EXAM HIGH SCHOOLS AND ACADEMIC ACHIEVEMENT:
EVIDENCE FROM NEW YORK CITY

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ABSTRACT

Publicly funded exam schools educate many of the world's most talented students. These schools typically contain higher achieving peers, more rigorous instruction, and additional resources compared to regular public schools. This paper uses a sharp discontinuity in the admissions process at three prominent exam schools in New York City to provide the first causal estimate of the impact of attending an exam school in the United States on longer term academic outcomes. Attending an exam school increases the rigor of high school courses taken and the probability that a student graduates with an advanced high school degree. Surprisingly, however, attending an exam school has little impact on Scholastic Aptitude Test scores, college enrollment, or college graduation -- casting doubt on their ultimate long term impact.

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1   Introduction

Public exam schools are prominent around the world. Exam schools make up over half of U.S. News and World Report's top 100 American high schools, and 20 out of the 21 high schools designated as the "public elite" by Newseek.[1] Governments in China, Malaysia, Romania, Singapore, and Turkey allocate students to secondary schools based almost entirely on admissions entrance exams. Gifted students in Australia, Japan, Korea, Mexico City, and the United Kingdom compete for limited spots in selective secondary schools.

To the extent that students benefit from high-achieving peers, more advanced coursework, or higher expectations, exam schools are likely to increase student achievement. Indeed, many argue that the success of exam school alumni is *prima facie* evidence of their success in educating students. Robert Fogel (Stuyvesant), Claudia Goldin (Bronx Science), and George Wald (Brooklyn Tech) are part of a long list of prominent exam school alumni that include numerous U.S. Representatives, Olympic Medalists, Grammy and Oscar nominees, Pulitzer Prize winners, and Nobel Laureates.

Conversely, exam school alumni may be successful simply because they were highly gifted and motivated teenagers who would have prospered in any school. Social interactions in exam schools could be negative, especially for students who are lower in the ability distribution with a comparative advantage in non-academic activities (Cicala, Fryer, and Spenkuch 2011). Lower relative ability may also make students less competitive in college admissions, even if their absolute level of achievement is unchanged (Attewell 2001). In these cases, exam school students might be better served by a less competitive environment or greater heterogeneity among their peers.[2]

Gaining a better understanding of the impact of attending an exam school on educational attainment and achievement is of significant importance for education policy, and the subject of this paper. We provide the first causal estimate of the impact of attending an exam high school in the United States on later outcomes, using data from three of the most prominent exam high schools in the United States - Brooklyn Technical High School, the Bronx High School of Science, and Stuyvesant High School. Our identification strategy exploits the fact that admission into New York City's exam high schools is a discontinuous function of an individual's admissions test score. As a result, there exist cutoff points around which very similar applicants attend different high

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[1] U.S. News and World Report 2010 high school rankings are available at http://education.usnews.rankingsandreviews.com/best-high-schools. Newsweek's list of "public elite" high schools for 2010 are available at http://www.newsweek.com/2010/06/13/america-s-best-high-schools-in-a-different-class.html.

[2] Students at Stuyvesant, one of the most prominent exam schools in the United States, describe a hyper-competitive atmosphere that left many of them disillusioned (Klein 2007).

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schools. The crux of our identification strategy is to compare the average outcomes of individuals just above and below these cutoffs. Intuitively, we attribute any discontinuous relationship between average outcomes and admissions test scores at these cutoffs to the causal impact of attending that school.

We find that attending an exam school increases the likelihood that a student takes more rigorous high school coursework and the probability that a student graduates with a more advanced high school diploma. Surprisingly, however, there is little impact of attending an exam school on Scholastic Aptitude Test (SAT) reading and writing scores, and, at best, a modest positive impact on SAT math scores. Moreover, the impact of exam school attendance on college enrollment or graduation is, if anything, *negative*. Students just eligible for Brooklyn Tech are 2.3 percentage points less likely to graduate from a four year college. Students eligible for Bronx Science and Stuyvesant are neither more or less likely to graduate – the 95 percent confidence interval rules out impacts larger than 2.8 percentage points for Bronx Science and 2.5 percentage points for Stuyvesant.

There are three important caveats to our analysis. First, we estimate the benefit of attending an exam school for the *marginal* student admitted to each exam school. It is plausible that the impact of attending an exam school is different for other parts of the distribution. To partially address this issue, we estimate the effect of exam school eligibility separately for students with high and low state test scores in 8th grade, finding no statistically significant differences. This suggests that exam schools affect both high and low ability students similarly, but our results should still be interpreted with this caveat in mind. Second, the counterfactual to attending an exam school is in some cases attending a private high school or another exam school. For example, nearly 40 percent of students just ineligible for Stuyvesant attend Bronx Science, with another 20 percent leaving the NYC public school system altogether. Thus, our estimates may be less about the impact of attending an exam school per se, than about the impact of attending a school with higher-achieving peers more generally.[3] Third, our set of outcomes is limited to various measures of academic attainment and achievement.[4] To the extent that attending an exam school increases human or social capital in ways that are important for later outcomes, independent of SAT scores,

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[3]Other school inputs such as teacher experience, teacher absences, and teacher salary do not differ systematically across exam schools, though, as a large body of literature points out, measurable inputs have little causal impact on student outcomes (Hanushek 1997).

[4]Our attempts to match our data to tax or social security records were not successful. We also attempted to match our list of 163,000 exam school applicants who have graduated high school to entries in the Marquis "Who's Who" volumes - a measure of professional success - but there were only 32 matches.

college enrollment or graduation, then there is reason to believe that our conclusions are premature and the true impact of an elite exam school will only be understood with the passage of time (and more data collection).[5]

Our work contributes to an impressive literature on the impact of school choice and school quality on later life outcomes (Cullen, Jacob and Levitt 2006, Hastings, Kane, and Staiger 2006, Hastings and Weinstein 2008, Deming et al. 2011, Deming forthcoming, Berkowitz and Hoekstra 2011, Gould, Lavy, and Paserman 2004, and Duflo, Dupas and Kremer, forthcoming). The subset of this literature most related to ours exploits discontinuities created by admission rules to examine the impact of attending selective schools in other countries. Pop-Eleches and Urquiloa (2011) use almost 2,000 regression discontinuity quasi-experiments observed in the context of Romania's high school educational system, finding is that students with access to higher achieving schools and tracks within schools score more highly on an end of high school exam. Dustan (2010) exploits the allocation mechanism to elite high schools in Mexico City to show that attending an elite schools is associated with higher end-of-school test scores. Clark (2007) employs a regression discontinuity design using entrance exam assignment rules to grammar schools in the United Kingdom, finding little effect of admission on exit exam scores four years later.

The next section provides a brief overview of exam schools around the world with a special emphasis on the three schools in NYC for which we have data. Section 3 reviews some theoretical explanations for why students may or may not benefit from exam schools. Section 4 describes our data and presents summary statistics. Section 5 details our research design. Section 6 describes results on the impact of attending exam schools on a host of academic outcomes. The final section concludes. An online data appendix describes the details of our sample construction.

2   Exam High Schools

Exam schools play a prominent role educating many of the world's most gifted students. Government authorities in China, Malaysia, Romania, Singapore, and Turkey allocate most students to secondary schools based on entrance exams, while students in Australia, Japan, Korea, Mexico City and the canton of Zurich compete for limited spots in selective secondary schools. In the United Kingdom, government funded grammar schools have historically taught a more challenging curriculum to the top 25 percent of students in a municipality. While the grammar school system

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[5]There is some evidence, for example, that advanced math coursework in high school is associated with higher wages for individuals unlikely to attend college (Rose and Betts 2004, Goodman 2009, Joensen and Nielsen 2010).

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was gradually reformed during the 1970s, there are still 164 grammar schools in England that select students based, at least in part, on an admissions examination. In Austria and Germany, students are separated into academic and vocational tracks based on previous achievement and teacher recommendations. In the United States, over half of U.S. News and World Report's top 100 high schools use merit based selection, and 20 of the 21 high schools designated as the "public elite" by Newsweek use exam based admissions.

2.1 New York City

The exam high schools of New York City are specialized public high schools, established and run by the New York City Department of Education. Originally there were three academically oriented specialized high schools - Brooklyn Tech, Bronx Science, and Stuyvesant - and one arts oriented specialized high school - LaGuardia High School. The High School of American Studies at Lehman College, the High School for Math, Science, and Engineering at City College, and the Queens High School for the Sciences at York College were founded in 2002 to educate students who did not get into one of the three original specialized schools. Staten Island Technical High School was declared a specialized school in 2005, and Brooklyn Latin School was founded in 2006 to further expand the set of specialized schools.

While there are nine total specialized high schools in New York City today, we only include the original three - Brooklyn Tech, Bronx Science, and Stuyvesant - in our analysis. Staten Island Technical High School and Brooklyn Latin School are too new to have alumni data, and LaGuardia High School does not admit students using the Specialized High Schools admissions test. The High School of American Studies at Lehman College, the High School for Math, Science, and Engineering at City College, and the Queens High School for the Sciences at York College have alumni data for only the 2007 through 2009 high school cohorts, none of which have graduated from college.[6]

Admissions to the academic exam schools is determined by the Specialized High Schools admissions test (SHSAT). The test is broken into a math and verbal section, with students given 2 hours and 30 minutes to complete each section. The verbal section is made up of 45 multiple-choice questions. 30 questions test reading comprehension, 10 questions test logical reasoning, and 5 questions require students to put sentences into the most logical order in a paragraph. The math

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[6]Results including all available schools for the 2007 - 2013 cohorts are available in Appendix Tables 1 through 5. In these tables we combine results for Lehman and the Queens High School for the Science, as the cutoffs overlap for the two schools in most years. When the cutoffs do not overlap, we use the lower of the two cutoffs. Results are nearly identical, if somewhat less precise, than our primary results using all cohorts from the three original exam schools.

section is comprised of 50 multiple-choice questions, which test basic math, algebra, geometry, basic graphing, logic, and word problems.

On the day of the exam, students rank the schools in order of where they want to go. Test results are ranked from the highest score to the lowest, and administrators place students in high schools starting with the students with the highest score. Each student is placed into their most preferred school that still has seats until no seats remain at any school.

Table 1 details the cutoffs for each school during our sample period. Stuyvesant and Bronx Science are typically higher on students preferences and fill up the quickest each year. The number of exam school applicants has increased from 14,173 in 1989 to 27,650 in 2008. The last student admitted to Stuyvesant is typically ranked 914th, while the last student admitted to Bronx Science and Brooklyn Tech is typically ranked 2,367th and 4,412nd respectively. The rank cutoff of the last student admitted to each school has also increased, as each school has expanded the number of available seats to accommodate the greater demand for seats. The increased number of seats has not been enough to fully offset the increase in demand, however, resulting in more stringent score requirements over the sample period.

2.2 Brooklyn Technical High School

Founded in 1922, Brooklyn Technical High School (Brooklyn Tech) is the largest and lease selective of the three original exam high schools. There are approximately 5,000 students enrolled in the school today.

US News and World Report ranked Brooklyn Tech 63rd on its Best High Schools of America list in 2010, and, along with Stuyvesant and Bronx Science, was designated a "public elite" high school by Newsweek in 2008. Brooklyn Tech counts two Nobel Prize winners amongst its alumni: Arno A. Penzias (Physics 1978), and George Wald (Physiology and Medicine 1967).

Students at Brooklyn Tech concentrate their studies by selecting majors that range from aerospace engineering to chemistry to environmental science. The school offers 20 AP classes, four foreign languages, and major specific classes that focus on research skills. Brooklyn Tech also encourages students to utilize research opportunities outside the school through an internship program. Brooklyn Tech hosts 30 varsity teams and over 100 clubs. Community service is required, as are a certain number of service credits that are earned through participation in school organizations and teams.

Like all public schools, Brooklyn Tech receives funding from federal, state, and local govern-

ments. However, to provide the resources for the advanced opportunities, Brooklyn Tech has an endowment that funds facility upgrades, curriculum enhancements, and faculty training. In 2009 the endowment - the Brooklyn Tech Alumni Foundation - reported income of $ 3.86 million dollars on assets of $7.89 million (Guidestar.org 2011). The school is currently attempting to raise an additional $21 million.

2.3   Bronx High School of Science

The Bronx High School of Science (Bronx Science) is located in the Bedford Park neighborhood in the Bronx. Founded in 1938, Bronx Science focuses on science and math, but the humanities are also included in the curriculum to provide students with a well-rounded education and worldview. Approximately 2,700 students attend the school.

Bronx Science was ranked 58th in the US News and World Report 2010 Rankings of the Best High Schools in America, and has been designated a "public elite" high school by Newsweek in 2008 through 2010. In the past 8 years, Bronx Science has produced 59 Intel Science Talent Search semi-finalists and 6 finalists, the fifth and eight best in the nation respectively. Since the inception of the Intel Science Talent Search, Bronx Science has been home to more finalists than any other school in the nation (132).

The school has produced 7 Nobel Prize winners, more than any other secondary institution in the world. Nobel Prize winners include Leon N. Cooper (Physics 1971), Sheldon L. Glashow (Physics 1979), Steven Weinberg (Physics 1979), Melvin Schwartz (Physics 1988), Russell A. Hulse (Physics 1993), H. David Politzer (Physics 2004), and Roy J. Glauber (Physics 2005). The school's alumni also include 6 Pulitzer Prize winners, 6 National Medal of Science recipients, and 29 members of the National Academy of Sciences amongst its alumni. Particularly notable alumni include biologist and winner of the National Medal of Science Bruce Ames, neuroscientist and first director of the New Jersey Stem Cell Institute Ira Black, and biochemist and winner of the 2008 National Medal of Science Robert J. Lefkowitz.

Bronx Science students are required to take four years of English, social studies, and lab science and three years of math. Students can choose among 35 AP classes and 10 language courses. Students are also able to enroll in research classes across all departments, which when taken over four years, culminates in an Intel Competition submission. Bronx Science is home to a weather station, a DNA crime lab furnished through a partnership with Syracuse University, a planetarium, and a Holocaust Museum, which is maintained by students in the Holocaust Museum Leadership

Class. Students can participate in 29 varsity teams and 62 clubs and organizations.

In 2008 Bronx Science began a capital campaign to raise $20 million to fund school initiatives. In 2009, the Bronx High School of Science Endowment Fund reported income of $209 thousand dollars on assets of $5.49 million. The Alumni Association of the Bronx High School of Science reported income of $1.09 million dollars on assets of $1.35 million (Guidestar.org 2011).

2.4 Stuyvesant

Stuyvesant High School (Stuyvesant, or just Stuy) is located in the Battery Park neighborhood of Manhattan. Stuyvesant was founded in 1904. In 1934 entrance exams were implemented, and in 1972, along with Brooklyn Tech, Bronx Science, and LaGuardia, Stuyvesant was designated a specialized high school by the state legislature of New York. Stuyvesant currently serves over 3,000 students.

Stuyvesant was ranked 31st on the 2010 US News and World Report Best High Schools rankings, and has produced 103 Intel Science Talent Search semi-finalists and 13 finalists in the past 8 years, the second best in the nation. Stuyvesant has been designated a "public elite" high school by Newsweek in 2008 through 2010. The school counts four Nobel Prize winners amongst its alumni: Joshua Lederberg (Physiology or Medicine 1958), Robert Fogel (Economics 1993), Roald Hoffmann (Chemistry 1981), and Richard Axel (Physiology or Medicine 2004). Other notable alumni including Attorney General Eric Holder, Special Advisor to President Obama David Axelrod, string theorist Brian Greene, and founder of the Broad Institute, Eric Lander.

Stuyvesant provides a college preparatory curriculum, requiring four years each of English, history, and lab science and three years each of math and a foreign language. There are 55 Advanced Placement (AP) courses offered each semester, and electives in 10 languages. including Hebrew, Italian, Spanish, German, Latin, Japanese, French, Chinese, Korean, and Arabic. Stuyvesant students can participate in 32 varsity sports, in addition to club and JV teams. There are over 90 clubs and 25 publications, as well as an orchestra, band, 3 choirs, and a chamber orchestra.

Conflicts between various Stuyvesant fund-raisers has led to multiple endowments for the school. The Stuyvesant High School Alumni Association reports assets of $509 thousand while the Campaign for Stuyvesant SHS Alumni and Friends Endowment Fund reports assets of $823 thousand. The Parents Association of Stuyvesant reports income of $330 thousand and assets of $375 thousand (Guidestar.org 2011). The Campaign for Stuyvesant's current capital campaign is aiming to raise $12 million.

3   Conceptual Framework

There are at least three theories for why the marginal student might benefit from exam schools. First, a well developed literature emphasizes the importance of peer groups (Coleman 1966), social interactions (Case and Katz 1991, Cutler and Glaeser 1997) and network externalities (Borjas 1995, Lazear 2001) are important in the formation of skill and values and the development of human and social capital (see Sacerdote (2011) for a recent review). In particular, there are likely to be fewer "bad apples" in exam schools that exert negative externalities on higher achieving students (Lazear 2001, Hoxby and Weingarth 2006, Carrell and Hoekstra 2011). Second, if teachers teach to the median student in their classrooms, exam schools are likely to have more academic rigor (Duflo, Dupas, Kremer, forthcoming). Third, exam schools are likely to have more resources than traditional public schools. Stuyvesant, Bronx Science, and Brooklyn Tech are all conducting multimillion dollar capital campaigns to augment the resources each school receives from the city.

There are also several theories that argue exam schools may be bad for the marginal student, particularly for boys. Peer interactions may be negative for the marginal student if they are lower in the ability distribution, leading them to have a comparative advantage in non-academic activities (Cicala, Fryer, and Spenkuch 2011). The marginal student is also likely to have a lower class rank than they otherwise would have, making them less competitive in college admissions even if their absolute level of achievement is unchanged (Attewell 2001). Exam schools may also have no impact if other endogenous variables in the production of achievement (e.g., parental inputs or time on homework) are substitutes for school quality or better peers. For instance, parents whose children score above the admission threshold may invest less in their child's education, provide less monitoring of their teachers, or simply be more trusting of the school with the education of their child. Finally, it is also possible that exam school courses are taught too far above the level of the marginal student.

It is impossible to identify the separate impact of each of these potential channels with the data available here. Instead, this paper's goal is to produce credible estimates of the net impact of attending an exam high school on a series of important educational outcomes. The resulting reduced form estimates will likely reflect a number of the channels specified in this section.

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4 Data and Descriptive Statistics

To test the impact of exam school attendance on later outcomes, we merge information from the Specialized High Schools Admissions Test (SHSAT) records, data on college enrollment and completion from the National Student Clearinghouse (NSC), and data on student demographics and outcomes from the New York City Department of Education (NYCDOE).

SHSAT records are available from 1989 to 2008, encompassing the high school graduating cohorts of 1994 to 2013. The admissions data include name, date of birth, gender, math and English scale scores, school preferences, and whether each student was eligible at each of the exam schools.

To explore the impact of exam school attendance on college outcomes, we match the admissions records to information on college attendance from the NSC, a non-profit organization that maintains enrollment information for 92 percent of colleges nationwide. The NSC data contain information on enrollment spells for all covered colleges that a student attended, though not grades or course work. The admissions data were matched to the NSC database by NSC employees using each student's full name, date of birth and high school graduation date, which the NSC used to match to its database. 4 percent of records from our sample that were blocked by the student or student's school. Students eligible for an exam school are no more or less likely to have a record blocked than other students, however. Other than the blocked records, the NSC data is available for all cohorts and students in the admissions data, regardless of eventual high school enrollment.

To provide a measure of college quality, we match the NSC records to data on college characteristics from the 2010 U.S. News and World Report. The U.S. News and World Report collects data on college characteristics and statistics for four-year colleges in the U.S., including average class size, size of the faculty, graduation rates, tuition, room and board, average debt, loan size, percent of students receiving aid, acceptance rate, standardized test scores, high school GPA where available, demographic information on gender and the diversity index, freshman retention, and annual alumni donations. We use midpoint SAT score in 2010 as our primary measure of college quality. When only ACT scores are available, we convert them to SAT scores using the ACT's official score concordance. We code all college outcomes through 2009, regardless of high school cohort. Results are identical if we only use the first 4, 5, or 6 years after a student graduates high school.

To explore the impact of exam school attendance on school outcomes such as high school course taking, SAT scores, and high school diploma type, we also match SHSAT scores to administrative

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data from NYCDOE. The NYCDOE data contain detailed information on students enrollment histories, test scores, course-taking and other outcomes of interest for students that stay in the public school system. The NYCDOE is available for only the 2002 through 2013 graduating cohorts, with some data available over fewer years.

Table 2 provides a detailed accounting of what data are available for each cohort. Background data on race is available for cohorts after 2008 for students who attended a public middle school, while 8th grade test scores are available for cohorts after 2002 in public schools. These data form the basis of our specification tests in Section 5. Complete Regents test score records are available for the 2005 through 2009 cohorts, with incomplete records available for the 1998 through 2013 cohorts. SAT scores are available for the 2007 through 2010 cohorts, while graduation data is available for the 2002 through 2009 cohorts.

An important caveat is that the NYCDOE data only includes students who enroll in a public high school for at least one year in NYC. Students who enroll in a private school or a public high school in another district are not included. If the most talented or motivated students who do not get accepted into an exam school are more likely to leave the NYC public system – and hence, not be in our data set – then our estimates using the NYCDOE data may be biased.

Figure 1 examines whether individuals who score above an exam school cutoff are more likely to stay in the NYC public school system. Those who score just below an exam school cutoff are more likely to attend a private school or transfer to another district. Students below the Brooklyn Tech cutoff are 4.1 percentage points less likely to stay in the NYC system, while students below the Bronx Science and Stuyvesant cutoffs are 4.2 and 4.7 percentage points less likely to stay in a NYC public school. The average match rate of the admissions test records to the NYCDOE data is 78.5 percent.

The second panel of Figure 1 examines students enrolled in a public middle school only, a group that may be less likely to enroll in a private high school if not eligible for an exam school. The match rate among this group is 88.6 percent. However, while attrition among public school students is less severe, public school students below the Brooklyn Tech cutoff are still 2.9 percentage points less likely to stay in the NYC system, while students below the Bronx Science and Stuyvesant cutoffs are 2.3 and 1.3 percentage points less likely to stay in a NYC public school, with the Stuyvesant estimate no longer statistically significant.

Figure 2 provides a partial test for the type of nonrandom attrition that would bias our high school results by examining the characteristics of public middle school students leaving the NYC

system. We regress observable baseline characteristics on each school's eligibility cutoff within the set of students who stay in NYC. If the characteristics of those who stay in the NYC public school system change discontinuously at an eligibly cutoff, this is evidence of nonrandom attrition. We limit the sample in Figure 2 to students who were previously enrolled in a public middle school, as these are the only students for whom we have baseline results, and they are less likely to attrit in the first place. All high school results will be from this same sample.

There is no clear pattern of nonrandom attrition into the NYCDOE data. In particular, public middle school students who leave the NYC public school system do not score higher on 8th grade math and English exams compared to students who stay.

As a second test of nonrandom attrition, we estimate our main results for college outcomes restricting the sample to public middle school students for whom we also have high school outcome data.[7] The impact of exam school attendance on college outcomes for our restricted high school sample is the same as in the full sample of all exam school applicants. Taken together with our results from Figure 2, this suggests that, at least among public middle school students, our high school results are not biased by nonrandom attrition.

Summary statistics for each exam school are displayed in Table 3. We include all of the available cohorts for each outcome as detailed in Table 2. School characteristics are for the 2008 - 2009 school year, the most recent available. Students at exam schools are more likely to be white or Asian than the typical student in NYC, less likely to be black or Hispanic, and less likely to be eligible for free or reduced price lunch. Students at Stuyvesant also score about 2.0 standard deviations higher than the typical NYC student on the state math and English exam in 8th grade, while students at Bronx Science and Brooklyn Tech score about 1.7 and 1.5 standard deviations higher respectively.

Students at Stuyvesant, Bronx Science and Brooklyn Tech are far more likely to take Regents exams compared to the typical NYC student, particularly in optional and more advanced subjects such as a second math class covering Trigonometry, Chemistry, and Physics.[8]

Students at exam schools are more likely to graduate high school than their peers in other NYC schools. 93.0 percent of Stuyvesant students graduate from high school, compared to 53.7 percent of students in NYC as a whole. 91.1 and 87.1 percent of Bronx Science and Brooklyn Tech graduate from high school. Exam school students are also far more likely to receive a Regents or Advanced

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[7]These results are available in Appendix Table 6.

[8]The structure of the New York math Regents changed over the sample period. Following the advice of the NYCDOE, we combine Math A and Integrated Algebra into a single score, and Math B and Trigonometry into a second score. Results are identical if we use Math A and B only, which make up the majority of the scores in our sample.

Regents diploma, earned by taking more advanced math and science courses. While 81.4 percent of Stuyvesant students, 68.7 percent of Bronx Science students, and 65.6 percent of Brooklyn Tech students receive an Advanced Regents diploma, only 9.2 percent of students in NYC do.

Students at exam schools are also much more likely to enroll in a four year college than the typical NYC student, and tend to attend more selective colleges than other students. 84 percent of Stuyvesant students enroll in a four year college during our sample period, with 28.4 percent of them enrolling in a school with a median SAT score of more than 1400.[9] At Bronx Science, 83.4 percent of students enroll in a four year college, with 13.8 percent enrolling in a school with a median incoming SAT score of more than 1400. At Brooklyn Tech, 77.7 percent of students enroll in a four year college, with 4.8 percent enrolling in a school with a median incoming SAT score of more than 1400. To put this in context, only 32.2 percent of NYC students enroll in a four year college, and only 0.9 percent enroll in a school with a median SAT score of more than 1400. Of that 0.9 percent, 51.3 percent attended one of the three exam schools in our sample. 64 percent of NYC students attending Harvard, Princeton or Yale graduated from Stuyvesant, Bronx Science or Brooklyn Tech.

Differences in educational inputs between exam schools and traditional public schools are less dramatic. The typical teacher at Stuyvesant made \$78,152 in 2008 - 2009, with teachers at Bronx Science and Brooklyn Tech earning \$72,088 and \$76,213 respectively. The typical teacher in NYC earned \$72,557. Teachers in the exam schools have somewhat more experience than other teachers, but are absent approximately the same number of school days each year. The exam schools do have somewhat lower student to teacher and student to staff ratios than traditional public schools in NYC.

5 Research Design

Our research design exploits the fact that entry into each exam school is a discontinuous function of a student's SHSAT score. Consider the following model of the relationship between future outcomes (y) and enrollment in a school (S_i):

$$y_i = \alpha_0 + \alpha_1 S_i + \varepsilon_i \tag{1}$$

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[9]Colleges with median SAT scores above 1400 are Amherst, Bowdoin, Brown, CalTech, Claremont McKenna, Columbia, Dartmouth, Duke, Emory, Harvard, Harvey Mudd, MIT, Northwestern, Notre Dame, Penn, Pomona, Princeton, Rice, Stanford, Swarthmore, Tufts, University of Chicago, Vanderbilt, Washington University, Williams, and Yale.

The parameter of interest is α_1, which measures the causal effect of exam school attendance on future outcomes y_i. The problem for inference is that if individuals select into high schools because of important unobserved determinants of later outcomes, such estimates may be biased. In particular, it is plausible that people who select into specialized high schools had different academic skills and motivation before they enrolled. Since exam school enrollment may be a function of ability, this can lead to a bias in the direct estimation of (1) using OLS. The key intuition of our approach is that this bias can be overcome if the distribution of unobserved characteristics of individuals who just barely eligible for a school is the same as the distribution among those who were just barely ineligible:

$$E[\varepsilon_i|score_i = c_s^* + \Delta]_{\Delta \to 0^+} = E[\varepsilon_i|score_i = c_s^* - \Delta]_{\Delta \to 0^+} \qquad (2)$$

where $score_i$ is an individual's SHSAT score and c_s^* is the cutoff score below which applicants are not admitted to school s. Equation (2) implies that the distribution of individuals to either side of the cutoff is as good as random with respect to unobserved determinants of future outcomes (ε_i). Since enrolling in an exam school is a discontinuous function of SHSAT score, whereas the distribution of unobservable determinants of future outcomes ε_i is by assumption continuous at each cutoff, the coefficient α_1 is identified. Intuitively, any discontinuous relation between future outcomes and the SHSAT score at the cutoff can be attributed to the causal impact of school enrollment under the identification assumption in equation (2).

We estimate the reduced form impact of scoring just above the eligibility cutoff for each school separately using standard methods for regression discontinuity analysis (e.g. Lee and Lemieux 2010). First, we restrict the data to scores within 0.25 standard deviations around each school's cutoffs. This is the largest bandwidth that never includes another school's eligibility cutoff. Rule of thumb and cross validation selection procedures suggest somewhat larger bandwidths of 0.35 to 0.75 standard deviations (see Appendix Table 7). This somewhat smaller bandwidth includes only the observations in the immediate neighborhood of the cutoffs, but at the cost of including less information, which can lessen precision.

Second, within our bandwidth, we estimate the following reduced form model of outcomes for each school:

$$y_i = \pi_0 + \pi_1(score_i > c_s^*) + \pi_2(score_i > c_s^*) \times (score_i - c_s) + \pi_3(score_i - c_s) + \pi_4 X_i + \pi_t + \varepsilon_i \quad (3)$$

Where y_i is a future outcome such as college enrollment or graduation, and $(score_i \geq c_s^*)$ is an

indicator that the student scored at or above the eligibility cutoff. We include separate score trend terms above and below the eligibility cutoff. We also control for gender, whether a student attended a private or public middle school, and the year of high school entry t. To address potential concerns about discreteness in the SHSAT score we cluster our standard errors at the SHSAT score level (Card and Lee 2008).

The identified parameter π_1 measure the average reduced form treatment effect of scoring just above the cutoff for each school. This is the causal impact of being eligible for an exam school. It is important to note that the counterfactual to attending an exam school in many cases is a private school or other exam school. Take, for example, the eligibility cutoff for Stuyvesant. Nearly 40 percent of students just ineligible for Stuyvesant graduate from Bronx Science, with another 20 percent leaving the NYC public school system, likely to attend a private school. The exception to this is Brooklyn Tech, where students below the eligibility cutoff are not eligible for any of the exam schools and must choose between a traditional public school in NYC or a private high school.

The key threat to a causal interpretation of our estimates is that exam school applicants are not distributed randomly around the school cutoffs. Such nonrandom sorting could invalidate our empirical design by creating discontinuous differences in respondent characteristics around the score cutoff. In Figure 3 we evaluate this possibility by testing whether the observable characteristics of applicants trends smoothly through each cutoff. Gender and middle school type is available for the 1994 through 2013 high school cohorts for all students. 8th grade test scores are available for only the 2002 through 2013 cohorts who attended a public middle school, while ethnicity data is only available for the 2008 through 2013 cohorts who attended a public middle school. Students eligible for Brooklyn Tech are less likely to be black, while students eligible for Stuyvesant are more likely to be Hispanic. Otherwise, there are no statistically significant differences between just eligible and just ineligible students.

Next, we examine whether the frequency of respondents changes at the cutoff. We follow the approach of McCrary (2008) and first collapse the data into equal sized bins of 0.01. We then regress the number of observations in each bin on a local linear regression which we allow to vary on either side of the cutoff. As suggested by Figure 4, the coefficient on the eligibility cutoffs is statistically insignificant for all three schools. Results are identical with either larger or smaller bin widths. Given the general lack of statistical significance on both of our robustness checks, we interpret our results as showing no clear evidence that our identifying assumption is violated in the full sample of exam school applicants.

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Recall that our high school outcomes are only available for the set of students who enroll in a public high school in NYC. Section 4 discusses the issues related to selection into this sample, and conducts a number of robustness checks. While we find that students scoring just above an exam school cutoff are more likely to enter the NYCDOE data, eligible and ineligible students are just as likely to be male, black, and Hispanic, and score about the same on 8th grade math and reading exams. Nonetheless, our high school results should be interpreted with this sample selection in mind.

6 Results

6.1 Impact of Eligibility Cutoffs on Exam High School Graduation

First stage results for the 2002 to 2009 high school cohorts are presented graphically in Figure 5.[10] We plot the fraction of individuals graduating from each exam school and predicted graduation rates from a local linear regression relating whether or not an individual graduated from the school to SHSAT score, an indicator for scoring above the eligibility cutoff, and SHSAT score interacted with the eligibility indicator.[11] In all results, the first cutoff is Brooklyn Tech, the second Bronx Science, and the third Stuyvesant. Point estimates and standard errors for the eligibility variable for each school are presented next to each cutoff. Regression estimates add controls for cohort, gender and middle school type.

Individuals scoring just above the Brooklyn Tech cutoff are 22 percentage points more likely to graduate from the school than individuals scoring just below the cutoff. Individuals who score just above the Bronx Science cutoff are 31.1 percentage points more likely to graduate from that school, while students scoring above the Stuyvesant cutoff are 56.8 percentage points more likely to graduate from Stuyvesant. Note that some students scoring below each school's cutoff still graduate from that school. This is because students can retake the SHSAT in 9th grade, allowing some students to change schools. Nonetheless, these first stage results suggest a strong relationship

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[10] We use graduation rather than "ever attended" due to data limitations in the early cohorts. First stage results using the number of years attending each exam high school are presented in Appendix Table 8.

[11] Lee and Lemieux (2010) propose a formal test for optimal bin width based on the idea that if the bins are narrow enough, then there should not be a systematic relationship between the outcome variable and the running variable within each bin. Otherwise, the bin is too wide and the mean value of the outcome variable is not representative at the boundaries. A simple test for this consists of adding a set of interactions between the bin dummies and the running variable to a base regression of the outcome variable on the set of bin dummies, and testing whether the interactions are jointly significant. Results from this test for the first stage variable and college enrollment are presented in Appendix Table 9. The interaction terms tend not to be jointly significant at our chosen bin width of 0.05. Results are nearly identical for other outcome variables.

between exam school attendance and the eligibility thresholds.

6.2   Impact of Exam School Eligibility on College Enrollment and Graduation

Reduced form results of the impact of attending an exam school on college enrollment and graduation are presented in Figure 6. We plot the average outcome for each bin and predicted outcomes from a local linear regression.[12]   Enrollment outcomes are presented for the 1994 to 2009 high school cohorts, while graduation outcomes are presented for the 1994 to 2004 cohorts only. Point estimates and standard errors from separate regressions that include controls for exam score, exam score interacted with school eligibility, cohort, gender and middle school type are presented next to each cutoff. As with the first stage results in Section 6.1, these estimates include all students who applied to an exam school, even if they later left the NYC school system.

Surprisingly, there appears to be little impact of exam schools on four year college enrollment and graduation. If anything, students eligible for exam schools are less likely to have attended or graduated from college by 2009. Students just eligible for Brooklyn Tech are 2.3 percentage points less likely to graduate from a four year college. Students just eligible for Bronx Science are 0.7 percentage points less likely to graduate, and students just eligible for Stuyvesant are 1.6 percentage points less likely to graduate, though neither estimate is statistically significant. With that said, the 95 percent confidence interval rules out impacts larger than 2.8 percentage points for Bronx Science and 2.5 percentage points for Stuyvesant.

The results are similar when examining college enrollment in more selective institutions. We regress an indicator variable equal to one if a student was ever enrolled in a four year college with a median SAT score above 1200, 1300, and 1400 on each school's eligibility indicator, exam score, and exam score interacted with eligibility. Colleges with median SAT scores above 1200 include Binghamton University, Boston University, Fordham University. Colleges with median SAT scores above 1300 include Boston College, Carnegie Mellon, Lehigh University, Geneso University, New York University, and the University of Rochester. Colleges with SAT scores above 1400 include the Ivies and schools like the University of Chicago and Washington University. Students eligible for Brooklyn Tech are 1.6 percentage points less likely to enroll in a school with a median SAT of above 1300. There is no impact of Stuyvesant or Bronx Science eligibility on enrollment in a school with a median SAT score of above 1300, and none of the schools have an impact on enrollment in

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[12]Including a linear spline, by year, or renorming the data so that the eligibility cutoffs are constant over time all give nearly identical results. These additional results are available from the authors by request.

schools with SAT scores above 1200 or 1400. Students eligible for an exam school also appear no more likely to enroll in a post-baccalaureate program. The relatively small standard errors rules out large positive effects for all college outcomes.

Table 4 presents results separately by middle school type and gender, the only two control variables available across all years and students. We interact the linear trend in exam score with both the group being tested and the cutoff variable. There are no clear patterns by ethnicity or free lunch status among the subset of students we have that data for. Males and students who attended private middle schools benefit somewhat more from being eligible for Stuyvesant, and women seem to benefit somewhat more from being eligible for Brooklyn Tech. Given the general lack of clear patterns and statistical significance, however, our estimates suggest that all groups are affected by exam school eligibility similarly.

Table 5 presents results separately by 8th grade state test score for students who were enrolled in a NYC middle school, the only group we have state scores for. The regression discontinuity estimates presented in this paper capture the causal effect of admission for students near the cutoff. At each cutoff, however, there exists a distribution of actual ability. Some high ability students may score lower on the entrance exam by chance, putting them nearer a cutoff than their ability would suggest, while some low ability students may, by chance, score higher on the entrance exam, gaining admission to a school with far more able students on average. We test for the heterogenous impact of exam school admission by ability by splitting the same by state test scores in 8th grade. We first limit the sample to students within 0.25 standard deviations of the Brooklyn Tech cutoff and above to eliminate students with no chance of admissions. We then split the remaining sample at the median and 75th percentile of combined math and English 8th grade state test score. We allow the linear trend in exam score to differ by both the group being tested and the cutoff variable.

Perhaps surprisingly, there are no clear patterns by baseline state test score. Of the eighteen results considered, only one difference is statistically significant at the ten percent level. This suggests that high and low ability students are affected by exam school eligibility similarly.

A null result on the impact of exam schools on college enrollment and outcomes, while surprising, is broadly consistent with the literature on the effect of school choice on college outcomes (e.g., Cullen, Jacob and Levitt 2006, Deming et al. 2011), but differs substantially from the popular view of exam schools. In Chicago, Cullen, Jacob and Levitt (2006) find no impact of winning a school choice lottery on test scores, but some benefits on behavioral outcomes such as self-reported criminal activity. On the other hand, Deming et al. (2011) find that high school choice winners in

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Charlotte-Mecklenburg score no better on high school exams, but are more likely to graduate from high school and attend college. Berkowitz and Hoekstra (2011) examine the effect of attending elite private high school on college placement using by examining the outcomes of admitted applicants who later chose not to attend, finding that the attending the school leads students to attend more selective universities.

6.3   Impact of Exam Schools on High School Graduation and Achievement

Reduced form results of the impact of attending an exam school on high school outcomes are presented in Figures 7 through 9. Recall that we only have high school data on individuals who attend a public high school in NYC. Students who leave the system to attend a private school or a public school in another district are excluded. This approach assumes that the students who leave NYC do not differ in some systematic from those that stay. While our robustness checks in Section 4 suggest little difference between students who stay in the system and those that leave, conditional on attending a public middle school. There is also no difference in the impact of exam schools on college outcomes in the full sample and the sample used for high school outcomes. Still, we cannot definitely rule out unobservable differences between leavers and stayers, so our results should be interpreted with this caveat in mind.

Reduced form impacts for high school diploma type for the 2002 through 2009 high school cohorts are presented in Figure 7. NYC awards special education, Local, Regents, and Advanced Regents diplomas. To receive a Local diploma, students must score at least 55 on each of five core Regents examinations: English, Mathematics, Science, U.S. History and Government, and Global History and Geography. In order to receive a more prestigious Regents Diploma, students must receive a score of at least 65 in each of these five core subjects. To earn the Advanced Regents Diploma, students must also score at least a 65 on elective exams in math, science, and foreign language.

Students eligible for Bronx Science are more likely to graduate from high school in general, and more likely to receive an Advanced Regents diploma. Students eligible for Brooklyn Tech are also more likely to receive an Advanced Regents diploma. Stuyvesant eligibility does not significantly affect high school graduation or the type of diploma obtained, perhaps because the marginal applicant is already quite likely to receive an advanced degree.

Figure 8 examines the impact of the exam schools on high school course taking for the 2005 through 2009 high school cohorts. Students eligible for Brooklyn Tech and Bronx Science are more

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likely to complete core courses such as Global History and English Language Arts, though no more likely to take the first math course. Students eligible for any of the three schools are more likely to take an optional second math course covering Trigonometry, though the estimate is only statistically significant for Bronx Science. Students eligible for Bronx Science and Stuyvesant take more science exams, and more likely to take more advanced subjects such as Physics. Students eligible for Stuyvesant are also more likely to take Chemistry, while students from Brooklyn Tech and Bronx Science are less likely to take that class. Taken together with the results from Figure 7, we see the Regents results as suggesting that exam school students take more advanced coursework than other students.

Figure 9 examines the impact of attending an exam school on SAT scores, a measure of human capital, for the 2007 through 2010 cohorts. Students eligible at each exam school are somewhat more likely to take the SAT, though none of the point estimates are statistically significant. Those eligible for Bronx Science score 10.9 points higher on the SAT math section conditional on having taken it, but no better in reading or writing. Students eligible for Stuyvesant and Bronx Science do no better in all three sections.

7 Concluding Remarks

Public exam high schools have educated some of the world's most successful scientists and professionals. We provide evidence that attending an exam school increases rigor of the marginal student's high school course work, and makes the marginal student more likely to graduate from high school with an advanced diploma. Surprisingly, however, the impact of attending an exam school on college enrollment or graduation is, if anything, negative. There is also little impact of attending an exam school on SAT reading and writing scores, and, at best, a modest positive impact on SAT math scores. The results are similar across gender, middle school type, and baseline state test scores.

Our analysis of exam schools suggests that students are encouraged or pushed to take harder course work but that their actual human capital essentially remains unchanged. With that said, without longer-term measures such as income, health, or life satisfaction, it is difficult to fully interpret our results. To the extent that attending an exam school increases social capital in ways that are important for later outcomes that are independent of college enrollment, graduation, or human capital, then there is reason to believe that our conclusions are premature and the true

impact of an elite exam school will only be understood with the passage of time. If, on the other hand, SAT scores, college enrollment and graduation are "sufficient statistics" for later life outcomes, then our results show the impact of attending an elite exam school for the marginal student is likely to be small.

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Figure 1
Match To NYC Sample
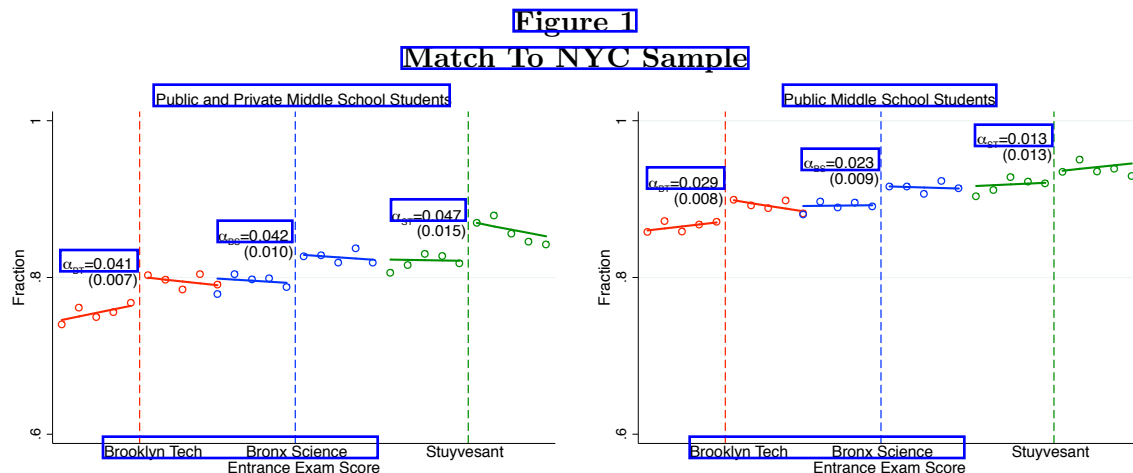
This figure presents raw outcomes in 0.05 wide bins and reduced form results. Outcomes within 0.25 standard deviations of each school's cutoff are presented, with cutoffs spaced by the average distance across the sample period. Point estimates and standard errors from a local linear regression of each outcome on entrance exam score, school eligibility, eligibility interacted with exam score, and cohort are displayed next to the relevant cutoff for each school. Standard errors are clustered at the exam score level. Results include the 2002 through 2012 graduating cohorts.

Figure 2
New York City Sample Characteristics
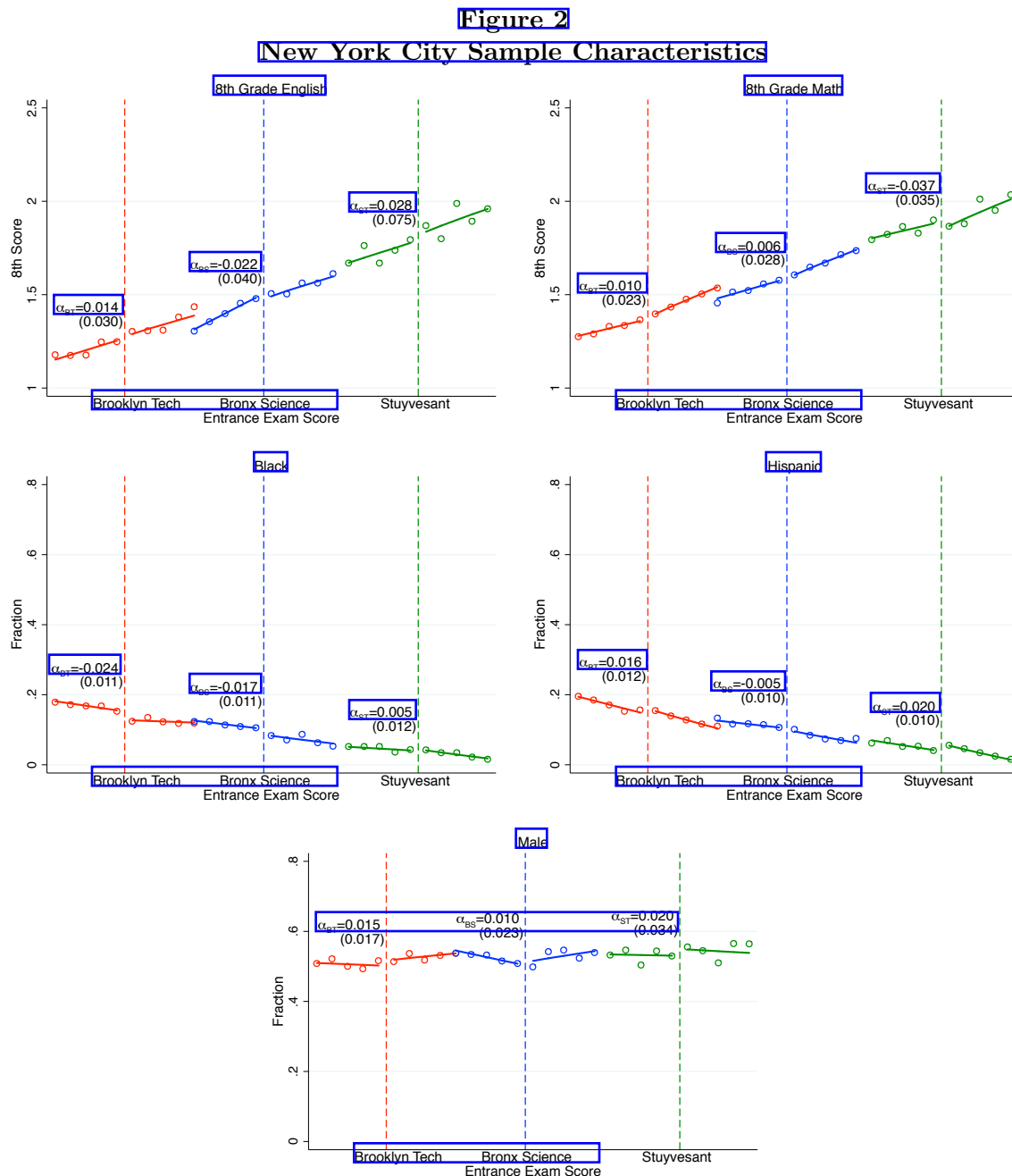
This figure presents raw outcomes in 0.05 wide bins and reduced form results for baseline characteristics of the sample of students staying in the NYC public school system. Outcomes within 0.25 standard deviations of each school's cutoff are presented, with cutoffs spaced by the average distance across the sample period. Point estimates and standard errors from a local linear regression of each outcome on entrance exam score, school eligibility, eligibility interacted with exam score, and cohort are displayed next to the relevant cutoff for each school. Standard errors are clustered at the exam score level. Results include the 2008 through 2013 cohorts who were enrolled in a public middle school. All results are run within the sample of students who stay in the NYC system for high school.

Figure 3
Baseline Characteristics
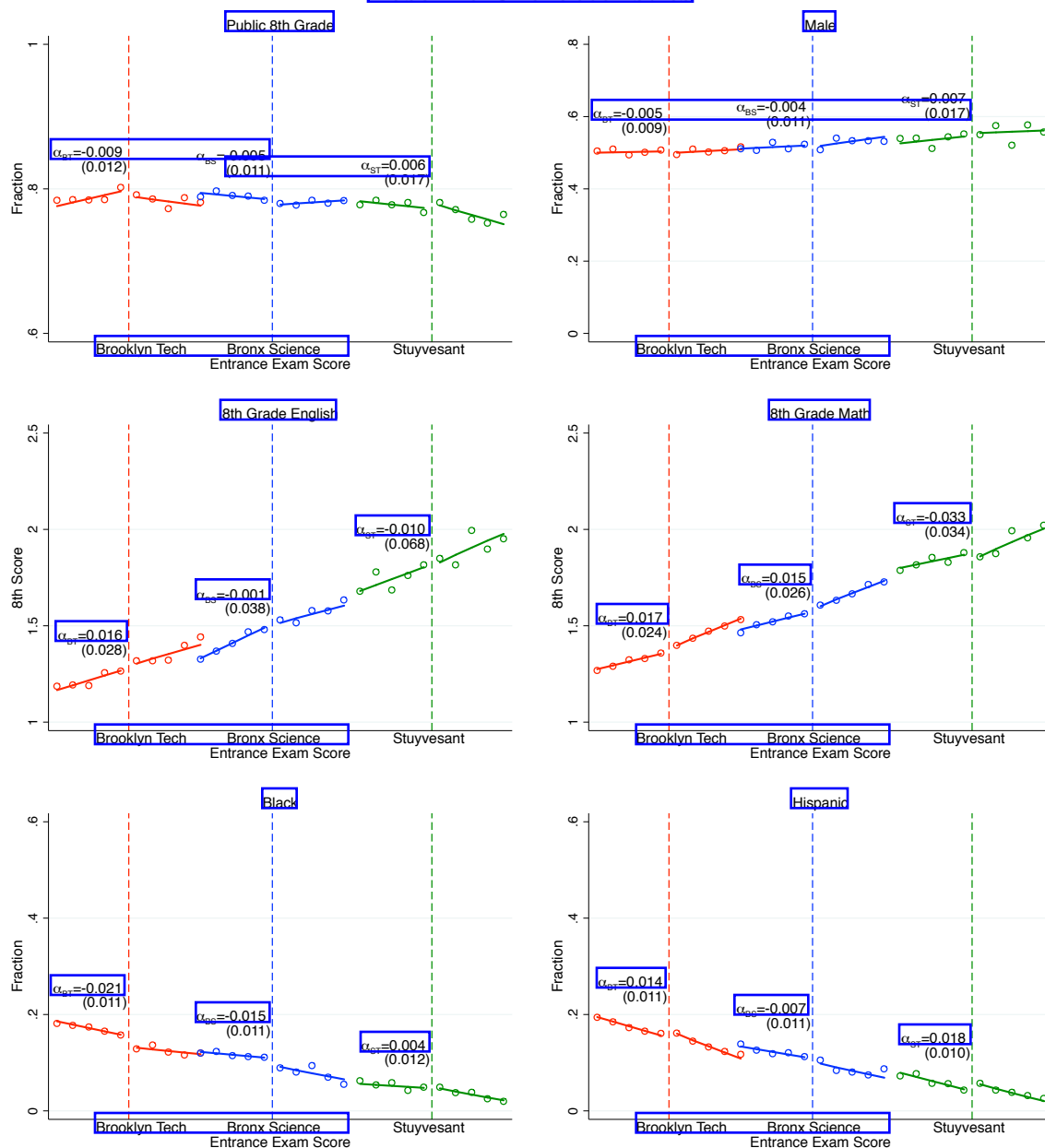
This figure presents raw outcomes in 0.05 wide bins and reduced form results for predetermined characteristics. Outcomes within 0.25 standard deviations of each school's cutoff are presented, with cutoffs spaced by the average distance across the sample period. Point estimates and standard errors from a local linear regression of each outcome on entrance exam score, school eligibility, eligibility interacted with exam score, and cohort are displayed next to the relevant cutoff for each school. Standard errors are clustered at the exam score level. Results for middle school type and gender include the 1994 through 2013 high school cohorts. Results for 8th grade test scores include the 2002 through 2013 cohorts who were enrolled in a public middle school. Results for ethnicity include the 2008 through 2013 cohorts who were enrolled in a public middle school.

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Figure 4
Number of Observations

This figure presents the number of outcomes in 0.01 wide bins. Outcomes within 0.25 standard deviations of each school's cutoff are presented, with cutoffs spaced by the average distance across the sample period. Point estimates and standard errors from a local linear regression of the number of outcomes on entrance exam score, school eligibility, and eligibility interacted with exam score are displayed next to the relevant cutoff for each school. Standard errors are clustered at the exam score level. Results include the 1994 through 2013 high school cohorts.

Figure 5
First Stage Results

This figure presents raw outcomes in 0.05 wide bins and reduced form results for the first stage results. Outcomes within 0.25 standard deviations of each school's cutoff are presented, with cutoffs spaced by the average distance across the sample period. Point estimates and standard errors from a local linear regression of each outcome on entrance exam score, school eligibility, eligibility interacted with exam score, and cohort are displayed next to the relevant cutoff for each school. Standard errors are clustered at the exam score level. Results include the 2002 through 2009 high school cohorts.
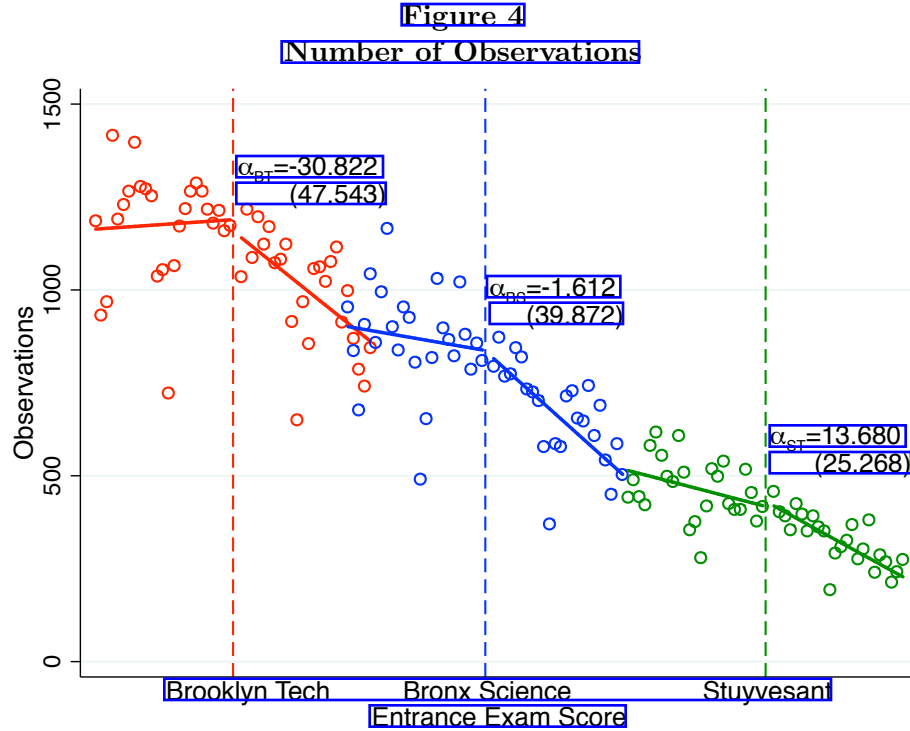
Figure 6
College Results
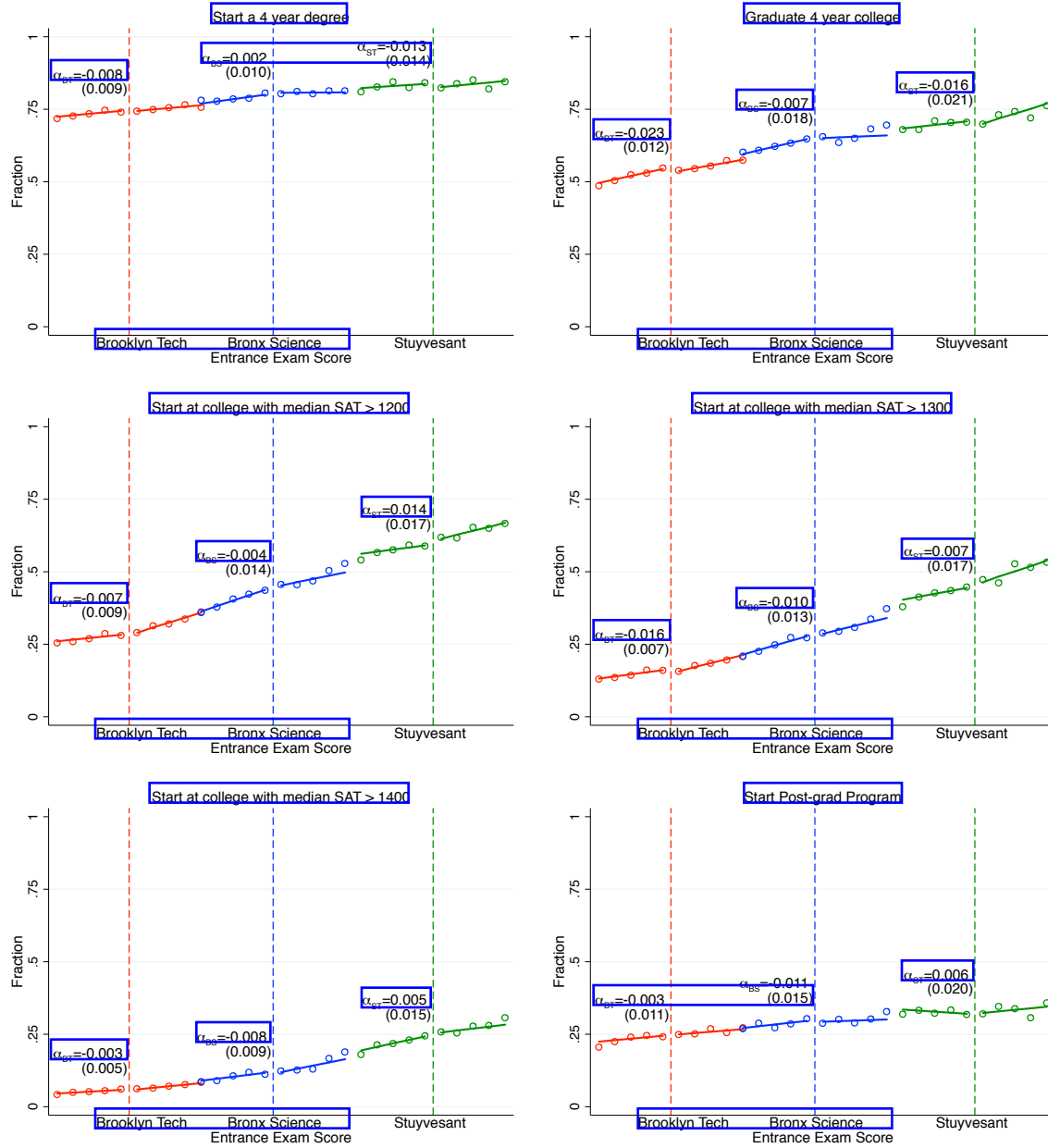
This figure presents raw outcomes in 0.05 wide bins and reduced form results for college enrollment and completion. Outcomes within 0.25 standard deviations of each school's cutoff are presented, with cutoffs spaced by the average distance across the sample period. Point estimates and standard errors from a local linear regression of each outcome on entrance exam score, school eligibility, eligibility interacted with exam score, and cohort are displayed next to the relevant cutoff for each school. Standard errors are clustered at the exam score level. Results for college enrollment include the 1994 through 2009 high school cohorts. Results for college graduation and post-grad enrollment include the 1994 through 2002 high school cohorts.

Figure 7
High School Graduation Results
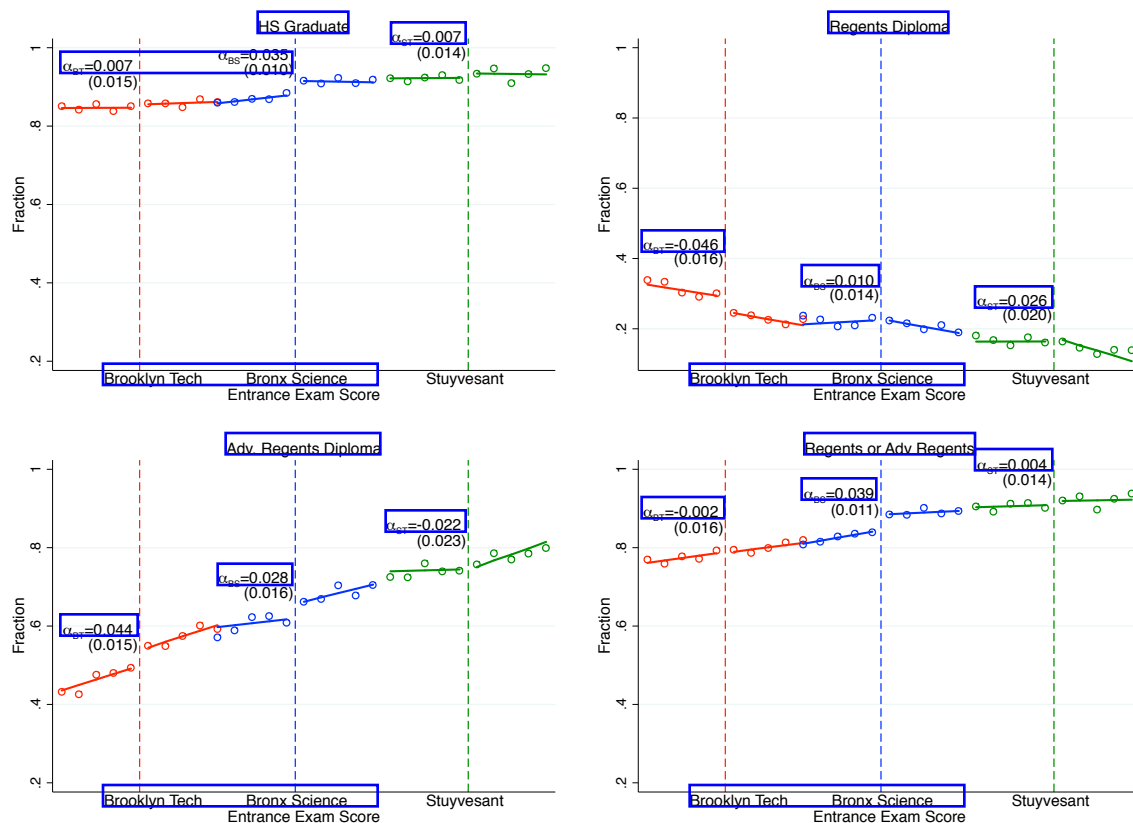
This figure presents raw outcomes in 0.05 wide bins and reduced form results for high school graduation and diploma type. Outcomes within 0.25 standard deviations of each school's cutoff are presented, with cutoffs spaced by the average distance across the sample period. Point estimates and standard errors from a local linear regression of each outcome on entrance exam score, school eligibility, eligibility interacted with exam score, and cohort are displayed next to the relevant cutoff for each school. Standard errors are clustered at the exam score level. Results include the 2002 through 2009 high school cohorts.
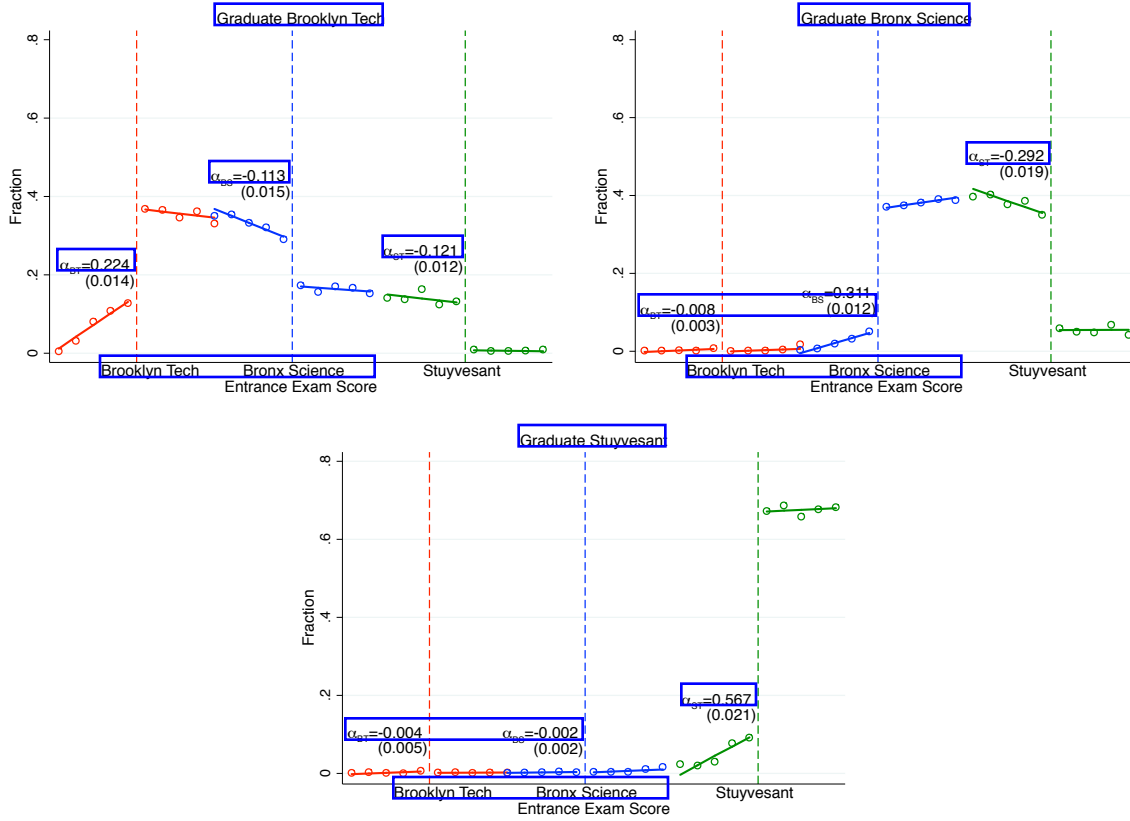
Figure 7
Regents Completion Results

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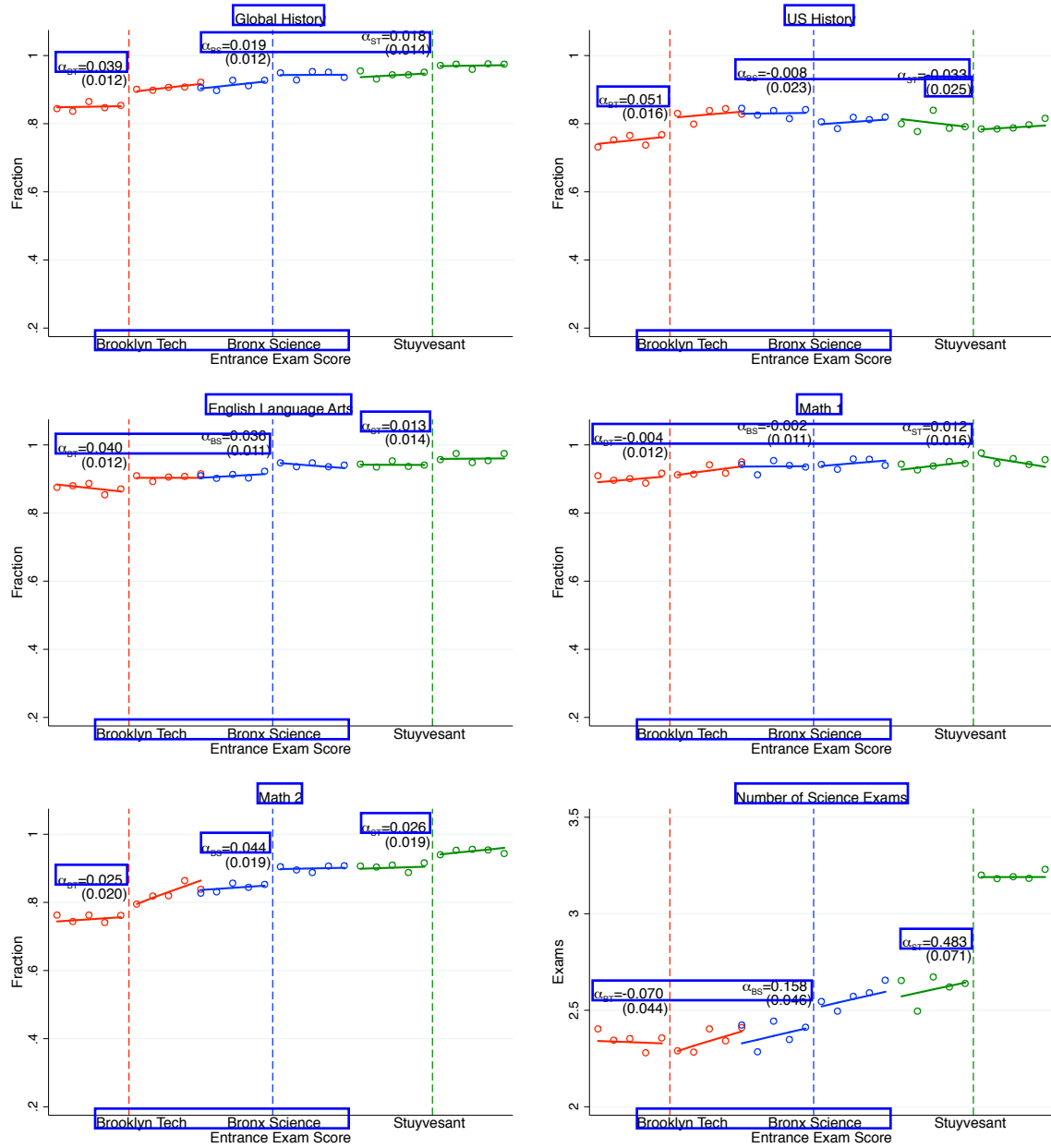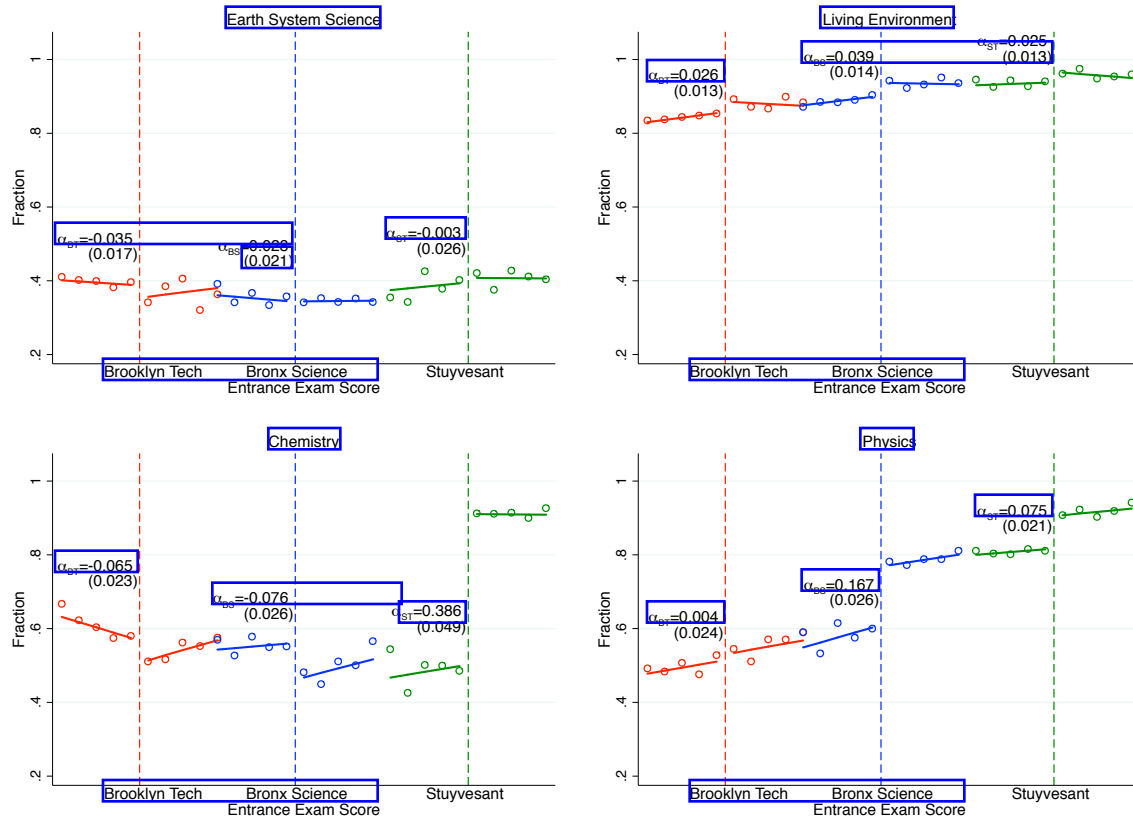
This figure presents raw outcomes in 0.05 wide bins and reduced form results for Regents exam completion. Outcomes within 0.25 standard deviations of each school's cutoff are presented, with cutoffs spaced by the average distance across the sample period. Point estimates and standard errors from a local linear regression of each outcome on entrance exam score, school eligibility, eligibility interacted with exam score, and cohort are displayed next to the relevant cutoff for each school. Standard errors are clustered at the exam score level. Results include the 2005 through 2009 high school cohorts.

Figure 9
SAT Results
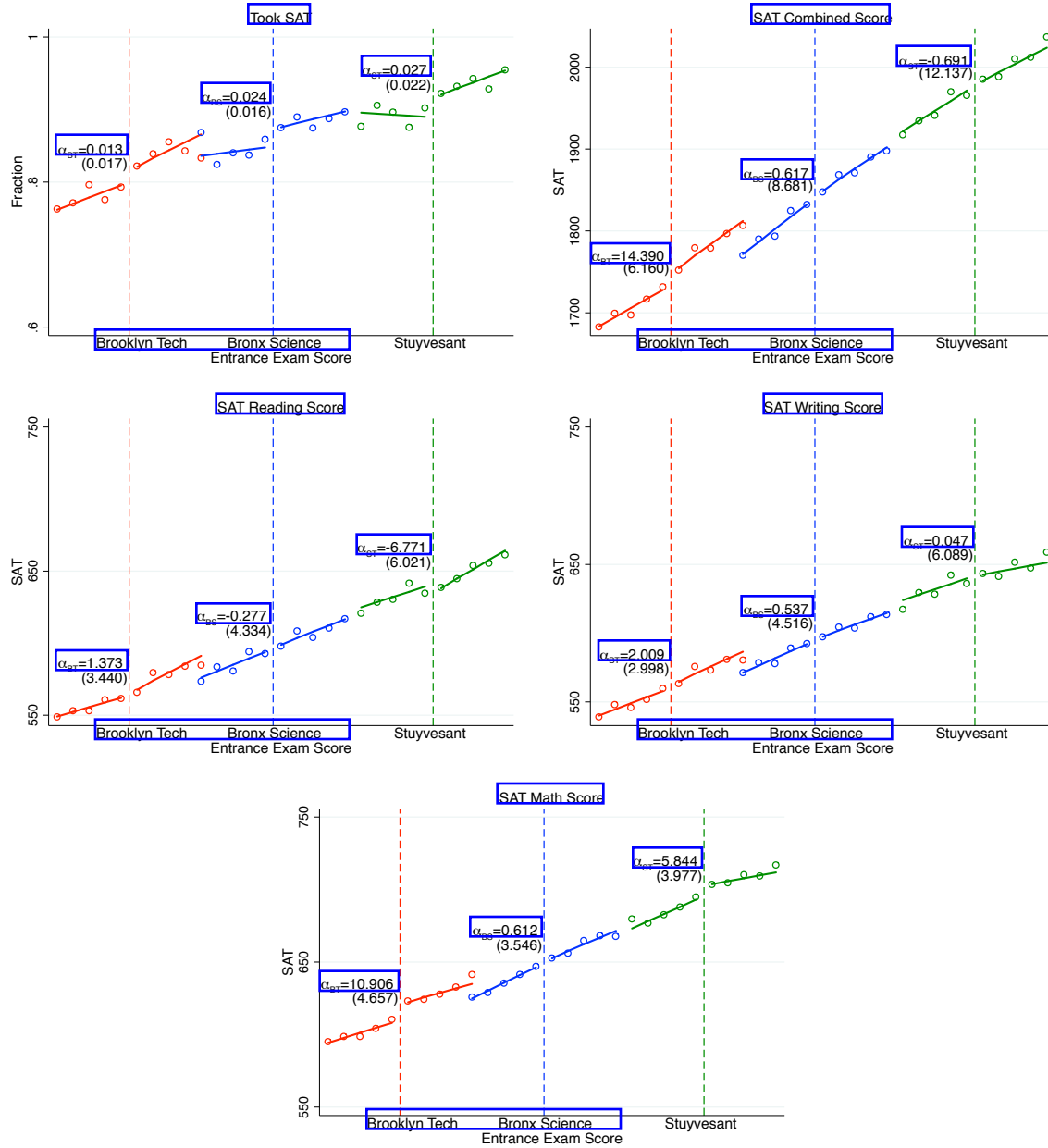
This figure presents raw outcomes in 0.05 wide bins and reduced form results for SAT results. Outcomes within 0.25 standard deviations of each school's cutoff are presented, with cutoffs spaced by the average distance across the sample period. Point estimates and standard errors from a local linear regression of each outcome on entrance exam score, school eligibility, eligibility interacted with exam score, and cohort are displayed next to the relevant cutoff for each school. Standard errors are clustered at the exam score level. Results include the 2007 through 2010 high school cohorts.

Table 1: SHSAT Score Cutoffs

HS Cohort	Applicants	Stuyvsant Rank Cutoff	Stuyvsant Score Cutoff	Bronx Sci Rank Cutoff	Bronx Sci Score Cutoff	Brooktech Rank Cutoff	Brooktech Score Cutoff
1994	14173	728	1.691	1995	1.104	5305	0.288
1995	13963	683	1.712	1821	1.171	4444	0.454
1996	14481	688	1.735	2118	1.100	4658	0.443
1997	16087	766	1.739	2321	1.123	5040	0.452
1998	16907	710	1.734	2114	1.183	4745	0.578
1999	17188	817	1.725	2006	1.228	5021	0.537
2000	17618	933	1.673	2248	1.177	4738	0.604
2001	18280	888	1.741	2330	1.186	4092	0.773
2002	18516	813	1.730	2245	1.170	4043	0.764
2003	19202	865	1.744	2264	1.230	4088	0.814
2004	19763	880	1.728	2202	1.241	3905	0.862
2005	19921	958	1.727	2190	1.279	3701	0.929
2006	20679	957	1.726	2075	1.312	3567	0.963
2007	25037	866	1.871	2046	1.434	3211	1.172
2008	26322	876	1.939	2313	1.410	3974	1.057
2009	26619	1088	1.863	2641	1.362	4182	1.040
2010	26707	1175	1.780	2966	1.265	4788	0.936
2011	25080	1220	1.740	3108	1.213	4853	0.894
2012	25871	1190	1.774	3289	1.182	4921	0.897
2013	27650	1179	1.814	3046	1.284	4976	0.941

This table reports the SHSAT cutoffs for each school and cohort. Test results are ranked from the highest score to the lowest, and administrators place students in high schools starting with the students with the highest score. Each student is placed into their most preferred school that still has seats until no seats remain at any exam school. We report the rank and standardized test score of the last student admitted to a school in each cohort.

Table 2

Data Availability

HS Cohort	Race Data	8th State Scores	Regents Scores	SAT Scores	HS Grad Data	College Enrollment
1994	No	No	No	No	No	Yes
1995	No	No	No	No	No	Yes
1996	No	No	No	No	No	Yes
1997	No	No	No	No	No	Yes
1998	No	No	No	No	No	Yes
1999	No	No	No	No	No	Yes
2000	No	No	No	No	No	Yes
2001	No	No	No	No	No	Yes
2002	No	Yes	No	No	Yes	Yes
2003	No	Yes	No	No	Yes	Yes
2004	No	Yes	No	No	Yes	Yes
2005	No	Yes	Yes	No	Yes	Yes
2006	No	Yes	Yes	No	Yes	Yes
2007	No	Yes	Yes	Yes	Yes	Yes
2008	Yes	Yes	Yes	Yes	Yes	Yes
2009	Yes	Yes	Yes	Yes	Yes	Yes
2010	Yes	Yes	No	Yes	No	No
2011	Yes	Yes	No	No	No	No
2012	Yes	Yes	No	No	No	No
2013	Yes	Yes	No	No	No	No

Table 3
Summary Statistics

Student Characteristics	NYC	Stuyvesant	Bronx Science	Brooklyn Tech
Male	0.510	0.575	0.561	0.576
White	0.124	0.280	0.269	0.214
Asian	0.137	0.670	0.599	0.570
Black	0.337	0.018	0.038	0.128
Hispanic	0.388	0.030	0.075	0.084
Free Lunch	0.619	0.390	0.312	0.621
8th Math	0.005	2.081	1.750	1.601
8th ELA	0.003	1.976	1.612	1.344
Regents Taking Outcomes				
Math 1	0.537	0.744	0.736	0.757
Math 2	0.171	0.748	0.741	0.717
English Language Arts	0.631	0.957	0.952	0.924
US History	0.518	0.762	0.770	0.909
Global History	0.641	0.965	0.963	0.942
Number of Science Regents	1.220	3.217	2.544	2.181
Living Environment	0.615	0.959	0.968	0.910
Earth System Science	0.296	0.358	0.252	0.356
Chemistry	0.214	0.960	0.377	0.391
Physics	0.095	0.940	0.947	0.525
Graduation Outcomes				
HS Graduate	0.468	0.930	0.911	0.871
Local Diploma	0.227	0.001	0.007	0.042
Regents Diploma	0.171	0.122	0.228	0.192
Adv. Regents Diploma	0.091	0.814	0.686	0.653
SAT Outcomes				
Took SAT	0.349	0.915	0.896	0.850
SAT Score (if taken)	1340.794	2058.967	1935.119	1794.771
College Outcomes				
Start 4-year College	0.319	0.839	0.834	0.777
College SAT > 1200	0.048	0.663	0.508	0.249
College SAT > 1300	0.024	0.519	0.321	0.129
College SAT > 1400	0.009	0.284	0.138	0.048
School Characteristics				
Teacher Salary	72557	78152	72088	76213
Teacher Experience	11.018	13.955	11.180	12.447
Teacher Absences	0.404	0.535	0.254	0.387
Students per Teacher	15.412	11.294	12.497	9.478
Students per Staff	14.440	10.674	10.165	9.281

This table reports summary statistics for New York City's exam high schools. The sample is restricted to NYC public school students in the 2002 through 2013 high school cohorts. Each outcome includes all available cohorts listed in Table 2. Regents Math 1 includes Math A and Integrated Algebra. Math 2 includes Math B and Trigonmetry. School characteristics are from the 2008 - 2009 school year.

Table 4
College Results by Gender and Middle School Type

Dependent Variable = Start a 4 year degree

	Public	Private	p-value	Male	Female	p-value
Stuyvesant	−0.023	0.019	0.129	−0.014	−0.012	0.949
	(0.017)	(0.022)		(0.018)	(0.022)	
	14156				14156	
Bronx Science	−0.003	0.020	0.335	0.004	−0.001	0.818
	(0.012)	(0.019)		(0.014)	(0.014)	
	27120				27120	
Brooklyn Tech	−0.001	−0.030*	0.209	−0.022	0.007	0.160
	(0.012)	(0.017)		(0.015)	(0.011)	
	39007				39007	

Dependent Variable = Graduate 4 year college

	Public	Private	p-value	Male	Female	p-value
Stuyvesant	−0.043	0.056	0.046	0.026	−0.068**	0.021
	(0.026)	(0.039)		(0.030)	(0.027)	
	9558				9558	
Bronx Science	−0.016	0.031	0.191	0.003	−0.018	0.411
	(0.022)	(0.028)		(0.021)	(0.022)	
	18709				18709	
Brooklyn Tech	−0.016	−0.039	0.504	−0.045***	−0.001	0.077
	(0.015)	(0.026)		(0.017)	(0.017)	
	27850				27850	

Dependent Variable = Start Post-grad Program

	Public	Private	p-value	Male	Female	p-value
Stuyvesant	−0.005	0.034	0.382	0.035	−0.029	0.065
	(0.023)	(0.039)		(0.027)	(0.027)	
	9558				9558	
Bronx Science	−0.018	0.010	0.427	−0.014	−0.013	0.974
	(0.018)	(0.028)		(0.018)	(0.024)	
	18709				18709	
Brooklyn Tech	−0.001	−0.004	0.917	−0.025**	0.018	0.050
	(0.012)	(0.023)		(0.012)	(0.017)	
	27850				27850	

Dependent Variable = Start at college with median SAT >1200

	Public	Private	p-value	Male	Female	p-value
Stuyvesant	0.019	0.003	0.629	0.013	0.015	0.954
	(0.020)	(0.028)		(0.025)	(0.026)	
	14156				14156	
Bronx Science	−0.007	0.011	0.531	−0.013	0.006	0.385
	(0.015)	(0.026)		(0.017)	(0.019)	
	27120				27120	
Brooklyn Tech	−0.012	0.017	0.279	−0.012	0.000	0.468
	(0.010)	(0.024)		(0.012)	(0.013)	
	39007				39007	

Dependent Variable = Start at college with median SAT >1300

	Public	Private	p-value	Male	Female	p-value
Stuyvesant	0.007	0.009	0.966	0.005	0.007	0.953
	(0.021)	(0.036)		(0.024)	(0.025)	
	14156				14156	
Bronx Science	−0.018	0.021	0.142	−0.030*	0.012	0.040
	(0.014)	(0.026)		(0.016)	(0.018)	
	27120				27120	
Brooklyn Tech	−0.014*	−0.022	0.703	−0.014	−0.017	0.816
	(0.008)	(0.020)		(0.009)	(0.012)	
	39007				39007	

Dependent Variable = Start at college with median SAT >1400

	Public	Private	p-value	Male	Female	p-value
Stuyvesant	0.018	−0.032	0.251	0.023	−0.018	0.179
	(0.018)	(0.037)		(0.019)	(0.025)	
	14156				14156	
Bronx Science	−0.017**	0.022	0.199	−0.020*	0.004	0.127
	(0.009)	(0.028)		(0.011)	(0.013)	
	27120				27120	
Brooklyn Tech	−0.004	0.001	0.716	−0.005	−0.001	0.783
	(0.005)	(0.014)		(0.006)	(0.009)	
	39007				39007	

This table reports reduced form estimates by subsample. The regressions also control for a local linear regression of each outcome on entrance exam score, school eligibility, eligibility interacted with exam score, and cohort. Standard errors are clustered at the SHSAT score level. *** = significant at 1 percent level, ** = significant at 5 percent level, * = significant at 10 percent level.

Table 5
College Results by Baseline State Test Score

Dependent Variable = Start a 4 year degree

	Upper Half	Lower Half	p-value	Upper Quartile	Lower Quartiles	p-value
Stuyvesant	0.011	−0.046	0.218	0.034	−0.036	0.074
	(0.027)	(0.044)		(0.033)	(0.032)	
		4250			4250	
Bronx Science	−0.014	−0.004	0.842	−0.022	−0.003	0.737
	(0.031)	(0.027)		(0.047)	(0.023)	
		7767			7767	
Brooklyn Tech	0.005	0.008	0.950	−0.047	0.015	0.343
	(0.040)	(0.024)		(0.064)	(0.020)	
		10286			10286	

Dependent Variable = Graduate 4 year college

	Upper Half	Lower Half	p-value	Upper Quartile	Lower Quartiles	p-value
Stuyvesant	0.031	0.004	0.832	−0.046	0.111	0.318
	(0.095)	(0.148)		(0.157)	(0.083)	
		696			696	
Bronx Science	−0.036	−0.005	0.810	0.066	−0.014	0.623
	(0.108)	(0.085)		(0.160)	(0.068)	
		1344			1344	
Brooklyn Tech	0.003	0.020	0.881	−0.040	0.031	0.797
	(0.098)	(0.045)		(0.246)	(0.046)	
		1830			1830	

Dependent Variable = Start Post-grad Program

	Upper Half	Lower Half	p-value	Upper Quartile	Lower Quartiles	p-value
Stuyvesant	0.046	0.031	0.915	0.074	−0.003	0.528
	(0.085)	(0.088)		(0.105)	(0.067)	
		696			696	
Bronx Science	−0.150	−0.056	0.426	−0.074	−0.068	0.962
	(0.111)	(0.049)		(0.137)	(0.047)	
		1344			1344	
Brooklyn Tech	−0.064	−0.009	0.520	0.035	−0.019	0.822
	(0.085)	(0.030)		(0.233)	(0.032)	
		1830			1830	

Dependent Variable = Start at college with median SAT >1200

	Upper Half	Lower Half	p-value	Upper Quartile	Lower Quartiles	p-value
Stuyvesant	0.062*	−0.027	0.125	0.072	0.002	0.290
	(0.036)	(0.048)		(0.048)	(0.042)	
		4250			4250	
Bronx Science	0.000	−0.007	0.875	−0.034	0.006	0.550
	(0.032)	(0.030)		(0.056)	(0.025)	
		7767			7767	
Brooklyn Tech	−0.009	0.001	0.828	−0.026	0.002	0.667
	(0.042)	(0.016)		(0.064)	(0.015)	
		10286			10286	

Dependent Variable = Start at college with median SAT >1300

	Upper Half	Lower Half	p-value	Upper Quartile	Lower Quartiles	p-value
Stuyvesant	0.059	−0.005	0.162	0.057	0.021	0.506
	(0.037)	(0.038)		(0.047)	(0.036)	
		4250			4250	
Bronx Science	0.002	−0.014	0.729	−0.023	−0.003	0.724
	(0.028)	(0.030)		(0.046)	(0.023)	
		7767			7767	
Brooklyn Tech	0.009	−0.020	0.427	0.029	−0.018	0.386
	(0.034)	(0.013)		(0.054)	(0.012)	
		10286			10286	

Dependent Variable = Start at college with median SAT >1400

	Upper Half	Lower Half	p-value	Upper Quartile	Lower Quartiles	p-value
Stuyvesant	0.060*	−0.001	0.161	0.054	0.028	0.566
	(0.032)	(0.027)		(0.037)	(0.027)	
		4250			4250	
Bronx Science	−0.027	−0.017	0.717	−0.063*	−0.009	0.188
	(0.023)	(0.014)		(0.038)	(0.011)	
		7767			7767	
Brooklyn Tech	0.010	−0.016**	0.311	0.045	−0.015**	0.098
	(0.023)	(0.008)		(0.035)	(0.007)	
		10286			10286	

This table reports reduced form estimates by 8th grade state test score. The sample includes the 2003 through 2009 high school cohorts who attended a public middle school in New York City. The upper half group consists of students with a combined math and English 8th grade score in the upper half of students close to and above the Brooklyn Tech cutoff. The upper quartile group is defined similarly. The regressions also control for a local linear regression of each outcome on entrance exam score, school eligibility, eligibility interacted with exam score, and cohort. Standard errors are clustered at the SHSAT score level. *** = significant at 1 percent level, ** = significant at 5 percent level, * = significant at 10 percent level.

8 Appendix A: Additional Results

Appendix Table 1
First Stage Results for All Exam Schools

	Stuyvesant	Bronx Science	Q. Sci/ Lehman	MSE	Brooklyn Tech
Stuyvesant	0.695***	−0.336***	−0.006	−0.001	−0.157***
	(0.025)	(0.029)	(0.009)	(0.005)	(0.023)
	3004	3004	3004	3004	3004
Bronx Science	0.001	0.346***	−0.074***	−0.021**	−0.075**
	(0.002)	(0.021)	(0.014)	(0.009)	(0.030)
	5872	5872	5872	5872	5872
Queens Science/Lehman	−0.005*	−0.006*	0.082***	−0.031**	−0.060**
	(0.003)	(0.004)	(0.011)	(0.015)	(0.029)
	7563	7563	7563	7563	7563
MSE	−0.007	−0.012**	−0.020**	0.068***	0.128***
	(0.008)	(0.005)	(0.010)	(0.018)	(0.041)
	8046	8046	8046	8046	8046
Brooklyn Tech	−0.009	−0.015***	−0.026***	0.021	0.242***
	(0.011)	(0.005)	(0.009)	(0.019)	(0.030)
	8150	8150	8150	8150	8150

This table presents reduced form estimates for graduating from each exam school. The sample includes the 2007 through 2009 high school cohorts. The Queens Science and Lehman results are combined as the cutoffs overlap in most years. When not overlapping, we use the lower of the two cutoffs. Standard errors are clustered by exam score. *** = significant at 1 percent level, ** = significant at 5 percent level, * = significant at 10 percent level.

College Results for All Exam Schools

	Start 4-year	1200+ SAT	1300+ SAT	1400+ SAT
Stuyvesant	−0.012	0.029	0.029	0.039
	(0.029)	(0.036)	(0.039)	(0.033)
	2720	2720	2720	2720
Bronx Science	0.005	0.012	0.000	−0.023
	(0.024)	(0.023)	(0.020)	(0.018)
	5111	5111	5111	5111
Queens Science/Lehman	−0.007	−0.015	−0.012	0.012
	(0.019)	(0.023)	(0.019)	(0.012)
	6415	6415	6415	6415
MSE	0.019	−0.010	−0.019	−0.029**
	(0.027)	(0.021)	(0.018)	(0.012)
	6778	6778	6778	6778
Brooklyn Tech	0.003	−0.021	−0.024	−0.029**
	(0.025)	(0.019)	(0.019)	(0.011)
	6855	6855	6855	6855

This table presents reduced form estimates for graduating from each exam school. The sample includes the 2007 through 2009 high school cohorts. The Queens Science and Lehman results are combined as the cutoffs overlap in most years. When not overlapping, we use the lower of the two cutoffs. Standard errors are clustered by exam score. *** = significant at 1 percent level, ** = significant at 5 percent level, * = significant at 10 percent level.

Appendix Table 3
High School Graduation Results for All Exam Schools

	Grad HS	Regents Diploma	Advanced Regents	Either Regents
Stuyvesant	−0.008	−0.007	−0.006	−0.013
	(0.015)	(0.019)	(0.022)	(0.017)
	2251	2251	2251	2251
Bronx Science	0.057***	−0.031*	0.079***	0.048***
	(0.014)	(0.017)	(0.024)	(0.013)
	4319	4319	4319	4319
Queens Science/Lehman	0.021	−0.015	0.036	0.021
	(0.019)	(0.016)	(0.023)	(0.019)
	5488	5488	5488	5488
MSE	0.031*	−0.009	0.025	0.016
	(0.017)	(0.024)	(0.028)	(0.019)
	5789	5789	5789	5789
Brooklyn Tech	0.029*	−0.029	0.054*	0.025
	(0.017)	(0.026)	(0.028)	(0.017)
	5866	5866	5866	5866

This table presents reduced form estimates for high school graduation outcomes. The sample includes the 2007 through 2009 high school cohorts. The Queens Science and Lehman results are combined as the cutoffs overlap in most years. When not overlapping, we use the lower of the two cutoffs. Standard errors are clustered by exam score. *** = significant at 1 percent level, ** = significant at 5 percent level, * = significant at 10 percent level.

SAT Results for All Exam Schools

	Took SAT	SAT Score
Stuyvesant	0.023	−6.271
	(0.030)	(22.850)
	3159	1015
Bronx Science	0.022	19.274
	(0.021)	(12.618)
	5996	1800
Queens Science/Lehman	−0.005	2.030
	(0.020)	(12.703)
	7544	2195
MSE	−0.008	17.383
	(0.019)	(13.259)
	7998	2297
Brooklyn Tech	−0.003	−3.021
	(0.016)	(12.866)
	8075	2320

This table presents reduced form estimates for SAT outcomes. The sample includes the 2007 through 2010 high school cohorts. The Queens Science and Lehman results are combined as the cutoffs overlap in most years. When not overlapping, we use the lower of the two cutoffs. Standard errors are clustered by exam score. *** = significant at 1 percent level, ** = significant at 5 percent level, * = significant at 10 percent level.

Appendix Table 6
College Results for NYC Sample

	Start 4-year	Grad College	1200+ SAT	1300+ SAT	1400+ SAT	Post Grad
Stuyvesant	−0.003	0.043	0.071**	0.042	0.036*	0.013
	(0.021)	(0.047)	(0.028)	(0.028)	(0.019)	(0.036)
	5569	1991	5569	5569	5569	1991
Bronx Science	−0.010	−0.007	0.005	−0.015	−0.022**	−0.048*
	(0.015)	(0.038)	(0.018)	(0.018)	(0.011)	(0.026)
	10504	4026	10504	10504	10504	4026
Brooklyn Tech	−0.001	−0.044	0.001	−0.002	−0.006	−0.018
	(0.016)	(0.030)	(0.013)	(0.010)	(0.006)	(0.022)
	13857	5389	13857	13857	13857	5389

This table presents reduced form estimates for college outcomes. The sample includes the 2002 through 2009 high school cohorts who attended a public middle and high school in NYC. Standard errors are clustered by exam score. *** = significant at 1 percent level, ** = significant at 5 percent level, * = significant at 10 percent level.

Appendix Table 7
Rule of Thumb Bandwidth

	Stuyvesant	Bronx Science	Brook Tech
First Stage Outcomes			
Graduate Stuyvesant	0.618	0.079	0.404
Graduate Bronx Science	0.289	0.221	0.103
Graduate Brooklyn Tech	0.324	0.165	0.174
NYC Public School	1.190	0.523	0.739
College Outcomes			
Start a 4 year degree	1.057	0.909	0.723
Graduate 4 year college	1.019	0.623	0.399
College SAT over 1200	0.750	0.489	0.728
College SAT over 1300	0.567	0.446	0.515
College SAT over 1400	0.592	0.477	0.459
Start Post-grad Program	0.653	0.761	0.804
High School Graduation Outcomes			
HS Graduate	0.421	0.914	0.353
Regents Diploma	0.645	0.532	0.268
Adv. Regents Diploma	1.027	0.499	0.430
Regents or Adv Regents	0.417	0.646	0.455
High School Regents Outcomes			
Math 1	0.766	0.413	0.599
Math 2	0.531	0.536	0.664
English Language Arts	0.567	0.560	0.728
US History	0.619	0.401	0.252
Global History	0.524	0.364	0.373
Number of Science Exams	0.726	0.761	0.408
Living Environment	0.536	0.377	0.480
Earth System Science	0.698	0.573	0.418
Chemistry	0.599	0.442	0.260
Physics	0.278	0.684	0.320
High School SAT Outcomes			
Took SAT	1.396	0.704	0.585
SAT Score (if taken)	0.781	0.567	0.703

This table reports optimal rule of thumb bandwidths from Imbens and Kalyanaraman (2009).

Appendix Table 8
Robustness of First Stage Results

	Stuyvesant	Bronx Science	Brooklyn Tech
Stuyvesant	2.712***	−1.350***	−0.617***
	(0.087)	(0.109)	(0.093)
	4218	4218	4218
Bronx Science	0.009	1.419***	−0.353***
	(0.007)	(0.063)	(0.089)
	8173	8173	8173
Brooklyn Tech	−0.030	−0.046***	1.110***
	(0.034)	(0.017)	(0.101)
	11301	11301	11301

This table presents reduced form estimates for the number of years attending each exam school. The sample includes the 2007 through 2010 high school cohorts. Standard errors are clustered by exam score. *** = significant at 1 percent level, ** = significant at 5 percent level, * = significant at 10 percent level.

Appendix Table 9
Bin Width Test

No. of Bins	Bin Size	Stuyvesant Enrollment	Grad	Bronx Science Enrollment	Grad	Brooklyn Tech Enrollment	Grad
25	0.02	0.003	0.002	0.956	0.565	0.169	0.227
13	0.04	0.506	0.510	0.702	0.552	0.757	0.294
10	0.05	0.247	0.290	0.349	0.035	0.559	0.041
5	0.010	0.000	0.000	0.000	0.000	0.000	0.000

This table reports results of the optimal bin width. Each column reports results of a regression of where we add a set of interactions between the bin dummies and the running variable to a base regression of an outcome variable on the set of bin dummies. The p-value is from the test of whether the interactions are jointly significant.

9 Appendix B: Data Description and Construction of Variables

9.1 New York City Administrative Data

Demographic variables

Demographic information was pulled from New York City enrollment files spanning the 2003-04 to 2009-10 school years, with precedence given to the most recent file. Race consisted of the following categories: Black, Hispanic, White, Asian, and Other. These categories are considered mutually exclusive.

A student was considered free lunch if he was coded as "A" or "1" in the raw data, which corresponds to free lunch or "2" which corresponds to reduced-price lunch. A student was considered non free lunch if the student was coded as a "3", which corresponds to Full Price. All other values, including blanks, were coded as missing.

New York State 8th Grade Test Scores

State test scores in 8th grade were pulled from the NYC test score files spanning the 1999 - 2000 to 2009 - 2010 school years. Scores were standardized by year and grade to have mean of zero and standard deviation of one. The state mathematics and English Language Arts tests, developed by McGraw-Hill, are exams conducted in the winters of third through eighth grade. The math test includes questions on number sense and operations, algebra, geometry, measurement, and statistics. Tests in later grades focus on advanced topics such as algebra and geometry. The ELA test is designed to assess students on three learning standards nformation and understanding, literary response and expression, critical analysis and evaluation ncludes multiple-choice and short-response sections based on a reading and listening section, along with a brief editing task.

New York State Regents Test Scores

Regents test scores for high school subjects were pulled from the NYC Regents test score files for 1998 - 1999 through 2009 - 2010. For each subject we construct indicator variables for a student having taken the exam, for having passed the exam at the basic level (55 out of 100), for having passed the exam at the Regents level (65 out of 100), and for having obtained mastery in the subject (85 out of 100). As the structure of the Math exams have changed over our sample period, we combine Sequential Math 1, Math A and Integrated Algebra scores and Sequential Math 3, Math B, and Trigonometry scores (based on the advice of NYC staff). Results are identical if we restrict the results to Math A and B, which make up the majority of our observations.

Regents exams are administered within schools in January, June, and August of each calendar year and are given in a wide variety of subjects, but scores range from 0 to 100 for every Regents exam. Students typically take exams at the end of the corresponding course, so that most students take the exams in June. Unlike most other standardized exams, teachers grade the Regents exams for students in their own school. The State Education Department of New York provides explicit guidelines for how the teacher-based scoring of each Regents exam should be organized.

Regents exam requirements have changed somewhat during the years we examine (1998 to 2010). To graduate, students generally must score at least 55 on each of five core Regents examinations: English, Mathematics, Science, U.S. History and Government, and Global History and Geography. In order to receive a more prestigious Regents Diploma, students must receive a score of at least 65 in each of these five core subjects. To earn an Advanced Regents Diploma, students must also score at least a 65 on elective exams in math, science, and foreign language.

Currently, the option of receiving a local diploma is being eliminated entirely. Beginning with those who entered the 9th grade in the fall of 2008, students are required to meet the Regents Diploma requirements (score 65 or higher in each of the five core subjects) in order to graduate

from high school in New York State. The shift from local diploma to Regents diploma requirements was done gradually, with students entering 9th grade in fall 2005 having to score 65 in at least two core subjects, and each subsequent cohort facing stricter requirements.

A score of 85 is labeled as achieving mastery of the subject matter. While scoring 85 or higher is not relevant for high school graduation, meeting this cutoff is often used by high schools as a prerequisite for courses and by New York State colleges as either a prerequisite or qualification for credit towards a degree. Beginning with students who entered 9th grade in the fall of 2009, an additional accolade of Annotation of Mastery in science and/or math became available for students who score above 85 on three Regents exams in science and/or math.

Regents examinations contain both multiple-choice and open-response questions. The foreign language exams also contain a speaking component. Scoring materials provided to schools include the correct answers to multiple-choice questions and detailed, subject-specific instructions and procedures for evaluating open-ended and essay questions.

School Characteristics

School-level student variables were constructed for each school based on the population of students who were assigned to that high school in the NYC graduation files for the 2002 through 2009 high school cohorts.

School-level teacher variables were constructed for each school based on the 2008 - 2009 Human Resources file. We define teacher salaries as the mean salary for all school staff designated as full time teachers. Teacher experience is defined similarly. Student to teacher and staff ratios were constructed using 2008 - 2009 staffing levels and the average cohort size for the 2002 through 2009 high school cohorts.

High School Graduation variables

High school graduation variables were pulled from the 2002 through 2009 city and state graduation files. City files are available for all years, while state files are only available for 2002 - 2008. In overlapping years the state files are given precendence. A student is defined as having graduated if she received a local, Regents, or Advanced Regents diploma. We define students who transfer, drop out, receive a GED, or receive a special education diploma as having not graduated.

SAT variables

SAT score variables were pulled from the 2006 through 2009 city SAT files, which consists of SAT scores for all students enrolled in a public NYC school when taking the SAT. We use a student's best combined score during the testing period. All scores are out of 2400.

9.2   Specialized High Schools Admissions Test Data

Admissions to the academic SHS is determined by the Specialized High Schools admissions test (SHSAT). The test is broken into two sections, one math and one verbal, and students are given 2 hours and 30 minutes per section with no break. The verbal section is made up of 45 multiple-choice questions. 30 questions test reading comprehension, 10 questions test logical reasoning, and 5 questions require students to put sentences into the most logical order in a paragraph. The math section is comprised of 50 multiple-choice questions, which test basic math, algebra (factoring and substitution), geometry, basic graphing, logic, and word problems.

In scoring the SHSAT, there is no penalty for wrong answers and correct answers receive points. The raw number of questions correct is scaled through a Department of Education formula, and scores fall between 200 and 800. Due to the formula used by the DOE, students who score very

highly in one section but poorly in another are more likely to have a higher score than students who score well on both.

On the day of the exam, students rank the schools in order of where they want to go. Test results are ranked from the highest score to the lowest, and administrators place students in high schools starting with the students with the highest score. Each student is placed into their most preferred school that still has seats until no seats remain at any SHS.

SHSAT scores, gender and middle school type were pulled from the NYC test score r 1989 through 2008. Scores were standardized by year to have mean of zero and standard deviation of one in the sample of test takers. Eligibility rank and score cutoffs were defined as the first student who wanted to attend a specific school but was not accepted to that school. Gender was coded as male, non-male, or missing. Middle school type was coded as public, private, or missing. We consider only 8th grade admissions, dropping all SHSAT scores from 9th grade.

9.3 National Student Clearinghouse Data

Information on college attendance and graduation comes from the National Student Clearinghouse (NSC), a non-profit organization that maintains enrollment information for 92 percent of colleges nationwide. We provided each student's full name, date of birth and high school graduation date, which the NSC used to match to its database. The NSC data contain information on enrollment spells for all covered colleges that a student attended. Information is available on full or part-time status and degree receipt in some cases.

We code a student as having enrolled in a four year college if she ever attends a four year school in the NSC data. We code a student as having graduated from a four year college if she if the NSC data indicates having received a degree from a four year school. We code a student as having enrolled in a post-graduate university if they enroll in any non-two-year college after receiving a four year degree.

To provide a measure of college quality, we match the NSC data to data on college characteristics from the U.S. News and World Report. The U.S. News and World Report collects data on college characteristics and statistics for four-year colleges in the U.S., including average class size, size of the faculty, graduation rates, tuition, room and board, average debt, loan size, percent of students receiving aid, acceptance rate, standardized test scores, high school GPA where available, demographic information on gender and the diversity index, freshman retention, and annual alumni donations. We use midpoint SAT score as our primary measure of college quality. When only ACT scores are available, we convert them to SAT scores using the ACT's official score concordance chart found at http://www.act.org/aap/concordance/. We code a student as having attended a school with an SAT over 1200/1300/1400 if any of the four year schools attended by that student have a median SAT over that threshold.

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