Is Busing Worth the Trip?
School Travel Effects in Boston and New York*

Joshua D. Angrist† Guthrie Gray-Lobe ‡ Clemence Idoux § Parag Pathak¶

October 19, 2021

PRELIMINARY AND INCOMPLETE

Abstract

School assignment in Boston and New York City came to national attention in the 1960s and 1970s in the wake of court-mandated desegregation. Today, district-wide choice allows Boston and New York students to enroll far from home, perhaps enhancing integration. Urban school transportation is costly, however, and the integration and education consequences of this expenditure unclear. Motivated by high transportation costs, we estimate the causal effects of school distance and travel time on integration and human capital using an identification strategy that exploits the Boston and New York City school matches. Simulations of alternative assignment schemes suggest that a return to neighborhood schools is likely to increase same-race exposure district-wide by only a few percentage points. Instrumental variables estimates show larger integration effects for those who currently choose to travel, but longer travel times have little or no effect on test scores and college attendance. Consistent with this, IV estimates of the effects of peer race directly fail to support the view that exposure to non-minority peers increases school quality for minority students. On balance, therefore, our results show little downside to school assignment policies that favor neighborhood enrollment.

*Thanks to Adrian Blattner, Kate Bradley, Nicolas Jimenez, Vendela Norman, and Chetan Patel for exceptional research assistance and to Eryn Heying and Anna Vallee for dependable administrative support. We gratefully acknowledge funding from the Spencer Foundation. This paper reports on research conducted under data-use agreements between MIT, the project principal investigators (Angrist and Pathak), the Boston Public Schools, and the New York City Department of Education. This paper reflects the views of the authors alone.

†MIT Department of Economics and NBER. Email: angrist@mit.edu

‡University of Chicago Department of Economics. Email: graylobe@uchicago.edu

§MIT Department of Economics. Email: cidoux@mit.edu

¶MIT Department of Economics and NBER. Email: ppathak@mit.edu

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1 Introduction

> We can no longer afford to spend millions a year to bus children across Boston to schools that are not demonstrably better than schools near their homes.
> – *Theodore Landsmark, January 2009*

For over a half a century, some of the most polarizing policy debates in American cities have centered on the consequences of school assignment for racial integration in public schools. Neighborhood-based assignment plans, still common in most suburban school districts, necessarily reflect patterns of residential segregation. But travel to non-neighborhood schools can be costly and time-consuming, and most families, white and nonwhite, report a preference for schools closer to home (Hastings, Kane and Staiger, 2009; Abdulkadiroğlu, Agarwal and Pathak, 2017). Widely-shared preferences for neighborhood schools notwithstanding, many of America's urban school districts spend large sums transporting children to school. This is documented in Figure 1, which plots average annual per-pupil transportation expenditure in the 150 largest U.S. school districts for 1997-2017. Boston and New York City Schools are at or near the top of per-pupil transportation costs, spending 1200−2100 per student annually. Transportation spending in Boston and New York is also growing: the cost of getting kids to school in these cities roughly doubled in the two decades covered by the figure.[1]

Transportation expenditures today are driven in part by the fact most large urban school districts allow families to choose non-neighborhood schools. In these districts, seats at over-subscribed schools are allocated by choice algorithms that reflect family preferences (usually in the form of a rank-order list) and school priorities that need not consider proximity. District-wide choice is an outgrowth of decades of contentious debate on the relationship between school assignment and segregation (Willie and Alves, 1996). In Boston, postwar segregation reflected the racial gerrymandering of school catchment areas, while early court-mandated interventions aimed at undoing this. As courts have gradually relaxed their oversight of school assignment, choice systems have come to be seen as an attractive compromise between zoned neighborhood assignment and mandatory busing for racial balance. Choice in large urban districts is appealing because it potentially decouples school assignment from underlying residential segregation, facilitating integration. Moreover, where school quality is unevenly distributed over neighborhoods, choice systems may give all students an equal shot at schools viewed as high-quality.

This paper asks whether school travel in the modern choice framework is working as hoped, boosting integration and school quality, especially for minority students. First, using a simulation of hypothetical neighborhood-prioritizing assignment, we quantify the district-wide consequences of reduced travel. We then apply quasi-experimental methods to capture the causal effects of travel to non-neighborhood schools for students who choose non-neighborhood schools. The latter analysis exploits the random assignment embedded in the matching algorithms deployed in Boston and New York. These two cities are of special interest in this context both because of their high

[1] New York City data omit the cost of subway and bus passes for high schools students.

transportation costs and because they've long been battlegrounds in the fight over integration.[2]

In aggregate, school choice appears to reduce same-race exposure (SRE), that is, the share of a student's classmates who are of the same race as the student. This modest integrating effect emerges from a simulation of a hypothetical neighborhood assignment system in which students and schools rank one another in order of proximity. Increased SRE from neighborhood school assignment is most pronounced for Black students, but still amounts to only a few percentage points. Along with a small increase in SRE, district-wide neighborhood schooling also yields a marked reduction in travel time and, consequently, in school transportation costs. Under conservative assumptions about costs, neighborhood assignment might save over US$ 1,000 per currently transported student.

The simulation results suggest neighborhood assignment policies need not boost segregation sharply. This finding reflects the fact that many students already enroll close to home and many who would be shifted by neighborhood assignment move to schools with a similar demographic make-up. But the gains from travel to non-neighborhood schools may be concentrated among those who choose to travel. Following the aggregate analysis, therefore, the paper turns to estimation of causal effects of non-neighborhood enrollment on students for whom school travel is currently facilitated by school choice.

As a benchmark, Ordinary Least Squares (OLS) estimates show that students who travel farther indeed score higher on tests and are more likely to enroll in college. However, these estimates may reflect selection bias if those who enroll farther from home are more motivated or from less disadvantaged families. The possibility of selection bias motivates an instrumental variables (IV) analysis strategy that exploits the randomization implicit in centralized assignment. Quasi-experimental IV estimates reveal that travel beyond neighborhood boundaries exposes children to fewer same-race peers, with larger integration effects on those who travel than are seen when neighborhood assignment is adopted district-wide. Perhaps surprisingly, however, the IV estimates show little evidence of travel-induced gains in achievement or college enrollment.

Our analysis connects with academic research considering the effects of school choice on individual students, including Hastings and Weinstein (2008) and Deming (2011). Other related work examines the consequences of attendance at various types of schools or sectors, such as charter and pilot schools, exam schools, magnet schools, or schools with high value-added (Cullen, Jacob and Levitt (2006); Abdulkadiroğlu et al. (2011); Abdulkadiroğlu et al. (2017*b*); Angrist et al. (2016); Lucas and Mbiti (2014); Ajayi (2014); Hoxby, Murarka and Kang (2009); Dobbie and Fryer (2011, 2014); Abdulkadiroğlu et al. (2016)). This literature, which finds the most robust evidence for learning gains to be generated by attendance at high-expectations charter schools and schools with high value-added, largely ignores questions related to distance and travel.

We also build on research that considers integration effects directly, including Welch and Light (1987); Hoxby (2000*b*); Rossell and Armor (1996); Rivkin and Welch (2006). The end of *de jure* segregation has been shown to have yielded important economic gains for Blacks (e.g., Smith

[2]School choice may have effects beyond those considered here. For example, the competition choice engenders may promote quality, as suggested by Chubb and Moe (1990). Research exploring such choice externalities includes Hoxby (2000*a*), Hastings, Kane and Staiger (2009) and Campos and Kearns (2021)

and Welch (1989) and Card and Krueger (1992)). Guryan (2004) and Johnson (2019) likewise report estimates showing integration-induced education gains for Black students outside the South. But the changes studied in this earlier work typically coincided with major changes in per-pupil expenditure and enrollment. Our study uses school assignment lotteries to isolate travel effects while holding district-level variables related to spending and enrollment fixed. And the importance of cross-neighborhood travel to these gains remains unclear. It is therefore worth asking how much travel to non-neighborhood schools contributes to integration and learning.[3]

The next section describes the Boston and NYC school districts. Section 3 discusses the data used in this study and presents descriptive statistics. After laying out key facts related to the evolution of SRE in the preceding two decades, Section 4 reports neighborhood-assignment simulation results. Section 5 details the IV estimates, while Section 6 considers possible explanations for the lack of an impact of travel on education outcomes. Consistent with the main findings, this section reports direct estimates of the effects of peer racial composition on education outcomes that also suggest null effects. These results therefore indicate that travel matters little not merely because the SRE consequences of travel are modest, but rather because SRE itself matters little. Finally, Section 7 summarizes our findings and suggests directions for further work.

2 Background

A seemingly quotidian matter, school transportation in many districts is the legacy of decades of racial strife. The debate over busing in the Boston Public Schools (BPS) came to national attention in April 1976, when the front page of the Boston Herald American featured a photo captioned "The Soiling of Old Glory" (Masur, 2008). Snapped on Boston's City Hall Plaza, the photo showed an angry white teen using the American flag to attack African American attorney Theodore Landsmark. The attacker was a participant in an unruly and sometimes-violent anti-school-busing protest, the victim, a bystander.

Massachusetts' Racial Imbalance Act of 1965 laid the legal groundwork for school busing in BPS. The Act defined racial imbalance in statistical terms and required that schools deemed racially imbalanced desegregate or lose state funding. This legislation notwithstanding, until 1974, BPS students attended schools in catchment areas that seemed designed to segregate by race. The elected Boston School Committee of the 1960s failed to cooperate with state efforts to desegregate schools. This defiance ultimately led to a 1974 Federal District Court ruling imposing the state's busing plan on the city. United States District Judge Arthur Garrity, the presiding judge in the case, effectively managed BPS school assignment until 1983, with the state taking over through 1988. Only in 1989 did responsibility for school assignment revert to the district.

BPS's "controlled choice" assignment plan of the early 1990s, described in Willie and Alves (1996) and Willie, Edwards and Alves (2002), initially targeted racial balance. In 1997, however, the Boston desegregation case was officially closed. Two years later, the Boston School Committee

[3] Chingos and Monarrez (2020) survey recent research on school choice and segregation. See also Monarrez (2020).

voted to eliminate the use of race and ethnicity for purposes of school assignment. Since the 2000-2001 school year, BPS school assignment has ignored race. From 1999 to 2004, the nascent BPS match used immediate acceptance, a widely-criticized manipulable assignment mechanism (Abdulkadiroğlu et al., 2006; Pathak and Sönmez, 2008). The modern era of centralized assignment begins with the Landsmark, Dajer and Gonsalves (2004) report, which recommended use of a strategy-proof algorithm for seat assignment. The Boston school match has since used deferred acceptance (DA) to assign seats at BPS's traditional public schools and Boston's pilot schools. DA in BPS uses a random "lottery number" to distinguish otherwise identical applicants. The Boston match relies on choice rather than court-ordered busing to facilitate school access across neighborhood lines.[4]

The New York City busing saga featured less court involvement than Boston's, but was no less contentious. In the 1950s and 1960s, New York City school assignment was mostly neighborhood-based. Unsurprisingly, segregated neighborhoods led to similarly segregated neighborhood schools, though not necessarily by design. In the 1960s, critics of the city's *de facto* segregation argued that the schools attended by Black children were overcrowded, run-down, and staffed by inexperienced teachers. Attempts both to mandate (and to proscribe) cross-neighborhood busing nevertheless repeatedly foundered (Delmont, 2016). Dissatisfaction with educational opportunities for minority children came to a head in February 1964, with a boycott in which nearly half a million mostly minority children stayed home from school, one of the largest protests in US history. The boycott was followed later in the year by a white-led counter-boycott.

Discussion of segregation in NYC today often focuses on the fact that white and upper income families have many options that effectively bypass mostly-minority traditional public schools.[5] These alternative options include private schools, screened public schools that select applicants according to a variety of criteria, and highly coveted seats at the city's specialized high schools, including the renowned Stuyvesant, Brooklyn Tech, and Bronx Science. The latter are assigned through a match within the specialized sector (seats at BPS's three selective enrollment schools, known as exam schools, are likewise assigned using DA with non-lottery tie-breaking). New York's many other selective enrollment "screened schools" came to prominence in the 1970s, when the City expanded the use of selective admissions in the hope of encouraging mostly white and Asian middle class families to remain in city schools.

Modern Centralized Assignment

Since the early 2000s, BPS has assigned seats centrally, taking as inputs to the assignment algorithm school priorities and student preferences over schools (which students rank). Between 2001 and 2005, BPS assigned students using an immediate acceptance algorithm. Since 2006, BPS has assigned seats using deferred acceptance (DA). The BPS version of DA gives priority to siblings of

[4]BPS pilot schools, run by the district, are meant to be a model halfway between the broad autonomy of state-authorized charter schools and traditional public schools. Boston charter schools mostly operate independently of BPS. Abdulkadiroğlu et al. (2011) estimates charter and pilot school effects on test scores.

[5]This viewpoint is reflected in the New York Times' widely-heard 2020 podcast, Nice White Parents.

enrolled students and to students deemed to reside in a school's neighborhood or walk zone. Boston students may also attend publicly funded charter schools and one of three public selective-enrollment "exam" schools. The BPS match breaks ties using a single random lottery number assigned to each student. Boston charter schools run single-school lotteries, while BPS exam schools run a separate DA match using a weighted average of middle school GPA and an admissions test result as the tie-breaker.[6]

Centralized assignment at NYCDOE schools is also based on student preferences, school-specific priorities, and a DA match. Priorities depend on many factors, including geography and attendance at an open house prior to the match. Within priority groups, tie-breaking is based either on a random lottery number or on (school-specific) non-lottery criteria like test scores, interviews, and auditions. Schools using non-lottery tie-breakers are known as "screened schools", while those using lottery tie-breaking are said to be "unscreened". The NYCDOE high school match excludes charter schools and a few highly selective exam schools such as Stuyvesant and Bronx Science (these are called "specialized high schools" in NYC vernacular). As in Boston, NYC exam schools run a separate match.

3 Data and samples

The BPS data analyzed here include all 6th and 9th grade students and the subsample of applicants for 6th and 9th grade seats in BPS traditional and pilot schools from 2002-16. The BPS applicant sample omits those who applied only to selective enrollment (exam) schools and charter schools. The applicant data include preferences as reflected in rank order lists, geocode of residence, priorities at each program listed, lottery tiebreaker values, and the program to which the applicant was assigned.

BPS assignment files are linked to state data files containing demographic characteristics and to files with scores on the Massachusetts Comprehensive Assessment System (MCAS) and college enrollment information originally obtained from the National Student Clearinghouse (NSC). The MCAS is a standardized assessment for all Massachusetts public school students, taken in Grades 3-10. We use Grade 4 MCAS tests in Math and English Learning Arts (ELA) as baseline controls for applicants to Grade 6, and Grade 8 MCAS scores in Math and ELA as baseline controls for applicants to Grade 9.

Our NYCDOE data cover all students who either enrolled in 9th grade at public city schools or who applied for a 9th grade seat through the high school match. We focus on New York applicants seeking 9th grade seats in traditional public schools from 2012-16.[7] As in Boston, applicants to NYC specialized (exam) and charter schools only are omitted from the applicant file. NYC match data include applicant's rank order lists of schools, priorities, and school assigned. Enrollment data indicate the school where the student enrolled in each year after assignment. Application and

[6]Boston's three exam schools admit students mainly in 7th and 9th grade. Abdulkadiroğlu, Angrist and Pathak (2014) uses the exam school match to estimate causal effects of exam school attendance on educational outcomes in Boston and New York.

[7]The most recent cohort is determined by outcome variable availability, while the initial cohort marks the poiint at which we can replicate the relevant match.

enrollment data are linked with standardized test scores in math and ELA from assessments in 6th grade and with SAT scores, taken mostly in 11th grade. The NYCDOE also supplied NSC-derived college enrollment for participants in the high school match.

The BPS and NYCDOE student populations, described in columns 1 and 5 of Table 1, are similar to those in many large urban school districts. Most students in these cities are Black or Hispanic, with 22% white or Asian in Boston and 29% white or Asian in NYC. Roughly three-fourth of BPS and NYCDOE students come from families poor enough to qualify for a free or subsidized lunch. 18% of BPS students receive special education services, with a slightly large share listed as having limited English proficiency. Special education students make up a much smaller share of the NYC applicants sample because most NYC students qualifying for special education services enroll in schools outside the main match. We estimate school proximity effects for students who participate in their district's match (seeking 6th or 9th grade seats in Boston; seeking 9th grade seats in NYC). Appendix Table 1 details the sample selection rules and sample sizes retained in the transition from the enrolled to applicant sample. The bulk of Boston non-participants are continuing 6th graders enrolled in K-8 schools or those applying to charter and exam schools only. NYC non-participants are mostly continuing 9th graders enrolled in 6-12 schools, special education students seeking programs outside the main match, students who fail to apply for one reason or another and are later administratively assigned, and students who apply to charter and exam schools only.[8]

The sample of applicants is broadly comparable demographically to the sample of enrolled applicants in both cities, although there are a few notable differences. Compared to the overall population of enrolled BPS students, applicants tend to be lower income. Out of the sample of BPS applicants, 81% receive free or reduced price lunch (column 2 of Table 1) compared to 73% of the enrolled population (column 1 of Table 1). Applicants are also slightly more likely to be Black or Hispanic, and have lower baseline test scores. These differences are explained in part by the fact that the applicant sample excludes students who applied only to exam or charter schools. These schools tend to enroll children from higher income families, more white and Asian students, and often use test scores for admissions. In NYCDOE, the applicant sample and the enrolled sample are similar in terms of racial composition and free or reduced price lunch status. However, baseline test scores for the applicant sample than the enrolled sample. This is attributable to the fact that the applicant sample excludes most students qualifying for special education services.

4 Choice vs. Neighborhood Assignment in Boston and NYC

Today's centralized school assignment schemes afford considerable opportunity for racial integration, at least in principle. The architecture of 21st Century school choice emerged in large part from a desire to stem a return to segregated neighborhood schools (Willie and Alves, 1996; Toch and Alderman, 2009). Boston and New York families now have a good chance of being assigned

[8]The applicant sample omits continuing students other than those who had submitted a transfer request. Applicant samples likewise omit late-arriving students seeking seats after the match.

to most of the public schools in their cities, including schools in neighborhoods well away from the one in which they live. At the same time, centralized assignment affords many families the option of a seat at nearby schools as well. Although choice facilitates integration, it does not guarantee it. As noted by Laverde (2020), preferences for neighborhood schools limit the integration afforded by choice.

In this section we consider the effect of reassigning students in Boston and New York City using a neighborhood assignment mechanism instead of the status quo choice system. We consider a neighborhood zoned assignment system that accounts for the geographic distribution of school capacity within each district. The neighborhood assignment system assigns students using a pseudo-deferred acceptance algorithm in which both students and schools rank one another in order of proximity. This assignment system uses information on the residential location of each student (geocode in BPS, census tract in NYCDOE), the location of each school, and the capacities of each school.[9] Capacities in both districts are unobserved and we impute the maximum feasible capacity at each school to be the maximum number of students who have ever enrolled at the school during the years for which we have data. The algorithm then uses the imputed preferences for proximity to allocate all available seats to students using a deferred acceptance algorithm.

We compare the status quo choice assignment to the neighborhood zoned assignment system for all students, including both the applicant sample and the sample of students who enroll in BPS schools but did not apply through the first round match. The non-applicant enrolled students may include students who were not required to apply through the centralized match because they were continuing in their same school from the prior year (BPS 6th grade applicants enrolled in K-8 schools and NYCDOE 9th grade applicants enrolled in 7-12 schools).

Neighborhood assignment is compared to the assignment under choice in terms of average travel time of students to schools, the share of students who are eligible for public transportation subsidies, and the degree of segregation. We use existing criteria for eligibility for publicly provided transportation in BPS and NYCDOE. Students are deemed eligible for public transportation to school when they travel more than 1.5 miles to school in BPS and 0.5 miles in NYCDOE. We gauge school segregation using a measure of same-race exposure: the share of students residing in a geographic area who are of the same racial group.[10]

Reassigning all students using the neighborhood zoned assignment policy reduces the travel time for students by half and has large negative effects on the share of students who qualify for public transportation. Among BPS 6th graders, assigning students to a neighborhood school could reduce the share who qualify for public transportation from 58 to 10 percent (Column 5 of Table A2).

[9] As part of remedies implemented in 1974, BPS students were assigned neighborhoods known as geocodes; these were used to identify school-centered "walk zones." Appendix Figure A1 reproduces the boundaries of Garrity-era geocodes and shows a few walk zones.

[10] Such measures have a long history in public discussion of segregated schools. The Morgan v. Hennigan 379 F. Supp. 410 (D. Mass. 1974) decision, for example, lamented "racially identifiable schools", noting that 84% of white students attended schools that were more than 80% white, while 62% of Black students attended schools that were more than 70% Black. Same-race exposure also features in many academic studies of residential and school segregation (e.g., Massey and Denton (1988); Fryer and Echenique (2007))

Among BPS 9th graders, assigning students to a neighborhood school could reduce the share who qualify for public transportation from 76 to 38 percent. Among NYCDOE 9th graders, assigning students to a neighborhood school could reduce the share who qualify for public transportation from 96 to 76 percent.

In aggregate, neighborhood assignment would increase segregation in both BPS and NYCDOE, especially for Black students. For BPS 6th graders, moving to neighborhood assignment from the current system of school choice would increase the share of a student's peers who are the same race 0.2 percentage points. For BPS 9th graders, neighborhood assignment would increase SRE by 1.8 percentage points. For NYCDOE 9th graders, neighborhood assignment would increase SRE by 4.7 percentage points. The effect of neighborhood assignment on SRE is largest for Black students, for whom the share of Black peers would increase by 2.3, 3.4 and 7.5 percentage points for BPS 6th graders, BPS 9th graders, and NYC 9th graders respectively.

On integration grounds, therefore, the current system can be seen as moderately successful: without compulsion, and using an assignment scheme that offers seats at highly ranked schools to the bulk of participating families, school matching increases integration.

Although these results are informative about the aggregate impacts of reassigning students, this analysis is descriptive and limited in important ways. Most importantly, the school assignment mechanism may influence whether students choose to participate in the traditional public school sector at all. Changes in policy that affect who can enroll in which schools may induce students to enter or leave the traditional public school system (Rossell and Armor, 1996; Baum-Snow and Lutz, 2011; Reber, 2011).

5 Causal Effects of Distance and Travel

5.1 Correlating Travel and Achievement

Ordinary least squares (OLS) estimates of the relationship between travel time and academic achievement provide a natural benchmark for the IV estimates that follow. These OLS estimates mostly show that Boston and New York students who travel farther to school have higher average test scores and are more likely to enroll in college than those who attend schools closer to home. This pattern may reflect selection bias arising when higher-achieving students choose to travel more, as well as any causal effects of traveling to better schools.[11]

OLS estimates are generated by fitting a linear model that can be written:

$$Y_i = \alpha G_i + X_i'\Gamma + u_i, \tag{1}$$

where G_i is one of two measures of school proximity, X_i is a vector of controls, and u_i is a regression residual. Coefficient α is the parameter of interest. In the BPS sample, G_i indicates BPS students

[11] Blagg, Rosenboom and Chingos (2018) likewise document a cross-sectional relationship between travel time and test scores in Washington, DC.

who travel to school beyond their BPS-designated Garrity-era walk zone.[12] The NYCDOE analog of out-of-walk-zone attendance indicates students who travel outside their city-defined school district.

We also swap continuous travel time, T_i, for G_i in equation (1) and in the 2SLS estimates below. T_i is given by drive time from the centroid of the student's residence geocode (in Boston) or census tract of residence (in New York) to the school's address, on a trip taken at 07:30 on a weekday morning in September. The appendix details travel time coding further.

The vector of controls in equation (1), denoted X_i, includes dummies for race, gender, special needs, free or reduced price lunch, and English proficiency status; year dummies; and dummies for exam school and charter enrollment. The dependent variable, Y_i, is an achievement test score or college enrollment. Achievement is measured by MCAS scores for BPS students and by an SAT score for NYCDOE students (specifically, 6th grade math and 7th grade ELA scores for BPS 6th graders, and 10th grade math and ELA for BPS 9th graders. The SAT outcome for New York is the math score.) Outcome scores are standardized by grade and year. Other outcomes are dummies for any-college and four-year-college enrollment.

BPS students who enrolled outside their walk zone score about 0.015σ higher on MCAS math tests and are about 4 percentage points more likely to enroll in college, including at four-year schools. These estimates are reported in Panel A of Table 3. Among BPS students, 10 minutes of additional school travel is also associated with 0.15σ higher test scores and 1.5 percentage points higher college enrollment. The estimates in Panel A are similar for Black and Hispanic students and the population of students as a whole.

New York students enrolled outside their district score roughly 0.064σ higher on the math portion of the SAT, a result shown in the first column of Panel B in Table 3. The relationship between out-of-district schooling and college attendance is weaker in New York than in Boston, and negative for the out-of-district dummy (though small and only marginally significantly different from zero). At the same time, out-of-district enrollment appears to boost NYCDOE students' four-year college enrollment, at least for Hispanic and other non-Black applicants. Longer travel times are associated with increased four-year college enrollment for the three applicant groups examined in the table. The increase here is about one point, a precisely estimated differential in favor of those who travel more. It remains to be seen, however, whether the association between school travel time and human capital documented in Table 3 indeed reflects a return to school quality.

5.2 Instrumental Variables Framework

Our econometric framework identifies the causal effects of non-neighborhood schooling for match applicants for whom school proximity is determined in part by random assignment. The quasi-experimental identification strategy uses information on the match to derive instruments for G_i, out of neighborhood assignment, and T_i, travel time to school. In each case, we use characteristics of

[12] The walk zone attendance variable appears in contemporary BPS student data files. A BPS student's walk-zone schools are defined as those one mile or less from at least one point on the boundary of their geocode of residence (Laverde, 2020).

the offered school assignment as an instrument for characteristics school where applicants actually enroll.

Offered school assignments reflect applicant type including preferences, priorities, and – in NYCDOE only – test scores, so that offered characteristics may be correlated with unobservables. We therefore control for the expected offered characteristic for each applicant given their type across random tiebreaker draws which is derived from knowledge of the assignment process (Borusyak and Hull, 2021; Abdulkadiroğlu, Agarwal and Pathak, 2017; Abdulkadiroglu et al., 2019). The expected instrument value controls for systematic differences that between applicants who travel farther distances and potential outcomes.

The derivation of the expectation of each instrument involves first identifying the probability that each applicant is assigned to each school s in the market $\mathcal{S}$ using knowledge of the assignment system and the applicants' stated preferences. In the Boston and NYCDOE matches, DA-generated offers are a function of applicant's preferences and priorities, which we refer to as *applicant type*, and a tie-breaking variable or variables. The Boston tie-breaker is a single lottery number; NYC tie-breakers include a common lottery number used by unscreened schools and a set of non-lottery tie-breakers (such as test scores) used by screened schools. The research design induced by these mechanisms treats type as non-stochastic and tie-breakers as random. The conditional probability applicant i is offered a seat at school s can be written

$$\varphi_s(\theta_i) = E[D_{is}|\theta_i],$$

where D_{is} indicates the offer of a seat at s and θ_i is i's type.

It remains to specify key features of the propensity scores needed here. In the large-market theoretical framework outlined in Abdulkadiroğlu et al. (2017*b*) and Abdulkadiroglu et al. (2019), propensity score $\varphi(\theta_i)$ depends only on a few match-determined parameters. $\varphi(\theta_i)$, also called the *assignment risk* faced by applicant i, is easily tabulated from data on the match. Because DA is a single-offer system, the propensity score for, say, Boston out-of-walk-zone assignment, is the sum of the scores for all out-of-walk-zone schools ranked by i. Out-of-district assignment risk for NYC is computed similarly. Travel-time risk is computed from a partition of travel time into 5-minute intervals; multiple propensity scores in this case record the probability that travel time offered falls into each interval. Figure 4 shows the distribution of travel times in Boston and New York, with the relevant intervals used for score calculation marked on the x-axis.

In each city we construct an instrument indicating whether an applicant was offered a non-neighborhood assignment $Z_{Gi} \in \{0, 1\}$. In BPS, this instrument indicates whether the applicant was *offered* a seat at a school outside their walk zone. In NYCDOE it represents whether the applicant was offered a seat outside their district. The expectation of Z_{Gi}, $E[Z_{Gi}|\theta]$ is derived as the total probability of being assigned to a school outside the student's neighborhood $\mathcal{N} \subset \mathcal{S}$:

$$\mu^G(\theta_i) = \sum_{s \in \mathcal{N}} \varphi_s(\theta_i) \ .$$

Adapting the Rosenbaum and Rubin (1983) propensity-score theorem to matching markets, Abdulkadiroğlu et al. (2017*b*) show that when seats are assigned by DA in a matching market with lottery tie-breaking, and assignments satisfy an exclusion restriction, potential outcomes indexed against school attended are independent of school offered conditional on $\varphi_s(\theta_i)$. Abdulkadiroglu et al. (2019) extend this conditional independence result to markets with non-lottery tie-breaking using a regression-discontinuity-type asymptotic sequence with a shrinking data-dependent bandwidth around match-determined cutoffs. The research design deployed here controls for propensity scores in two-stage least squares (2SLS) procedure using Z_{Gi} and Z_{Ti} to instrument G_i and T_i. Propensity score conditioning ensures instrument validity, controlling for the fact that, for example, out-of-district enrollment rates vary with type.

We also construct an instrument for offered travel time to the school $Z_{Ti} \in \mathbb{R}^+$ as the expected value of distance given the multinomial probability distribution $\phi(\theta_i)$:

$$\mu^T(\theta_i) = \sum_{s \in \mathcal{S}} \varphi_s(\theta_i) d_{is}$$

where d_{is} denotes the travel time between applicant i and school s.

When Z_{Gi} is used to instrument G_i, the causal effect of interest is an estimate of coefficient β in the 2SLS system:

$$Y_i = \beta G_i + \kappa_2 \mu^G(\theta_i) + X_i' \delta_2 + \varepsilon_i \tag{2}$$

$$G_i = \gamma Z_{Gi} + \kappa_1 \mu^G(\theta_i) + X_i' \delta_1 + \nu_i, \tag{3}$$

First and second stage models include a set of baseline covariates, denoted X_i.[13]

To estimate the effect of continuous travel time, we swap G_i for T_i in equations 2 and Z_{Gi} for Z_{Ti} in Equation 3, with parameters relabeled accordingly.

In addition to baseline covariates, equations 2 and 3 control for the propensity score associated with Z_i^G. Because π_i is discrete, score control is obtained by including as regressors a set of dummy variables (denoted $1[\pi_i = j]$) for all score values, j, with coefficients labeled λ_j and κ_j. Abdulkadiroğlu et al. (2017*b*) derive the propensity score formula used here to construct π_i^G in BPS. In NYCDOE, some schools use test scores to determine admissions instead of lottery tie-breakers. Abdulkadiroğlu et al. (2017*a*) derive propensity score formulas used in the presence of multiple tie-breakers.

Each instrument is associated with a distinct experimental sample, the sample with non-degenerate variation or risk for that instrument. In the case of analysis of the effects of non-neighborhood assignment G_i, the analysis is restricted to applicants who face non-degenerate risk of being assigned to a non-neighborhood school. In the case of travel time T_i, the analysis is restricted to the sub-sample of applicants who have risk of being assigned to more than one travel time value.

[13] Baseline covariates consist of dummies for Black, Asian, Hispanic, white, female, special needs, free or reduced price lunch, and limited English proficiency, baseline math and ELA scores, and year of application dummies.

Columns 3-4 and 7-8 in Table 1 describe the experimental samples. Boston experimental samples are similar to the population of applicants. In New York City, the at-risk samples appear to be a positively selected sub-sample of the population of applicants. The at-risk sample in New York is likely to receive special education services, less likely to be assigned limited English proficiency, and average baseline test scores are more than 0.2σ greater than population of applicants.

5.3 Effects on Peer Characteristics

This section applies the IV framework described above to evaluate the effect of non-neighborhood assignment and travel time on a student's school peer characteristics. We present results on the effect of non-neighborhood assignment and travel time on the racial composition of the school where an applicant enrolls. We examine the effect of share of students who are Black, Hispanic, and the total Black or Hispanic share. We also examine the effect on peer achievement as defined as the average test score.

There are three motivations for presenting these results. First, we want to understand what is changing for students when they travel outside their neighborhood. If travel time is reducing the segregation that an individual student experiences, or exposes students to higher achieving peers, then these changes may be important to the interpretation of the estimated effects on test scores and college enrollment. Second, we show that these results link directly to the simulation results described above. The IV estimates of the effect of travel on test scores and enrollment reflect a local average treatment effect (LATE) for the set of experimental compliers. The LATE for students for whom neighborhood assignment will bring them closer to home may be different from the subset of experimental compliers, as may be the schools that receive them. By showing that the IV effect on changes in school characteristics is similar to that for the aggregate impact of reassigning students to neighborhood schools, we can have greater confidence that the IV estimates are informative about the effects of changing assignments. Third, several studies of preferences in school choice find that peer academic achievement is an important characteristic for parents (Hastings, Kane and Staiger, 2009; Abdulkadiroglu et al., 2017). Parents may care intrinsically about peer test scores if peers have a causal effect on their classmates' test scores.

IV estimates of the effect of travel on peer racial composition show that, in both BPS and NYCDOE, enrolling in a school farther from one's home tends to reduce same-race exposure. In BPS, Black students who enroll in schools outside their walk zone are in schools where the peer share Black is 9.4 percentage points lower than it would be in their walk zone (Column 2 of Table 4). Enrolling in a school 10 minutes farther from one's home reduces the share of Black students' peers who are also Black by almost 5.3 percentage points. In NYCDOE, Black students who enroll in schools outside their district have 7.1 percentage points fewer Black peers than they would if they enrolled in their district, and travelling 10 additional minutes reduces the share of peers who are Black by 4.5 percentage points. Hispanic students experience smaller reductions in peer share Hispanic as a result of travel, but the results are negative across specifications. In BPS, Hispanic students who enroll in schools outside their walk zone attend schools with 2.4 percent fewer Hispanic

peers, and enrolling in a school ten minutes farther from home is associated with a reduction in 2.2 percent fewer Hispanic peers. In NYCDOE, Hispanic students who enroll outside their district attend schools with 5.9 percent more Hispanic peers, travelling ten additional minutes to school is associated with a reduction of 1.4 percentage points.

The IV estimates of the effect of travel time on same race exposure mirror the effect of choice versus neighborhood assignment presented in Table 2. Table 2 showed, for instance that neighborhood assignment reduce travel time for Black BPS 9th graders by 8.1 minutes in aggregate while increasing same race exposure by 3.4 percentage points. The IV estimates predict an increase in same race exposure of 4.2 percentage points. For NYCDOE 9th graders, neighborhood assignment reduced travel times by 12.5 minutes and increased same race exposure by 7.5 percentage points. The IV estimates for NYDOE predict an increase in same race exposure of 5.6 percentage points.

When Black and Hispanic students travel, they tend to encounter similar fractions of other minorities. In BPS, Black students enrolling in a school outside one's neighborhood is associated with an 6.1 percentage point increase in fraction of Hispanic peers, accounting for almost two thirds of the reduction in same race exposure (Column 2 of Table 4). For Hispanic students, enrolling in a school outside one's neighborhood is associated with a 2.4 percentage point increase in the fraction of Black peers, accounting 80 percent of the reduction in same race exposure. In New York, the 60 percent of the reduction in same race exposure for Black students from enrolling outside their district comes from increasing Hispanic share. One exception to this pattern is NYCDOE Hispanic students for whom only 16 percent of the reduction in same race exposure is accounted for by an increase in the Black share of enrollment. However, for travel time, 57 percent of the reduction in same race exposure from ten minutes additional travel is accounted for by an increase in the Black share of enrollment. For both Black and Hispanic students, travel outside one's neighborhood is associated with a reduction in same race exposure, but this reduction in same race share is largely accounted for by increases in the share of other disadvantaged minority groups.

For the experimental sample, travel is associated with higher peer achievement. In BPS, travelling outside one's walk zone is associated with a 0.029σ increase in peer test scores, pooling all applicants and increasing travel time by ten minutes is associated with an increase in 0.020σ peer test scores (Column 1 of Table 4). In NYCDOE, travelling outside one's walk zone is associated with a 0.04σ increase in peer test scores and travelling an additional ten minutes to school is associated with an increase in 0.02σ higher test scores. Similar positive effects are observed for the Black and Hispanic sub-samples.

Additional travel induced by the travel offer instruments may, therefore, be to better schools on average than that experienced by the average BPS student who travels under the choice system. This may reflect the well-known over-subscription problem in the literature on the use of lotteries to estimate the effects of schools. If schools with higher performing peers are more likely to be oversubscribed, and the IV estimate weights oversubscribed schools more heavily, then longer travels in the experimental sample may tend to be toward schools that have higher performing peers on average. This fact raises some questions about the external validity of our estimates for the overall

population of BPS students who would be affected by neighborhood zoned assignment. However, this fact would tend to lead us to overstate the effects of travels, and furthermore the effects on peer achievement tend to be small in magnitude.

5.4 Distance and Travel Effects on Human Capital

This section presents the main results of the paper on the effects of the enrolling in a non-neighborhood school and travel time on test scores and college enrollment. Causal effects of school proximity on educational outcomes are estimated using a setup paralleling that used for travel time effects on peer composition above. We evaluate the effect of each measure of neighborhood enrollment on test scores and college enrollment. In Boston, the test scores are from the MCAS assessment. For 6th grade students, we use the 6th grade math and ELA assessments, and for 9th grade students, we use the 10th grade MCAS math and ELA scores. In New York the test scores are from the Scholastic Aptitude Test (SAT). We estimate the effect on SAT test taking and on the level of the test scores on the math and reading sub-tests. Test taking is an informative education milestone on its own and may reflect intentions to pursue post-secondary education. We also report this as a test of differential attrition. If students who enroll outside their neighborhood take the SAT at different rates, then, within the sub-sample of test takers, students offered schools outside their neighborhood may be different from those offered schools in their neighborhood.

In both Boston and New York, enrolling in a school outside one's neighborhood has at most very small effects on test scores. Table 5 reports the 2SLS estimated effects of enrolling in a school outside one's neighborhood on test scores. In Boston, students who are induced to enroll outside their walk zone by the lottery tiebreaker score lower on MCAS assessments in Math and ELA, although we cannot reject the null hypothesis and the effects are noisily estimated (Columns 1-3, Panel A, Table 5). Similarly, we are unable to reject the null hypothesis that travelling 10 minutes farther to school has no effect on MCAS scores in either subject (Columns 4-5). In New York, enrolling in a school outside a student's district reduces the likelihood that they take the SAT by about 3 percentage points (Column 1, Panel B, Table 5), and we are unable to reject the null hypothesis that effects on test scores are zero. The negative effect on SAT test taking appears to be driven by Hispanic students who are 5.5 percentage points less likely to take the SAT when they enroll outside their district. Black students who enroll outside their district are 4.3 percentage points less likely to take the SAT, but we are unable to reject the null hypothesis in this case. Traveling an additional 10 minutes to school also has a negative effect on SAT test taking (Column 4). Students who travel 10 additional minutes score about 0.0145σ higher on the SAT reading test. One interpretation of the positive effect on test scores is that it represents selection in terms of who takes the test if travel is inducing students who would otherwise score low on the SAT to skip the test altogether.

Students who enroll in schools farther from their home are no more likely to go on to enroll in college, and may even be less likely to enroll in college. In Boston, we are unable to reject the null hypothesis that travel has no effect on college enrollment, 2-year college enrollment, or 4-year

college enrollment (Panel A of Table 6). The effects, however, are noisily estimated, and it should be noted that we are unable to reject the hypothesis that travel has small positive effects on college enrollment in Boston. The estimates for the effect of enrolling in a school ten minutes farther from one's home are more precise and yield similar interpretations (columns 4-6 of Table 6). In BPS, enrolling in a school 10 minutes farther from a students home reduces college attendance overall by about 2 percentage point, and this effect is statistically significant at the 10% level.

The larger sample size in New York affords greater precision in the estimated effect on college enrollment. We are also unable to reject the null hypothesis of no effect of enrolling outside a students' district in New York (Columns 1-3, Panel B of Table 6). Enrolling in a school 10 minutes farther from a students home is associated with a reduction in the likelihood that a student enrolls in college by about a fifth of a percentage point, and this effect is estimated with a standard error of 0.6 percentage points, so we are able to reject even small positive effects of travel on enrollment at college.

6 Direct Effects of a More-Integrated School Environment

Families who opt for a longer ride to school presumably do so in hopes of higher school quality. What explains the lack of a achievement and college enrollment gains for those who travel? In this section, we scrutinize this interpretation using a similar IV strategy. We again use our knowledge of the assignment system to derive the expected racial group share for each applicant. We then instrument for the racial composition of the school where a student enrolls while controlling for this expected racial group share. The results in this section may be informative for the question of whether racial composition of a student's class has an impact on a student's later life academic achievement.

Social scientists have long been interested in the effects of racial segregation on child development and educational outcomes. The 1954 *Brown v. Board of Education* decision specifically cited concerns that segregated schools affected child development raised by the work of psychologists Kenneth and Mamie Clark's Doll test (Clark and Clark, 1950). Since at least the Coleman Report, researchers have recognized the potential role of peers and racial isolation in the Black-white achievement gap. More recently, studies have found that court-ordered desegregation increased educational attainment of Blacks (Guryan, 2004), reduced incarceration and increased wages (Johnson, 2019). However, desegregation orders also had large effects on educational resources available to Black students, so it is unclear if these effects are due to integration *per se* (Reber, 2010; Johnson, 2019). Billings, Deming and Rockoff (2014) find evidence of harmful effects of re-segregation in Charlotte-Mecklenberg on educational attainment and crime, and provide some suggestive evidence that the effects are in part due to resegregation.

However, there are several reasons why these results may not be relevant to the question of whether *de facto* segregation within school districts is detrimental to the achievement of minority students today. First, today per pupil expenditures across schools within districts tends to be fairly

equal, and if anything tend to be higher in schools with higher minority enrollment to support programs for students with special instruction needs. Appendix Table **??** shows IV estimates of the effect of travel on observed school inputs. Travel is associated with a small increase in student-teacher ratios across most specifications, although in Boston, these effects are not statistically significant. In both cities, we find some evidence of positive, statistically significant effects of travel on the percent of teachers licensed in their teaching assignment, and some positive effects on the percent of academic classes taught by highly-qualified teachers, depending on the specification and sample. However, in all cases, these effects are fairly small, suggesting that enrollment induced by the experimental instruments does not generate large changes in inputs.[14]

Second, the racial composition of many urban school districts has changed dramatically over the past half century. White enrollment in Boston and New York fell steadily in the 1980s and 1990s. Since the turn of the millennium, however, demographic change in these city's schools has been driven by falling Black enrollment and growing Hispanic enrollment. As can be seen in Figure 2, these trends have combined to produce a modest reduction in racial isolation of Black and Hispanic students as group. At the same time, same-race exposure for Black students has fallen sharply. The sharp changes documented in Figure 2 raise the question of whether and how much these changes matter. We've seen that distance and travel facilitate racial mixing, but the consequences of this for education appear to be modest. These findings may be reconciled by direct estimates of the causal effects of cross-race exposure.

We examine the effect of enrolling in a school with ten percent more Black/Hispanic students and ten percent more Hispanic students using an analogous IV framework as that used to estimate the effects of travel. In each case, we use the peer composition of the school from the year prior to avoid a reflection problem that could arise from including individual i's race in the calculation of i's offered school peer composition. In each case, we use knowledge of the assignment mechanism to derive the expected offered school racial composition for each student. We then use the simulated offered school racial composition given the observed lottery number assigned to the student as an instrument for the racial composition of the school where the student enrolled. Balance results are presented in Table **??**.

We find that enrolling in a school with a higher share of minority students has little impact on test scores. In all cases, we can rule out even moderate negative effects of enrolling in high minority share schools and in many cases the estimated effects are positive, including for minority students (Table 7b). One exception is that we find small negative effects of enrolling in schools with high minority shares in NYCDOE on SAT scores. However, these effects are small and because there is a small positive effect on test taking from enrolling at a school with a higher minority share, the negative effects on test scores may partly reflect selection in terms of the types of students who take the test.

We also find that enrolling in schoolls with higher minority share has little impact on college

[14] We have also examined the effects of travel on school value-added and find that travel is associated with modest increases in VA.

enrollment and may even have a positive effect. While overall, the results seem to suggest that the racial composition of schools is not predictive of their effects on future college enrollment decisions, it is noteworthy that in NYCDOE, enrolling in a school with a ten percentage points higher Hispanic share increases the likelihood that Hispanic students enroll in college by 1.49 percentage points (Column 6, Panel B of Table 7b). While it is important to exercise caution in interpreting a single marginally significant result, one interpretation is that this effect reflects a mismatch between school programs and student needs.

7 Summary, Cost Savings, and Research Horizons

[TBD]

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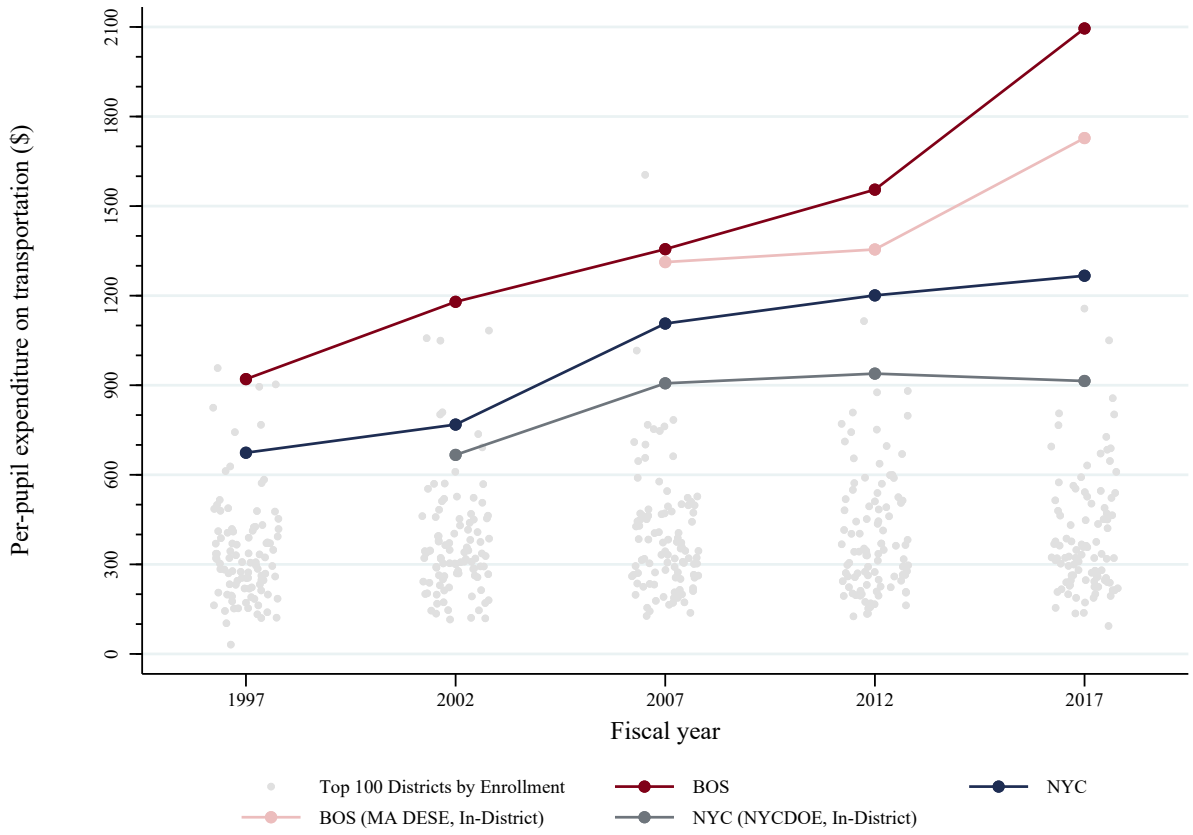
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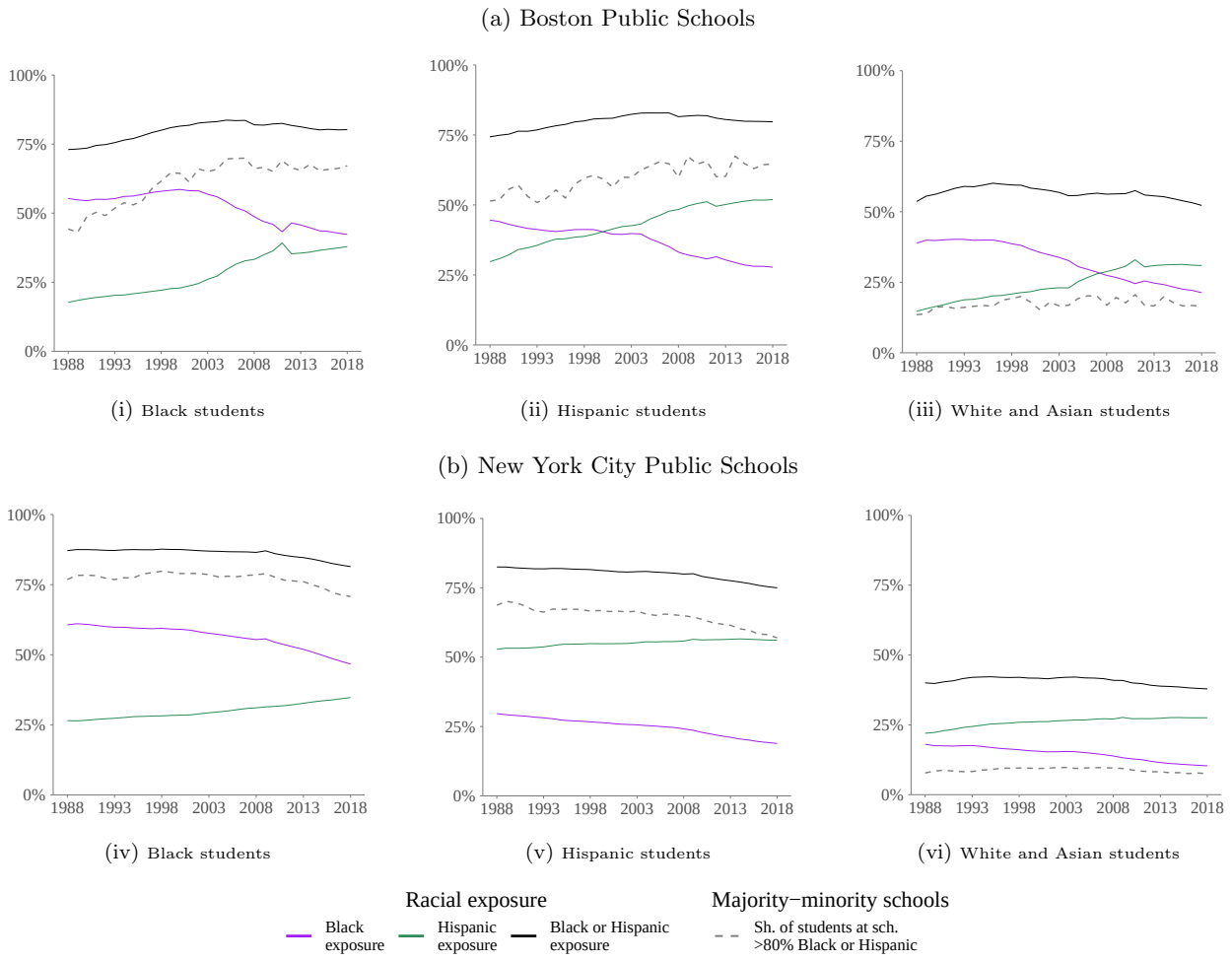
Figure 1: Per-Pupil Annual Expenditures on Student Transportation

Top 100 School Districts by Enrollment, FY 1997-2017



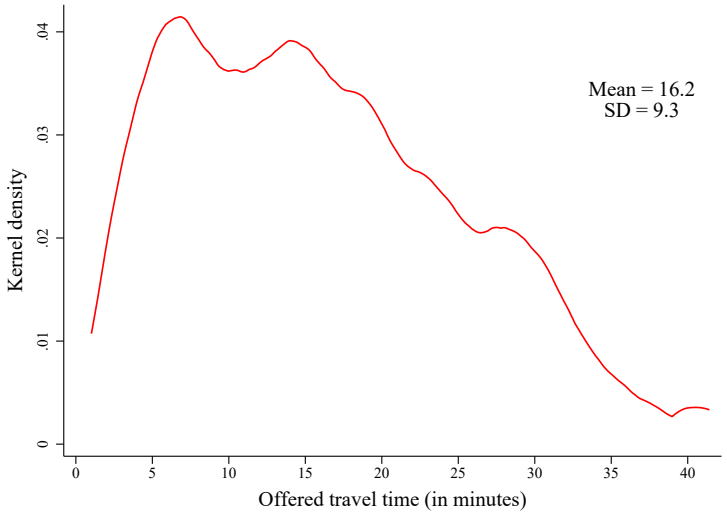
Source: National Center for Education Statistics (NCES) Common Core of Data, District Fiscal Reports. *Notes:* Transportation expenditure includes spending covering the transportation of public school students, including vehicle operation, monitoring riders, and vehicle servicing and maintenance. Enrollment data is from the NCES and totals the number of students the district is financially responsible for. This is standard in NCES tables and in practice does not differ that much from actual enrollment. Fiscal year X corresponds to school year $X-1$ to X. Expenditure data is adjusted to June 2017 dollars using the Consumer Price Index (Series ID = CUUR0000SA0). Top 100 districts by enrollment is a within-year designation. In-district expenditure is pulled from the MA DESE and NYC DOE respectively for available years. NCES expenditure data is presumed to be in and out-of-district transportation.

Figure 2: Racial Exposure and Proportion in Majority-minority Schools in Boston and New York City Public Schools, 1988-2018

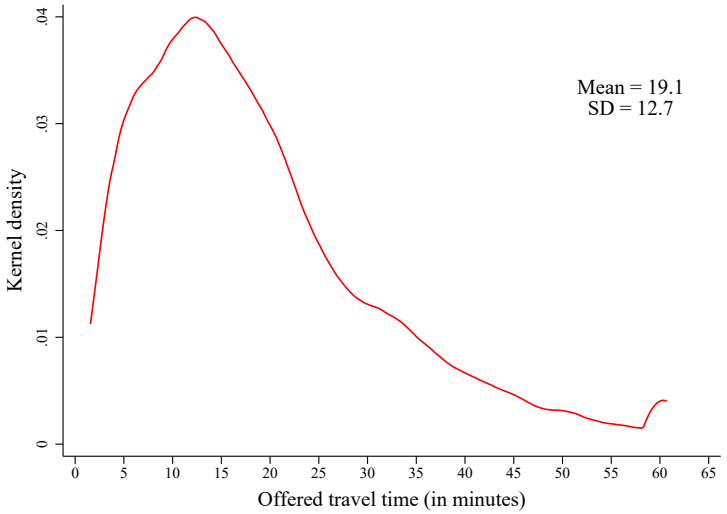


Notes: This figure reports the school-level peer share [race] experienced by the average [race] student over time in Boston Public Schools (Panel A) and NYC Public Schools (Panel B) as solid thin lines. It reports the share of [race] students in a school with greater than [threshold] share Black or Hispanic over time in Boston Public Schools (Panel A) and NYC Public Schools (Panel B) as dotted thicker lines. Year X corresponds to school year X to $X+1$. The data source is the Common Core Public Elementary and Secondary School Universe Survey. Schools with missing race data are not included in the sample. NYC Public Schools are defined as enrollment in the aggregated NYC district code or enrollment in the NYC community districts. Virtual schools are not included in the sample. Future, closed, or inactive schools are not included in the sample. The sample includes all grades however students in adult education are not included. Asian includes Asian, Hawaiian, and Pacific Islander race categories. Black is non-Hispanic, Black. White is non-Hispanic, White. In 2009, the racial categorization of the survey changed allowing individuals to list two or more races. The sharp change at approximately 2011 in some Boston Public Schools' panels is believed to be due to a court-ordered coding change.

Figure 3: Travel Times in Boston and NYC



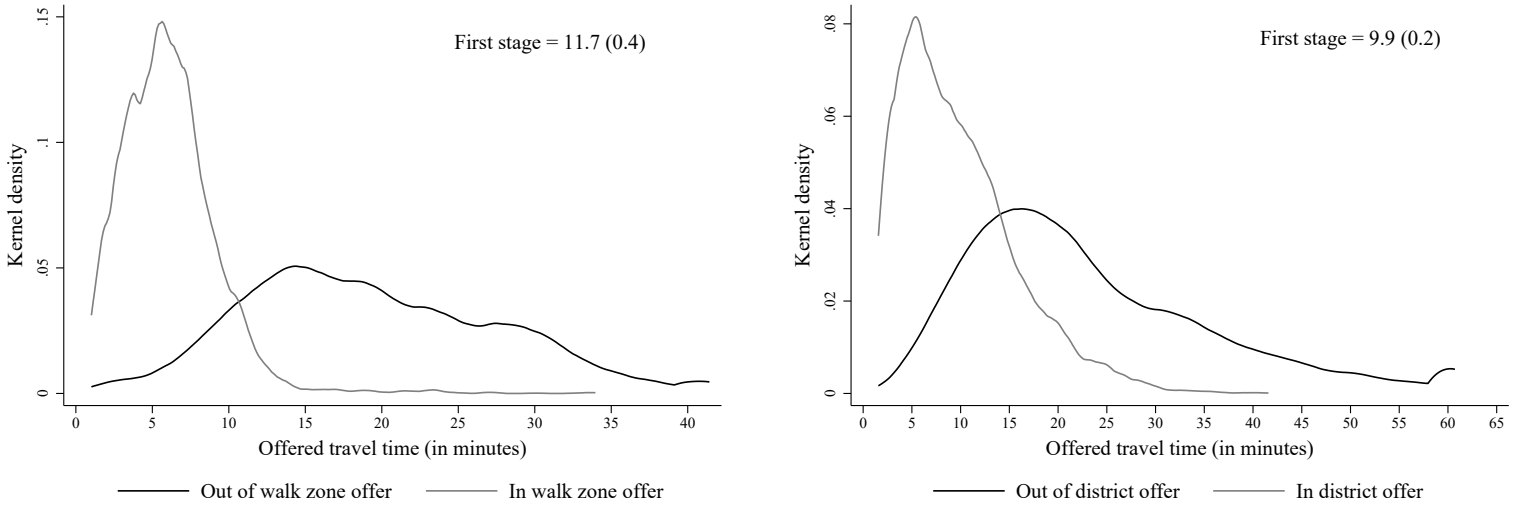
(i) Boston



(ii) NYC

Notes: The Boston sample includes all middle school and high school match applicants who are (i) offered a seat, (ii) enrolled in 6th/9th grade in 2002-2016, and (iii) who have non-degenerate risk of school assignment. The NYC sample includes all high school match applicants satisfying criterions (i) and (iii) above who are enrolled in 9th grade in 2012-2016. Travel times are winsorized at the 1st and 99th percentiles.

Figure 4: Travel Times in Boston and NYC by Garrity Walk Zone or District Status



(i) Boston

(ii) NYC

Notes: The Boston sample includes all middle school and high school match applicants who are (i) offered a seat, (ii) enrolled in 6th/9th grade in 2002-2016, and (iii) who have non-degenerate risk of school assignment. The NYC sample includes all high school match applicants satisfying criterions (i) and (iii) above who are enrolled in 9th grade in 2012-2016. Travel times are winsorized at the 1st and 99th percentiles. The first-stage estimate is from a regression of enrolled travel time on offered Garrity walk zone or district status.

Table 1: Boston and NYC Data and Estimation Samples

	Boston (6th and 9th grade)			NYC (9th grade)		
	Enrolled	Applicants	Experimental sample	Enrolled	Applicants	Experimental sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Race						
Black	0.42	0.43	0.47	0.30	0.28	0.30
Hispanic	0.35	0.38	0.38	0.40	0.39	0.44
White or Asian	0.22	0.18	0.14	0.29	0.32	0.25
Panel B: Other covariates						
Free and reduced-price lunch	0.73	0.81	0.83	0.77	0.76	0.79
Female	0.49	0.50	0.51	0.49	0.52	0.52
Special education	0.18	0.17	0.18	0.20	0.07	0.08
Limited English proficiency	0.20	0.19	0.16	0.12	0.10	0.06
Baseline math	0.00	-0.10	-0.15	0.01	0.18	0.06
Baseline English	0.00	-0.09	-0.12	0.01	0.18	0.05
Panel C: School sectors						
Enrolled in charter	0.15	0.08	0.09	0.06	0.04	0.04
Enrolled in exam/specialized	0.10	0.03	0.04	0.06	0.07	0.05
Enrolled in screened				0.12	0.13	0.08
Panel D: Travel						
Rank out of Garrity walk zone / district first	0.72	0.72	0.80	0.66	0.66	0.72
Enrolled out of Garrity walk zone / district	0.80	0.74	0.80	0.65	0.64	0.69
Travel time enrolled	14.0	14.1	15.5	17.6	18.0	18.5
Distance enrolled	3.44	3.47	3.86	4.45	4.59	4.71
Eligible for busing	0.77	0.71	0.77	0.96	0.96	0.97
N	150,280	72,751	28,179	346,507	274,642	75,237

Notes: Statistics for Boston use data on high school students enrolled in 9th grade and middle school students enrolled in 6th grade in 2002-03 to 2016-17. Statistics for NYC use data on high school students enrolled in 9th grade in 2012-13 to 2016-17. Columns 1 and 4 report descriptive statistics for the sample of enrolled students who have demographic information. Columns 2 and 5 restrict the sample to match applicants. The experimental samples in columns 3 and 6 restrict the sample to offered students who have non-degenerate risk of school assignment and who have non-missing baseline test scores. The experimental sample is equivalent to the sample used to estimate out of walk zone and out of district effects. The sample used to estimate travel time effects is the subset of the experimental sample with non-missing offered and enrolled travel time. Statistics for this subsample are omitted as they are nearly identical to the experimental sample. Boston baseline test scores are from the MCAS (4th grade Math and ELA for middle school, 8th grade Math and 7th/8th grade ELA for high school); NYC baseline scores are 8th grade scores from the NY State standardized assessments. Screened schools are defined as those with no lottery programs. Busing elgibility is defined as being enrolled at a school that has a driving distance of more than 1.5 miles in Boston and more than .5 miles in NYC.

Table 2: Neighborhood Reassignment with Increased Capacities

	Baseline scenario			Change relative to baseline			
	Time	Busing eligibility	Same-race exposure	Time	Busing eligibility	Same-race exposure	Percent reassigned
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Panel A: Boston (6th grade)				
All applicants	10.6	0.58	0.458	-5.9	-0.48	0.002	76%
Black applicants	11.3	0.63	0.455	-6.7	-0.54	0.023	83%
Hispanic applicants	10.8	0.57	0.489	-6.3	-0.48	-0.017	77%
Black or Hispanic applicants	11.0	0.60	0.800	-6.5	-0.51	0.004	80%
White or Asian applicants	9.3	0.52	0.395	-4.3	-0.39	0.002	64%
			Panel B: Boston (9th grade)				
All applicants	16.5	0.76	0.437	-7.8	-0.39	0.017	82%
Black applicants	17.9	0.81	0.453	-8.1	-0.38	0.032	89%
Hispanic applicants	15.7	0.73	0.487	-8.3	-0.41	0.005	77%
Black or Hispanic applicants	16.8	0.77	0.858	-8.2	-0.40	0.005	83%
White or Asian applicants	14.7	0.71	0.189	-6.4	-0.34	0.015	73%
			Panel C: NYC (9th grade)				
All applicants	17.3	0.96	0.477	-9.6	-0.20	0.039	89%
Black applicants	20.6	0.97	0.459	-12.5	-0.24	0.071	94%
Hispanic applicants	17.1	0.96	0.529	-10.3	-0.24	0.019	92%
Black or Hispanic applicants	18.5	0.96	0.714	-11.2	-0.24	0.034	93%
White or Asian applicants	14.7	0.96	0.418	-8.0	-0.15	0.036	77%

Notes: The BPS sample includes students enrolled in the 2006-16 school years; the NYC sample includes students enrolled in the 2012-16 school years. Baseline statistics in columns 1-3 show student-weighted average school characteristics, using school offered for match applicants and school enrolled for others. Statistics are for students who: (i) participate in the match and enroll in a match school, or (ii) match non-participants enrolled in a match school and with non-missing geographic information. Columns 4-7 characterize simulated alternative assignments generated by a match in which students and schools rank each other by proximity. School capacities in this simulation are set to equal maximum observed enrollment (in 2001-2016 for Boston and in 2009-2016 for NYC). The statistics in columns 4-7 are changes relative to columns 1-3. Same-race exposure is defined as the proportion same-race in the assigned school (in the same grade). Students are deemed busing-eligible when they travel 1.5 miles or farther in Boston and .5 miles or farther in NYC.

Table 3: OLS Estimates of Distance and Travel Effects

		Out of Garrity walk zone / district			Travel time		
		All students	Black students	Hispanic students	All students	Black students	Hispanic students
		(1)	(2)	(3)	(4)	(5)	(6)
				Panel A: Boston			
MCAS Math		0.0171**	0.0682***	-0.0036	0.0156***	0.0469***	0.0083
		(0.0062)	(0.0096)	(0.0098)	(0.0033)	(0.0049)	(0.0054)
	N	122,997	51,571	41,656	101,789	41,089	35,568
Any college		0.0418***	0.0570***	0.0376***	0.0145***	0.0176***	0.0137***
		(0.0056)	(0.0091)	(0.0083)	(0.0025)	(0.0037)	(0.0040)
	Mean	0.435	0.396	0.374	0.435	0.395	0.372
4-year college		0.0354***	0.0466***	0.0329***	0.0110***	0.0145***	0.0095**
		(0.0049)	(0.0078)	(0.0071)	(0.0022)	(0.0033)	(0.0035)
	Mean	0.331	0.282	0.261	0.330	0.281	0.259
	N	45,066	18,957	15,806	44,556	18,717	15,620
				Panel B: NYC			
Took SAT		-0.0000	-0.0059*	-0.0065**	0.0011*	0.0006	-0.0000
		(0.0017)	(0.0035)	(0.0027)	(0.0006)	(0.0011)	(0.0010)
	Mean	0.678	0.604	0.630	0.696	0.625	0.645
SAT Math		0.0716***	0.0362***	0.0530***	0.0241***	0.0241***	0.0311***
		(0.0035)	(0.0065)	(0.0050)	(0.0012)	(0.0021)	(0.0020)
	N	234,498	61,883	88,005	233,222	61,365	87,580
Any college		0.0005	-0.0022	-0.0081**	0.0023**	0.0033**	0.0015
		(0.0021)	(0.0041)	(0.0033)	(0.0007)	(0.0013)	(0.0012)
	Mean	0.534	0.437	0.467	0.549	0.454	0.479
4-year college		0.0182***	0.0063*	0.0124***	0.0103***	0.0093***	0.0111***
		(0.0020)	(0.0037)	(0.0029)	(0.0007)	(0.0011)	(0.0011)
	Mean	0.345	0.251	0.245	0.356	0.261	0.252
	N	270,301	81,340	109,199	261,521	77,804	105,976

Notes: This table reports OLS estimates of the relationship between school proximity and achievement or college enrollment. BPS data cover students enrolled in the 2002-16 school years; NYC statistics cover the population enrolled in the 2012-16 school years. Travel time effects are reported per 10 minutes of travel. These estimates are from models that control for student demographic characteristics, match participation, charter school enrollment, specialized school enrollment (NYC), and exam school enrollment (Boston). Boston test scores are from the MCAS (6th grade Math and 7th grade ELA for middle school, 10th grade Math and ELA for high school); NYC test scores are from the SAT.

Table 4: 2SLS Estimates of School Travel Effects on Peer Race and Achievement

		Out of Garrity walk zone / district			Travel time		
		All applicants	Black applicants	Hispanic applicants	All applicants	Black applicants	Hispanic applicants
		(1)	(2)	(3)	(4)	(5)	(6)
				Panel A: Boston			
Peer share Black		-0.0252**	-0.0995***	0.0288*	-0.0165**	-0.0506***	0.0117
		(0.0094)	(0.0147)	(0.0151)	(0.0052)	(0.0070)	(0.0083)
	Mean	0.442	0.498	0.400	0.441	0.497	0.399
Peer share Hispanic		0.0276**	0.0636***	-0.0238*	0.0058	0.0275***	-0.0233**
		(0.0088)	(0.0126)	(0.0143)	(0.0047)	(0.0060)	(0.0079)
	Mean	0.388	0.353	0.438	0.388	0.353	0.438
Peer share Black or Hispanic		0.0024	-0.0359**	0.0050	-0.0107**	-0.0230***	-0.0116**
		(0.0079)	(0.0112)	(0.0111)	(0.0040)	(0.0054)	(0.0058)
	Mean	0.830	0.851	0.837	0.829	0.851	0.837
Peer achievement		0.0315*	0.0855***	0.0300	0.0172*	0.0428***	0.0015
		(0.0169)	(0.0241)	(0.0244)	(0.0094)	(0.0127)	(0.0139)
	Mean	-0.139	-0.171	-0.156	-0.139	-0.171	-0.157
	N	28,179	13,143	10,762	27,984	13,028	10,701
				Panel B: NYC			
Peer share Black		-0.0056	-0.0753***	0.0111**	-0.0120***	-0.0452***	0.0072**
		(0.0036)	(0.0111)	(0.0045)	(0.0020)	(0.0041)	(0.0026)
	Mean	0.270	0.413	0.239	0.269	0.413	0.238
Peer share Hispanic		-0.0240***	0.0475***	-0.0589***	0.0109***	0.0371***	-0.0132***
		(0.0037)	(0.0090)	(0.0055)	(0.0019)	(0.0033)	(0.0029)
	Mean	0.391	0.340	0.489	0.391	0.341	0.490
Peer share Black or Hispanic		-0.0297***	-0.0278**	-0.0477***	-0.0012	-0.0080**	-0.0059*
		(0.0041)	(0.0089)	(0.0057)	(0.0020)	(0.0032)	(0.0031)
	Mean	0.660	0.753	0.728	0.660	0.754	0.728
Peer achievement		0.0389***	0.0320**	0.0454***	0.0214***	0.0248***	0.0215***
		(0.0070)	(0.0149)	(0.0087)	(0.0034)	(0.0054)	(0.0048)
	Mean	-0.007	-0.122	-0.112	-0.005	-0.119	-0.110
	N	75,237	22,932	33,233	74,677	22,675	33,024

Notes: This table reports 2SLS estimates of distance and travel effects on the variables at the left, computed in the sample of applicants for Boston middle and high school seats and NYC high school applicants. The sample is limited to offered applicants with non-degenerate risk of school assignment. Travel time effects are per 10 minutes of travel. The instrument for columns 1-3 indicates an out-of-walk zone assignment; the instrument for remaining columns is travel time offered. The corresponding endogenous variables are 6th/9th grade out-of-walk zone enrollment and enrolled travel time. The Boston walk zone first stage is approximately 0.43. The NYC out of district first stage is about 0.66. Travel time first stages are around 0.39 for Boston and 0.56 for NYC. Offer risk controls are as described in the text. All models control for student demographics and baseline achievement.

Table 5: 2SLS Estimates of School Travel Effects on Test Scores

		Out of Garrity walk zone / district			Travel time		
		All applicants	Black applicants	Hispanic applicants	All applicants	Black applicants	Hispanic applicants
		(1)	(2)	(3)	(4)	(5)	(6)
				Panel A: Boston			
MCAS Math		0.0490	0.0217	-0.0038	0.0182	0.0192	-0.0073
		(0.0411)	(0.0602)	(0.0673)	(0.0227)	(0.0323)	(0.0363)
MCAS ELA		0.0414	0.0734	0.0105	0.0065	0.0306	-0.0235
		(0.0410)	(0.0610)	(0.0667)	(0.0218)	(0.0314)	(0.0345)
	N	23,618	11,113	8,898	23,452	11,012	8,849
				Panel B: NYC			
Took SAT		-0.0311**	-0.0344	-0.0461**	-0.0101**	-0.0010	-0.0199**
		(0.0097)	(0.0237)	(0.0150)	(0.0048)	(0.0087)	(0.0079)
SAT Math		-0.0089	0.0197	-0.0041	0.0011	0.0045	0.0037
		(0.0147)	(0.0314)	(0.0203)	(0.0068)	(0.0110)	(0.0104)
SAT Reading		0.0108	0.0422	0.0256	0.0121*	0.0065	0.0212*
		(0.0153)	(0.0349)	(0.0213)	(0.0071)	(0.0120)	(0.0110)
	N	55,313	15,515	23,293	55,138	15,441	23,220

Notes: This table reports 2SLS estimates of distance and travel effects on the variables at left, computed in the sample of applicants for Boston middle and high school seats and NYC high school applicants. The sample is limited to offered applicants with non-degenerate risk of school assignment. Travel time effects are per 10 minutes of travel. The instrument for columns 1-3 indicates an out-of-walk zone assignment; the instrument for the remaining columns is travel time offered. The corresponding endogenous variables are 6th/9th grade out-of-walk zone enrollment and enrolled travel time. Offer risk controls are as described in the text. All models control for student demographics and baseline achievement. Standardized test results correspond to MCAS test results for Boston and SAT test results for NYC.

Table 6: 2SLS Estimates of School Travel Effects on College Attendance

	Out of Garrity walk zone / district			Travel time		
	All applicants	Black applicants	Hispanic applicants	All applicants	Black applicants	Hispanic applicants
	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A: Boston			
Any college	0.0366	-0.0348	0.0656	-0.0190	-0.0583**	0.0080
	(0.0417)	(0.0681)	(0.0588)	(0.0198)	(0.0275)	(0.0311)
2-year college	0.0174	-0.0589	0.0509	-0.0069	-0.0207	0.0017
	(0.0299)	(0.0488)	(0.0429)	(0.0143)	(0.0193)	(0.0227)
4-year college	0.0181	0.0215	0.0147	-0.0116	-0.0366	0.0063
	(0.0371)	(0.0594)	(0.0512)	(0.0177)	(0.0246)	(0.0274)
N	15,526	7,227	6,114	15,378	7,134	6,071
			Panel B: NYC			
Any college	-0.0159	-0.0415	-0.0180	-0.0017	0.0007	-0.0108
	(0.0127)	(0.0301)	(0.0193)	(0.0062)	(0.0109)	(0.0102)
2-year college	-0.0093	-0.0403	-0.0148	-0.0003	-0.0104	-0.0040
	(0.0112)	(0.0257)	(0.0175)	(0.0053)	(0.0091)	(0.0093)
4-year college	-0.0066	-0.0012	-0.0031	-0.0014	0.0111	-0.0068
	(0.0118)	(0.0267)	(0.0167)	(0.0057)	(0.0097)	(0.0090)
N	58,204	18,068	26,009	57,713	17,838	25,826

Notes: This table reports 2SLS estimates of distance and travel effects on the variables at left, computed in the sample of applicants for Boston middle and high school seats and NYC high school applicants. The sample is limited to offered applicants with non-degenerate risk of school assignment. Travel time effects are per 10 minutes of travel. The instrument for columns 1-3 indicates an out-of-walk zone assignment; the instrument for the remaining columns is travel time offered. The corresponding endogenous variables are 6th/9th grade out-of-walk zone enrollment and enrolled travel time. Offer risk controls are as described in the text. All models control for student demographics and baseline achievement.

Table 7a: 2SLS Estimates of Peer Share Effects on Test Scores and College Attendance

	Peer share Black			Peer share Hispanic			Peer share Black or Hispanic		
	All applicants	Black applicants	Hispanic applicants	All applicants	Black applicants	Hispanic applicants	All applicants	Black applicants	Hispanic applicants
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Boston									
MCAS Math	0.0117	0.0185	0.0117	0.0044	-0.0126	0.0105	0.0127	0.0048	0.0255
	(0.0116)	(0.0162)	(0.0200)	(0.0128)	(0.0188)	(0.0218)	(0.0112)	(0.0173)	(0.0199)
MCAS ELA	-0.0304*	-0.0193	-0.0528*	0.0208	0.0005	0.0306	-0.0204	-0.0345	-0.0378
	(0.0184)	(0.0270)	(0.0302)	(0.0193)	(0.0305)	(0.0287)	(0.0188)	(0.0264)	(0.0342)
N	13,677	6,332	5,418	13,677	6,332	5,418	13,677	6,332	5,418
Panel B: NYC									
Took SAT	0.0027	0.0109**	-0.0044	0.0013	-0.0133**	0.0111**	0.0039	0.0055	0.0080*
	(0.0031)	(0.0045)	(0.0057)	(0.0031)	(0.0064)	(0.0046)	(0.0027)	(0.0052)	(0.0044)
SAT Math	-0.0174***	-0.0165**	-0.0093	-0.0008	0.0137	-0.0092	-0.0159***	-0.0131*	-0.0159**
	(0.0044)	(0.0061)	(0.0074)	(0.0045)	(0.0083)	(0.0062)	(0.0042)	(0.0072)	(0.0061)
SAT Reading	-0.0090**	-0.0128**	-0.0046	-0.0111**	-0.0004	-0.0153**	-0.0172***	-0.0189**	-0.0186**
	(0.0045)	(0.0064)	(0.0078)	(0.0047)	(0.0094)	(0.0065)	(0.0043)	(0.0075)	(0.0064)
N	55,313	15,515	23,293	55,313	15,515	23,293	55,313	15,515	23,293

Notes: This table reports 2SLS estimates of peer share effects on the variables at the left, computed in the sample of applicants for Boston middle and high school seats and NYC high school applicants. The sample is limited to offered applicants with non-degenerate risk of school assignment. Peer share effects are per 10 percentage point changes. School peer shares are computed on the sample of enrolled students. The instrument for columns 1-3 indicates the share of students at the assigned school who are of the same race (Black, Hispanic, White, or Asian); the instrument for the remaining columns is the share of students at the assigned school who are Black or Hispanic. The endogenous variables are the corresponding peer shares for the enrolled school. All models control for demographics and baseline score achievement.

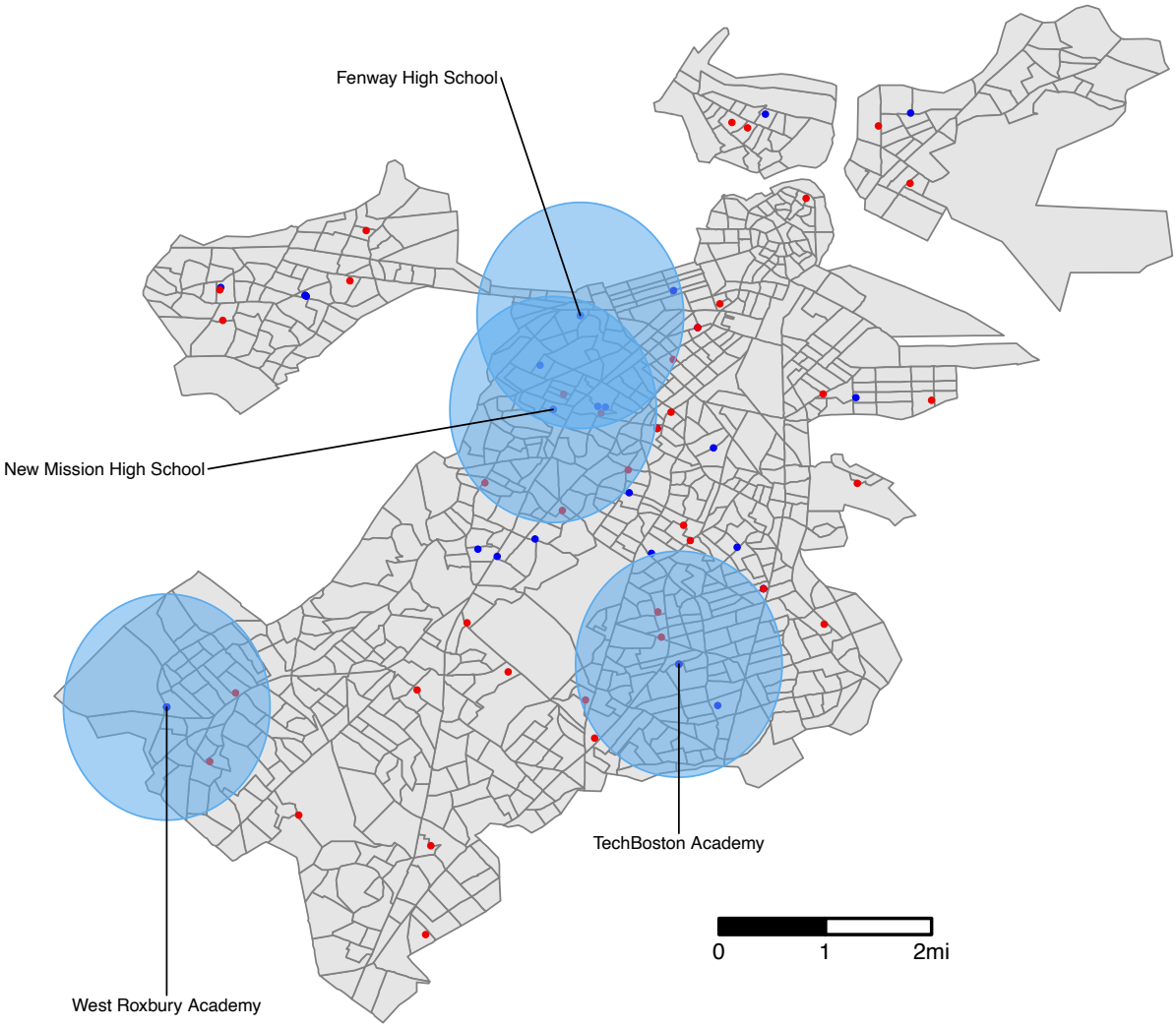
Table 7b: 2SLS Estimates of Peer Share Effects on Test Scores and College Attendance

	Peer share Black			Peer share Hispanic			Peer share Black or Hispanic		
	All applicants	Black applicants	Hispanic applicants	All applicants	Black applicants	Hispanic applicants	All applicants	Black applicants	Hispanic applicants
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Boston									
Any college	-0.0101	-0.0044	-0.0207	0.0245*	0.0100	0.0470**	0.0122	0.0020	0.0391
	(0.0133)	(0.0180)	(0.0235)	(0.0147)	(0.0212)	(0.0237)	(0.0137)	(0.0189)	(0.0246)
2-year college	-0.0100	-0.0098	-0.0107	0.0178*	0.0117	0.0267	0.0084	0.0015	0.0247
	(0.0096)	(0.0122)	(0.0180)	(0.0107)	(0.0150)	(0.0179)	(0.0092)	(0.0122)	(0.0180)
4-year college	-0.0001	0.0054	-0.0100	0.0065	-0.0022	0.0203	0.0035	-0.0003	0.0144
	(0.0119)	(0.0161)	(0.0207)	(0.0133)	(0.0189)	(0.0212)	(0.0125)	(0.0174)	(0.0216)
N	15,425	7,169	6,086	15,425	7,169	6,086	15,425	7,169	6,086
Panel B: NYC									
Any college	-0.0030	0.0031	-0.0116	0.0039	0.0014	0.0122**	0.0006	0.0057	0.0031
	(0.0039)	(0.0056)	(0.0072)	(0.0041)	(0.0079)	(0.0060)	(0.0036)	(0.0064)	(0.0058)
2-year college	-0.0016	0.0084*	-0.0117*	-0.0019	-0.0000	0.0013	-0.0031	0.0124**	-0.0081
	(0.0034)	(0.0048)	(0.0065)	(0.0036)	(0.0067)	(0.0055)	(0.0032)	(0.0056)	(0.0054)
4-year college	-0.0014	-0.0052	0.0000	0.0058	0.0014	0.0109**	0.0037	-0.0067	0.0112**
	(0.0035)	(0.0049)	(0.0059)	(0.0037)	(0.0068)	(0.0052)	(0.0033)	(0.0057)	(0.0051)
N	58,204	18,068	26,009	58,204	18,068	26,009	58,204	18,068	26,009

Notes: This table reports 2SLS estimates of peer share effects on the variables at the left, computed in the sample of applicants for Boston middle and high school seats and NYC high school applicants. The sample is limited to offered applicants with non-degenerate risk of school assignment. Peer share effects are per 10 percentage point changes. School peer shares are computed on the sample of enrolled students. The instrument for columns 1-3 indicates the share of students at the assigned school who are of the same race (Black, Hispanic, White, or Asian); the instrument for the remaining columns is the share of students at the assigned school who are Black or Hispanic. The endogenous variables are the corresponding peer shares for the enrolled school. All models control for demographics and baseline score achievement.

A Appendix

Figure A1: Boston Geocodes and Walk Zones



Notes: Lines mark geocode boundaries; blue shading marks a few school walk zones. Blue dots mark Boston high schools in 2013; red dots mark Boston middle schools in 2013.

Table A1: 2SLS Sample Construction

	Boston		NYC
	6th grade	9th grade	9th grade
	(1)	(2)	(3)
All enrolled students with demographic information	71,481	78,799	346,507
Excluding charter only and exam only applicants	61,341	60,410	341,813
Excluding continuing students	41,839	43,668	340,678
Excluding special-ed. applicants			296,437
Excluding ineligible applicants			287,094
Applicants in the match (excludes transfers)	34,212	38,539	274,642
With baseline scores	31,022	34,462	247,083
Who are offered a seat	28,359	30,727	230,065
Ranked at least two programs, the first over-subscribed	23,992	28,413	208,024
Has non-degenerate risk of school assignment	11,019	17,160	75,237

Notes: This table illustrates how we construct our 2SLS sample. Starting from the sample of all enrolled students with demographic information, we eliminate students who apply exclusively to charter and exam (or specialized) schools. Next, we exclude from our sample "continuing" students, that is, students who do not change schools when moving from 5th to 6th or 8th to 9th grade. In Boston these are primarily 6th graders enrolled in K-8 schools. In NYC these are primarily students enrolled in vocational schools. For NYC, we also eliminate students with disabilities applying to special education programs and "ineligible" applicants, where the latter are either students who are ineligible at all the schools they apply to or students who do not apply and are later administratively assigned by NYCDOE. The remaining gap between the sample at this stage and the sample of match applicants in both cities is presumably accounted for by transfer students. In order to obtain our 2SLS sample, we start from the subset of all match applicants and first eliminate all applicants who are missing baseline test scores. We then restrict to the set of applicants who are offered a seat. Next, we consider applicants who rank at least two programs, the first of which is over-subscribed. Last, we restrict to individuals who have non-degenerate risk of school assignment.

Table A2: Neighborhood Reassignment

	Baseline scenario			Change relative to baseline			
	Time	Busing eligibility	Same-race exposure	Time	Busing eligibility	Same-race exposure	Percent reassigned
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Panel A: Boston (6th grade)				
All applicants	10.6	0.58	0.458	-4.6	-0.38	-0.008	76%
Black applicants	11.3	0.63	0.455	-5.1	-0.43	0.008	82%
Hispanic applicants	10.8	0.57	0.489	-5.0	-0.38	-0.021	77%
Black or Hispanic applicants	11.0	0.60	0.800	-5.0	-0.40	-0.004	79%
White or Asian applicants	9.3	0.52	0.395	-3.3	-0.33	-0.011	64%
			Panel B: Boston (9th grade)				
All applicants	16.5	0.76	0.437	-5.7	-0.34	0.012	82%
Black applicants	17.9	0.81	0.453	-5.3	-0.32	0.022	88%
Hispanic applicants	15.7	0.73	0.487	-6.6	-0.37	0.005	77%
Black or Hispanic applicants	16.8	0.77	0.858	-5.9	-0.35	0.001	83%
White or Asian applicants	14.7	0.71	0.189	-5.2	-0.31	0.004	73%
			Panel C: NYC (9th grade)				
All applicants	17.3	0.96	0.477	-7.2	-0.19	0.034	89%
Black applicants	20.6	0.97	0.459	-9.5	-0.23	0.058	95%
Hispanic applicants	17.1	0.96	0.529	-7.7	-0.23	0.017	92%
Black or Hispanic applicants	18.5	0.96	0.714	-8.4	-0.23	0.033	93%
White or Asian applicants	14.7	0.96	0.418	-6.9	-0.15	0.035	77%

Notes: The BPS sample includes students enrolled in the 2006-16 school years; the NYC sample includes students enrolled in the 2012-16 school years. Baseline statistics in columns 1-3 show student-weighted average school characteristics, using school offered for match applicants and school enrolled for others. Statistics are for students who: (i) participate in the match and enroll in a match school, or (ii) match non-participants enrolled in a match school and with non-missing geographic information. Columns 4-7 characterize simulated alternative assignments generated by a match in which students and schools rank each other by proximity. The statistics in columns 4-7 are changes relative to columns 1-3. Same-race exposure is defined as the proportion same-race in the assigned school (in the same grade). Students are deemed busing-eligible when they travel 1.5 miles or farther in Boston and .5 miles or farther in NYC.

Table A3: Boston Attrition and Covariate Balance

		Pooled					
			Out of Garrity walk zone	Travel time	Peer share Black	Peer share Hispanic	Peer share Black or Hispanic
		Mean	Offer gap	Offer gap	Offer gap	Offer gap	Offer gap
		(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Attrition and selection into other sectors							
Has outcome MCAS Math		0.854	-0.0060	-0.0041	-0.0011	0.0050*	0.0041
			(0.0083)	(0.0048)	(0.0025)	(0.0027)	(0.0027)
Has outcome MCAS ELA		0.838	-0.0113	-0.0068	-0.0007	0.0064**	0.0065**
			(0.0089)	(0.0049)	(0.0027)	(0.0029)	(0.0030)
	N		28,179	28,074	28,047	28,047	28,047
Charter offer		0.108	-0.0091	-0.0030	0.0002	0.0010	0.0014
			(0.0077)	(0.0044)	(0.0024)	(0.0025)	(0.0027)
Charter enrolled		0.087	0.0133*	0.0088**	-0.0002	0.0026	0.0028
			(0.0074)	(0.0041)	(0.0024)	(0.0025)	(0.0026)
	N		24,238	24,149	24,125	24,125	24,125
Exam offer		0.093	0.0082	0.0068	0.0044	-0.0044	-0.0065
			(0.0113)	(0.0054)	(0.0033)	(0.0032)	(0.0048)
Exam enrolled		0.071	0.0015	0.0048	0.0028	-0.0035	-0.0072*
			(0.0103)	(0.0049)	(0.0030)	(0.0029)	(0.0044)
	N		13,762	13,686	13,677	13,677	13,677
Panel B: Baseline covariates							
Black		0.466	-0.0020	0.0090	0.0025	0.0005	0.0099**
			(0.0131)	(0.0070)	(0.0038)	(0.0040)	(0.0045)
Hispanic		0.382	0.0081	-0.0103	-0.0038	0.0017	0.0019
			(0.0128)	(0.0069)	(0.0037)	(0.0039)	(0.0042)
Female		0.505	0.0235*	0.0079	0.0036	0.0051	0.0105**
			(0.0134)	(0.0071)	(0.0040)	(0.0042)	(0.0045)
Special education		0.184	0.0000	-0.0038	-0.0019	0.0015	0.0004
			(0.0102)	(0.0053)	(0.0032)	(0.0033)	(0.0032)
Limited English proficiency		0.159	0.0131	0.0010	-0.0024	0.0010	-0.0013
			(0.0095)	(0.0048)	(0.0029)	(0.0032)	(0.0033)
Free and reduced-price lunch		0.829	-0.0041	-0.0035	0.0043	-0.0024	0.0044
			(0.0097)	(0.0052)	(0.0029)	(0.0031)	(0.0033)
Baseline math		-0.146	0.0029	-0.0025	0.0124*	-0.0081	-0.0088
			(0.0236)	(0.0127)	(0.0071)	(0.0075)	(0.0086)
Baseline English		-0.119	-0.0000	-0.0005	0.0087	0.0005	-0.0000
			(0.0242)	(0.0131)	(0.0074)	(0.0079)	(0.0084)
	N		24,238	24,149	24,125	24,125	24,125

Notes: Stacked model interacts year and a dummy for grade (6th or 9th). Exam school offer and enrollment outcomes are restricted to the sample of 9th grade applicants. Does not restrict to sample with outcomes.

Table A4: NYC Covariate Balance

		High School				
		Out of district	Travel time	Peer share Black	Peer share Hispanic	Peer share Black or Hispanic
	Mean	Offer gap	Offer gap	Offer gap	Offer gap	Offer gap
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Selection into other sectors						
Specialized school enrolled	0.047	-0.0009	-0.0015	0.0018**	-0.0001	0.0018*
		(0.0034)	(0.0014)	(0.0007)	(0.0008)	(0.0009)
Charter enrolled	0.043	0.0015	0.0010	0.0018*	-0.0011	0.0008
		(0.0030)	(0.0014)	(0.0009)	(0.0010)	(0.0007)
N		75,237	75,027	75,237	75,237	75,237
Panel B: Baseline covariates						
Black	0.305	0.0018	0.0005	0.0038**	-0.0046**	-0.0009
		(0.0061)	(0.0028)	(0.0019)	(0.0019)	(0.0018)
Hispanic	0.442	0.0043	0.0031	-0.0033*	0.0015	-0.0021
		(0.0072)	(0.0029)	(0.0019)	(0.0021)	(0.0019)
Female	0.516	-0.0055	-0.0020	-0.0000	-0.0012	-0.0011
		(0.0074)	(0.0029)	(0.0019)	(0.0021)	(0.0020)
Special education	0.077	0.0013	0.0019	-0.0013	0.0017	0.0001
		(0.0040)	(0.0016)	(0.0011)	(0.0012)	(0.0010)
Limited English Proficiency	0.063	0.0000	-0.0021*	-0.0011	0.0024**	0.0011
		(0.0038)	(0.0013)	(0.0009)	(0.0011)	(0.0010)
Free and reduced-price lunch	0.785	-0.0165**	-0.0004	0.0002	0.0016	0.0015
		(0.0065)	(0.0027)	(0.0017)	(0.0018)	(0.0018)
Baseline math	0.057	-0.0077	-0.0026	0.0036	-0.0072**	-0.0021
		(0.0108)	(0.0043)	(0.0028)	(0.0031)	(0.0030)
Baseline English	0.054	-0.0085	0.0005	-0.0009	-0.0039	-0.0041
		(0.0118)	(0.0046)	(0.0030)	(0.0033)	(0.0032)
N		75,237	75,027	75,237	75,237	75,237

Notes: Balance regressions include propensity score and running variable controls. Does not restrict to sample with outcomes.

Table A5: Reduced-Form Estimates on Peer Race

		Out of Garrity walk zone / district				
		All applicants	Black applicants	Hispanic applicants	Black or Hispanic applicants	White or Asian applicants
		(1)	(2)	(3)	(4)	(5)
				Panel A: Boston		
Peer share Black		0.0040	0.0075*	0.0028	0.0037	0.0107
		(0.0036)	(0.0044)	(0.0059)	(0.0038)	(0.0101)
Peer share Hispanic		-0.0064*	-0.0056	-0.0073	-0.0051	-0.0104
		(0.0034)	(0.0034)	(0.0061)	(0.0035)	(0.0106)
Peer share Black or Hispanic		-0.0024	0.0020	-0.0046	-0.0014	0.0003
		(0.0029)	(0.0035)	(0.0044)	(0.0028)	(0.0087)
Peer share White or Asian		0.0020	-0.0024	0.0045	0.0012	-0.0013
		(0.0028)	(0.0035)	(0.0044)	(0.0028)	(0.0087)
	N	29,332	13,707	11,248	24,955	3,901
				Panel B: NYC		
Peer share Black		-0.0004	-0.0052	-0.0002	-0.0015	0.0013
		(0.0019)	(0.0053)	(0.0023)	(0.0025)	(0.0026)
Peer share Hispanic		-0.0031*	0.0010	-0.0030	-0.0017	-0.0050**
		(0.0017)	(0.0042)	(0.0023)	(0.0022)	(0.0025)
Peer share Black or Hispanic		-0.0036*	-0.0042	-0.0032	-0.0031	-0.0037
		(0.0018)	(0.0041)	(0.0027)	(0.0022)	(0.0028)
Peer share White or Asian		0.0047**	0.0043	0.0050*	0.0044*	0.0048*
		(0.0019)	(0.0047)	(0.0026)	(0.0023)	(0.0028)
	N	83,408	25,049	36,833	61,882	20,780

Notes: This table reports reduced-form estimates of distance and travel on the left-hand side variables, computed in the sample of applicants for Boston middle and high school seats and NYC high school applicants. The sample is limited to offered applicants with non-degenerate risk of school assignment. The instrument for columns 1-5 indicates an out-of-walk zone or out-of-district assignment. The outcomes to the left correspond to school walk zone/district peer shares. These shares are computed by averaging peer shares over all in-walk zone (in-district) schools for each school walk zone (district), weighting by the number of enrolled students. The reduced-form model includes offer risk controls, which are as described in the text.

Table A6: 2SLS Estimates of School Travel Effects on School Characteristics

		Out of Garrity walk zone / district			Travel time		
		All applicants	Black applicants	Hispanic applicants	All applicants	Black applicants	Hispanic applicants
		(1)	(2)	(3)	(4)	(5)	(6)
				Panel A: Boston			
Student-teacher ratio		0.1435	0.4494	0.2155	0.2926**	0.3374**	0.4310**
		(0.1675)	(0.2847)	(0.2303)	(0.1124)	(0.1658)	(0.1698)
	Mean	13.027	12.943	12.885	13.022	12.940	12.877
	SD	3.352	3.509	3.121	3.353	3.511	3.120
Percent of teachers licensed in teaching assignment		0.0075	0.0116	0.0020	0.0009	-0.0053	0.0091
		(0.0076)	(0.0121)	(0.0120)	(0.0046)	(0.0072)	(0.0068)
	Mean	0.901	0.888	0.910	0.902	0.888	0.910
	SD	0.134	0.148	0.122	0.134	0.147	0.122
Percent of core academic classes taught by highly-qualified teachers		0.0248***	0.0271**	0.0229**	0.0113***	0.0191***	-0.0021
		(0.0051)	(0.0084)	(0.0076)	(0.0032)	(0.0049)	(0.0047)
	Mean	0.880	0.878	0.879	0.879	0.878	0.879
	SD	0.115	0.119	0.112	0.115	0.119	0.112
	N	23,756	11,245	8,933	23,662	11,196	8,904
				Panel B: NYC			
Student-teacher ratio		0.5711***	-0.2600	0.6976***	0.0340	-0.0621	0.1445**
		(0.0702)	(0.1770)	(0.0974)	(0.0354)	(0.0636)	(0.0530)
	Mean	15.836	15.364	15.109	15.843	15.371	15.114
	SD	3.165	3.138	2.850	3.165	3.138	2.849
Percent of teachers licensed in teaching assignment		0.0132***	0.0079	0.0231***	0.0056**	-0.0011	0.0137***
		(0.0037)	(0.0092)	(0.0058)	(0.0019)	(0.0034)	(0.0032)
	Mean	0.792	0.774	0.779	0.792	0.773	0.779
	SD	0.159	0.166	0.166	0.159	0.166	0.166
Percent of core academic classes taught by highly-qualified teachers		0.0060**	-0.0054	0.0177***	0.0045***	-0.0023	0.0117***
		(0.0025)	(0.0062)	(0.0039)	(0.0012)	(0.0022)	(0.0021)
	Mean	0.856	0.846	0.843	0.856	0.846	0.843
	SD	0.107	0.109	0.113	0.107	0.109	0.113
	N	56,509	17,144	25,047	56,247	17,019	24,941

Notes: This table reports 2SLS estimates of distance and travel effects on the variables at the left, computed in the sample of applicants for Boston middle and high school seats and NYC high school applicants. The sample is limited to offered applicants with non-degenerate risk of school assignment. Travel time effects are per 10 minutes of travel. The instrument for columns 1-3 indicates an out-of-walk zone assignment; the instrument for remaining columns is travel time offered. The corresponding endogenous variables are 6th/9th grade out-of-walk zone enrollment and enrolled travel time. The Boston walk zone first stage is approximately 0.44. Travel time first stages are around 0.49 for Boston and 0.63 for NYC. Offer risk controls are as described in the text. All models control for student demographics and baseline achievement as for the estimates reported in Table 2.

Table A7: 2SLS Estimates of School Travel Effects on Behavioral Outcomes

		Out of Garrity walk zone / district			Travel time		
		All applicants	Black applicants	Hispanic applicants	All applicants	Black applicants	Hispanic applicants
		(1)	(2)	(3)	(4)	(5)	(6)
				Panel A: Boston			
Ever suspended (6th or 9th grade)		0.0143	-0.0206	0.0621**	0.0122	0.0032	0.0314*
		(0.0201)	(0.0345)	(0.0310)	(0.0109)	(0.0174)	(0.0165)
	Mean	0.117	0.150	0.102	0.116	0.149	0.102
	SD	0.321	0.357	0.303	0.321	0.356	0.303
Number of suspensions (6th or 9th grade)		0.0150	-0.0356	0.1238	0.0585	0.0923	0.0675
		(0.0714)	(0.1253)	(0.1055)	(0.0413)	(0.0661)	(0.0618)
	Mean	0.308	0.408	0.260	0.306	0.404	0.257
	SD	1.870	2.387	1.405	1.867	2.385	1.404
Ever truant (6th or 9th grade)		-0.0009	-0.0082	-0.0122	-0.0001	-0.0056	-0.0023
		(0.0163)	(0.0224)	(0.0254)	(0.0086)	(0.0118)	(0.0135)
	Mean	0.329	0.284	0.391	0.328	0.282	0.391
	SD	0.470	0.451	0.488	0.469	0.450	0.488
Number of days truant (6th or 9th grade)		-0.1099	0.5209	-0.4309	0.3713	0.3238	0.7809
		(0.6446)	(0.7918)	(1.2343)	(0.3519)	(0.4575)	(0.5865)
	Mean	4.439	3.685	5.685	4.429	3.665	5.678
	SD	12.52	11.12	14.08	12.52	11.10	14.09
Days absent (6th or 9th grade)		-0.6385	-3.9691	-1.7036	0.8372	-0.1359	0.9678
		(2.4716)	(3.7114)	(3.8335)	(1.3988)	(1.9761)	(2.1778)
	Mean	25.711	25.211	26.621	25.710	25.253	26.577
	SD	42.06	41.89	40.97	42.01	41.90	40.85
Disciplinary index (6th or 9th grade)		0.0055	-0.0599	0.1010	0.0370	0.0104	0.0884*
		(0.0569)	(0.0915)	(0.0910)	(0.0313)	(0.0472)	(0.0484)
	Mean	-0.010	0.028	0.012	-0.011	0.027	0.011
	SD	0.961	1.002	0.945	0.961	1.003	0.944
	N	26,103	12,028	10,118	25,910	11,915	10,057
				Panel B: NYC			
Days absent (9th grade)		0.4136	1.0779	0.5330	0.4607**	0.3052	0.6628*
		(0.4192)	(1.0582)	(0.6918)	(0.2085)	(0.3768)	(0.3726)
	Mean	12.862	14.515	14.794	12.756	14.357	14.715
	SD	19.55	21.02	20.74	19.41	20.85	20.63
	N	75,121	22,899	33,190	74,676	22,675	33,024

Notes: This table reports 2SLS estimates of distance and travel effects on the variables at left, computed in the sample of applicants for Boston middle and high school seats and NYC high school applicants. The sample is limited to offered applicants with non-degenerate risk of school assignment. Travel time effects are per 10 minutes of travel. The instrument for columns 1-3 indicates an out-of-walk zone assignment; the instrument for the remaining columns is travel time offered. The corresponding endogenous variables are 6th/9th grade out-of-walk zone enrollment and enrolled travel time. Offer risk controls are as described in the text. All models control for student demographics and baseline achievement.

Table A8: OLS Estimates of Peer Share Effects

		Peer share Black			Peer share Hispanic			Peer share Black or Hispanic		
		All students	Black students	Hispanic applicants	All students	Black students	Hispanic applicants	All students	Hispanic applicants	Hispanic applicants
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Boston										
MCAS Math		-0.0510***	-0.0480***	-0.0480***	0.0067***	0.0114***	0.0297***	-0.0550***	-0.0553***	-0.0413***
		(0.0014)	(0.0021)	(0.0021)	(0.0016)	(0.0028)	(0.0023)	(0.0015)	(0.0025)	(0.0030)
	N	122,997	51,571	41,656	122,997	51,571	41,656	122,997	51,571	41,656
Any college		-0.0062***	-0.0056**	-0.0008	-0.0107***	-0.0090**	-0.0065**	-0.0213***	-0.0203***	-0.0135***
		(0.0015)	(0.0024)	(0.0025)	(0.0018)	(0.0029)	(0.0028)	(0.0018)	(0.0031)	(0.0036)
	Mean	0.435	0.396	0.374	0.435	0.396	0.374	0.435	0.396	0.374
4-year college		-0.0074***	-0.0037*	-0.0019	-0.0134***	-0.0131***	-0.0087***	-0.0261***	-0.0221***	-0.0197***
		(0.0014)	(0.0022)	(0.0023)	(0.0016)	(0.0026)	(0.0025)	(0.0017)	(0.0029)	(0.0033)
	Mean	0.331	0.282	0.261	0.331	0.282	0.261	0.331	0.282	0.261
	N	45,066	18,957	15,806	45,066	18,957	15,806	45,066	18,957	15,806
Panel B: NYC										
SAT Math		-0.0517***	-0.0268***	-0.0564***	-0.0514***	-0.0198***	-0.0394***	-0.0838***	-0.0644***	-0.0654***
		(0.0009)	(0.0012)	(0.0015)	(0.0008)	(0.0014)	(0.0012)	(0.0008)	(0.0016)	(0.0011)
	N	234,506	61,888	88,006	234,506	61,888	88,006	234,506	61,888	88,006
Any college		-0.0148***	-0.0038***	-0.0277***	-0.0050***	-0.0067***	0.0014*	-0.0170***	-0.0144***	-0.0159***
		(0.0005)	(0.0007)	(0.0009)	(0.0005)	(0.0008)	(0.0007)	(0.0005)	(0.0009)	(0.0007)
	Mean	0.533	0.436	0.466	0.533	0.436	0.466	0.533	0.436	0.466
4-year college		-0.0117***	-0.0048***	-0.0141***	-0.0082***	-0.0041***	-0.0025***	-0.0172***	-0.0128***	-0.0110***
		(0.0005)	(0.0006)	(0.0008)	(0.0004)	(0.0007)	(0.0007)	(0.0004)	(0.0008)	(0.0006)
	Mean	0.344	0.251	0.245	0.344	0.251	0.245	0.344	0.251	0.245
	N	270,914	81,517	109,421	270,914	81,517	109,421	270,914	81,517	109,421

Notes: This table reports OLS estimates of the relationship between school demographics and achievement or college enrollment. BPS data cover students enrolled in the 2002-16 school years; NYC statistics cover the population enrolled in the 2012-16 school years. Peer share effects are per 10 percentage point changes. These estimates are from models that control for student demographic characteristics, match participation, charter school enrollment, specialized school enrollment (NYC), and exam school enrollment (Boston). Boston test scores are from the MCAS (6th grade Math and 7th grade ELA for middle school, 10th grade Math and ELA for high school); NYC test scores are from the SAT.