008, (2) schools have a useful life of 30 years, (3) the annual discount rate is 5 percent, and (4) average SSC enrollment is 440 students, then the annualized cost per SSC would be $40,657, or *less than $100 per SSC student per year*. Furthermore, if we assume that start-up resources provided by all other sources were equal to those of the Gates contribution, the additional costs would be less than $200 per student per year. Thus, it seems unlikely that consideration of these costs would substantially alter our conclusions.

Taken singly, consideration of facility usage, external resources, and start-up costs are unlikely to influence policy conclusions. Taken together, however, they might have more substantive implications. For example, they would enlarge somewhat the estimated annual per-student "cost disadvantage" of SSCs reported in Tables 1 and 4 relative to other NYCDOE high schools. In addition, they would reduce somewhat the estimated total per-student "cost advantage" of SSCs reported in Table 5 relative to schools attended by control group members. Thus it is probably most accurate to say that there are no substantial differences in the total resources devoted to average target SSC enrollees and their control group counterparts. However, because of the substantially higher graduation rate for SSC enrollees, the average total cost per high school graduate is still likely to be substantially *lower* for SSC enrollees than for their control group counterparts.

8. Implications for Policy

Our findings indicate that annual per-pupil operating costs for SSCs are higher than those for other New York City high schools — particularly for high schools with over 2,000 students. For example, the difference between per-pupil direct service spending by SSCs and the typical New York City high school with more than 2,000 students in 2010-2011 was $2,920, or 23.6 percent of average per-pupil spending in the large high schools.[22] This difference appears to reflect nonoptimal use of indivisible inputs such as school administrators and specialized teachers.

However, control group counterparts in our analysis (1) also enrolled in schools with above-average resource usage, (2) were more likely than target SSC enrollees to attend a fifth year of high school, and (3) were less likely than target SSC enrollees to graduate from high school. Thus the present findings provide strong evidence that the cost per graduate for SSC enrollees is substantially less than that for their control group counterparts. These results are robust to different ways of estimating teacher costs, accounting for differences in student composition, and considerations of facility usage, start-up costs, and external provided resources.

It is important to note, however, that neither the comparison of SSCs with other NYCDOE high schools nor the comparisons of resources devoted to target SSC enrollees and their control group counterparts provide a basis for assessing the costs of New York City's small high schools initiative relative to the counterfactual situation of never having undertaken the small schools initiative. In the absence of this initiative, SSC students would not necessarily have attended the schools attended by their control group counterparts; many of them would likely have attended the large failing high schools that were closed as part of the

[22]This figure is based on a comparison of average 2010-2011 per-pupil direct service expenditures in SSCs from Table 1 and average 2010-2011 per-pupil direct service expenditures in other New York City high schools with enrollments over 2,000 from Table 2.

small schools initiative. Because it is not possible to identify what schools students would have attended in the absence of the small schools initiative nor to estimate the concurrent per-pupil costs of the large failing high schools that were closed, it is not possible to estimate the costs of the small high schools initiative relative to the counterfactual situation of never having undertaken the initiative.

Nonetheless, combined with the results from Bloom and Unterman (2014), the present analysis provides internally valid, robust estimates of both the costs and benefits of a large sample of new, small schools relative to a well-defined control group. As a result, the analyses have important policy implications. To clarify these implications, it is worth distinguishing among three decisions that education policymakers might want to make.

First, policymakers might need to decide whether an intervention in its current form and place ought to be continued. In this case, should the NYCDOE continue SSCs in their current form or seek to replace them with more cost-effective types of schools or programs? Of course, the answer to this question depends on what would be put in place of SSCs. Our findings suggest that the cost per graduating target SSC enrollee is 14 percent to 16 percent lower than that for their control group counterparts. Thus, replacing SSCs with schools like those attended by the control group counterparts is not warranted.

The data do suggest, however, that placing SSC students in high schools with enrollments greater than 2,000 might reduce NYCDOE expenditures by approximately $12,000 per student over a student's high school career. But these relative cost savings need to be weighed against the relative benefits of SSCs. For example, Rouse (2007) estimates that the average net present value of lifetime earnings gains produced by graduating from high school are between $300,000 and $635,000 in 2010 dollars.[23] If we assume that attending an SSC increases the probability of graduating from high school by 9.5 percentage points (as found by Bloom and Unterman, 2014), then SSCs generate income benefits that are between $28,500 and $60,000 per entering ninth grader. This approximate lifetime earning advantage of SSCs is several times the approximate $12,000 cost disadvantage of SSCs relative to very large high schools in New York City. Furthermore, the effects of attending an SSC on high school graduation rates relative to attending a low-expenditure, large high school might be even greater than those relative to attending schools such as those of the average control group counterpart in our analysis. In addition, the benefits of graduating from high school are not limited to lifetime earnings gains (Belfield and Levin, 2007).

[23]Rouse (2007) actually reports between $260,000 and $550,000 in 2004 U.S. dollars, which are converted here to 2010 dollars using the Bureau of Labor CPI Inflation Calculator.

Thus, whether SSCs are compared with the types of high schools attended by control group counterparts or with the least expensive large New York City high schools, it appears that SSC benefits exceed their costs. Consequently, unless a superior alternative to New York City's SSCs can be found, the present evidence suggests that they should be maintained.

Second, officials might be interested in whether an intervention should be expanded in its current location. In this context, should the NYCDOE create more SSCs so that their benefits can reach more students? And, if so, how many additional SSCs should be created? These questions are more difficult to address. For example, additional SSCs might draw students from schools with lower per-pupil costs and thereby increase district costs. In order to be cost effective, the benefits of these new SSCs in terms of increased graduation rates for their students must exceed their additional costs. However, the estimated positive effects of SSCs on graduation rates used for the present analysis apply to students who list SSCs as a school choice and who participate in an SSC lottery. Whether graduation effects for students who would be drawn into an expanded set of SSCs would be large enough to justify any increased costs involved in creating more SSCs is difficult to say. Thus, the marginal net benefits of adding more SSCs, while potentially large, are less clear than the average net benefits of existing SSCs.

Third, policymakers might be interested in whether a similar school reform should be undertaken in other settings. In this case, should schools similar to SSCs be established in other urban districts? Few large-scale education reforms have been as rigorously evaluated as New York City's SSCs and shown to be effective. Because SSCs generate positive net benefits relative to other New York City high schools, they represent a promising model. Whether SSCs would generate similar net benefits elsewhere (or benefits that are large enough to justify their costs) is likely to depend on a variety of factors. For example, the present analysis suggests that in districts with large high schools, the creation of new small high schools could increase annual school operating costs. Whether the benefits of new small schools will justify those additional costs depends on the effectiveness of current high schools and whether features of SSCs that made them effective, in addition to their small size, can be replicated.

A number of urban districts have undertaken efforts to create new small high schools (Iatarola et al., 2008; Wasley et al., 2000), and other districts may be considering this model as part of their high school reform plans. However, evaluations of small schools reforms have been limited in their scope and methods and, to our knowledge, none of them has been subjected to a rigorous cost-effectiveness or cost-benefit analysis. This paper, in conjunction with previous research on SSC benefits (Bloom and Unterman, 2014), provides such an analysis for a large sample of newly created small high schools and finds that their costs per high school graduate are considerably less than those for schools attended by control group counterparts. In addition to encouraging innovation with small high schools elsewhere, we hope that these analyses help to provide a framework for how to conduct future evaluations of small schools initiatives.

Exhibits

Small Schools of Choice

Table 1

Direct Service Expenditures per Pupil

	SSCs			Other NYC High Schools			Difference in Means		
Year	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Difference**	**S.E.**	**P-Value**
2005-2006	71	$11,499	1,403.9	225	$10,560	2,020.7	$940	505.54	0.064
2006-2007	79	$12,294	1,315.6	234	$11,563	2,022.6	$731	416.06	0.080
2007-2008	84	$13,399	1,727.0	240	$12,720	2,332.0	$678	428.88	0.115
2008-2009	84	$14,513	1,526.5	261	$13,702	2,335.0	$811	394.63	0.041
2009-2010	84	$14,835	1,983.6	276	$13,679	2,451.1	$1,156	404.17	0.004
2010-2011	84	$15,286	1,875.9	295	$13,876	2,760.5	$1,411	438.41	0.001

SOURCE: New York City Department of Education School-Based Expenditure Reports.

Small Schools of Choice

Table 2

Direct Service Expenditures per Pupil, by School Enrollment, 2010-2011

	SSCs			Other NYC High Schools			Difference in Means		
Enrollment	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Difference**	**S.E.**	**P-Value**
0-250	4	$16,038	718.5	33	$18,962	4,608.7	-$2,925	1,984.67	0.150
251-500	71	$15,462	1,921.3	110	$15,599	2,423.6	-$137	341.49	0.688
501-1,000	9	$14,115	1,274.3	77	$15,258	2,819.9	-$1,143	1,046.34	0.278
1,001-2,000	0	-	-	37	$14,156	2,122.9	-	-	-
Above 2,000	0	-	-	38	$12,366	1,935.3	-	-	-

SOURCE: New York City Department of Education School-Based Expenditure Reports.

Small Schools of Choice

Table 3

Teacher Experience and Salaries

	SSCs			Other NYC High Schools			Difference in Means		
Year	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Difference**	**S.E.**	**P-Value**
2005-2006									
Average years experience	70	5.92	2.56	218	12.20	3.34	-6.28	0.850	0.000
Percentage novice teachers	70	27.0	17.6	218	8.5	7.7	18.6	2.200	0.000
Average salary	70	$47,523	3,691	218	$56,972	4,804	-$9,449	1,222	0.000
2006-2007									
Average years experience	78	6.43	2.52	225	12.38	3.39	-5.95	0.712	0.000
Percentage novice teachers	78	20.9	14.6	225	6.9	6.5	14.0	1.599	0.000
Average salary	78	$53,519	4,311	225	$63,638	5,495	-$10,119	1,157	0.000
2007-2008									
Average years experience	84	6.75	2.67	232	12.46	3.34	-5.71	0.618	0.000
Percentage novice teachers	84	17.9	11.5	232	6.6	5.9	11.3	1.249	0.000
Average salary	84	$56,281	4,835	232	$66,422	5,702	-$10,141	1,062	0.000
2008-2009									
Average years experience	84	7.12	2.63	252	12.70	3.51	-5.59	0.600	0.000
Percentage novice teachers	84	12.7	9.1	252	5.6	6.5	7.2	1.199	0.000
Average salary	84	$61,655	5,169	252	$72,248	6,372	-$10,593	1,095	0.000
2009-2010									
Average years experience	84	8.09	2.66	268	13.16	3.58	-5.08	0.589	0.000
Percentage novice teachers	84	4.6	5.7	268	2.2	5.0	2.4	0.859	0.006
Average salary	84	$63,781	5,144	268	$73,666	6,457	-$9,885	1,066	0.000
2010-2011									
Average years experience	84	9.04	2.54	285	13.51	3.77	-4.46	0.599	0.000
Percentage novice teachers	84	3.4	4.6	285	2.4	4.7	1.0	0.763	0.179
Average salary	84	$65,817	4,912	285	$74,332	6,789	-$8,515	1,085	0.000

SOURCE: New York State Personnel Master File.

Small Schools of Choice

Table 4

Adjusted Direct Service Expenditures per Pupil

	SSCs			Other NYC High Schools			Difference in Means		
Adjusted for Differences in Teacher Salaries									
Year	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Difference**	**S.E.**	**P-Value**
2005-2006	70	$12,071	1,393.0	218	$10,494	2,090.5	$1,578	529.5	0.003
2006-2007	78	$12,931	1,298.4	225	$11,490	2,060.2	$1,441	430.1	0.001
2007-2008	84	$14,010	1,726.8	232	$12,579	2,271.1	$1,430	419.8	0.001
2008-2009	84	$15,171	1,595.8	252	$13,583	2,333.0	$1,588	396.6	0.000
2009-2010	84	$15,437	2,033.3	268	$13,495	2,343.1	$1,943	389.4	0.000
2010-2011	84	$15,794	1,946.4	285	$13,664	2,581.6	$2,129	409.0	0.000
Adjusted for Differences in Teacher Salaries and Student Needs									
Year	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Difference**	**S.E.**	**P-Value**
2005-2006	66	$11,718	1,350.4	213	$10,914	1,730.9	$804	450.7	0.076
2006-2007	78	$12,526	1,351.7	218	$11,963	1,530.8	$563	325.8	0.085
2007-2008	84	$13,490	1,678.2	226	$13,062	1,740.1	$428	329.0	0.194
2008-2009	84	$14,555	1,320.8	247	$14,293	1,588.6	$262	274.4	0.340
2009-2010	84	$14,751	1,879.5	256	$14,214	1,656.6	$537	285.8	0.061
2010-2011	84	$15,168	1,684.2	276	$14,271	1,941.6	$897	315.6	0.005

SOURCES: Author's computations (described in Appendix B) using data from New York City Department of Education School-Based Expenditure Reports, New York State Personnel Master File, and New York State Report Cards.

Small Schools of Choice

Table 5

Effects of SSC Enrollment on Direct Service Expenditures per Entering Ninth-Grader

	Target SSC Enrollees	Control Group Counterparts	Estimated Effect	Estimated Effect (%)	P-Value for Estimated Effect
Direct Service Expenditures					
Year 1	$11,936	$11,956	-20	-0.2	0.944
Year 2	$12,707	$12,980	-273	-2.1	0.293
Year 3	$13,935	$14,405	-470	-3.3	0.056
Year 4	$14,918	$15,414	-495	-3.2	0.070
Year 5	$3,749	$5,063	-1,313	-25.9	0.000
Five-Year Total	$57,246	$59,818	-2,572	-4.3	0.023
Direct Service Expenditures Adjusted for Teacher Salaries					
Year 1	$12,516	$12,180	336	2.8	0.241
Year 2	$13,288	$13,189	98	0.7	0.699
Year 3	$14,520	$14,602	2	-0.6	0.740
Year 4	$15,437	$15,577	-140	-0.9	0.617
Year 5	$3,810	$5,106	-1,296	-25.4	0.000
Five-Year Total	$59,571	$60,654	-1,083	-1.8	0.338
Direct Service Expenditures Adjusted for Teacher Salaries and Student Needs					
Year 1	$12,267	$11,992	275	2.3	0.310
Year 2	$12,957	$12,951	6	0.0	0.982
Year 3	$14,159	$14,227	-68	-0.5	0.765
Year 4	$15,060	$15,268	-207	-1.4	0.433
Year 5	$3,804	$5,109	-1,304	-25.5	0.001
Five-Year Total	$58,247	$59,546	-1,299	-2.2	0.223
Sample Size	3,544	4,977			

SOURCES: Findings are based on data from the NYCDOE High School Application Processing System for eighth-graders in 2004-2005 and 2005-2006 plus data from the NYCDOE School-Based Expenditure Reports for school years 2005-2006 through 2010-2011.

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Table 6

Effects of SSC Enrollment on School Capacity-Enrollment Ratios
Five-Year Follow-Up Sample, Cohorts 1-2

	Target SSC Enrollees	Control Group Counterparts	Estimated Effect	Estimated Effect (%)	P-Value for Estimated Effect
Year 1	1.18	1.07	0.11	10.2	0.033
Year 2	1.17	1.07	0.10	9.5	0.030
Year 3	1.16	1.06	0.11	10.1	0.010
Year 4	1.14	1.08	0.06	5.4	0.108
Year 5	0.26	0.34	-0.08	-23.9	0.002
Years 1-5	4.91	4.61	0.29	6.4	0.102
Sample Size	3,544	4,977			

SOURCES: Findings are based on data from the New York City Department of Education (NYCDOE) High School Application Processing System for eighth-graders in 2004-2005 (cohort 1) and 2005-2006 (cohort 2) plus data from the NYCDOE School Construction Authority's 2010-2011 Enrollment, Capacity, and Utilization Report for school years 2008-2009 through 2010-2011.

NOTE: See page 16 of the report for more detail.

Appendix A

Supplementary Tables

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Appendix Table A.1

Percentage of Students in Various Need Categories

	Special Education		Limited English Proficient		Free-Lunch Eligible	
Year	SSCs	**Other NYC HS**	**SSCs**	**Other NYC HS**	**SSCs**	**Other NYC HS**
2005-2006	9.48	10.17	6.57	9.90	71.03	49.28**
2006-2007	10.86	10.26	6.01	8.89	69.50	49.42**
2007-2008	12.41	10.43**	7.94	11.71	70.85	49.92**
2008-2009	14.14	10.98**	7.46	11.04	69.56	49.28**
2009-2010	15.59	11.15**	8.68	12.07	77.95	62.10**
2010-2011	17.08	12.14**	9.51	12.29	78.31	64.73**

SOURCE: New York State Report Cards.

NOTE: A two-tailed t-test was applied to the estimated effect. Statistical significance levels are indicated as: ** = 5 percent.

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Appendix Table A.2

Classroom Instruction Expenditures per Pupil

	SSCs			Other NYC High Schools			Difference in Means		
Year	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Difference**	**S.E.**	**P-Value**
2005-2006	71	$6,454	979.7	225	$6,110	1,051.3	$345	265.90	0.196
2006-2007	79	$6,843	732.6	234	$6,638	1,091.6	$205	224.79	0.362
2007-2008	84	$7,341	1,119.6	240	$7,217	1,287.7	$124	239.27	0.606
2008-2009	84	$7,685	872.2	261	$7,627	1,243.8	$58	210.97	0.783
2009-2010	84	$7,841	909.0	276	$7,567	1,307.4	$274	213.47	0.200
2010-2011	84	$8,148	874.6	295	$7,617	1,385.3	$531	219.20	0.016

SOURCE: New York City Department of Education School-Based Expenditure Reports.

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Appendix Table A.3

Instructional Support Services Expenditures per Pupil

	SSCs			Other NYC High Schools			Difference in Means		
Year	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Difference**	**S.E.**	**P-Value**
2005-2006	71	$1,509	413.4	225	$1,388	431.1	$122	109.18	0.266
2006-2007	79	$1,612	490.8	234	$1,561	506.6	$50	106.38	0.637
2007-2008	84	$2,011	516.9	240	$1,839	577.0	$172	107.46	0.110
2008-2009	84	$2,232	579.3	261	$1,998	644.7	$234	111.28	0.036
2009-2010	84	$2,202	644.3	276	$1,912	711.9	$289	118.48	0.015
2010-2011	84	$2,312	690.5	295	$1,999	791.6	$313	127.90	0.015

SOURCE: New York City Department of Education School-Based Expenditure Reports.

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Appendix Table A.4

Leadership, Supervision, and Support Expenditures per Pupil

	SSCs			Other NYC High Schools			Difference in Means		
Year	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Difference**	**S.E.**	**P-Value**
2005-2006	71	$1,718	410.0	225	$1,311	381.6	$406	97.27	0.000
2006-2007	79	$1,856	510.4	234	$1,512	423.8	$344	90.75	0.000
2007-2008	84	$1,987	555.9	240	$1,675	513.7	$312	97.39	0.001
2008-2009	84	$2,157	519.4	261	$1,791	534.6	$365	92.95	0.000
2009-2010	84	$2,203	554.3	276	$1,828	548.4	$376	92.30	0.000
2010-2011	84	$2,255	487.1	295	$1,803	631.8	$452	101.11	0.000

SOURCE: New York City Department of Education School-Based Expenditure Reports.

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Appendix Table A.5

Ancillary Support Expenditures per Pupil

	SSCs			Other NYC High Schools			Difference in Means		
Year	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Difference**	**S.E.**	**P-Value**
2005-2006	71	$697	118.9	225	$691	154.5	$5	38.79	0.889
2006-2007	79	$771	133.3	234	$762	175.2	$9	36.26	0.811
2007-2008	84	$816	142.3	240	$811	194.0	$6	35.66	0.877
2008-2009	84	$868	151.1	261	$854	199.7	$15	34.03	0.669
2009-2010	84	$903	151.2	276	$897	217.8	$5	35.55	0.879
2010-2011	84	$892	137.6	295	$914	189.4	-$22	30.19	0.462

SOURCE: New York City Department of Education School-Based Expenditure Reports.

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Appendix Table A.6

Building Services Expenditures per Pupil

	SSCs			Other NYC High Schools			Difference in Means		
Year	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Difference**	**S.E.**	**P-Value**
2005-2006	71	$1,082	549.6	225	$1,026	935.2	$56	233.07	0.810
2006-2007	79	$1,163	566.8	234	$1,049	705.5	$114	146.44	0.437
2007-2008	84	$1,156	448.4	240	$1,096	717.7	$60	130.93	0.645
2008-2009	84	$1,428	852.8	261	$1,298	735.3	$130	130.55	0.319
2009-2010	84	$1,579	1,530.9	276	$1,374	735.1	$205	144.45	0.156
2010-2011	84	$1,510	1,486.7	295	$1,392	888.5	$118	159.22	0.459

SOURCE: New York City Department of Education School-Based Expenditure Reports.

Appendix B

Computation of Adjusted Spending Measures

Direct service expenditures per pupil adjusted for teacher salary differences were computed as follows:

1. Using data from the New York State Personnel Master File (PMF), we computed for each year the average annual teacher salaries for each NYCDOE high school and for all NYCDOE high school teachers combined. We refer to the latter as the "district-wide" annual average teacher salary.

2. We then used information from the PMF to determine the total number of full-time equivalent teachers at each high school.[1] Using these teacher counts, we created two estimates of total teacher salaries for each school. The first measure equaled the product of the number of full-time equivalent (FTE) teachers at the school times the district-wide mean teacher salary. The second measure equaled the product of the number of FTE teachers at the school times the mean teacher salary for that school.

3. We then computed the *difference* between the first and second teacher salary measures for each school and added it to the school's total direct student service expenditures. For schools with teacher salaries that were below the district-wide mean (like most SSCs), this adjustment increased estimated costs. For schools with teacher salaries that were above the district-wide mean, this adjustment reduced estimated costs.

4. Last, we divided the adjusted total direct student service expenditures for each school by the school's student enrollment. This created our first adjusted measure of direct service expenditures per pupil for each school.

Direct service expenditures per pupil adjusted for teacher salary and student need differences were computed as follows:

1. Using data for our sample of high schools, we regressed each school's measure of per-pupil spending adjusted for teacher salary differences on the percentage of its students who were eligible for special education services, the percentage of its students who had limited English proficiency, and the percentage of its students who were eligible for free lunches.

2. For each school, we then plugged its actual percentages of special education students, students with limited English proficiency, and free-lunch-eligible students into the estimated regression equation to compute its predicted spending per pupil.

3. We then subtracted the predicted spending per pupil for each school from its actual spending per pupil. The resulting difference indicates how much more or how much less a school spends than what the predicted spending would be for a school with the same student composition (in terms of special education status, limited English proficiency status, and eligibility for free lunch).

[1]Any teacher who is less than full-time is counted as 0.5 FTE. However, because only a very small percentage of teachers are less than full-time, the adjustments described here are not sensitive to how part-time teachers are treated.

4. We then added the difference computed in step 3 to the average per-pupil spending level for all schools in the sample. This last step rescales our adjusted measure of per-pupil expenditures to a level that is more similar to our unadjusted measure of per-pupil spending.

Appendix C

Estimating Mean Expenditures for Target SSC Enrollees and Their Control Group Counterparts

Table 5 reports estimates of mean per-pupil expenditures for target SSC enrollees and their control group counterparts. Because these two types of students cannot be identified individually, their mean expenditure levels cannot be observed directly. Instead, they must be inferred. This is made possible by the statistical properties of randomization plus two plausible assumptions. SSC lottery winners can be split into two main subgroups: those who enroll in an SSC (a large majority) and those who do not enroll in an SSC (a small minority who become no-shows). The model also portrays two main subgroups of control group counterparts: those who do not enroll in an SSC (a large majority) and those who do enroll in an SSC (a small minority who become crossovers).

Assume (as seems plausible) that students are more likely to enroll in an SSC if they win an SSC lottery than if they do not win. Given this assumption, which is often referred to as "monotonicity," or the absence of "defiers,"[1] there are two more subgroups in the model: "no-show counterparts" among control group members (control group members who do not enroll in an SSC and would not have done so if they had won their SSC lottery) and crossover counterparts among SSC lottery winners (lottery winners who enroll in an SSC and would also have done so if they had been randomized to the control group).[2] Lottery winners who are neither no-shows nor crossover counterparts are target SSC lottery enrollees. This is the subgroup of students for whom SSC effects were estimated, and it has a counterpart subgroup among control group members. These control group students who complied with their first SSC lottery plus target SSC enrollees are often called compliers in the literature.

Randomization ensures that in expectation, (1) the proportion of SSC lottery winners who are no-shows (P_{NS}) equals the proportion of control group members who are no-show counterparts; and (2) the proportion of control group members who are crossovers (P_{CO}) equals the proportion of SSC lottery winners who are crossover counterparts. Hence, the proportion of target SSC enrollees among SSC lottery winners equals the proportion of control group members who are their counterparts.

Now assume that students winning an SSC lottery *per se* has no appreciable direct effect on future expenditures and that only by causing students to enroll in an SSC can their winning a lottery affect expenditures per pupil (which is often referred to as an "exclusion" restriction).[3] Consequently, randomization ensures that in expectation, mean expenditures per pupil for crossovers in the control group ($\bar{Y}_{CO}$) equal those for crossover counterparts among SSC lottery winners.

Now note that the mean value of per-pupil expenditures for all SSC lottery winners who enroll in an SSC ($\bar{Y}_{LWE}$) is a weighted average of mean per-pupil expenditures for target SSC enrollees ($\bar{Y}_{tarE}$) and crossover counterparts with weights equal to the relative size of each group. Then note that the observed mean expenditures per pupil for crossovers ($\hat{Y}_{CO}$) is an unbiased estimate of mean expenditures per pupil for crossover counterparts. Together, these facts imply that:

[1] See Angrist, Imbens, and Rubin (1996).

[2] Angrist, Imbens, and Rubin (1996) refer to no-shows and their control-group counterparts as "never takers" and to crossovers and their treatment-group counterparts as "always takers."

[3] See Angrist, Imbens, and Rubin (1996).

$$\bar{Y}_{LWE} = \left[\frac{1-P_{NS}-P_{CO}}{1-P_{NS}}\right] \cdot \bar{Y}_{tarE} + \left[\frac{P_{CO}}{1-P_{NS}}\right] \cdot \bar{Y}_{CO} \quad \text{(C.1)}$$

Solving Equation C.1 for $\bar{Y}_{tarE}$ yields

$$\bar{Y}_{tarE} = \left[\frac{1-P_{NS}}{1-P_{NS}-P_{CO}}\right] \cdot \bar{Y}_{LWE} - \left[\frac{P_{CO}}{1-P_{NS}-P_{CO}}\right] \cdot \bar{Y}_{CO} \quad \text{(C.2)}$$

In this way, the implied value of $\bar{Y}_{tarE}$ can be inferred from observed values of $P_{NS}, P_{CO}, \bar{Y}_{LWE}$, and $\bar{Y}_{CO}$. Findings in column two of Table 5, which are estimates of the mean unadjusted and adjusted direct service expenditures per pupil for control group counterparts, are obtained by subtracting the estimated effect of enrolling in an SSC in column three from the estimated mean unadjusted and adjusted direct service expenditures per pupil for target SSC enrollees in column one.

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