Diverse Paths to College Success: The Impact of Massachusetts' Urban and Nonurban Charter Schools on College Trajectories

Sarah Cohodes
Astrid Pineda

February 14, 2025

Different Paths to College Success: The Impact of Massachusetts' Charter Schools on College Trajectories *

Sarah R. Cohodes[†]
University of Michigan and NBER

Astrid Pineda
Teachers College Columbia University

February 24, 2025

Abstract

The charter school movement encompasses many school models. In Massachusetts in the 2010's, the site of our study, urban charter schools primarily used "No Excuses" practices, whereas nonurban charters had greater model variety. Using randomized admissions lotteries, we estimate the impact of charter schools by locality on college preparation, enrollment, and graduation. Urban charter schools boost all of these outcomes. Nonurban charter schools raise college enrollment and graduation despite reducing state test scores and AP enrollment. Notably, the nonurban charter college graduation edge is more than twice as large as that from urban charter attendance.

Despite the recent decline in the college wage premium, college graduates still outearn their peers with only a high-school diploma by 75 percent (Bengali et al., 2023; Autor et al., 2023). With much policy and research in the United States focused on college access, we know less about how K–12 educational experiences contribute to college success (Dynarski et al., 2023). This paper uses application lotteries to show the causal effects of one K–12 educational intervention—charter schools—on college preparation, enrollment, and graduation.

Charter schools are autonomously operated public schools with oversight, curricular, budgetary, and hiring independence from traditional school districts. They are authorized by a state-empowered entity, undergo periodic review, and may be subject to closure. When oversubscribed, charter schools admit students via randomized admissions lotteries. Charter schools are not monolithic in character. Many urban charter schools feature longer school days and school years, a culture of high expectations, frequent teacher observations and feedback, data-driven instruction, use of tutoring, and strict discipline—practices which are often referred to as "No Excuses" (Angrist et al., 2013; Dobbie and Fryer, 2013). In recent years, many of these schools have moved away from this label and some of the associated practices (Torres, 2022). Other charter schools operate on the basis of a greater range of educational models and include project-based learning schools, themed schools (e.g. arts, language, STEM, culture), Montessori schools, and personalized learning schools.

This paper builds on Angrist et al. (2013) (APW), which examines the effects of Massachusetts charter schools on test scores across urban and nonurban areas. APW find that urban charter schools generate large test score gains whereas nonurban charters have null or negative effects. In our shared Massachusetts sample, at the time students were enrolled in the 2000's and 2010's, the urban charter schools mostly adhered to "No Excuses" practices and served a primarily minority and economically disadvantaged population. The nonurban schools did not, embracing alternative charter school models—in particular, project-based learning—and serving primarily white children. APW find that the different practices and student bodies help account for the different test scores trajectories, aligning with the existing literature on charter schools.

With a longer time horizon and more cohorts and schools, we return to APW's diverse sample of charter schools and report several novel findings. First, we replicate their test score results, finding that urban charters boost standardized test scores and nonurban charters do not. Next, we find that urban and nonurban charters both accelerate college preparation but via different means. Urban charters increase Advanced Placement (AP) and SAT test-taking and scores and completion of a college-ready curriculum, but increase time to high-school graduation. Nonurban charters decrease AP test-taking but boost completion of a college-ready curriculum.

Turning to college, both urban and nonurban charter schools boost four-year college enrollment, by 7.9 and 9.8 percentage points, respectively. Regarding college graduation, we find that attending an urban charter school raises attainment of any degree by 4.6 percentage points from the comparison mean of 24 percent and BA completion by 4.2 percentage points from a comparison

1

of 22 percent. Nonurban charter schools increase attainment of any degree by 11.2 percentage points from a comparison mean of 52 percent and BA attainment by 11.9 percentage points over a comparison rate of 47 percent. In short, both urban and nonurban charter schools lift degree attainment, but nonurban charter schools—the same schools that do not boost test scores—induce very large gains, more than twice as large as the college graduation boost from urban charters.

Our test score findings are consistent with the many lottery-based studies that have shown attending urban charter schools increases students' test scores (see Cohodes and Roy (2024) for a summary of this research) and the more limited lottery-based evidence on nonurban charter schools, which shows mixed impacts on test scores, with findings of small positive effects (Dynarski et al., 2018) and, in other cases, null or negative effects (Gleason et al., 2010; Angrist et al., 2013). Observational estimates of charter school impacts appear to confirm the lottery-based evidence that urban charter schools boost test scores while nonurban charters do not (see Cohodes and Parham (2021) for an overview).

The test score evidence has led some to conclude that charter schools are most successful in urban contexts when they adopt "No Excuses" practices (Chabrier et al., 2016; Epple et al., 2016; Cohodes and Parham, 2021). This conclusion is bolstered by lottery-based evidence showing that urban charters that boost test scores also boost college preparation and enrollment and even shape non–test score outcomes such as voting and risky behavior (Angrist et al., 2016; Dobbie and Fryer, 2015; Wong et al., 2014; Davis and Heller, 2019; Cohodes and Feigenbaum, 2021; Reber et al., 2023; Demers et al., 2017). However, there is much less evidence on nonurban charter schools and nontest outcomes. Lottery-based evidence on college graduation comes from a broad sample of charter schools in a federally funded national evaluation of charter schools (Gleason et al., 2010) extended to college outcomes (Place and Gleason, 2019), which finds no impact on college enrollment or graduation and no relationship between test scores and college outcomes. This is perhaps because their sample only consists of middle schools, whereas most of the schools in our sample offer high-school grades. Evidence from the mostly-urban KIPP schools is consistent with the idea that high-school grades are important. Demers et al. (2017) find no college enrollment or graduation boost from a lottery-based evaluation of KIPP middle schools, but when they add an instrumental variables approach to account for attendance at a KIPP high school, they find large college gains. Dobbie and Fryer (2020) use propensity score matching to show that "No Excuses" charter schools improve test scores and four-year college enrollment whereas "other" charter schools decrease both.[1]

This paper makes two main contributions. First, we add to the evidence on charter schools by presenting lottery-based estimates of their impacts on college graduation from a diverse sample of schools. The findings expand our as yet limited knowledge of the impact of different charter school models on college outcomes. Second, we demonstrate that charter school test score effects do not

---

[1]Observational work from Florida shows that charter schools initially decrease scores (Sass, 2006) but increase college persistence (Sass et al., 2016), but it does not differentiate by location type or model.

always align with the schools' impacts on students' life trajectories. Standardized test scores provide a useful but limited measure of student learning. Jackson (2018) and Jackson et al. (2020) highlight that teacher and school effects on test scores and student behavior separably contribute to longer-term outcomes. Nevertheless, researchers often use standardized test scores as a proxy for other outcomes that we care about (Krueger, 2003; Chetty et al., 2011; Hanushek, 2011; Chetty et al., 2014; Ganimian et al., 2021), but had we done so for our sample of Massachusetts charter schools, we would have come to the wrong conclusion about the schools' impacts on attainment. Now that sufficient time has passed for APW's sample of students to have completed their education, we can measure their longer-term outcomes directly and do so in the remainder of this paper.

1   Data and Descriptive Statistics

1.1   Data and Sample

Massachusetts charter school records from randomized admissions lotteries in 2002–2014, corresponding to cohorts projected to graduate high school in 2006–2018, form the basis of our investigation into charter school impacts. We include schools with admission in the middle-school grades or later, as students admitted for elementary school are too young to observe longer-term outcomes. Our sample, based on APW's but augmented by a few additional schools, includes 15 urban charter schools and 9 nonurban charter schools. We define schools as urban if they are in towns where the school district participated in the Massachusetts Urban Superintendents Network and as nonurban otherwise. The sample covers all Massachusetts charter schools that offered admission for middle- or high-school grades at the time of the initial lottery record collection (2009–2011) and for which there are records of lotteries with more applicants than seats available (Appendix Table A.1). All students in the sample are old enough to be observed 5 years after their projected high-school graduation, with one fewer cohort available at 6 years after projected high-school graduation.

The lottery records include students' names and dates of birth alongside lottery information (application grade, sibling status, town of residence, admissions offers, and waitlist status). We use the lotteries for entry grades, as these have the greatest number of open seats and a standard open admission process, and exclude guaranteed-admission siblings and non-randomized late and out-of-area applicants. We create indicators both for admission on the day of the lottery (initial offers) and offers extended from the randomized waitlist (waitlist offers). The sample includes students present in the Massachusetts data at baseline, excluding students who applied to charter schools from private schools.

We use name, date of birth, town of residence, and application cohort to match the lottery records to state administrative data from the Massachusetts Department of Elementary and Secondary Education (DESE). These records include student information such as school enrollment,

gender, race, special education status, English learner status, subsidized lunch status, days of attendance, suspensions, and high-school graduation status from the Student Information Management System (SIMS), course enrollment from the Student Course System (SCS), and achievement scores from the Massachusetts Comprehensive Assessment System (MCAS). DESE also provided information on AP and SAT exams from the College Board and college records from the National Student Clearinghouse (NSC).

Key outcomes include MCAS scores two years after the lottery, APs and SATs, MassCore curriculum completion, high-school graduation, college enrollment, and degree attainment. We standardize MCAS scores by subject, grade, and year to have mean zero and standard deviation one for the entire state.[2] AP and SAT outcomes are available for the class of 2007 and later. SAT and AP test participation indicators are marked as zeroes for students who were present in 11th or 12th grade but did not take each exam and missing if not present. MassCore completion is an indicator that the student has completed college-ready high-school curriculum, as defined by the state for the 2008 cohort and forward.[3] High-school graduation and MassCore completion is measured for students that appear in 9th grade. Indicators for IB and calculus course-taking come from the SCS but are only available for the 2015 and later cohorts. We report college outcomes within timeframes of expected high-school graduation, where the expected high-school graduation year is based on the year and grade of the application lottery. Thus, an outcome such as bachelor's attainment within 6 years indicates that a student obtained a bachelor's within 6 years of her expected high-school graduation based on when she applied to a charter school. We mark college indicators as zeroes if student information was sent to the NSC but no college records were returned, otherwise they are marked as missing.

1.2 Schools

In addition to diverging from their traditional public school counterparts, urban and nonurban charter schools diverge in their characteristics and practices from each other. Table 1 compares school characteristics for the charter schools in the lottery sample and other public schools. We measure school characteristics in the early 2010's, the point at which most students in our sample matriculated. Urban charter schools have the lowest share of teachers with formal credentials (59 percent licensed in their subject), followed by nonurban charters (71 percent), in contrast to public schools, where almost all teachers are licensed in their subject. All urban charter schools receive federal Title 1 funds for serving a high-poverty student body, as do about two-thirds of nonurban charters. Among traditional schools, 77 percent of urban schools and 41 percent of

---

[2]MCAS scores exclude middle-school scores from 2015 and 2016, when districts could select the MCAS or PARCC exam.

[3]The MassCore curriculum entails completing 4 years of math coursework, 4 years of ELA, 3 years of science, 3 years of history, 2 years of a world language, 1 year of arts and 5 additional units of core courses. The indicator is reported by school districts to the state.

nonurban schools receive Title 1. The student–teacher ratio is lower in charter schools (12:1 or 11:1 in charters and 14:1 or 13:1 in other public schools). Charter schools are small schools, with approximately 430 students per school. This compares to 663 students at urban traditional schools and 2,271 students per school in nonurban areas, which often have large comprehensive high schools. Per-pupil expenditures (in 2014 dollars) are slightly higher in urban charters ($16,250) than in urban traditional schools ($15,661) and lower in nonurban charters ($11,982) than in nonurban traditional schools ($14,411). Urban areas have higher disciplinary rates. However, relative to traditional public schools, urban charters use discipline more, whereas nonurban charters have fewer disciplinary incidents.

For the charter schools only, we have responses to a survey on school practices (Panel B). Urban charters have longer school days and school years, use tutoring, frequent teacher observations, and frequent checks for student understanding, and have a culture of high expectations. Two of the urban schools are affiliated with multi-state charter management organizations associated with No Excuses practices (KIPP and Uncommon Schools). Nonurban charters are less likely to deploy these practices, though half of them use frequent checks for student understanding and 75 percent use differentiated instruction (even higher than the 69 percent for urban charters). They are more likely to use project-based learning (63 percent versus 23 percent for urban charters). One of the nonurban schools is associated with the Coalition of Essential Schools, which focuses on individualized learning and civic contributions; another nonurban charter is associated with Expeditionary Learning, which emphasizes real-world projects and active learning;[4] and another nonurban school is an International Baccalaureate (IB) school, following a rigorous college-prep curriculum focused on critical thinking. Finally, one nonurban school focuses on performing arts. In all, 4 of 9 nonurban campuses have an explicit non-No Excuses affiliation or theme.

1.3 Students

Table 1, Panel C, also presents descriptive statistics for lottery applicants (Columns 1 and 2) and students who attended public schools in Massachusetts in 9th grade and were projected to graduate between 2006 and 2018 (Columns 3 and 4). We see important differences across urban and nonurban areas. In urban areas, Black and Latino/a students comprise 20 and 32 percent of the public school student population, respectively, and 53 and 28 percent of lottery applicants. Sixty-four percent of urban students in noncharter public schools and 74 percent of lottery applicants receive free or reduced-price lunch. Urban students and lottery applicants also have low average baseline scores: 0.43σ and 0.37σ below the state average in math and 0.43σ and 0.42σ below the average in English language arts (ELA). Regarding test scores, lottery applicants are representative of urban students overall.

In contrast, most students in nonurban areas are white: 84 percent of nonurban public school

---

[4]One urban school also follows this model.

students and 88 percent of lottery applicants are white. Students in nonurban locations are of more affluent backgrounds and have better baseline academic outcomes. Twenty percent of public school students in nonurban areas and 13 percent of charter school applicants receive subsidized lunch. Nonurban students and lottery applicants score 0.15σ and 0.33σ above the state average in math and 0.16σ and 0.41σ above the average in ELA.

2 Empirical Framework

To estimate the impact of urban and nonurban charter schools on educational attainment and other outcomes, we take advantage of the natural experiment created by charter school lotteries. We use randomized lottery offers as instruments for charter school attendance at each type of charter school in a two-stage least squares (2SLS) strategy with multiple endogenous variables. We link charter school attendance to outcomes with an equation of the following form:

$$y_i = \sum_j \delta_j d_{ij} + X_i'\Gamma + \rho^u C_i^u + \rho^n C_i^n + \epsilon_i, \tag{1}$$

where y_i is an educational outcome for student i, such as degree attainment. Charter attendance is represented by type with C_i^u and C_i^n, which are indicators for attendance prior to when y_i occurs at an urban (u) or nonurban (n) charter school with a lottery. The effect of attending an urban or nonurban charter is captured by ρ^u and ρ^n, respectively. A vector of baseline characteristics, X_i, increases statistical precision and includes indicators for gender, race, special education, English learner status, and subsidized lunch status and a set of year of birth fixed effects. Key to our estimation strategy is the inclusion of "risk sets," indicated by d_{ij}, which are lottery fixed effects that account for the set of charter schools applied to by each student and include the application year and grade. The risks sets thus account for different probabilities of charter school attendance conditional on the number of schools applied to or a school's popularity. We use robust standard errors.

Randomized charter school lottery offers serve as instruments for charter school attendance, coded as mutually exclusive indicator variables: Z_{i1} represents an initial offer and Z_{i2} represents a waitlist offer. In a few cases, schools reported only initial or waitlist offer information; in such situations we include the school but only make use of the single source of offer variation. Thus, the first stage of our 2SLS framework is:

$$C_i^k = \sum_j \mu_j d_{ij} + X_i'\beta + \pi_1^u Z_{i1}^u + \pi_2^u Z_{i2}^u + \pi_1^n Z_{i1}^n + \pi_2^n Z_{i2}^n + \eta_i; k \in u, n, \tag{2}$$

where C_i^k indicates attendance at a charter school of k type, where $k \in u, n$, and is estimated as a function of the risk sets described above, the same vector of student characteristics, and the

randomized lottery offers. The effect of lotteries on attendance is captured by π_1^k for the initial offer and π_2^k for the waitlist offer.

First stage estimates showing that charter offers boost charter attendance by 34 to 60 percentage points are presented in Appendix Table A.2. We demonstrate in Appendix Table A.3 that the characteristics of students offered seats in the lottery are very similar to not-offered students in both locations, offering a check on lottery randomization. Match rates to the SIMS data are above 99 percent and are very similar across lottery offers (Appendix Table A.4). We observe a small but statistically significant amount of differential attrition between lottery winners and losers for test scores and in 9th grade (Appendix Table A.5), prompting us to use Lee (2009) bounds for MCAS and high school outcomes (see Appendix A for a more detailed discussion). Our analysis is concerned primarily with college outcomes. For these outcomes there is no differential attrition and we have almost complete sample coverage (94 percent). We thus do not present bounds for college outcomes.

The control complier mean (CCM) is our preferred indicator for the counterfactual comparison (Katz et al., 2001; Abadie, 2002). The CCM is the average value of the outcome for compliers without charter school offers. These are students who do not attend a charter when they do not receive an initial or waitlist offer in the first charter school lottery they apply to. We estimate the CCM for each charter type k as follows (Katz et al., 2001; Abadie, 2002):

$$y_i * \left(1 - C_i^k\right) = \sum_j \lambda_j d_{ij} + X_i'\alpha + \tau \left(1 - C_i^k\right) + \nu_i; k \in u, n, \tag{3}$$

where τ is the estimate of the CCM and $(1\text{-}C_i^k)$ is instrumented by the initial and waitlist offers, with risk sets and demographics accounted for as in Equation 2.

3 Results

3.1 Standardized Test Scores

MCAS math and ELA scores two years after the lottery serve as our benchmark to compare our findings to those of previous studies (Table 2). After two years, urban charters increase scores by almost half a standard deviation (σ) in math (0.48σ) and 0.32σ in ELA. These results align with the per-year effects found in APW of 0.33σ for middle-school math, 0.15σ for middle-school ELA, 0.34σ for high-school math, and 0.26σ for high-school ELA, though the comparison is inexact because of the different parameterizations. The urban results are also on par with those reported for Boston (Abdulkadiroğlu et al., 2011; Angrist et al., 2016; Walters, 2018; Cohodes et al., 2021; Setren, 2021; Cohodes and Feigenbaum, 2021).

After a student spends two years in a nonurban charter school, test scores drop by 0.11σ in math and 0.14σ in ELA. The corresponding per-year middle-school estimates from APW are -0.12σ

for math and -0.14σ for middle-school ELA, with negative but not statistically significant impacts on high-school tests. Separating the sample into schools that exclusively serve middle-school grades (i.e. 6–8 or 5–8) and schools that offer high-school grades (e.g. 9–12 or 6–12) yields results that closely align with APW (Table 4).

We also present Lee bounds on the reduced form estimates to address differential attrition. Findings from this exercise suggest that, even in the presence of nonrandom attrition, the overarching test score patterns remain consistent with our main results. The bounds for MCAS scores in urban areas are very tight, given the minor differential attrition there. The nonurban upper bound is zero rather than negative, however, implying that if differential MCAS attrition is fully due to nonrandom selection into the sample, we would not find negative nonurban MCAS effects.

Notably, test score gains and losses occur at different points in the test score distribution. Comparison (traditional) urban students score approximately a third of a standard deviation below the state mean, whereas traditional nonurban students score almost half a standard deviation above the state mean. Thus, the test score gains in urban charters shift the distribution of scores rightward from below the state average to at or above the state average in two years, whereas nonurban charter students, despite their performance being lower than that of traditional nonurban students, still perform above the state mean (Appendix Figure B.1).

3.2 College Preparation

High-school students can prepare for college with several college-prep curricula, including AP courses, IB coursework, and other rigorous classes. We show the impact of charter school attendance on those outcomes in Table 2. Both urban and nonurban charters increase college-prep coursework, but via different paths.

In terms of AP preparation, in urban areas, charter attendance increases the AP-taking rate by 16 percentage points whereas in nonurban areas, charter attendance *decreases* AP test-taking by 29 percentage points. The decline is at least partly due to nonurban charters offering fewer APs. AP passing rates (scoring 3 or above) align with the change in AP-taking, with urban charters boosting scores of 3 or above by 5 percentage points and nonurban charters decreasing this rate by 19 percentage points (Appendix Table B.2). While AP courses are a popular college-readiness program, some high schools offer alternative paths. One nonurban charter school offers an IB curriculum; this results in nonurban charter attendance increasing the IB course-taking rate by 14 percentage points. We also examine enrollment in calculus regardless of AP Calculus enrollment, as it is an important college precursor. Calculus-taking rates increase for urban charter students by 5 percentage points and they decrease by a slightly smaller amount for nonurban charter students though this difference is not statistically significant.

AP, IB, and calculus may not encompass all college-ready curricular paths, especially in nonurban schools, many of which adhere to more individualized, project-based curricula. As a summa-

tion of college preparation, we turn to MassCore completion, which indicates a rigorous college-preparation curriculum as defined by the state. In urban areas, about 42 percent of comparison students meet the MassCore threshold; charter attendance increases this to 53 percent. In nonurban areas the charter bump is even larger: an increase from 74 percent MassCore completion for comparison students to 88 percent. Both urban and nonurban charter schools increase college preparation, with urban charters focusing on AP courses and MassCore and nonurban charters emphasizing the MassCore college-prep curriculum.

Taking, and scoring well on, the SAT test is another milestone on the path to college. As shown in Table 2, urban charter attendance increases SAT taking by about 4 percentage points, up from 63 percent for comparison students. Nonurban charter attendance does not change the rate of SAT-taking, with 79 percent of nonurban students in the sample taking the SAT. Urban charter attendance boosts the test scores of takers by 39 points (out of 1600), with little difference in nonurban scores.[5]

In order to matriculate to college, high-school students must also progress through high school and graduate. We display treatment estimates for high-school graduation in Table 2. Here, the findings diverge from those on test scores. Urban students are less likely to graduate high school on time, with a 7-percentage-point decrease in high-school graduation in four years. Urban charter students do catch up, with little difference in graduation rates vis-à-vis their peers' at the 5-year horizon. This is consistent with Angrist et al. (2016), which suggests that many Boston charter students take five years to graduate in order to complete high-school requirements, and our finding that urban charter attendance increases the likelihood that students repeat 9th or 10th grade by 4 percentage points (Appendix Table B.3). Nonurban charter students graduate at the same rates and within the same timeframe as their peers.

Since there is modest differential attrition in presence in high school in the nonurban areas, we present Lee bounds for high-school outcomes as well. The bounds for these outcomes are quite tight and the small differences in appearance in the data do not affect our conclusions.

Overall, our findings suggest that attending an urban charter school boosts several measures of college preparation: students increase the number of APs taken, their completion of a college-ready high-school curriculum, the likelihood that they take the SAT, and their SAT scores. There are negative impacts on high-school graduation, which diminish over time. These estimates are similar to those previously reported for Boston charters (Angrist et al., 2016; Setren, 2021; Cohodes and Feigenbaum, 2021). For the first time, we present evidence on nonurban charter attendance on college preparation: nonurban charter attendees take fewer APs, given their schools' lower AP course offerings, but are much more likely to complete the rigorous MassCore curriculum. SAT and high-school graduation outcomes are unchanged by nonurban charter attendance.

---

[5]We display SAT reasoning scores (out of 1600) since all cohorts take the relevant SAT subsections and only some take the exam scored out of 2400.

3.3 College Enrollment

College preparation in high school is an important precursor to college, but college enrollment, persistence, and graduation show whether students succeed outside secondary education. Within a year of projected high-school graduation, both urban and nonurban charter students enroll in four-year college at greater rates than their peers, as shown in Figure 1 and Table 3. Additionally, both types divert enrollments from two-year institutions, such that initial enrollment in any post-secondary institution remains flat in both localities (Appendix Table B.4). Urban charter attendance boosts immediate four-year enrollment to 45 percent from 39 percent; nonurban charter attendance boosts enrollment to 62 percent from 53 percent (Figure 1). The decline in two-year college enrollment due to urban charter attendance is 4 percentage points and that due to nonurban charter attendance is 7 percentage points. By the second year after projected high-school graduation, an interval that allows for late high-school graduation, there is little difference in enrollment at two-year institutions, and four-year college enrollment increases by 8 and 10 percentage points for urban and nonurban charters, respectively. Since two-year enrollment changes little and four-year enrollment rises, enrollment in any college increases for both charter types in the second year after projected high-school graduation, as shown in Table 3. With no differential attrition in the college data, we do not present bounds for these or other college outcomes.

Following the time trend in Figure 1 into the 3rd and 4th years after expected high-school graduation, urban charters boost four-year college enrollment by 5 to 7 percentage points, with the control complier mean decreasing over time as students drop out. In the 5th and 6th years after high-school graduation, urban charters increase enrollment, though the interpretation of this outcome is ambiguous: If it represents progress toward a degree, enrollment could be beneficial; if it represents a delay in joining the workforce, it could be detrimental. The decrease in control complier enrollment is now due in part to graduation from college. Nonurban charters boost four-year enrollment in the 3rd and 4th years by 10 to 13 percentage points, with lower dropout among the counterfactual students. Nonurban charter students are also more likely to be enrolled in the 5th and 6th years after projected high-school graduation by 4 to 5 percentage points, though only the 6th year difference is statistically significant. Urban and nonurban charters increase both initial college enrollment and persistence through college.

3.4 Degree Attainment

Both urban and nonurban charter school attendance increases the likelihood that a student obtains any degree, in particular a bachelor's from a four-year institution. In the 4th year after projected high-school graduation, which corresponds to on-time high-school progress and on-time college progress, urban charters increase BA receipt by 3 percentage points and nonurban charters by 7 percentage points (Figure 1). Urban charters boost two-year attainment by a small amount, whereas nonurban schools decrease it, meaning that both school types increase receipt of a degree

of any type by 4 to 6 percentage points (Appendix Table B.5).

As time goes on, urban charter attendance increases the BA boost to 4.2 percentage points by the 6th year after projected high-school graduation and the gains in any degree attainment to 4.6 percentage points. The nonurban edge increases to an even greater extent over time, with a bump of 11.9 percentage points for BA attainment (11.2 percentage points for any degree) in the 6th year after projected high-school graduation (Table 3). By the 6th year, 22 percent of urban control compliers graduate with a BA, with urban charter attendance increasing this to 26 percent, an increase of 19 percent of the comparison mean. By the 6th year, 47 percent of the nonurban control compliers graduate college, with the charter effect boosting this outcome for treated compliers to 59 percent, a 25 percent increase over the mean. Charter attendees are more likely to enroll and graduate from four-year colleges in both urban and nonurban areas. Our conclusions are robust to excluding covariates, adding baseline scores, or instrumenting using initial offers only (Appendix Table B.6). The nonurban charter effect is even larger for college graduation outcomes than for college enrollment outcomes. Notably, 6 years after high-school graduation, the college graduation edge from nonurban charter attendance is more than twice as large as that from urban charter attendance.

3.5 College Quality

College quality can increase college graduation and earnings (Hoekstra, 2009; DeAngelo et al., 2011; Cohodes and Goodman, 2014; Zimmerman, 2014; Goodman et al., 2017; Ge et al., 2022; Black et al., 2023). Thus, we investigate the impact of charter attendance on college quality using college categories from the Barron's Guide and college characteristics from the US Department of Education's Integrated Postsecondary Education Data System (IPEDS) in Table 3. IPEDS college information is assigned to students by their first enrolled institution. We also consider the extent to which college quality accounts for the observed boost in graduation. Urban charter attendance increases both four-year college enrollment and BA attainment in fairly equal measure at highly competitive institutions and competitive institutions. Nonurban charter attendance boosts college enrollment primarily at highly competitive institutions and graduation at highly competitive and competitive institutions. The differences in college atmospheres are reflected in increased instructional expenditures per student (compensation for instruction divided by number of students) of $809 for urban college attendees and $928 (not significant) for nonurban. Nonurban college students attend institutions with lower student/faculty ratios (number of non-graduate students divided by number of non-graduate-teaching instructional staff).

To measure institution graduation rate, we use the IPEDS' 150% completion rate, which reflects graduation within 6 years for 4-year programs and within 3 years for 2-year programs. Urban charter attendance improves the institutional graduation rate by 4.3 percentage points. Nonurban charter attendance also boosts the graduation rate of the institution attended by 4.3 percentage points.

11

The graduation rate shift due to urban charter attendance almost exactly matches the boost in any degree attainment (4.6 percentage points) whereas in nonurban areas, the shift in graduation rates is about 40 percent of the change in degree attainment ($\frac{0.043}{0.112}$). The shift in college quality appears to explain the degree gains for urban charters but not for nonurban charters.

We can show this another way by considering the implicit 6-year graduation rates for treated and untreated compliers at 4-year colleges. In urban areas, the graduation rate for comparison students is 58.9 percent ($\frac{0.216}{0.367}$). For treated students, the graduation rate is a similar 57.8 percent ($\frac{0.216+0.042}{0.367+0.079}$). In nonurban areas, the graduation rate is 85 percent for counterfactual students ($\frac{0.472}{0.557}$), whereas it is 88.9 percent for treated students ($\frac{0.472+0.119}{0.557+0.098}$). This implies that the nonurban charter college boost operates not only through enrolling in high quality institutions but also through how students experience and complete college.

3.6 Alternative School Groupings

In Table 4, we present results with alternative school groupings. The college gains for both localities are concentrated among schools that offer high-school grades (a majority of our sample), with no and perhaps negative effects on college for the few schools that only offer middle-school grades, similar to the evidence from Place and Gleason (2019) and Demers et al. (2017). This finding indicates that continuity between the charter school environment and college transition may be a key factor behind the college boost. We also regroup schools by their practices rather than their localities. One nonurban school in our sample follows No Excuses practices and two urban schools do not follow the No Excuses model. Under this categorization the No Excuses gains are slightly larger than the urban ones, and the non-No Excuses schools generally follow the pattern for the nonurban schools. However, the test score results are null rather than negative and the college boost is slightly smaller. This analysis reinforces the notion that multiple school models can lift college outcomes and that test score gains are not a necessary precursor to college gains.

4 Conclusion

We confirm previous evidence from Massachusetts that urban charters boost test scores, whereas nonurban charters do not, a pattern that aligns with results in the broader charter school literature. However, when we turn to college enrollment and graduation, we have several novel findings. First, we show that the bump in college enrollment found previously for Boston charter attendance translates into degree completion in a wider sample of urban schools, with urban charters boosting BA attainment rates by 4.2 percentage points and attainment of any degree by 4.6 percentage points within 6 years. Second, we show that nonurban charter schools—the same schools that do not increase test scores—increase four-year college enrollment and BA attainment by 9.8 and 11.9 percentage points, respectively. The current analysis cannot speak to all of the mechanisms behind

the college gains, but we present evidence on a few key factors. Offering high-school grade levels seems to be a necessary condition for college impact, with no college gains for schools that offer only middle-school grades. Charters in both locales boost college-ready curricula, via AP and MassCore in urban areas and MassCore in nonurban ones. This academic preparation may be a key factor for the persistence effects. The college institutions that students enroll in matters: The urban charter college edge exactly parallels the rise in graduation rates due to type of enrolled institution, whereas for nonurban charters it accounts for 40 percent of gains. The remaining nonurban advantage is unexplained. In future work, we will investigate more of the mechanisms behind this pattern of results, including differences in school practices and contexts.

We draw two main conclusions from these findings. First, multiple charter school models can induce college gains. While many have focused on the "No Excuses" practices as key to charter school success, the nonurban schools in this sample operating on alternative models deliver a large boost to BA attainment. Second, although test scores and longer-term outcomes are typically positively correlated, we add to the evidence that shows that the relationship between test scores and college outcomes does not hold in all contexts, concluding that researchers and policymakers should be wary of evaluating programs solely on standardized test results.

References

Abadie, A. (2002). Bootstrap tests for distributional treatment effects in instrumental variables models. *Journal of the American Statistical Association 97*(457), 284–292.

Abdulkadiroğlu, A., J. Angrist, S. Dynarski, T. J. Kane, and P. Pathak (2011). Accountability and flexibility in public schools: Evidence from Boston's charters and pilots. *The Quarterly Journal of Economics 126*(2), 699–748.

Angrist, J., P. Pathak, and C. Walters (2013). Explaining charter school effectiveness. *American Economic Journal: Applied Economics 5*(4), 1–27.

Angrist, J. D., S. R. Cohodes, S. M. Dynarski, P. A. Pathak, and C. R. Walters (2016). Stand and deliver: Effects of Boston's charter high schools on college preparation, entry, and choice. *Journal of Labor Economics 34*(2), 275–318.

Autor, D., A. Dube, and A. McGrew (2023). The unexpected compression: Competition at work in the low wage labor market. Technical report, National Bureau of Economic Research.

Bengali, L., M. Sander, R. G. Valletta, and C. Zhao (2023). Falling college wage premiums by race and ethnicity. *FRBSF Economic Letter 2023*(22), 1–6.

Black, S. E., J. T. Denning, and J. Rothstein (2023). Winners and losers? The effect of gaining and losing access to selective colleges on education and labor market outcomes. *American Economic Journal: Applied Economics 15*(1), 26–67.

Chabrier, J., S. Cohodes, and P. Oreopoulos (2016). What can we learn from charter school lotteries. *Journal of Economic Perspectives 30*(3), 57–84.

Chetty, R., J. N. Friedman, N. Hilger, E. Saez, D. W. Schanzenbach, and D. Yagan (2011). How does your kindergarten classroom affect your earnings? Evidence from Project STAR. *The Quarterly Journal of Economics 126*(4), 1593–1660.

Chetty, R., J. N. Friedman, and J. E. Rockoff (2014). Measuring the impacts of teachers II: Teacher value-added and student outcomes in adulthood. *American Economic Review 104*(9), 2633–2679.

Cohodes, S. and J. J. Feigenbaum (2021, September). Why does education increase voting? Evidence from Boston's charter schools. Working Paper 29308, National Bureau of Economic Research.

Cohodes, S. and S. Roy (2024). Thirty years of charter schools: What does lottery-based research tell us? *Journal of School Choice 0*(0), 1–42.

Cohodes, S. R. and J. S. Goodman (2014). Merit aid, college quality, and college completion: Massachusetts' Adams scholarship as an in-kind subsidy. *American Economic Journal: Applied Economics 6*(4), 251–285.

Cohodes, S. R. and K. S. Parham (2021). Charter schools' effectiveness, mechanisms, and competetive influence. *National Bureau of Economic Research Working Paper 28477*.

Cohodes, S. R., E. M. Setren, and C. R. Walters (2021). Can successful schools replicate? Scaling up Boston's charter school sector. *American Economic Journal: Economic Policy 13*(1), 138–67.

Davis, M. and B. Heller (2019). No excuses charter schools and college enrollment: New evidence from a high school network in Chicago. *Education Finance and Policy 14*(3), 414–440.

DeAngelo, L., R. Franke, S. Hurtado, J. H. Pryor, and S. Tran (2011). Completing college: Assessing graduation rates at four-year institutions.

Demers, A., I. Nichols-Barrer, E. Steele, M. Bartlett, and P. Gleason (2017). Long-term impacts of kipp middle and high schools on college enrollment, persistence, and attainment. Technical report, Mathematica.

Dobbie, W. and R. Fryer (2013). Getting beneath the veil of effective schools: Evidence from New York City. *American Economic Journal: Applied Economics 5*(4), 28–60.

Dobbie, W. and R. Fryer (2015). The medium-term impacts of high-achieving charter schools. *Journal of Political Economy 123*(5), 985–1037.

Dobbie, W. and R. G. Fryer (2020). Charter schools and labor market outcomes. *Journal of Labor Economics 38*(4), 915–957.

Dynarski, S., D. Hubbard, B. Jacob, and S. Robles (2018). Estimating the effects of a large for-profit charter school operator. Technical report, National Bureau of Economic Research.

Dynarski, S., A. Nurshatayeva, L. C. Page, and J. Scott-Clayton (2023). Addressing nonfinancial barriers to college access and success: Evidence and policy implications. Volume 6 of *Handbook of the Economics of Education*, pp. 319–403. Elsevier.

Epple, D., R. Romano, and R. Zimmer (2016). Charter schools: A survey of research on their characteristics and effectiveness. In *Handbook of the Economics of Education*, Volume 5, pp. 139–208. Elsevier.

Ganimian, A. J., K. Muralidharan, and C. R. Walters (2021). Augmenting state capacity for child development: Experimental evidence from india. Technical report, National Bureau of Economic Research.

Ge, S., E. Isaac, and A. Miller (2022). Elite schools and opting in: Effects of college selectivity on career and family outcomes. *Journal of Labor Economics 40*(S1), S383–S427.

Gleason, P., M. Clark, C. C. Tuttle, and E. Dwoyer (2010, June). The evaluation of charter school impacts: Final report. NCEE 2010-4029, National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education, Washington, DC.

Goodman, J., M. Hurwitz, and J. Smith (2017). Access to 4-year public colleges and degree completion. *Journal of Labor Economics 35*(3), 829–867.

Hanushek, E. A. (2011). The economic value of higher teacher quality. *Economics of Education review 30*(3), 466–479.

Hoekstra, M. (2009). The effect of attending the flagship state university on earnings: A discontinuity-based approach. *The review of economics and statistics 91*(4), 717–724.

Jackson, C. K. (2018). What do test scores miss? The importance of teacher effects on non–test score outcomes. *Journal of Political Economy 126*(5), 2072–2107.

Jackson, C. K., S. C. Porter, J. Q. Easton, A. Blanchard, and S. Kiguel (2020). School effects on socioemotional development, school-based arrests, and educational attainment. *American Economic Review: Insights 2*(4), 491–508.

Katz, L. F., J. R. Kling, and J. B. Liebman (2001). Moving to opportunity in Boston: Early results of a randomized mobility experiment. *The Quarterly Journal of Economics 116*(2), 607–654.

Krueger, A. B. (2003). Economic considerations and class size. *The economic journal 113*(485), F34–F63.

Lee, D. S. (2009). Training, wages, and sample selection: Estimating sharp bounds on treatment effects. *The Review of Economic Studies 76*(3), 1071–1102.

Place, K. and P. Gleason (2019). Do charter middle schools improve students' college outcomes? *NCEE Evaluation Brief* (2019-4005).

Reber, S. J., D. Rünger, and M. D. Wong (2023). The effects of charter high schools on academic achievement and college enrollment: Evidence from los angeles. *Education Finance and Policy*, 1–19.

Sass, T. R. (2006, 01). Charter Schools and Student Achievement in Florida. *Education Finance and Policy 1*(1), 91–122.

Sass, T. R., R. W. Zimmer, B. P. Gill, and T. K. Booker (2016). Charter high schools' effects on long-term attainment and earnings. *Journal of Policy Analysis and Management 35*(3), 683–706.

Setren, E. (2021). Targeted vs. general education investments: Evidence from special education and english language learners in boston charter schools. *Journal of Human Resources 56*(4), 1073–1112.

Torres, C. (2022). Classroom management in "no-excuses" charter schools. In *Handbook of Classroom Management*, pp. 152–166. Routledge.

Walters, C. R. (2018). The demand for effective charter schools. *Journal of Political Economy 126*(6).

Wong, M. D., K. M. Coller, R. N. Dudovitz, D. P. Kennedy, R. Buddin, M. F. Shapiro, S. H. Kataoka, A. F. Brown, C.-H. Tseng, P. Bergman, et al. (2014). Successful schools and risky behaviors among low-income adolescents. *Pediatrics 134*(2), e389–e396.

Zimmerman, S. D. (2014). The returns to college admission for academically marginal students. *Journal of Labor Economics 32*(4), 711–754.

Figure 1: Four-Year College Progression
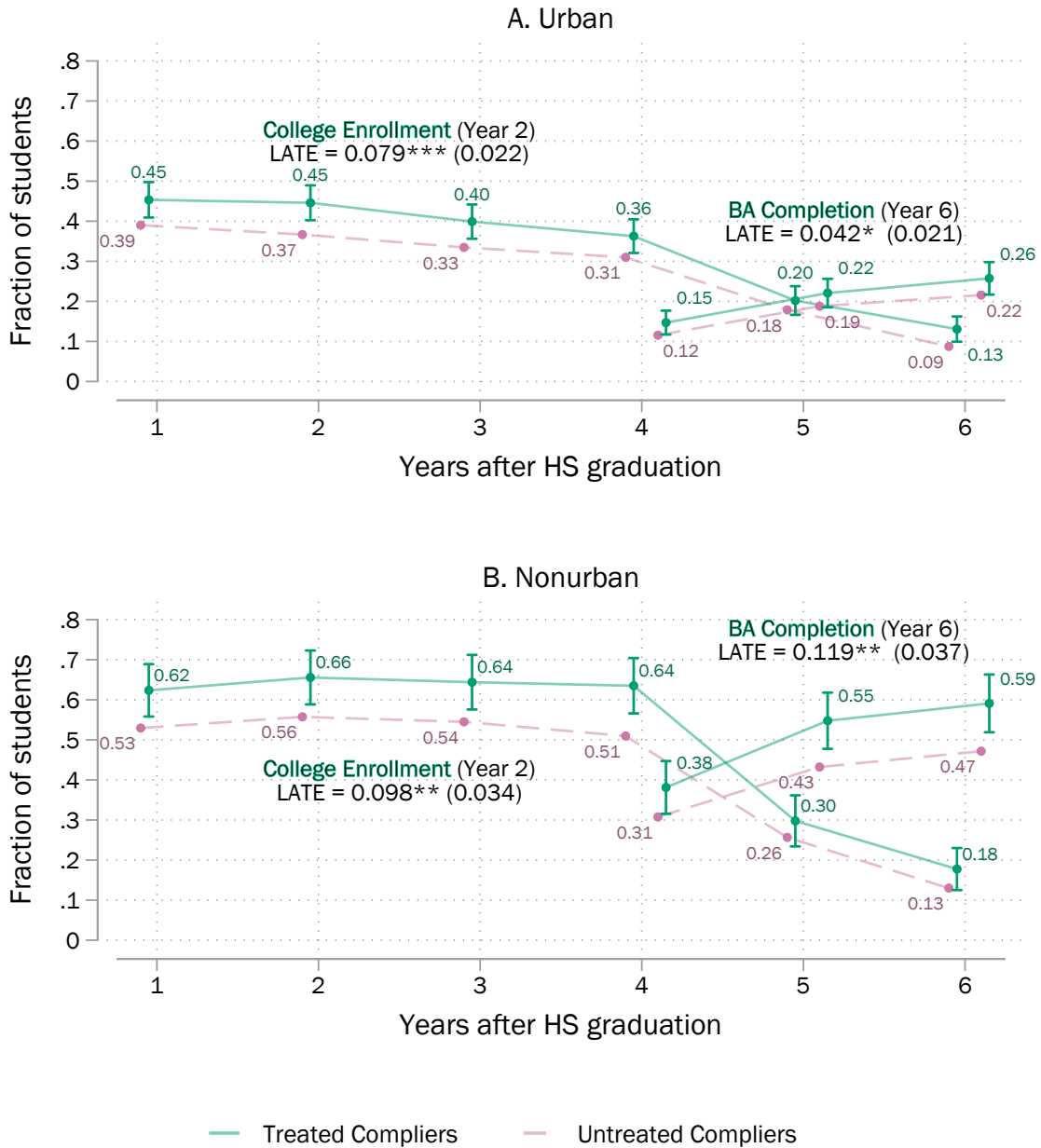
Notes: This figure shows the treatment and control complier means for four-year college enrollment and graduation for treated and untreated compliers. Treatment effects on college enrollment two years after projected high-school graduation and graduation rates six years after projected high-school graduation are reported under the labels. Details for the other treatment effects are in Appendix Tables B.4 and B.5. Robust standard errors in parentheses (+ p<0.10 * p<0.05 ** p<0.01 ***p<0.001).

Table 1: School and Student Characteristics

	Charter Schools		Other Public Schools	
	Urban (1)	Nonurban (2)	Urban (3)	Nonurban (4)
(A) Schools: Administrative Records				
% of teachers licensed in subject	58.867	70.611	96.608	96.855
% of core classes taught by highly qualified teachers	86.227	94.089	89.876	97.378
Title 1 school	1.000	0.667	0.767	0.409
Student-teacher ratio	11.721	10.511	13.955	13.165
Per-pupil expenditure	16250	11982	15661	14411
School size	433	435	663	2271
Counselors per 1000 students	5.204	2.150	2.793	3.043
Disciplined students per 1000 students	191.923	33.963	122.090	45.412
(B) Schools: Survey Responses				
Days per school year	192	182	-	-
Hours per school day	7.935	6.974	-	-
High-quality tutoring	0.615	0.111	-	-
Frequent teacher observations	0.538	0.375	-	-
Frequent checks for student understanding	0.846	0.500	-	-
Differentiated instruction	0.692	0.750	-	-
Culture of high expectations	0.733	0.111	-	-
Project-based learning	0.231	0.625	-	-
N(Schools)	15	9	266	599
(C) Students: Baseline Characteristics				
Female	0.518	0.519	0.483	0.491
Asian	0.030	0.030	0.076	0.039
Black	0.526	0.026	0.199	0.046
Latinx	0.284	0.036	0.316	0.062
Other race	0.041	0.028	0.028	0.017
White	0.119	0.880	0.380	0.836
Special education	0.194	0.159	0.187	0.177
English learner	0.114	0.011	0.179	0.028
Free/reduced price lunch	0.740	0.128	0.644	0.198
Baseline MCAS ELA	-0.418	0.417	-0.432	0.155
Baseline MCAS Math	-0.364	0.331	-0.426	0.153
N	14,191	3,583	276,401	643,585

Notes: This table shows characteristics for urban and nonurban charter schools in the lottery analysis sample and lottery applicants in Columns 1 and 2. Information on traditional public schools that serve 6th and/or 9th grades in urban and nonurban areas and their students appears in Columns 3 and 4 for comparative purposes. Data sources for Panel A are Massachusetts Department of Elementary and Secondary Education School District Profiles for the 2013–2014 school year. Title I eligibility is reported for the 2013–2014 school year and comes from the U.S. Department of Education Common Core of Data (CCD). The data for Panel B come from a survey of charter school leaders fielded in 2011 and 2012. The survey response rate was 87.5% (12 out of 15 urban schools, all 9 nonurban schools). Panel C uses the student-level data for charter school applicants enrolled in schools in the state of Massachusetts at the time of application in the projected high-school classes of 2006–2018 in Columns 1 and 2 and for students who attended schools in the state of Massachusetts in 9th grade in the projected high-school classes of 2006–2018 in Columns 3 and 4.

Table 2: The Impact of Charter School Attendance on Tests and High School Academics

	MCAS		HS Curriculum				SAT		HS Graduation	
	Math	ELA	Took AP	Took IB	Took Calc	MassCore	Took SAT	Score	4 Year	5 Year
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(A) Urban										
2SLS	0.475***	0.318***	0.164***	-0.018*	0.052**	0.105***	0.042*	39.026***	-0.066***	-0.018
	(0.040)	(0.038)	(0.023)	(0.009)	(0.025)	(0.025)	(0.023)	(9.459)	(0.023)	(0.022)
CCM	-0.299	-0.332	0.323	0.023	0.166	0.423	0.626	892.771	0.655	0.733
N	10,706	10,822	10,831	5,938	5,938	9,761	10,831	6,951	11,983	11,983
Reduced Form	0.226***	0.151***	0.076***	-0.009*	0.029**	0.046***	0.014	17.984***	-0.029***	-0.009
	(0.020)	(0.019)	(0.011)	(0.005)	(0.013)	(0.012)	(0.011)	(4.512)	(0.011)	(0.010)
Lower Bound	0.192***	0.114***	0.076***	-0.009*	0.029**	0.046***	0.014	16.577***	-0.030***	-0.011
	(0.020)	(0.019)	(0.011)	(0.005)	(0.013)	(0.012)	(0.011)	(4.486)	(0.011)	(0.010)
Upper Bound	0.271***	0.215***	0.076***	-0.009*	0.031**	0.046***	0.014	18.319***	-0.028***	-0.008
	(0.019)	(0.018)	(0.011)	(0.005)	(0.013)	(0.012)	(0.011)	(4.512)	(0.011)	(0.010)
(B) Nonurban										
2SLS	-0.114*	-0.139***	-0.289***	0.142***	-0.037	0.140***	0.010	11.389	-0.016	-0.012
	(0.059)	(0.051)	(0.035)	(0.031)	(0.047)	(0.033)	(0.032)	(15.316)	(0.026)	(0.024)
CCM	0.372	0.481	0.512	0.066	0.289	0.737	0.786	1121.508	0.815	0.903
N	3,198	3,164	3,081	1,729	1,729	2,942	3,081	2,376	3,175	3,175
Reduced Form	-0.069**	-0.082***	-0.159***	0.078***	-0.014	0.083***	0.012	6.982	-0.013	-0.011
	(0.035)	(0.029)	(0.021)	(0.017)	(0.027)	(0.019)	(0.018)	(8.987)	(0.015)	(0.014)
Lower Bound	-0.113***	-0.120***	-0.165***	0.075***	-0.016	0.077***	0.005	-5.198	-0.018	-0.015
	(0.035)	(0.029)	(0.020)	(0.017)	(0.027)	(0.019)	(0.018)	(8.819)	(0.015)	(0.014)
Upper Bound	0.012	0.004	-0.153***	0.080***	-0.012	0.090***	0.017	18.507**	-0.009	-0.005
	(0.034)	(0.027)	(0.021)	(0.017)	(0.027)	(0.019)	(0.018)	(8.880)	(0.015)	(0.014)

Notes: Each coefficient labeled 2SLS is the instrumental variables estimate of the effect of attending an urban or nonurban charter on the outcome listed in the column heading as described in Equation 1. The control complier mean is listed in the rows labeled CCM. The estimate of the effect of winning an urban or nonurban charter lottery is reported in the rows labeled Reduced Form. For concision, the reduced form estimates use a single offer variable, ever offer, in each locality. Estimates of the reduced form using Lee Bounds are labeled Lower Bound and Upper Bound. The sample includes charter lottery applicants in the projected high-school classes of 2006–2018. MassCore refers to graduating within 5 years with a college-preparation curriculum as defined by the state. It is available for the classes of 2008–2018. The IB and Calculus indicators are available for the classes of 2015–2018. Robust standard errors in parentheses (+ p<0.10 * p<0.05 ** p<0.01 ***p<0.001).

19

Table 3: The Impact of Charter School Attendance on College Outcomes

	Urban			Nonurban		
	2SLS	CCM	N	2SLS	CCM	N
	(1)	(2)	(3)	(4)	(5)	(6)
(A) College Enrollment (in Y2)						
All	0.077***	0.495	13,281	0.063+	0.684	3,414
	(0.023)			(0.032)		
All: Graduation rate (IPEDS)	0.043**	0.447	7,993	0.043*	0.573	2,728
	(0.014)			(0.019)		
All: Instructional exp./student	809.324*	7184.252	7,849	927.703	9258.788	2,711
	(332.370)			(757.111)		
All: Student/faculty ratio	-0.061	15.748	7,993	-0.530+	14.921	2,728
	(0.220)			(0.310)		
2 Year	-0.002	0.127	13,281	-0.035	0.127	3,414
	(0.016)			(0.023)		
4 Year	0.079***	0.367	13,281	0.098**	0.557	3,414
	(0.022)			(0.034)		
4 Year: Highly Competitive	0.036*	0.118	13,281	0.065+	0.317	3,414
	(0.016)			(0.034)		
4 Year: Competitive	0.044*	0.185	13,281	0.036	0.204	3,414
	(0.019)			(0.031)		
4 Year: Noncompetitive	0.001	0.062	13,281	-0.001	0.036	3,414
	(0.011)			(0.015)		
(B) College Degrees (by Y6)						
All	0.046*	0.240	11,608	0.112**	0.519	3,158
	(0.022)			(0.037)		
AA	0.009	0.041	11,608	-0.030	0.093	3,158
	(0.011)			(0.020)		
BA	0.042*	0.216	11,608	0.119**	0.472	3,158
	(0.021)			(0.037)		
BA: Highly Competitive	0.023+	0.082	11,608	0.078*	0.260	3,158
	(0.014)			(0.034)		
BA: Competitive	0.022	0.095	11,608	0.052+	0.161	3,158
	(0.015)			(0.029)		
BA: Noncompetitive	-0.003	0.037	11,608	-0.011	0.049	3,158
	(0.010)			(0.016)		

Notes: Each coefficient in columns labeled 2SLS is the instrumental variables estimate of the effect of attending an urban or nonurban charter on the outcome listed in the column heading as described in Equation 1. The control complier mean is listed in the column labeled CCM. The sample includes charter lottery applicants in the projected high-school classes of 2006–2018. Highly Competitive includes Barron's categories *highly competitive*, *most competitive*, and *very competitive*; Competitive includes the categories *competitive* and *special*; and Noncompetitive includes *noncompetitive*, *unranked*, and *less competitive*. College characteristics come from IPEDS and are availabe for students enrolled in college: graduation rate is the 150% graduation rate; instructional expenditures/student is the institution-reported expenditures on instructional staff compensation divided by the number of full-time equivalent students; and student/faculty ratio is the number of full-time equivalent non-graduate students divided by the number of full-time equivalent instructional staff teaching non-graduate students. Robust standard errors in parentheses (+ p<0.10 * p<0.05 ** p<0.01 ***p<0.001).

Table 4: The Impact of Charter School Attendance on Key Outcomes, Alternative Samples

| | Urban | | | Nonurban | | |
	Math MCAS	4-Year College Enrollment	4-Year College Graduation	Math MCAS	4-year College Enrollment	4-year College Graduation
	(1)	(2)	(3)	(4)	(5)	(6)
Main specification	0.475***	0.079***	0.042*	-0.114+	0.098**	0.119**
	(0.040)	(0.022)	(0.021)	(0.059)	(0.034)	(0.037)
N	10,706	13,281	11,608	3,198	3,414	3,158
Serves HS grades	0.418***	0.095***	0.062**	-0.039	0.125**	0.153***
	(0.044)	(0.025)	(0.023)	(0.071)	(0.041)	(0.043)
N	9,001	11,294	10,236	2,494	2,689	2,475
Serves MS only	0.608***	0.011	-0.072+	-0.346***	0.020	0.010
	(0.071)	(0.040)	(0.038)	(0.097)	(0.063)	(0.067)
N	1,690	1,983	1,351	704	725	683

	No Excuses			Non-No Excuses		
	(7)	(8)	(9)	(10)	(11)	(12)
Alt. Grouping	0.494***	0.078***	0.043*	-0.021	0.070*	0.075*
	(0.038)	(0.022)	(0.020)	(0.058)	(0.033)	(0.033)
N	10,071	12,402	10,821	4,937	5,949	5,367

Notes: The first row of the table repeats the main specification reported in the other tables, see Tables 2 and 3 for details. Four-year college enrollment is enrollment in 2 years of projected high school graduation. Each subsequent row shows an alternative sample definition. The row labeled Serves HS grades restricts the sample to schools that offer high-school grade levels. The row labeled Serves MS only restricts the sample to schools that exclusively offer middle-school grade levels and do not offer high-school grade levels. The row labled Alt. Grouping groups schools by No Excuses and not No Excuses instead of urban and nonurban. Since students may apply to both types of schools, they may be counted in the N for each type. Robust standard errors in parentheses (+ p<0.10 * p<0.05 ** p<0.01 ***p<0.001).

Appendix

Different Paths to College Success: The Impact of Massachusetts'
Charter Schools on College Trajectories

Sarah R. Cohodes and Astrid Pineda

Appendix A: Lottery Details

Table A.1: Massachusetts Charter Schools Eligible for Lottery Study

School (1)	Town (2)	Urban (3)	CMO/ Affiliation (4)	Grades Served (5)	Lottery Entry Grade(s) (6)	Available Lottery Years (7)
(A) Participating Schools						
Academy of the Pacific Rim Charter School	Boston	Yes		5-12	5,6	2005-2010
Boston Collegiate Charter School	Boston	Yes		5-12	5	2002-2010
Boston Green Academy	Boston	Yes		6-12	9	2011-2014
Boston Preparatory Charter Public School	Boston	Yes		6-12	6	2005-2011, 2014
Cape Cod Lighthouse Charter School	Orleans	No		6-8	6	2007-2010
City on a Hill Charter Public School (Circuit Street)	Boston	Yes		9-12	9	2002, 2004-2014
City on a Hill Charter Public School (Dudley Square)	Boston	Yes		9-12	9	2013-2014
Codman Academy Charter Public School	Boston	Yes	Expeditionary Learning	K-12	9	2004, 2008-2014
Edward Brooke Charter School	Boston	Yes		K-12	5	2006-2009
Excel Academy Charter School	Boston	Yes		5-8	5	2008-2010
Four Rivers Charter Public School	Greenfield	No	Expeditionary Learning	7-12	7	2003-2012
Francis W Parker Charter Essential School	Devins	No	Coalition of Essential Schools	7-12	7	2006-2011
Global Learning Charter Public School	New Bedford	Yes		5-12	5	2006-2007, 2009
Innovation Academy Charter School	Tyngsboro	No		5-12	5	2007-2010
KIPP Academy Lynn	Lynn	Yes	KIPP	K-12	5	2005-2009
Marblehead Community Charter Public School	Marblehead	No		4-8	4	2005-2007, 2009
MATCH Charter Public School	Boston	Yes		K-12	6,9	2002-2011
Pioneer Valley Performing Arts Charter Public School	South Hadley	No		7-12	7	2006-2010
Rising Tide Charter Public School	Plymouth	No		5-8	5	2009-2010
Roxbury Preparatory Charter School	Boston	Yes	Uncommon Schools	6-12	6	2002-2011
Salem Academy Charter School	Salem	No		6-12	6	2010-2011
Sturgis Charter Public School	Hyannis	No	IB	9-12	9	2004, 2006, 2008-2011
UP Academy Boston	Boston	Yes		K-8	6	2011
(B) Eligible but Nonparticipating Schools						
Advanced Math and Science Academy Charter School	Marlborough	No		6-12		
Berkshire Arts and Technology Charter Public School	Adams	No		6-12		
Christa McAuliffe Regional Charter Public School	Framingham	Yes		6-8		
Community Charter School of Cambridge	Cambridge	Yes	Expeditionary Learning	7-12		
Hampden Charter School of Science	Chicopee	Yes		6-12		
Health Careers Academy Charter School	Boston	Yes		9-12		
New Leadership Charter School	Springfield	Yes		6-12		
Phoenix Charter Academy	Chelsea	Yes		9-12		
Pioneer Charter School of Science	Everett	Yes		7-12		
Sizer School, A North Central Charter Essential School	Fitchburg	Yes	Coalition of Essential Schools	7-12		

Notes: This table includes charter schools that meet the following criteria: 1) admitted students for middle- or high-school grades (4-7, 9); 2) has students in the projected high-school classes of 2006-2018; 3) does not serve special populations (such as students at risk of dropping out), and 4) are not closed charter schools. Schools that indicate grade ranges that do not begin at the lottery entry grade expanded grades served after lottery data was collected. Schools in Panel B that are eligible for the lottery study either had fewer applicants than seats available or did not retain usable lottery records. There were 12 closed schools at appropriate grade levels. Urban towns include those which participate in the Massachusetts Urban Superintendents Network: Boston, Brockton, Cambridge, Chelsea, Chicopee, Everett, Fall River, Fitchburg, Framingham, Haverhill, Holyoke, Lawrence, Leominster, Lowell, Lynn, Malden, New Bedford, Pittsfield, Quincy, Revere, Somerville, Springfield, Taunton, and Worcester (Salem joined the network at a later date and thus is categorized as nonurban in this study). Match is included in the study as both a middle and a high school.

Appendix 2

Table A.2: The Impact of Charter School Offers on Charter Attendance

	Non-offered Mean (1)	Initial Offer (2)	Waitlist Offer (3)
(A) Ever attended charter			
Urban	0.101	0.483*** (0.010)	0.343*** (0.009)
F-statistic		1198.3	
p-value		0.000	
Nonurban	0.226	0.603*** (0.018)	0.421*** (0.023)
F-statistic		489.5	
p-value		0.000	
(B) Years attended charter			
Urban	0.729	1.739*** (0.051)	1.333*** (0.049)
F-statistic		1198.3	
p-value		0.000	
Nonurban	0.920	2.765*** (0.094)	2.089*** (0.116)
F-statistic		489.5	
p-value		0.000	

Notes: This table shows the impact of a charter school offer on charter school attendance for the urban and nonurban samples. The sample is restricted to students enrolled in Massachusetts schools at the time of application in the projected high-school classes of 2006–2018. Column 1 shows the proportion of non-offered students attending a charter school. Columns 2 and 3 report coefficients from regressions of charter attendance on initial and waitlist offer dummies, including controls for demographic characteristics and risk sets. Robust standard errors in parentheses (+ $p<0.10$ * $p<0.05$ ** $p<0.01$ ***$p<0.001$). The Sanderson-Windmeijer F-statistic and its associated p-value are reported under the offer coefficients. N (urban) = 14,191, N (nonurban) = 3,583.

Appendix 3

Table A.3: Covariate Balance

	Urban			Nonurban		
	Fraction of Non-Offered With Outcome (1)	Initial Offer Differential (2)	Waitlist Offer Differential (3)	Fraction of Non-Offered With Outcome (4)	Initial Offer Differential (5)	Waitlist Offer Differential (6)
Female	0.515	-0.003 (0.010)	0.009 (0.011)	0.526	-0.000 (0.019)	0.013 (0.022)
Asian	0.028	0.004 (0.003)	-0.001 (0.003)	0.025	-0.007 (0.007)	0.015+ (0.008)
Black	0.519	0.001 (0.010)	-0.000 (0.010)	0.032	-0.002 (0.006)	-0.004 (0.006)
Latinx	0.280	-0.006 (0.009)	0.009 (0.009)	0.033	0.006 (0.007)	0.000 (0.008)
Other race	0.042	0.002 (0.004)	-0.008+ (0.004)	0.039	-0.001 (0.006)	-0.014* (0.006)
White	0.131	-0.002 (0.006)	-0.000 (0.006)	0.870	0.003 (0.012)	0.002 (0.013)
Special education	0.196	-0.002 (0.008)	-0.012 (0.008)	0.164	0.004 (0.014)	-0.009 (0.015)
English learner	0.107	0.000 (0.006)	0.008 (0.007)	0.014	-0.008* (0.004)	0.004 (0.005)
Subsidized lunch	0.723	0.008 (0.009)	0.001 (0.009)	0.120	-0.007 (0.012)	0.019 (0.014)
Baseline MCAS ELA	-0.408	-0.013 (0.021)	0.023 (0.022)	0.436	0.018 (0.032)	-0.049 (0.037)
Baseline MCAS Math	-0.375	-0.010 (0.020)	0.015 (0.021)	0.322	0.022 (0.036)	-0.015 (0.041)
p-value		0.951	0.718		0.454	0.364

Notes: This table shows student characteristics and test scores, and differentials between offered and nonoffered charter applicants. The sample is restricted to students enrolled in Massachusetts schools at the time of application in the projected high-school classes of 2006–2018. Columns 1 and 4 show the proportion of non-offered students with a given characteristic. Columns 2, 3, 5, and 6 report coefficients from regressions of the student characteristic on initial and waitlist offer dummies, including controls for risk sets (+ p<0.10 * p<0.05). N (urban) = 13947, N (nonurban) = 3583.

Appendix 4

Table A.4: Match Rate to SIMS

Projected HS Class	Non-offered Mean (1)	Initial Offer Differential (2)	Waitlist Offer Differential (3)	Number of Applications (4)
2006	0.986	-0.008 (0.012)	0.008 (0.009)	515
2007	0.997	-0.011 (0.017)	-0.033 (0.038)	422
2008	0.996	-0.014 (0.011)	0.007 (0.009)	937
2009	0.992	0.003 (0.009)	-0.007 (0.009)	1,010
2010	0.994	0.000 (0.009)	-0.003 (0.010)	1,332
2011	0.996	-0.000 (0.006)	-0.002 (0.008)	1,597
2012	0.985	-0.002 (0.006)	0.001 (0.005)	2,142
2013	0.991	-0.004 (0.006)	0.001 (0.005)	2,456
2014	0.993	0.001 (0.005)	-0.005 (0.005)	2,949
2015	0.993	0.000 (0.005)	-0.002 (0.004)	3,746
2016	0.992	-0.001 (0.005)	0.001 (0.004)	3,698
2017	0.993	-0.000 (0.004)	-0.001 (0.003)	5,226
2018	0.995	-0.002 (0.003)	0.001 (0.003)	5,581
All cohorts	0.993	-0.002+ (0.001)	-0.000 (0.001)	31,611

Notes: This table shows the match between lottery records and the SIMS data by projected high school class. The sample excludes disqualified, late, out-of-area, and sibling applications. Individuals can be in the sample multiple times if they apply to multiple schools. Columns 2 and 3 report coefficients from regressions of the student characteristic on initial and waitlist offer dummies, including controls for risk sets (+ $p<0.10$ * $p<0.05$ ** $p<0.01$ ***$p<0.001$).

Appendix 5

A.1 Details on Attrition and Lee Bounds

The main text mentions that there is some differential attrition in our sample. Here, we detail the differential attrition and how we address the concern. Students offered seats in the lottery are slightly more likely to have test score outcomes than those not offered seats in the lottery by 1.4–1.8 percentage points in the urban lotteries and 3.5 percentage points in nonurban ones (Appendix Table A.5). This is not surprising, since winning the lottery makes it more likely a student enrolls in a charter school (and thus not a private or out-of-state school). Nonurban offered students are also more likely to be present in the data in 9th and 12th grade by 4 and 2 percentage points respectively on the initial offer indicator.

Given the differential attrition, we report Lee (2009) bounds for the MCAS and high-school outcomes in Table 2. By locality, we calculate the lower bound by dropping the fraction of the highest-scoring lottery winners until the response rates among lottery winners and losers are equal. To estimate the upper bound, we drop the fraction of lowest-scoring lottery winners. To avoid commingling noncompliance and attrition, we estimate these bounds on the reduced form. The reduced form is estimated by substituting y_i for the outcome in Equation 2, though to reduce the number of reported coefficients, we use a single ever-offer instrument, which is the sum of $Z_{i1}^k + Z_{i2}^k$. For binary outcomes we conduct a similar procedure but randomly select cases to drop among those with a value of one (lower bound) or zero (upper bound). This bounding exercise shows little scope for the modest differential attrition to explain the MCAS or high-school results.
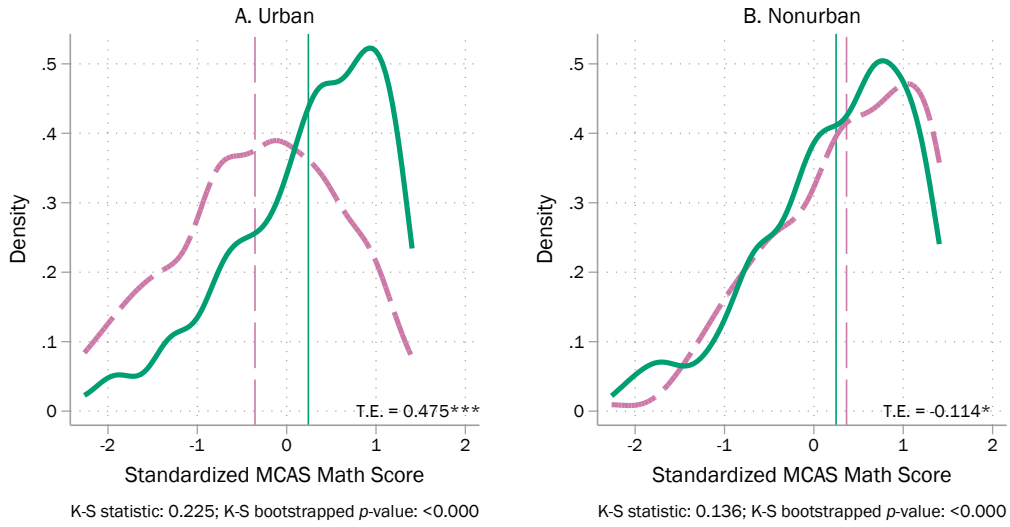
Table A.5: Attrition

	Urban			Nonurban		
	Fraction of Non-Offered With Outcome (1)	Initial Offer Differential (2)	Waitlist Offer Differential (3)	Fraction of Non-Offered With Outcome (4)	Initial Offer Differential (5)	Waitlist Offer Differential (6)
Has ELA score	0.812	0.014+ (0.008)	0.017* (0.008)	0.855	0.033** (0.011)	0.007 (0.013)
Has math score	0.800	0.015+ (0.008)	0.013 (0.008)	0.866	0.031** (0.012)	0.006 (0.013)
Present in 9th grade in MA	0.860	0.010 (0.007)	-0.002 (0.007)	0.858	0.038*** (0.012)	0.003 (0.014)
Present in 12th grade in MA	0.751	-0.002 (0.009)	-0.002 (0.009)	0.807	0.018 (0.014)	0.005 (0.016)
Sent to NSC	0.945	0.006 (0.004)	0.006 (0.004)	0.941	0.003 (0.008)	0.013 (0.009)

Notes: This table shows follow-up rates for MCAS scores two years after charter application, presence in the Massachusetts data in 9th or 12th grade, and an indicator for being sent to the NSC to be matched to college outcome and data for Massachusetts charter school applicants. The sample is restricted to students enrolled in Massachusetts schools at the time of application in the projected high-school classes of 2006–2018. Columns 1 and 4 show the proportion of non-offered students with a given outcome. Columns 2, 3, 5, and 6 report coefficients from regressions of indicators for follow-up datae on initial and waitlist offer dummies, including controls for risk sets (+ p<0.10 * p<0.05 ** p<0.01 ***p<0.001). N (urban) = 13,947, N (nonurban) = 3,583.

Appendix 7

Appendix B: Additional Results

Figure B.1: Test Score Distributions for Treated and Untreated Compliers

I. Math

A. Urban

K-S statistic: 0.225; K-S bootstrapped *p*-value: <0.000

B. Nonurban

K-S statistic: 0.136; K-S bootstrapped *p*-value: <0.000

II. ELA

A. Urban

K-S statistic: 0.161; K-S bootstrapped *p*-value: <0.000

B. Nonurban

K-S statistic: 0.160; K-S bootstrapped *p*-value: 0.004
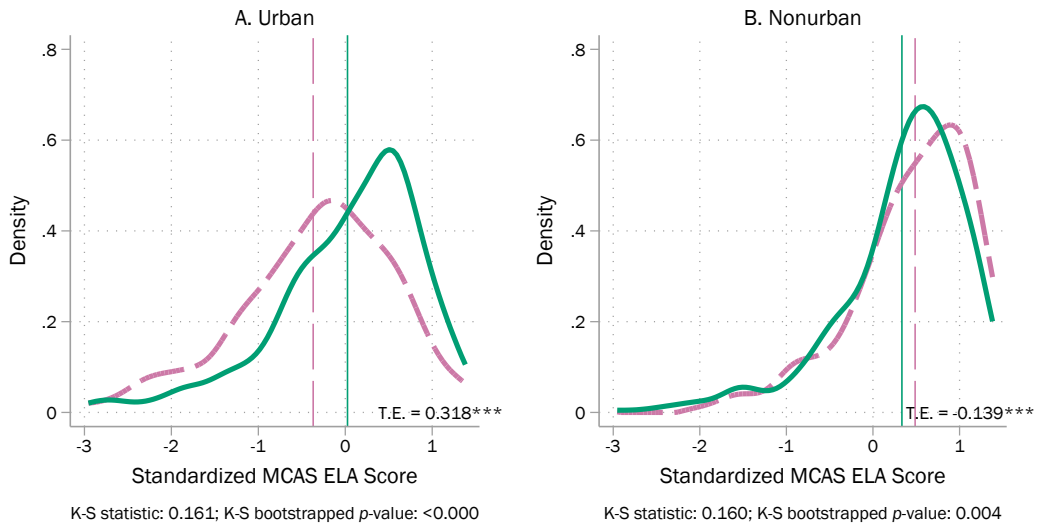
Untreated Compliers   Treated Compliers

Notes: This figure shows the distribution of test scores for treated and untreated compliers, for MCAS Math and ELA two years after the lottery.

Appendix 9

Table B.1: Sample Characteristics and Outcomes

	Urban				Nonurban			
	Noncharter Public Schools (1)	Lottery Applicants (2)	Offered Charter (3)	Not Offered Charter (4)	Noncharter Public Schools (5)	Lottery Applicants (6)	Offered Charter (7)	Not Offered Charter (8)
(A) Baseline characteristics								
Female	0.483	0.518	0.519	0.517	0.491	0.519	0.516	0.526
Asian	0.076	0.030	0.029	0.030	0.039	0.030	0.033	0.025
Black	0.199	0.526	0.538	0.504	0.046	0.026	0.023	0.032
Latinx	0.316	0.284	0.287	0.278	0.062	0.036	0.037	0.033
Other race	0.028	0.041	0.038	0.047	0.017	0.028	0.023	0.039
White	0.380	0.119	0.107	0.142	0.836	0.880	0.884	0.870
Special education	0.187	0.194	0.194	0.195	0.177	0.159	0.156	0.164
English learner	0.179	0.114	0.117	0.109	0.028	0.011	0.010	0.014
Free/reduced price lunch	0.644	0.740	0.752	0.717	0.198	0.128	0.132	0.120
Baseline MCAS ELA	-0.432	-0.418	-0.433	-0.389	0.155	0.417	0.407	0.436
Baseline MCAS Math	-0.426	-0.364	-0.368	-0.356	0.153	0.331	0.336	0.322
(B) Charter school enrollment								
Attend any charter in grades 5-12	0.058	0.427	0.513	0.262	0.052	0.568	0.708	0.284
(C) Academic outcomes								
MCAS Math	-0.359	-0.202	-0.141	-0.311	0.174	0.296	0.297	0.295
MCAS ELA	-0.391	-0.287	-0.248	-0.355	0.189	0.357	0.340	0.394
Took any AP	0.278	0.364	0.378	0.340	0.345	0.313	0.271	0.403
Score 3+ on any AP	0.127	0.102	0.102	0.102	0.244	0.214	0.189	0.266
Took SAT	0.546	0.642	0.638	0.647	0.679	0.771	0.770	0.773
SAT score (1600) (for takers)	94.864	898.188	895.774	902.551	107.148	1125.715	1130.180	1116.332
Graduate high school (4 years)	0.609	0.624	0.608	0.654	0.827	0.821	0.827	0.809
Graduate high school (5 years)	0.656	0.711	0.701	0.731	0.850	0.883	0.880	0.889
Enroll in any college	0.501	0.601	0.604	0.595	0.700	0.799	0.803	0.791
Enroll in 4-year college	0.315	0.446	0.452	0.436	0.563	0.669	0.678	0.651
Enroll in 2-year college	0.217	0.200	0.199	0.201	0.176	0.182	0.176	0.195
Complete any degree	0.257	0.249	0.248	0.251	0.492	0.558	0.566	0.543
Complete BA	0.214	0.214	0.212	0.219	0.449	0.512	0.524	0.490
Complete AA	0.059	0.050	0.052	0.047	0.066	0.070	0.062	0.085
N	275,245	14,191	9,303	4,888	642,470	3,583	2,403	1,180

Notes: This table shows demographic characteristics and outcome means for various samples. Charter attendance includes attendance at non-lottery charters and thus will not match first stage estimates. The sample in Column 1 is restricted to students who attended schools in the state of Massachusetts in 9th grade in the projected high-school classes of 2006–2018. The sample in Column 2 is restricted to charter school applicants enrolled in schools in the state of Massachusetts at the time of application in the projected high-school classes of 2006–2018. The samples in Columns 3 and 4 are further restricted to those offered and not offered a seat at a charter in the lottery, respectively.

Table B.2: The Impact of Charter School Attendance on Advanced Placement

	Urban			Nonurban		
	2SLS (1)	CCM (2)	N (3)	2SLS (4)	CCM (5)	N (6)
(A) Advanced Placement						
Offered AP	0.080*** (0.021)	0.743	13,623	-0.539*** (0.032)	0.786	3,583
Number of APs offered	-1.131*** (0.269)	5.727	13,623	-5.659*** (0.411)	8.172	3,583
(B) AP by subject						
Offered AP Calculus	0.103*** (0.023)	0.542	13,623	-0.483*** (0.034)	0.702	3,583
Offered AP English	-0.136*** (0.023)	0.623	13,623	-0.531*** (0.032)	0.756	3,583
Offered AP History	0.021 (0.023)	0.459	13,623	-0.517*** (0.033)	0.730	3,583
Offered AP Science	-0.072** (0.023)	0.511	13,623	-0.490*** (0.032)	0.674	3,583
(C) AP scores						
Score 2+ on any AP	0.099*** (0.018)	0.170	13,623	-0.239*** (0.031)	0.411	3,583
Score 3+ on any AP	0.045** (0.014)	0.108	13,623	-0.188*** (0.029)	0.333	3,583
Score 4+ on any AP	0.008 (0.011)	0.063	13,623	-0.137*** (0.027)	0.240	3,583
Score 5 on any AP	-0.000 (0.007)	0.026	13,623	-0.100*** (0.022)	0.157	3,583
(D) Conditional AP scores						
Score 2+ on any AP	0.058+ (0.034)	0.608	3,936	-0.065 (0.044)	0.947	965
Score 3+ on any AP	0.008 (0.034)	0.381	3,936	0.014 (0.064)	0.738	965
Score 4+ on any AP	-0.038 (0.028)	0.221	3,936	0.002 (0.077)	0.541	965
Score 5 on any AP	-0.023 (0.018)	0.089	3,936	-0.071 (0.074)	0.366	965

Notes: Each coefficient labeled 2SLS is the instrumental variables estimate of the effect of attending an urban or nonurban charter at any period of time before the outcome listed in the column heading occurred as described in Equation 1. Indicator variables for a lottery offer on the day of the lottery (initial offer) and lottery offer from the waitlist (waitlist offer), separately for urban and nonurban charters, are the instruments for charter attendance. The control complier mean is labeled CCM. All regressions control for lottery risk sets and a vector of demographic characteristics including indicators for race, gender, birth year, calendar year, and baseline special education, English learner, and free or reduced price lunch status. The sample is restricted to students enrolled in Massachusetts schools at the time of application in the projected high-school classes of 2006–2018. Robust standard errors in parentheses (+ p<0.10 * p<0.05 ** p<0.01 ***p<0.001). AP outcomes are available for the class of 2007 and later. In the second panel, AP offers are defined based on whether the high school that the student attended offered an AP class. In the third panel, AP scores are conditional on having taken at least one AP.

Table B.3: The Impact of Charter School Attendance on High School Progression

	Urban			Nonurban		
	2SLS (1)	CCM (2)	N (3)	2SLS (4)	CCM (5)	N (6)
(A) On-time grade progression						
10th grade	-0.021 (0.014)	0.914	11,209	-0.002 (0.008)	0.995	3,097
11th grade	-0.045** (0.015)	0.920	10,411	0.006 (0.009)	0.992	3,007
12th grade	-0.036* (0.015)	0.912	10,426	-0.014 (0.011)	0.989	2,966
Repeat 9th or 10th	0.041* (0.019)	0.161	12,001	-0.005 (0.013)	0.027	3,175
(B) High school graduation						
Graduate high school (4 years)	-0.066** (0.023)	0.655	11,983	-0.016 (0.026)	0.815	3,175
Graduate high school (5 years)	-0.018 (0.022)	0.733	11,983	-0.012 (0.024)	0.903	3,175
Graduate high school (6 years)	-0.012 (0.021)	0.787	11,983	-0.017 (0.023)	0.915	3,175
(C) Days attended						
9th grade	0.624 (1.789)	162.716	11,967	1.026 (1.816)	169.753	3,175
10th grade	1.274 (1.597)	161.866	11,199	2.743+ (1.639)	167.366	3,097
11th grade	2.201 (1.769)	156.651	10,401	1.007 (1.709)	167.441	3,007
12th grade	3.722* (1.658)	153.191	10,417	-2.305 (1.618)	160.852	2,966

Notes: Each coefficient labeled 2SLS is the instrumental variables estimate of the effect of attending an urban or nonurban charter at any period of time before the outcome listed in the column heading occurred as described in Equation 1. Indicator variables for a lottery offer on the day of the lottery (initial offer) and lottery offer from the waitlist (waitlist offer), separately for urban and nonurban charters, are the instruments for charter attendance. The control complier mean is labeled CCM. All regressions control for lottery risk sets and a vector of demographic characteristics including indicators for race, gender, birth year, calendar year, and baseline special education, English learner, and free or reduced price lunch status. The sample is restricted to students enrolled in Massachusetts schools at the time of application in the projected high-school classes of 2006–2018. Robust standard errors in parentheses (+ p<0.10 * p<0.05 ** p<0.01 ***p<0.001).

Table B.4: The Impact of Charter School Attendance on College Enrollment

Year after Projected High School Graduation	Any College		4 Year College		2 Year College		
	2SLS (1)	CCM (2)	2SLS (3)	CCM (4)	2SLS (5)	CCM (6)	N (7)
(A) 1st year							
Urban	0.024 (0.023)	0.518	0.063** (0.023)	0.390	-0.039** (0.015)	0.127	13,281
Nonurban	0.022 (0.031)	0.665	0.094** (0.033)	0.529	-0.072** (0.022)	0.135	3,414
(B) 2nd year							
Urban	0.077*** (0.023)	0.495	0.079*** (0.022)	0.367	-0.002 (0.016)	0.127	13,281
Nonurban	0.063+ (0.032)	0.684	0.098** (0.034)	0.557	-0.035 (0.023)	0.127	3,414
(C) 3rd year							
Urban	0.073** (0.023)	0.439	0.064** (0.022)	0.335	0.010 (0.015)	0.103	13,281
Nonurban	0.095** (0.034)	0.631	0.099** (0.035)	0.545	-0.004 (0.020)	0.086	3,414
(D) 4th year							
Urban	0.068** (0.023)	0.396	0.053* (0.021)	0.310	0.015 (0.014)	0.085	13,281
Nonurban	0.121*** (0.035)	0.572	0.125*** (0.035)	0.510	-0.004 (0.017)	0.062	3,414
(E) 5th year							
Urban	0.015 (0.020)	0.245	0.023 (0.018)	0.179	-0.010 (0.012)	0.066	13,281
Nonurban	0.029 (0.034)	0.299	0.041 (0.033)	0.257	-0.013 (0.013)	0.043	3,414
(F) 6th year							
Urban	0.049** (0.019)	0.132	0.043** (0.016)	0.087	0.006 (0.011)	0.044	11,608
Nonurban	0.040 (0.028)	0.151	0.048+ (0.027)	0.130	-0.009 (0.011)	0.023	3,158

Notes: Each coefficient labeled 2SLS is the instrumental variables estimate of the effect of attending an urban or nonurban charter at any period of time before the outcome listed in the column heading occurred as described in Equation 1. Indicator variables for a lottery offer on the day of the lottery (initial offer) and lottery offer from the waitlist (waitlist offer), separately for urban and nonurban charters, are the instruments for charter attendance. The control complier mean is labeled CCM. All regressions control for lottery risk sets and a vector of demographic characteristics including indicators for race, gender, birth year, calendar year, and baseline special education, English learner, and free or reduced price lunch status. The sample is restricted to students enrolled in Massachusetts schools at the time of application in the projected high-school classes of 2006–2018. Robust standard errors in parentheses (+ p<0.10 * p<0.05 ** p<0.01 ***p<0.001).

Table B.5: The Impact of Charter School Attendance on College Degrees

Year after Projected High School Graduation	Any Degree		B.A.		A.A.		
	2SLS (1)	CCM (2)	2SLS (3)	CCM (4)	2SLS (5)	CCM (6)	N (7)
(A) 4th year							
Urban	0.037* (0.016)	0.133	0.031* (0.015)	0.116	0.008 (0.008)	0.022	13,281
Nonurban	0.061+ (0.035)	0.364	0.074* (0.034)	0.308	-0.027 (0.017)	0.074	3,414
(B) 5th year							
Urban	0.038* (0.019)	0.211	0.033+ (0.018)	0.188	0.003 (0.009)	0.037	13,281
Nonurban	0.105** (0.036)	0.483	0.115** (0.036)	0.432	-0.031+ (0.018)	0.085	3,414
(C) 6th year							
Urban	0.046* (0.022)	0.240	0.042* (0.021)	0.216	0.009 (0.011)	0.041	11,608
Nonurban	0.112** (0.037)	0.519	0.119** (0.037)	0.472	-0.030 (0.020)	0.093	3,158

Notes: Each coefficient labeled 2SLS is the instrumental variables estimate of the effect of attending an urban or nonurban charter at any period of time before the outcome listed in the column heading occurred as described in Equation 1. Indicator variables for a lottery offer on the day of the lottery (initial offer) and lottery offer from the waitlist (waitlist offer), separately for urban and nonurban charters, are the instruments for charter attendance. The control complier mean is labeled CCM. All regressions control for lottery risk sets and a vector of demographic characteristics including indicators for race, gender, birth year, calendar year, and baseline special education, English learner, and free or reduced price lunch status. The sample is restricted to students enrolled in Massachusetts schools at the time of application in the projected high-school classes of 2006–2018. Robust standard errors in parentheses (+ $p<0.10$ * $p<0.05$ ** $p<0.01$ ***$p<0.001$). Students can obtain both a BA and an AA, so the coefficient for any degree will not be the sum of the BA and AA coefficients.

Table B.6: The Impact of Charter School Attendance on Key Variables, Alternative Specifications

	Urban			Nonurban		
	Math MCAS (1)	4-Year College Enrollment (2)	4-Year College Graduation (3)	Math MCAS (4)	4-year College Enrollment (5)	4-year College Graduation (6)
Main Specification	0.475***	0.079***	0.042*	-0.114+	0.098**	0.119**
	(0.040)	(0.022)	(0.021)	(0.059)	(0.034)	(0.037)
N	10,706	13,281	11,608	3,198	3,414	3,158
Initial offer only	0.424***	0.062*	0.036	-0.086	0.103*	0.111*
	(0.052)	(0.031)	(0.029)	(0.075)	(0.044)	(0.046)
N	10,706	13,281	11,608	3,198	3,414	3,158
Baseline test scores	0.483***	0.076**	0.039+	-0.091	0.104**	0.127***
	(0.041)	(0.023)	(0.022)	(0.062)	(0.036)	(0.039)
N	9,923	11,996	10,456	2,714	2,869	2,665
No covariates	0.500***	0.085***	0.044*	-0.100	0.097**	0.121**
	(0.044)	(0.023)	(0.021)	(0.064)	(0.035)	(0.038)
N	10,706	13,281	11,608	3,198	3,414	3,158

Notes: The first row of the table repeats the main specification reported in the other tables, see Tables 2 and 3 for details. Four-year college enrollment is enrollment within 2 years of projected high school graduation. Each subsequent row shows an alternative specification. The row labeled Initial offer only uses only admissions offers on the day of the charter school lottery as an instrument for charter attendance (excluding the waitlist offer). The row labeled Baseline test scores uses only students for which baseline math MCAS scores are available. The row labeled No covariates excludes all demographic variables from the regression. Robust standard errors in parentheses (+ p<0.10 * p<0.05 ** p<0.01 ***p<0.001).

Appendix 15