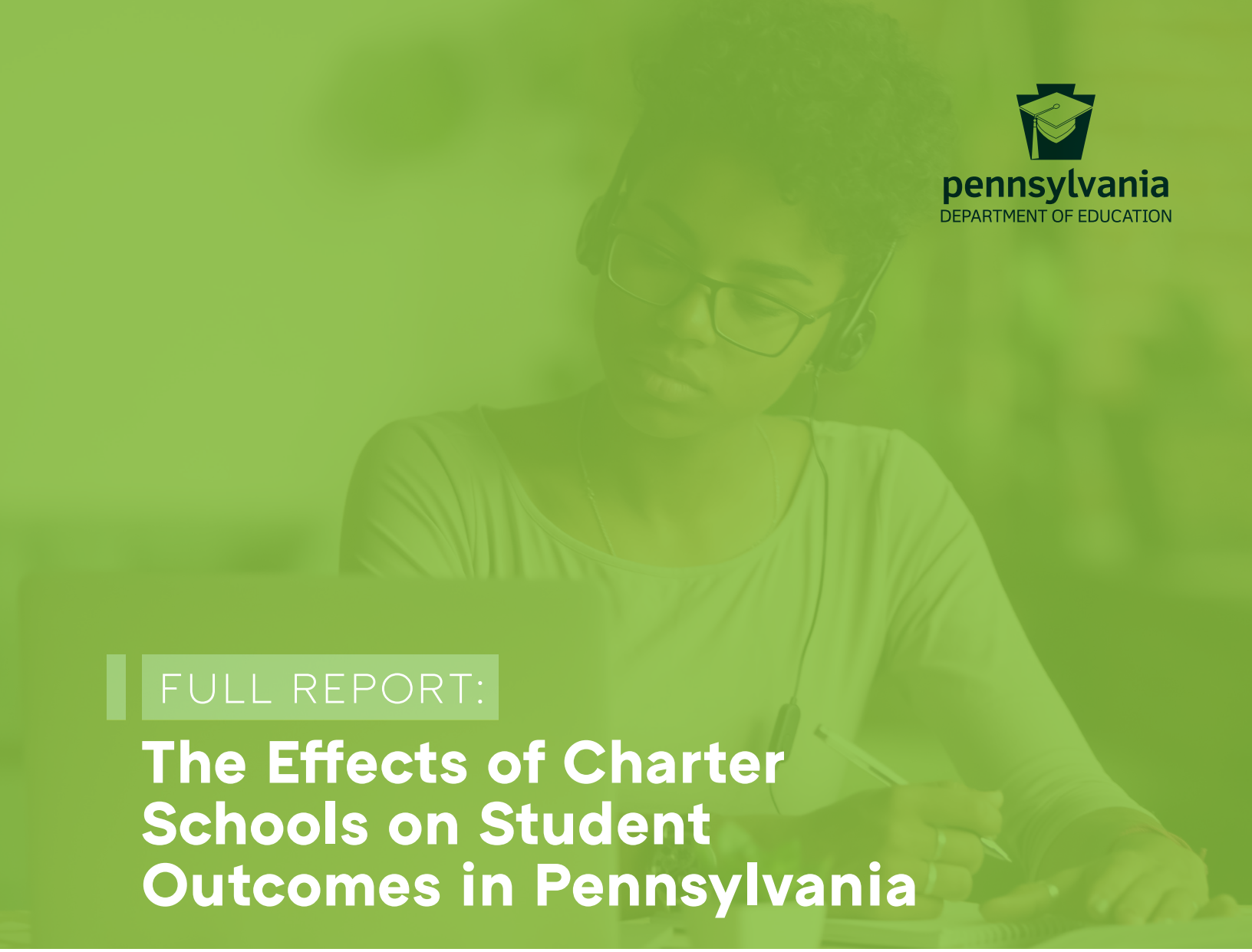

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DEPARTMENT OF EDUCATION

FULL REPORT:

The Effects of Charter Schools on Student Outcomes in Pennsylvania

Report to the Pennsylvania Department of Education
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RECIPIENT OF THE
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Research and Evaluation

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Research and Evaluation

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The Pennsylvania Department of Education (PDE) Evaluation and Research project is an effort that was established through a State Longitudinal Data System (SLDS) Grant from the Institute of Education Sciences (IES), National Center for Education Statistics (NCES), awarded in October 2015. The Research and Evaluation project is an initiative to make full use of the P-16+ system data and other data sources to answer priority questions from the PDE research agenda, to form collaborative research partnerships, and to increase PDE's capacity to conduct research. Our mission is to evaluate and analyze data to provide insight that can be used to positively impact policy, inform decision making and lead to improved student outcomes.

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The mission of the Department of Education is to ensure that every learner has access to a world-class education system that academically prepares children and adults to succeed as productive citizens. Further, the Department seeks to establish a culture that is committed to improving opportunities throughout the commonwealth by ensuring that technical support, resources, and optimal learning environments are available for all students, whether children or adults.

Abstract

Despite the continued growth of Pennsylvania's charter school sector, little is known about the impact of these schools on student achievement and attendance and even less is known about the effects on high-school and post-secondary outcomes. The purpose of this report is to answer three key questions:

1. What is the impact of Pennsylvania's charter schools on students' academic achievement, attendance, and post-secondary outcomes?
2. How does this vary based on characteristics of the charter school (i.e. Charter Management Organizations (CMOs) versus single school, online versus brick and mortar, suburban versus urban, number of years in operation, etc.)?
3. How does this vary for different groups of students (i.e. economically disadvantaged, students with disabilities, English learners, etc.)?

Administrative data from PDE, the National Student Clearinghouse (NSC), EdNA, and the Common Core of data (CCD) was used to answer these questions for three primary samples: an elementary school sample, a middle school sample, and a high school sample. In order to estimate the effect of charter schools on student performance, charter school students were matched to a group of traditional public school students using "cells" of baseline zoned school, gender, race, and cohort where baseline is defined as kindergarten for the elementary school analysis, grade 4 for the middle school analysis, and grade 8 for the high school analysis. Regression analysis was used to estimate the effect of charter school enrollment on student outcomes controlling for baseline characteristics, student test scores, and matched cell effects.

Overall, charter schools were found to have negative or no impacts on test scores, but positive effects on other outcomes including attendance, high school graduation and intensity of postsecondary enrollment. These averages mask considerable differences based on charter school characteristics, however. Most notably, cyber charter schools have a consistent negative effect across all outcomes except graduation, while brick and mortar charter schools have positive or no effects on student outcomes, including test scores and post-secondary enrollment. There are also notable differences by locale, as urban charter schools have positive effects on test scores, attendance, graduation, and full-time post-secondary enrollment, while suburban and rural charters generally have negative or no effects. Finally, CMOs seem to be somewhat more effective than independent charter schools.

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Executive Summary

Despite the continued growth of Pennsylvania's charter school sector, little is known about the impact of these schools on student achievement and attendance and even less is known about the effects on high-school and post-secondary outcomes. Therefore, the purpose of this report is to answer three key questions:

1. What is the impact of Pennsylvania's charter schools on students' academic achievement, attendance, and post-secondary outcomes?
2. How does this vary based on characteristics of the charter school (i.e. CMO versus single school, online versus brick and mortar, suburban versus urban, number of years in operation, etc.)?
3. How does this vary for different groups of students (i.e. economically disadvantaged, students with disabilities, English learners, etc.)?

The questions explored in this study align directly with and build upon the Pennsylvania Department of Education's (PDE) research agenda around charter schools and school choice.

Data for this study are drawn from the PDE, the National Student Clearinghouse (NSC), EdNA, and the Common Core of data (CCD). PDE administrative data provide information on school attended, student characteristics, test scores, graduation, and post-secondary expectations, while NSC data provide information on post-secondary enrollment. This is supplemented with EdNA data, which are used to identify charter and cyber charter schools and CCD data, which are used to examine differential impacts by charter locale.

I focus on three primary samples: an elementary school sample, a middle school sample, and a high school sample. The elementary school sample consists of students who were in third grade in 2014 or 2015, were enrolled in Pennsylvania public schools in kindergarten, and who were zoned for a kindergarten school with at least one charter and traditional public school student of the same gender and race. The middle school sample consists of students who were in sixth grade in 2013, 2014, or 2015, were enrolled in Pennsylvania public schools in fourth grade, and who were zoned for a fourth grade school with at least one charter and traditional public school student of the same gender and race. The high school sample consists of students who were in ninth grade in 2012 or 2013, were enrolled in Pennsylvania public schools in eighth grade, and who were zoned for an eighth grade school with at least one charter and traditional public school student of the same gender and race. Overall, students in these samples are more likely to be black, more likely to be eligible for free lunch, and are lower performing than other PA public school students.

Overall, students in these samples are more likely to be black, more likely to be eligible for free lunch, and are lower performing.

To estimate the effect of charter schools on student performance, I combined matching with regression analysis. Specifically, I match charter school students to a group of traditional public school students using "cells" of baseline zoned school, gender, race, and cohort where baseline is defined as kindergarten for the elementary school analysis, grade 4 for the middle school analysis, and grade 8 for the high school analysis. I then use regression analysis to estimate the effects of the number of years in a charter school on student outcomes controlling for baseline characteristics, student test scores, and matched cell effects. Thus, comparisons are made between observationally equivalent charter and public school students who are of the same gender and race and were zoned to attend the same school at baseline. A similar approach has been shown to produce comparable estimates to those from lottery analyses, which exploit the random offer of charter school admission among applicants to mimic randomized control trials.

Comparisons are made between observationally equivalent charter and public school students who are of the same gender and race and were zoned to attend the same school at baseline.

I find that overall, charter schools have negative or no impacts on test scores, but positive effects on other outcomes. Charter school enrollment leads to small increases in attendance rates, reduces the probability of chronic absenteeism, and increases the probability of high school graduation. While charter schools do not have an impact on whether students enroll in post-secondary institutions, they affect the type and intensity of enrollment—shifting students from less than half-time to at least half time and from 2- to 4-year enrollment.

These averages mask considerable differences based on charter school characteristics, however. Most notably, cyber charter schools have a consistent negative effect across all outcomes except graduation, while brick and mortar charter schools have positive or no effects on student outcomes, including test scores and post-secondary enrollment. There are also notable differences by locale, as urban charter schools have positive effects on test scores, attendance, graduation, and full-time post-secondary enrollment, while suburban and rural charters generally have negative or no effects. Finally, CMOs seem to be somewhat more effective than independent charter schools.

Black, Hispanic, and economically disadvantaged students appear to benefit most from charter school attendance, while charter schools have large negative effects on the test scores of white students. In terms of post-secondary enrollment, black, economically disadvantaged, general education and non-EL (English Learner) students appear to benefit more from charter schools than other groups.

Overall these findings are consistent with prior work finding mixed effects of charter schools on performance and positive effects on attainment.

Introduction and Research Questions

Charter schools are an important and growing sector of the public education market in the state of Pennsylvania. As of 2016-17, over 130,000 or approximately 7.7 percent of public school students were enrolled in charter schools, up from 5.1 percent in the 2010-11 school year. Despite growth in enrollments, little is known about the impact of these schools on student achievement and attendance and even less is known about the effects on high-school and post-secondary outcomes. Therefore, the purpose of this report is to answer three key questions:

1. What is the impact of Pennsylvania's charter schools on students' academic achievement, attendance, and post-secondary outcomes?
2. How does this vary based on characteristics of the charter school (i.e. Charter Management Organizations (CMOs) versus single school, online versus brick and mortar, suburban versus urban, number of years in operation, etc.)?
3. How does this vary for different groups of students (i.e. economically disadvantaged, students with disabilities, English learners, etc.)?

The questions explored in this study align directly with and build upon PDE's research agenda around charter schools and school choice. This will be the first study to explore impacts of Pennsylvania's charter schools from elementary through postsecondary and one of the first to examine whether and how these impacts differ based on student and charter school characteristics. In addition, it will expand upon a smaller but growing body of literature that explores the effects of charter schools on outcomes beyond test scores, including high school graduation and post-secondary expectations and enrollment.

Prior Literature

Charter school effects in Pennsylvania

Three prior studies examine the effects of charter schools on student test scores in the state of Pennsylvania, but all are limited in focus to exploring the impacts on test scores. The first of these examines the effects of charter schools on reading and math scores using data from 2001-2007 (Zimmer, Gill, Lavertu, & Sass, 2009). The authors find no average effects of charter schools on either math or reading gains, but positive effects for students always enrolled in charter schools. However, these estimates are over a decade old and do not reflect the current charter landscape, perhaps most notably the advent and expansion of cyber charter schools.

The second study, published by Center for Research on Education Outcomes (CREDO) in 2013, examined the effects of Pennsylvania charter schools on student achievement in grades 3-8 for years 2008-2011, and found that charter school students performed slightly worse than their peers in traditional public schools. These estimates were produced as part of a national study and did not disaggregate results by student subgroup or explore whether specific features of charter schools, such as location or management, make them more or less successful in improving student outcomes. Understanding these differences could be beneficial not only to authorizers when considering new charter school applications and application renewals, but also to policy-makers considering revisions to the existing charter school law.

A number of these issues were addressed in a 2019 CREDO study specifically focused on the effects of charter schools in Pennsylvania. To identify the impacts of charter schools, this study used a virtual control record (VCR) approach, which matches students at a given charter school with students from a traditional public school (feeder school) whose students transfer to that charter. Charter school students are then matched to traditional public school students at the feeder school based on grade level, gender, race/ethnicity, poverty status, EL status, special education status, and prior test scores. This more recent study finds that charter schools have small negative effects in reading and no effects in math. Further, it finds that impacts vary by charter school characteristics, such as locale and delivery system. Specifically, urban charter schools have small positive effects in reading with no effects in math, while suburban, town, and rural charter schools have negative effects in both subjects. It also finds that while cyber charter schools have large negative impacts in both subjects, brick and mortar charter schools have positive effects in reading and no effects in math.

The findings presented in this report depart from these previous studies findings in three important ways. First, while the CREDO study reports single-year impacts, the analysis here reports the effects of each additional year of enrollment in a charter school, up to four years for students in the high school sample. Given the findings from Zimmer et al. (2009) that students always enrolled in charters had significantly higher math gains, focusing on single year gains, as most prior studies in Pennsylvania have done, may mask effects for students enrolled across multiple years. Second, this report examines a variety of outcomes beyond test scores including chronic absenteeism, high school graduation, and college enrollment. Given PDE's efforts to close the achievement gap and promote postsecondary access and success, it is important to know and understand the impact of charter schools on all of these metrics. Finally, I employ a different research methodology that has been shown to produce similar estimates to those from lottery analyses, which exploit the random offer of charter school admission among applicants to mimic randomized control trials.

This report examines a variety of outcomes beyond test scores including chronic absenteeism, high school graduation, and college enrollment.

Cyber charter schools

Studies of cyber charter schools consistently report negative effects on student performance. Ahn and McEachin (2017) find that cyber charter school students in Ohio score worse in reading and math than either traditional public school students or other charter school students. Lueken, Ritter, and Beck (2015) find that students who attend a cyber charter school have significantly lower math and literacy growth to similar public school students. The literature on cyber charters remains relatively sparse, however, so providing new evidence from a different context will contribute to a broader understanding of the impacts of these schools.

Graduation and Post-secondary outcomes

A small, but growing literature explores the effects of charter schools on high school graduation and post-secondary outcomes and tends to find positive effects. Zimmer et al., 2009 find that students who attend charter high schools in Florida and Chicago are significantly more likely to graduate from high

school. There is also evidence from a number of studies that charter high schools increase the probability of college enrollment (Zimmer et al., 2009; Booker, Sass, Gill, & Zimmer, 2011; Dobbie & Fryer, 2015; Angrist et al., 2016; Davis & Heller, 2017). Further evidence from Boston shows that attending a charter high school causes a shift in enrollment from 2- to 4-year institutions (Angrist et al., 2016). Many of these studies rely on charter school lotteries to estimate impacts, however, and necessarily focus on a select group of oversubscribed charter schools. The high demand for these schools may be an indicator of quality, in which case we might not find similar effects in other charter schools. Results from this report will be much more generalizable, as they will provide evidence on a broader set of charter schools, including suburban and cyber charters, as well as urban charters that are not oversubscribed.

Data, measures, and sample

Data

Data for this report come from four different sources: administrative records from PDE, the National Student Clearinghouse (NSC), EdNA, and the Common Core of Data (CCD). Administrative records from PDE include student demographic and program information, school attended, zoned school, and student outcomes including standardized test scores, attendance, and graduation. NSC data contain information enrollment in postsecondary education including intensity and institution type. EdNA data are used to identify charter schools and define cyber charter schools. Data from the CCD are used to identify charter school locale (urban, suburban, and rural).

Students included in the final sample attend zoned schools throughout the state and do not appear to draw disproportionately from any single district.

Sample

I examine three different samples: elementary school, middle school, and high school. The elementary school sample consists of the third grade cohorts of 2014 and 2015, the middle school sample consists of the sixth grade cohorts of 2013, 2014, and 2015, and the high school sample consists of the ninth grade cohorts of 2012 and 2013. There are three additional restrictions for students to be included in the final sample. First, students must to be enrolled in Pennsylvania public schools at baseline (kindergarten for elementary, fourth grade for middle, and eighth grade for high school). Second, charter school students are included in the analysis only if they are in a matched zoned school-gender-race-cohort cell with at least one traditional public school student and TPS students are included only if they are in a matched zoned school-gender-race-cohort cell with at least one charter school student. Finally, only matched zoned school-gender-race-cohort cells with at least 10 students are included. These restrictions are imposed due to the research design, which is discussed in more detail below. As shown in Appendix Figures 1-3, students included in the final sample attend zoned schools throughout the state and do not appear to draw disproportionately from any single district.

Elementary school sample. A total of 259,386 students were enrolled in third grade in 2014 or 2015, whereas only 68,594 of these students are included in the final sample. The elementary school sample has a significantly higher share of black and free lunch eligible students and lower shares of white, Asian and other race students than the overall third cohorts. Attendance is similar between all Pennsylvania public school students and sample students, but students

in the sample have slightly higher rates of chronic absenteeism and lower performance. When comparing students who ever attend a charter elementary school to those who never attend a charter elementary school, important differences emerge. For example, students who ever attend a charter elementary school are less likely to be white (30.7 percent versus 68.8 percent), more likely to be black (52.9 versus 19.6 percent), Hispanic (12.9 versus 9.4 percent), or free lunch eligible (69.0 versus 50.9 percent) and are more likely to be chronically absent at baseline (18.0 versus 10.4 percent).

Middle school sample. A total of 310,678 students were enrolled in sixth grade in 2013, 2014, or 2015, with 131,678 of these students included in the final sample. The middle school sample has a significantly higher share of black and free lunch eligible students and lower shares of white and Asian students than the overall sixth grade cohorts. The sample used for analysis also has higher rates of chronic absenteeism and is lower performing, with average scores of -0.125 standard deviations (sds) in math and reading compared to 0.011 sds in math and 0.010 sds in reading among all Pennsylvania public school sixth graders. Among the analysis sample, students who ever attend a charter middle school are significantly less likely to be white (30.9 versus 74.2 percent) and more likely to be black (48.3 versus 17.0 percent), Hispanic (18.6 versus 7.9 percent), and free lunch eligible (67.3 versus 44.0 percent) than traditional public school students. Charter school students are also more likely to be chronically absent and have significantly lower baseline test scores than students in the sample who never attend a charter middle school.

High school sample. A total of 282,076 students were enrolled in ninth grade in 2012 or 2013, and 147,412 of these are included in the final sample. Unlike the middle and elementary school sample, the high school sample contains a higher share of white students and similar shares of black and free lunch eligible students than the overall Pennsylvania public school population. However, similar to the elementary and middle school samples, students who ever attend a charter high school are more likely to be black (36.6 versus 12.6 percent), Hispanic (16.4 versus 5.5 percent), and free lunch eligible (53.7 versus 31.1 percent) than sample students who never attend a charter school and are more likely to be chronically absent (35.2 versus 16.5 percent).

Measures

Charter school enrollment. Key to this analysis is the measure of charter school enrollment. While most prior work in Pennsylvania focuses on single-year estimates, these may understate the impact of charter schools if effects are cumulative. Therefore, I use a cumulative measure of years enrolled, which better captures charter school dosage. Specifically, I measure charter school enrollment as the number of years attending any charter school at a given level (elementary, middle, or high school). For the elementary school analysis, this is defined as the number of years enrolled in a charter school between grades 3 and 5; for the middle school analysis, it is defined as the number of years enrolled in a charter between grades 6 and 8; and for the high school analysis, it is defined as the number of years enrolled in a charter between grades 9 and 12. For all levels, charter school enrollment is based on students' fall school of enrollment.

To examine whether there is a differential impact by features of the charter school, I disaggregate this single charter school measure in multiple ways. First, I separately examine the effects of brick and mortar versus cyber charter schools, where a cyber charter school is defined based on the designation from the EdNA website. Next, I examine the effects by locale: urban, suburban, and rural, which is based on the locale designation from the CCD. Finally, I separately examine the effects of attending a CMO versus independent charter, where I define CMOs based on the list provided in a 2017 CREDO report.

Outcomes. Test scores: For the elementary and middle school analysis, I examine performance on reading and math exams that are administered annually in grades 3 through 8, while for high school I examine performance on the Keystone Algebra, Biology, and Literature exams. Elementary and middle school test scores are standardized by grade and year to have a mean 0 and standard deviation of 1, whereas Keystone exams are standardized by subject and year. Therefore, all estimates are reported in standard deviation units.

Attendance and chronic absenteeism: Attendance is measures as the percent of days present (0-100) and chronic absenteeism is an indicator for whether a student is absent for at least 10 percent of the days for which he or she is enrolled.

Attainment and post-secondary expectations: Attainment is measured as an indicator for whether a student graduated from high school, which is further divided into whether the student received a diploma or GED. I also examine a number of postsecondary expectations, but focus on four in this report: whether students expect to attend a 4 year institution in Pennsylvania, a 4 year institution outside of Pennsylvania, a 2 year institution in Pennsylvania, or a 2 year institution outside of Pennsylvania.

Postsecondary outcomes: Postsecondary outcomes are limited to college enrollment based on NSC data. The most basic measure is an indicator of any enrollment, which is equal to one if a student is ever enrolled in a post-secondary institution as reported by the NSC. Since enrollment can take many forms, I also explore the intensity of enrollment (ever full time, half time enrollment, and less than half-time enrollment) and type of institution (ever 2 year, 4 year institution, public, and private). Finally, I explore the probability that a student ever enrolls in college within the commonwealth of Pennsylvania. Given that this sample only allows me to examine postsecondary outcomes for up to two years following graduation, I do not explore persistence, although this is an important area for future research.

The primary challenge to identifying the effects of charter school attendance on student outcomes is selection.

Methods

The primary challenge to identifying the effects of charter school attendance on student outcomes is selection—namely that students who choose to attend charter schools are different than those who do not in ways that may be correlated with performance. For example, charter school students may come from more motivated families or place a higher value on education, in which case these students would have better outcomes regardless of charter school attendance. Conversely, because charter schools are more prevalent in urban and low-income neighborhoods, charter school students may come from more disadvantaged families, in which case we might expect these students to have worse outcomes than their TPS peers. We see some evidence of this in **Table 1**, which shows that students who ever enroll in charter schools are more likely to be eligible for free lunch. As a consequence, a simple comparison of charter school and TPS student performance is likely to yield biased estimates of the impact of attending a charter school on student performance, although the direction of the bias is unclear.

In order to overcome this issue, much prior work on charter school impacts uses a lottery design, which compares outcomes of students who apply and are offered admission to charter schools to those

Table 1. Baseline Characteristics, Elementary, Middle, and High School Cohorts.

		Sample Students		
	All PA (1)	All (2)	Ever Charter (3)	Never Charter (4)
Panel A: Third Grade				
White	66.7	62.9	30.7	68.8
Black	14.6	24.8	52.9	19.6
Hispanic	10.9	10.0	12.9	9.4
Asian	3.8	1.2	1.5	1.1
Other	4.1	1.2	1.9	1.1
Free lunch	44.8	53.7	69.0	50.9
Reduced price lunch	4.3	4.2	4.8	4.0
Special Ed.	17.0	15.6	14.9	15.8
EL	4.1	3.0	3.2	3.0
Gifted	3.5	2.6	0.8	2.9
Repeated grade	0.2	0.0	0.0	0.0
Attendance rate	95.3	94.9	93.9	95.0
Chronically absent	9.2	11.5	18.0	10.4
Zread	0.010	-0.136	-0.437	-0.082
Zmath	0.009	-0.145	-0.500	-0.081
N	259,386	68,594	10,599	57,995
Panel B: 4th Grade				
White	69.4	67.8	30.9	74.2
Black	14.7	21.7	48.3	17.0
Hispanic	9.8	9.5	18.6	7.9
Asian	3.7	0.5	0.9	0.5
Other	2.4	0.5	1.2	0.3
Free lunch	40.4	47.4	67.3	44.0
Reduced price lunch	4.9	4.6	4.8	4.5
Special Ed.	16.6	17.1	18.2	16.9
EL	2.7	2.1	3.4	1.8
Gifted	5.3	4.5	1.5	5.0
Repeated grade	0.4	0.4	0.8	0.3
Attendance rate	94.9	94.5	93.3	94.7
Chronically absent	11.2	13.8	21.0	12.5
Zread	0.010	-0.125	-0.527	-0.056
Zmath	0.011	-0.125	-0.580	-0.046
N	310,678	131,678	19,549	112,129
Panel C: 8th Grade				
White	70.3	77.3	45.6	81.2
Black	15.7	15.2	36.6	12.6
Hispanic	9.1	6.7	16.4	5.5
Asian	3.3	0.5	0.5	0.5
Other	1.6	0.3	0.9	0.2
Free lunch	34.6	33.6	53.7	31.1
Reduced price lunch	5.6	5.4	6.2	5.3
Special Ed.	15.7	15.2	17.9	14.9
EL	2.8	1.7	3.2	1.5
Gifted	4.9	5.3	1.7	5.8
Repeated grade	3.7	1.7	4.1	1.4
Attendance rate	92.6	93.1	89.5	93.5
Chronically absent	19.5	18.6	35.2	16.5
Observations	282,076	147,412	16,106	131,306

Notes: Sample column restricted to students in final analysis sample. Ever charter students are those who are enrolled in a charter school for at least one year at the given grade level. Never charter students are those who are never enrolled in a charter school at a given grade level.

who apply and are not offered admission. The benefit of this design is that because charter offers are random, it mimics a randomized control trial and produces unbiased impact estimates for charter school applicants. The drawback of this type of design, however, is that it can only be used to study oversubscribed charter schools and grades, which are likely different from other charter schools. The findings of such studies also only apply to charter school applicants and cannot reasonably be generalized to a broader student population. In addition, it requires access to lottery records that can then be matched to other administrative data. Since the purpose of this report is to examine the impact of all Pennsylvania charter schools and lottery records are not available, I employ an alternative approach, which combines matching with regression analysis.

Specifically, I match charter school students to a group of traditional public school students using "cells" of baseline zoned school, gender, race, and cohort where baseline is defined as kindergarten for the elementary school analysis, grade 4 for the middle school analysis, and grade 8 for the high school analysis. Charter school students are included in the analysis only if they are in a baseline cell with at least one TPS student and TPS students are included only if they are in a baseline cell with at least one charter school student. All other students are dropped from the sample. A similar approach has been used by Dobbie and Fryer (2015) to examine the impact of charter schools on post-secondary outcomes in Texas, as well as by Angrist, Pathak, and Walters (2013) and Dobbie and Fryer (2013).

Next, I estimate the following model using my restricted sample:

$$Y_{it} = \beta YRSCHART_{ilt} + \gamma X_i + \delta_{sgrc} + \varepsilon_{ilt}$$

Where **Y** is an outcome for student **i** in year **t** and **YRSCHART** is the number of years the student **i** has spent in a charter of level **l** as of year **t**. **X** is a vector of the following baseline student characteristics: free or reduced price lunch eligibility, limited English proficiency, gifted designation, special education status, and indicator for whether the student repeated the baseline grade, an indicator of whether the baseline school attended was a charter school, and the number of years spent at a charter not included in the analysis.[1] For the middle and high school analysis, I also include controls for third order polynomials of baseline reading and math test scores and indicators for missing baseline scores.[2] Finally, **δ** is a set of "matched cell" fixed effects. The inclusion of these fixed effects ensures that charter students' outcomes are compared only to TPS students from the same baseline zoned school, gender, race, and cohort. For example, a black male zoned for school A in fourth grade in 2011 would only be compared to other black males zoned for school A in fourth grade in 2011. Using this approach I compare the outcomes of observationally similar students who were zoned for the same school at baseline, but who attended different elementary, middle, or high schools. Any differences in student outcomes are then attributed to the number of years enrolled in a charter school.

The key assumption necessary for this approach to yield unbiased estimates is that zoned school-gender-race-cohort effects and baseline characteristics account for all observed and unobserved differences between charter and traditional public school students. Previous research finds that analogous designs yield similar test score estimates as lottery based designs (Abdulkadiroglu et al., 2011; Angrist, Pathak, and Walters, 2013; Dobbie and Fryer, 2013; and Deming, 2014), suggesting that this is a reasonable assumption. In addition, I partially test for selection bias by regressing baseline characteristics on the

1 Thus for the elementary school analysis, this controls for number of years observed in a charter prior to grade 3. For middle school, this controls for number of years observed in a charter prior to grade 6. For high school, this controls for number of years observed in a charter prior to grade 9.

2 Missing scores are then filled in with the sample average.

number of years at a charter school, matched cell effects, and all other baseline characteristics than the dependent variable. The results from these analyses for each level (elementary, middle, and high school) are reported in Appendix Table 1. Column 2 shows results for all charter school students combined while Columns 3 and 4 show results from a single regression where years at a charter is replaced with separate measures for years at a brick and mortar charter and years at a cyber charter.

While there are some statistically significant differences in baseline characteristics such as free lunch eligibility or EL status, almost none of these are economically meaningful. Among the middle and high school samples, there are some significant differences in baseline test scores. However, in the middle school sample these differences are in the opposite direction (positive in reading and negative in math) and in the high school sample these differences are only significant in math and not reading. If there were selection, we would expect more consistent differences across tests. Therefore, it does not appear that there is significant selection into the years at a charter school after accounting for matched cell effects and other student characteristics.

A similar picture emerges when examining selection into years at a brick and mortar charter school, however there are a number of significant differences for those enrolled in cyber charter schools. Specifically, these students are significantly more likely to be free lunch eligible, less likely to be eligible for special education, and have lower math performance at baseline. Since some of these baseline differences, particularly in terms of math performance are rather large, some caution is warranted in interpreting the results for cyber charter schools as causal.

> Each additional year at a brick and mortar charter elementary school has positive effects in reading and no or positive effects in math. Conversely, each additional year spent at a cyber charter school has large negative impacts across all subject levels.

Results

Performance

On average, charter schools have negative impacts on math with no or negative impacts on reading scores (**Table 2, Panel A**). Specifically, each additional year in a charter elementary school is associated with a 0.046 sd reduction in math scores and a 0.014 sd reduction in reading scores, whereas each year in charter middle school decreases math scores by 0.018 sd with no effect in reading. Impacts of charter high schools on Keystone scores show similar patterns, with each additional year at a charter high school leading to a reduction in Algebra I scores of 0.020 sds and in Biology of 0.015 sds. However, charter high schools seem to have a very small positive impact on Literature scores (0.009 sds).

These averages mask significant differences based on charter school characteristics, however. When results are disaggregated for brick and mortar versus cyber charter schools, a very different picture emerges (**Table 2, Panel B**). Each additional year at a brick and mortar charter elementary or middle school has positive effects in reading (0.015-0.026 sds) and no or positive effects in math. Similarly,

Table 2: Effects of Charter Schools on student test scores, 2012-2017.

	Elementary School		Middle School		High School		
	Reading	Math	Reading	Math	Algebra I	Biology	Literature
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Pooled Results							
Years any charter	-0.012**	-0.046***	0.002	-0.017***	-0.020***	-0.014***	0.009*
	(0.005)	(0.005)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)
Panel B: By Charter Type							
Years brick & mortar	0.026***	-0.000	0.028***	0.015***	0.013***	0.018***	0.037***
	(0.005)	(0.005)	(0.003)	(0.002)	(0.004)	(0.005)	(0.005)
Years cyber charter	-0.212***	-0.275***	-0.099***	-0.142***	-0.087***	-0.079***	-0.049***
	(0.012)	(0.011)	(0.005)	(0.005)	(0.007)	(0.007)	(0.007)
Panel C: By Location							
Years urban	0.070***	0.044***	0.037***	0.029***	0.029***	0.039***	0.049***
	(0.006)	(0.005)	(0.003)	(0.003)	(0.005)	(0.005)	(0.006)
Years suburban	-0.056***	-0.091***	0.010*	-0.021***	-0.066***	-0.055***	-0.021
	(0.009)	(0.009)	(0.005)	(0.005)	(0.014)	(0.014)	(0.015)
Years rural	-0.091***	-0.108***	-0.044***	-0.071***	-0.072***	-0.067***	-0.013
	(0.025)	(0.025)	(0.012)	(0.012)	(0.016)	(0.014)	(0.018)
Years cyber	-0.231***	-0.292***	-0.102***	-0.146***	-0.090***	-0.090***	-0.054***
	(0.012)	(0.011)	(0.005)	(0.005)	(0.007)	(0.007)	(0.007)
Panel D: By CMO							
Years CMO	-0.078	-0.011	0.035	-0.001	-0.000	-0.015	0.022*
	(0.048)	(0.041)	(0.027)	(0.022)	(0.009)	(0.011)	(0.012)
Years Independent	-0.018***	-0.059***	-0.018***	-0.037***	-0.022***	-0.014***	0.007
	(0.006)	(0.005)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)
Observations	203,540	203,966	378,967	378,910	66,043	65,308	65,603
R-squared	0.332	0.339	0.693	0.713	0.715	0.692	0.675

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Years any charter is the number of years in any type of charter at given level. All other charter school variables are defined analogously. Models also include controls for baseline free or reduced price lunch eligibility, special education status, English language learner status, gifted status, an indicator for whether student repeated baseline grade, total number of years enrolled in a charter prior to grade 3 for elementary school, grade 6 for middle school, and grade 9 for high school, and an indicator for enrolled in a charter at baseline. Models in columns 3-7 also include controls for third order polynomials of baseline reading and math scores and indicators for missing test scores at baseline. All models also control for baseline zoned school x cohort x race x gender fixed effects. Standard errors are clustered at the student level.

enrollment in brick and mortar charter high schools has a positive effect on all Keystone exams as each additional year at a charter high school increases Algebra I scores by 0.013 sds, Biology scores by 0.018 sds , and Literature scores by 0.037 sds. Conversely, each additional year spent at a cyber charter school has large negative impacts on the order of a tenth of a standard deviation or more across all subjects and levels.

Consistent with prior research, there are also noticeable differences based on charter school locale (**Table**

2, Panel C). While urban charter schools have positive impacts across subjects and grade levels, suburban and rural charter schools have consistently negative impacts. Specifically, each additional year at an urban charter elementary or middle school increases reading scores by 0.029-0.070 sds and math scores by 0.029-0.044 sds and each additional year at an urban charter high school increases Algebra I scores by 0.029 sds, Biology scores by 0.039 sds, and literature scores by 0.049 sds. However, each additional year at a suburban charter school decreases math scores by 0.021-0.091 sds, decreases scores on Algebra I and Biology Keystone exams by 0.066 and 0.055 sds, respectively, and has mixed results in reading and Literature. Rural charter schools have the largest negative effect among brick and mortar charter schools. Each additional year in a rural charter elementary or middle school decreases reading scores by 0.041-0.091 sds and math scores by 0.071-0.108 sds and each additional year spent at a rural charter high school decreases Keystone Algebra I and Biology scores by approximately 0.7 sds.

Finally, when I examine differential impacts of CMO versus independent charter schools, I find that attending a CMO charter has no impact on test scores, whereas attending an independent charter school is associated with lower test scores across subjects (**Panel D**).

Attendance

While the effects of charter schools on test scores are mixed, the effects on attendance and chronic absenteeism are quite consistent—charter schools have positive effects on both measures. Attending a charter elementary or middle school for an additional year increases attendance by 0.40-0.46 percentage points and decreases the probability of chronic absenteeism by 1.3-1.9 percentage points (**Table 3, Panel A**). While the effects on attendance are quite small in magnitude, the reductions in chronic absenteeism are meaningful, representing a 10-21 percent reduction in the likelihood of chronic absenteeism among elementary and middle school students. Charter high schools have similar, but smaller impacts.

While the effects on attendance are quite small in magnitude, the reductions in chronic absenteeism are meaningful.

While both brick and mortar and cyber charters both have positive impacts on attendance rates, brick and mortar charters decrease the probability of chronic absenteeism, while the opposite is true of cyber charter schools (**Table 3, Panel B**). Each year at a brick and mortar charter school decreases the probability of chronic absenteeism by 1.0-2.7 percentage points, while each year at a cyber charter school increases the probability of chronic absenteeism by 1.0-2.0 percentage points. While it may seem counterintuitive that attending a cyber charter increases attendance but also increases the probability of chronic absenteeism, it is important to note that the effects on attendance rate are small and may not be enough to push students over the threshold so that they are no longer chronically absent.

As with test scores, urban charter schools are more effective in terms of attendance and chronic absenteeism, suburban charter schools have no

Table 3: Effects of Charter Schools on attendance, AY 2014-2017.

	Elementary School		Middle School		High School	
	Attendance Rate	Chronically Absent	Attendance Rate	Chronically Absent	Attendance Rate	Chronically Absent
	(1)	(2)	(3)	(4)		
Panel A: Pooled Results						
Years any charter	0.356***	-0.013***	0.434***	-0.019***	0.175***	-0.007***
	(0.036)	(0.002)	(0.031)	(0.001)	(0.043)	(0.001)
Panel B: By Charter Type						
Years brick & mortar	0.347***	-0.021***	0.454***	-0.027***	0.315***	-0.010***
	(0.038)	(0.002)	(0.034)	(0.002)	(0.049)	(0.002)
Years cyber charter	0.385***	0.020***	0.357***	0.010***	-0.149**	0.001
	(0.067)	(0.003)	(0.059)	(0.002)	(0.073)	(0.002)
Panel C: By Location						
Years urban	0.561***	-0.032***	0.617***	-0.034***	0.634***	-0.022***
	(0.043)	(0.002)	(0.037)	(0.002)	(0.057)	(0.002)
Years suburban	-0.042	0.001	-0.102	-0.003	-0.141	0.000
	(0.059)	(0.003)	(0.063)	(0.003)	(0.129)	(0.005)
Years rural	-0.611***	0.023***	-0.649***	0.023***	-2.432***	0.105***
	(0.111)	(0.007)	(0.128)	(0.007)	(0.176)	(0.007)
Years cyber	0.318***	0.025***	0.479***	0.006**	-0.296***	0.006***
	(0.067)	(0.003)	(0.058)	(0.002)	(0.074)	(0.002)
Panel D: By CMO						
Years CMO	0.559***	-0.029***	-0.886**	0.024	0.437***	-0.016***
	(0.081)	(0.005)	(0.361)	(0.017)	(0.108)	(0.004)
Years Independent	-1.289***	0.066***	0.446***	-0.019***	0.132***	-0.005***
	(0.153)	(0.009)	(0.034)	(0.002)	(0.047)	(0.002)
Observations	212,452	212,458	396,602	396,614	546,802	546,852
R-squared	0.114	0.103	0.126	0.118	0.166	0.158

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Years any charter is the number of years in any type of charter at given level. All other charter school variables are defined analogously. Models also include controls for baseline free or reduced price lunch eligibility, special education status, English language learner status, gifted status, an indicator for whether student repeated baseline grade, total number of years enrolled in a charter prior to grade 3 for elementary school, grade 6 for middle school, and grade 9 for high school, and an indicator for enrolled in a charter at baseline. Models in columns 3-7 also include controls for third order polynomials of baseline reading and math scores and indicators for missing test scores at baseline. All models also control for baseline zoned school x cohort x race x gender fixed effects. Standard errors are clustered at the student level.

effects, and rural charter schools have a negative effect on attendance rates and increase the likelihood of chronic absenteeism (**Table 3, Panel C**). One potential explanation for this finding is that it could be more difficult for students to get to rural charter schools than to their zoned traditional public school, either because the school is further away or because of differences in transportation access or quality.

The impacts of CMOs versus independent charters are more mixed (**Table 3, Panel D**). At the elementary level, CMOs have positive effects on both attendance and chronic absenteeism whereas independent charters have negative effects (i.e. reducing attendance rates and increasing likelihood of chronic absenteeism). In middle school, CMOs have no or negative impacts on attendance, while independent charters have positive effects. At the high school level, both CMOs and independent charters have positive effects on attendance rates and decrease the likelihood of chronic absenteeism, by 1.6 and 0.5 percentage points, respectively.

Attainment, Expectations, and Postsecondary Outcomes

Attainment. All charter high schools have positive effects on graduation—on average, each additional year at a charter school increases the probability of graduation by 7.3 percentage points and this is driven entirely by an increased probability earning a diploma (**Table 4, Panel A, Columns 1-3**). While all types of charter schools increase the likelihood of graduation, certain types do seem to be more effective. Brick & mortar charters are slightly more effective than cyber charter schools (**Table 4, Panel B**), increasing graduation rates by 8.1 versus 5.5 percentage points and CMOs are more effective than independent charters (**Table 4, Panel D**), increasing graduation rates by 11.5 versus 6.6 percentage points. However, impacts do not differ by charter location.

There are some differences in postsecondary expectations between charter schools with different characteristics. Students at brick and mortar and urban charters are more likely to report that they expect to attend a 4-year institution in Pennsylvania, but students at cyber, suburban, and rural charters are less likely to report the same.

Post-secondary enrollment. Charter schools do not affect the probability of post-secondary enrollment (**Table 5, Panel A, Column 1**), but may cause a shift in the type of enrollment. Specifically, while charter school students are no more likely to enroll in post-secondary than their TPS peers, for each year at a charter high school, they are 0.5 percentage points less likely to enroll in a 2-year institution and 0.8 percentage points more likely to enroll in a 4-year institution. This is a

> Charter school students are less likely than their TPS peers to enroll in a post-secondary institution located in Pennsylvania.

Table 4: Effects of Charter Schools on attainment and post-secondary expectations, High School, AY 2014-2016, students in Grades 9-12.

	Graduate	Diploma	GED	Expect 4 year PA	Expect 4 year, not PA	Expect 2 year PA	Expect 2 year not PA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Pooled Results							
Years any charter	0.073***	0.070***	0.000	0.017***	0.006***	0.004***	0.003***
	(0.001)	(0.001)	(0.000)	(0.002)	(0.001)	(0.001)	(0.000)
Panel B: By Charter Type							
Years brick & mortar	0.081***	0.080***	-0.000	0.048***	0.009***	0.004***	0.002***
	(0.001)	(0.001)	(0.000)	(0.002)	(0.001)	(0.001)	(0.000)
Years cyber charter	0.055***	0.047***	0.000	-0.061***	-0.002	0.004***	0.006***
	(0.002)	(0.002)	(0.000)	(0.003)	(0.002)	(0.001)	(0.001)
Panel C: By Location							
Years urban	0.077***	0.077***	0.000	0.061***	0.011***	0.006***	0.002***
	(0.001)	(0.001)	(0.000)	(0.002)	(0.001)	(0.001)	(0.000)
Years suburban	0.062***	0.062***	0.000	-0.015**	-0.002	-0.001	-0.003***
	(0.003)	(0.003)	(0.000)	(0.006)	(0.004)	(0.002)	(0.001)
Years rural	0.065***	0.065***	-0.000	-0.028***	0.014**	-0.001	0.003
	(0.004)	(0.004)	(0.000)	(0.007)	(0.006)	(0.002)	(0.002)
Years cyber	0.047***	0.047***	0.000	-0.064***	-0.002	0.004***	0.006***
	(0.002)	(0.002)	(0.000)	(0.003)	(0.002)	(0.001)	(0.001)
Panel D: By CMO							
Years CMO	0.115***	0.112***	-0.000	0.063***	0.006***	0.003***	0.001*
	(0.002)	(0.002)	(0.000)	(0.004)	(0.002)	(0.001)	(0.001)
Years Independent	0.066***	0.063***	0.000	0.008***	0.006***	0.004***	0.003***
	(0.001)	(0.001)	(0.000)	(0.002)	(0.001)	(0.001)	(0.001)
Observations	548,764	548,764	548,764	136,497	136,497	136,497	136,497
R-squared	0.019	0.050	0.010	0.208	0.143	0.055	0.104

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Years any charter is the number of years between grades 9 & 12 enrolled in any type of charter, years brick & mortar is the number of years between grades 9 & 12 enrolled in a brick & mortar charter, while years cyber charter is the number of years between grades 9 & 12 enrolled in a cyber charter. Models also include controls for 8th grade free or reduced price lunch eligibility, special education status, English language learner status, gifted status, an indicator for whether student repeated 8th grade, total number of years enrolled in a charter prior to grade 9, an indicator for whether 8th grade school is a charter, third order polynomials of 8th grade reading and math scores and indicators for missing 8th grade reading and math scores. All models also control for 8th grade zoned school x cohort x race x gender fixed effects. Standard errors are clustered at the student level.

Table 5: Effects of Charter High Schools on Postsecondary Outcomes, AY 2015-2016.

	Enrolled	Enrolled full-time	Enrolled half-time	Enroll less than half-time	Enrolled in 4 year	Enrolled in 2 year	Enrolled in PA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Pooled Results							
Years any charter	-0.002	-0.001	0.000	-0.004**	0.008***	-0.005**	-0.010***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
Panel B: By Charter Type							
Years brick & mortar	0.002	0.008***	-0.005**	-0.004*	0.025***	-0.019***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
Years cyber charter	-0.024***	-0.045***	0.028***	-0.006	-0.076***	0.068***	-0.016***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)
Panel C: By Location							
Years urban	0.004	0.014***	-0.007**	-0.001	0.037***	-0.029***	-0.012***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.002)
Years suburban	-0.009	-0.012*	0.002	-0.036***	-0.001	-0.004	0.000
	(0.007)	(0.007)	(0.008)	(0.007)	(0.008)	(0.009)	(0.008)
Years rural	-0.010	-0.012*	-0.003	-0.033***	-0.001	-0.001	-0.030***
	(0.008)	(0.007)	(0.008)	(0.010)	(0.010)	(0.012)	(0.011)
Years cyber	-0.022***	-0.042***	0.024***	-0.008*	-0.072***	0.063***	-0.018***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)
Panel D: By CMO							
Years CMO	0.001	0.007	-0.004	-0.001	0.031***	-0.019***	0.004
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.004)
Years Independent	-0.004	-0.006**	0.002	-0.007**	-0.004	0.002	-0.017***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Observations	81,560	81,560	81,560	81,560	81,560	84,510	81,560
R-squared	0.101	0.154	0.080	0.059	0.251	0.217	0.112

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Years any charter is the number of years between grades 9 & 12 enrolled in any type of charter, years brick & mortar is the number of years between grades 9 & 12 enrolled in a brick & mortar charter, while years cyber charter is the number of years between grades 9 & 12 enrolled in a cyber charter. Models also include controls for 8th grade free or reduced price lunch eligibility, special education status, English language learner status, gifted status, an indicator for whether student repeated 4th grade, total number of years enrolled in a charter prior to grade 9, and an indicator for whether 8th grade school is a charter. Models in even columns also control for 4th grade zoned school x cohort x race x gender fixed effects. Standard errors are clustered at the student level.

relatively small change, however, as the 4-year enrollment rate among non-charter students is 78 percent. Contrary to students' reported expectations, charter school students are less likely than their TPS peers to enroll in a post-secondary institution located in Pennsylvania.

Once again these average effects mask significant differences by charter type. While attending a brick and mortar charter has no effect on the probability of any post-secondary enrollment, cyber charters have a negative effect—decreasing the likelihood of any post-secondary enrollment by 2.4 percentage points for each year enrolled (**Table 5, Panel B, Column 1**). Students who attend brick and mortar charter schools are more likely to be enrolled full-time and less likely to be enrolled half or less than half time than their TPS peers. In addition, they are more likely to enroll in a 4-year institution and less likely to enroll in a 2-year institution. This again suggests that attending a brick and mortar charter schools causes a shift in post-secondary enrollment—from part to full-time and from 2- to 4-year institutions. Cyber charter schools, however, appear to have the opposite effect, shifting enrollment from full to part-time and from 4- to 2-years institutions.

The effects on post-secondary enrollment appear to be driven by urban charter high schools and CMOs, as there is little to no effect of suburban, rural, or independent charter schools on post-secondary enrollment (**Table 5, Panels C and D**).

Brick and mortar charter schools appear to be particularly beneficial for black and Hispanic student performance.

Subgroups

Next, I examine whether charter school impacts vary for key subgroups of students. Understanding whether and to what extent there are differential impacts has important equity implications, particularly if average impacts mask subgroup differences that could exacerbate current educational disparities. In the results below, student subgroups are defined using baseline characteristics as some subgroup designations (i.e. special education, EL) might themselves be affected by charter enrollment. Given the large differences in impacts for brick and mortar and cyber charter schools, all of results below provide separate subgroup estimates for these two types of charter schools.

Race/ethnicity. Brick and mortar charter schools appear to be particularly beneficial for black and Hispanic student performance, as these schools increases math

Although cyber charter schools have negative impacts on all racial/ethnic groups, they have the largest negative impact on white students.

Table 6: Effects of Charter Elementary Schools on Academic Outcomes, AY 2014-2017, Grades 3-5, By Race.

	Black	Hispanic	White	Asian	Other Race
	(1)	(2)	(3)	(4)	(5)
Panel A: Pooled Results					
Years brick & mortar	0.007	-0.003	-0.014	0.022	0.101***
	(0.006)	(0.012)	(0.011)	(0.035)	(0.032)
Years cyber charter	-0.128***	-0.195***	-0.310***	0.107	-0.096
	(0.019)	(0.033)	(0.014)	(0.165)	(0.079)
Observations	49,170	19,885	117,148	3,550	2,349
R-squared	0.128	0.156	0.196	0.352	0.300
Panel B: Reading					
Years brick & mortar	0.028***	0.037***	0.014	0.042	0.125***
	(0.007)	(0.014)	(0.011)	(0.032)	(0.035)
Years cyber	-0.105***	-0.198***	-0.225***	0.020	0.017
	(0.025)	(0.041)	(0.015)	(0.134)	(0.097)
Observations	48,938	19,843	117,035	3,541	2,341
R-squared	0.163	0.183	0.221	0.362	0.352
Panel C: Chronic Absenteeism					
Years brick & mortar	-0.026***	-0.020***	-0.015***	0.003	-0.015
	(0.003)	(0.006)	(0.003)	(0.009)	(0.014)
Years cyber	-0.002	0.023	0.022***	-0.002	0.021
	(0.009)	(0.015)	(0.004)	(0.021)	(0.030)
Observations	51,894	20,790	121,190	3,640	2,636
R-squared	0.066	0.085	0.065	0.096	0.139

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Years brick & mortar is the number of years between grades 3 & 5 enrolled in a brick & mortar charter, years cyber charter is defined analogously. Models also include controls for kindergarten grade free or reduced price lunch eligibility, special education status, English language learner status, gifted status, an indicator for whether student repeated kindergarten, total number of years enrolled in a charter prior to grade 3, and an indicator for whether kindergarten grade school is a charter. Models also control for kindergarten zoned school x cohort x race x gender fixed effects. Standard errors clustered at the student level.

Table 7: Effects of Charter Middle Schools on Academic Outcomes, AY 2014-2017, Grades 6-8, By Race & Gender.

	Black	Hispanic	White	Asian	Other Race
	(1)	(2)	(3)	(4)	(5)
Panel A: Pooled Results					
Years brick & mortar	0.037***	0.009**	-0.031***	0.004	0.077***
	(0.003)	(0.005)	(0.006)	(0.022)	(0.025)
Years cyber charter	-0.087***	-0.099***	-0.166***	-0.205***	-0.177***
	(0.008)	(0.015)	(0.006)	(0.051)	(0.038)
Observations	78,605	34,590	243,765	3,477	1,232
R-squared	0.589	0.601	0.681	0.716	0.674
Panel B: Reading					
Years brick & mortar	0.048***	0.026***	-0.022***	0.078***	0.082***
	(0.003)	(0.005)	(0.006)	(0.020)	(0.030)
Years cyber	-0.046***	-0.051***	-0.126***	-0.140***	-0.147***
	(0.010)	(0.017)	(0.006)	(0.045)	(0.043)
Observations	78,577	34,559	243,852	3,477	1,232
R-squared	0.613	0.637	0.649	0.712	0.674
Panel C: Chronic Absenteeism					
Years brick & mortar	-0.032***	-0.024***	-0.012***	0.001	-0.016
	(0.002)	(0.004)	(0.003)	(0.006)	(0.017)
Years cyber	0.004	0.004	0.002	0.008	-0.019
	(0.007)	(0.011)	(0.003)	(0.010)	(0.023)
Observations	84,324	36,429	252,983	3,572	1,334
R-squared	0.095	0.114	0.095	0.102	0.174

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Years brick & mortar is the number of years between grades 6 & 8 enrolled in a brick & mortar charter, years cyber charter is defined analogously. Models also include controls for third order polynomials of 4th grade reading and math scores, 4th grade free or reduced price lunch eligibility, special education status, English language learner status, gifted status, an indicator for whether student repeated 4th grade, total number of years enrolled in a charter prior to grade 6, an indicator for whether 4th grade school is a charter, third order polynomials of 4th grade reading and math scores, and indicators of missing 4th grade reading and math scores. Models also control for 4th grade zoned school x cohort x race x gender fixed effects. Standard errors clustered at the student level.

Table 8: Effects of Charter High Schools on Academic Outcomes, AY 2014-2017, Grades 9-12, By Race & Gender.

	Black	Hispanic	White	Asian	Other Race
	(1)	(2)	(3)	(4)	(5)
Panel A: Algebra					
Years brick & mortar	0.028***	0.062***	-0.035***	0.021	0.045
	(0.006)	(0.011)	(0.009)	(0.032)	(0.041)
Years cyber charter	-0.059***	-0.066***	-0.103***	-0.063	-0.072
	(0.014)	(0.024)	(0.008)	(0.058)	(0.070)
Observations	8,586	3,272	49,189	504	209
R-squared	0.698	0.696	0.677	0.779	0.864
Panel B: Biology					
Years brick & mortar	0.029***	0.060***	-0.037***	0.065*	-0.022
	(0.007)	(0.011)	(0.009)	(0.037)	(0.038)
Years cyber	-0.036**	-0.027	-0.100***	-0.079	-0.144*
	(0.016)	(0.028)	(0.008)	(0.079)	(0.076)
Observations	8,244	3,142	49,024	495	208
R-squared	0.600	0.628	0.644	0.730	0.823
Panel C: Literature					
Years brick & mortar	0.041***	0.068***	0.006	0.043	0.073*
	(0.007)	(0.013)	(0.010)	(0.036)	(0.040)
Years cyber	-0.005	-0.025	-0.061***	-0.122**	-0.003
	(0.016)	(0.028)	(0.009)	(0.060)	(0.090)
Observations	8,326	3,177	49,130	502	211
R-squared	0.625	0.664	0.640	0.764	0.784
Panel D: Chronic Absenteeism					
Years brick & mortar	-0.022***	-0.031***	0.017***	0.011	-0.038**
	(0.003)	(0.004)	(0.004)	(0.012)	(0.017)
Years cyber	-0.012*	-0.024**	0.005**	0.028	-0.043**
	(0.006)	(0.011)	(0.003)	(0.019)	(0.021)
Observations	75,822	28,519	399,533	3,611	1,389
R-squared	0.127	0.135	0.116	0.164	0.221

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Years brick & mortar is the number of years between grades 9 & 12 enrolled in a brick & mortar charter, years cyber charter is defined analogously. Models also include controls for third order polynomials of 8th grade reading and math scores, 8th grade free or reduced price lunch eligibility, special education status, English language learner status, gifted status, an indicator for whether student repeated 8th grade, total number of years enrolled in a charter prior to grade 9, an indicator for whether 8th grade school is a charter, third order polynomials of 8th grade reading and math scores, and indicators for missing 8th grade reading and math scores. Models also control for 8th grade zoned school x cohort x race x gender fixed effects. Standard errors clustered at the student level.

scores in middle and high school (**Tables 6-8, Panel A**), increase reading scores at all levels (Tables 6-8, Panel B), and reduce the probability of chronic absenteeism at all levels. Results for white students are more mixed--brick and mortar charter schools have negative or no impacts on test scores, but also reduce the probability of chronic absenteeism. However, these reductions are smaller than those for black or Hispanic students. Although cyber charter schools have negative impacts on all racial/ethnic groups, they have the largest negative impact on white students—each additional year spent in a cyber charter middle or high school decreases white students' test scores by 0.1 sds or more. In addition, while cyber charter schools have no impact on chronic absenteeism for black, Hispanic, or Asian students, they increase the likelihood of chronic absenteeism for white students as compared to their public school peers.

These findings are mirrored for attainment and post-secondary outcomes (**Table 9**). While there are no differential subgroup impacts of brick and mortar charter schools on graduation, the effects on post-secondary outcomes are largest for black students. Each additional year at a brick and mortar charter increases the probability of black students enrolling in any post-secondary school by 0.7 percentage points, increases the probability of full-time enrollment by 1.8 percentage points, increases the probability of enrolling in a 4-year institution by 3.2 percentage points, and reduces the probability of enrolling in a 2-year institution by 2.5 percentage points. While brick and mortar charters do not affect the probability of any postsecondary enrollment for white or Hispanic students, they do appear to shift enrollment from 2- to 4-year institutions, with a somewhat smaller effect on white students than Hispanic students. Cyber charter schools have similar impacts for all racial groups.

Economically disadvantaged, special education, and EL students. Brick and mortar charter schools are most effective at improving test scores for economically disadvantaged and EL students, but also have small positive impacts on test scores for special education, general education, and non-EL students (**Tables 10-12**). However, brick and mortar charter schools have negative impacts on non-poor students across grade levels and subject areas, with the only exception being a marginally significant positive impact of charter high schools on literature scores. While brick and mortar charters decrease the probability of chronic absenteeism for most groups of students, the largest impact is on economically disadvantaged students. Specifically, each additional year at a brick and mortar charter school decreases the probability of chronic absenteeism among economically disadvantaged students by 2.5 percentage points in elementary school, 3.0

Brick and mortar charter schools are most effective at improving test scores for economically disadvantaged and EL students.

Table 9: Effects of Charter High Schools on Attainment, AY 2014-2017, Grades 9-12, By Race & Gender.

		Black	Hispanic	White	Asian	Other Race
		(1)	(2)	(3)	(4)	(5)
Panel A: Graduated	Years brick & mortar	0.074***	0.096***	0.088***	0.082***	0.084***
		(0.001)	(0.002)	(0.002)	(0.007)	(0.010)
	Years cyber charter	0.041***	0.043***	0.064***	0.027	0.069***
		(0.004)	(0.007)	(0.002)	(0.018)	(0.017)
	Observations	76,355	28,757	400,564	3,626	1,396
	R-squared	0.044	0.062	0.012	0.034	0.061
Panel B: Enrolled in any postsecondary	Years brick & mortar	0.007**	0.001	-0.001	-0.003	0.008
		(0.003)	(0.007)	(0.004)	(0.015)	(0.030)
	Years cyber	-0.030**	-0.050	-0.023***	-0.046	0.055
		(0.014)	(0.032)	(0.005)	(0.048)	(0.077)
	Observations	8,595	2,633	63,756	654	179
	R-squared	0.124	0.154	0.065	0.261	0.634
Panel C: Enrolled full-time	Years brick & mortar	0.018***	0.009	-0.003	0.006	-0.023
		(0.003)	(0.007)	(0.003)	(0.014)	(0.029)
	Years cyber	-0.067***	-0.035	-0.039***	-0.107**	0.066
		(0.016)	(0.030)	(0.006)	(0.047)	(0.058)
	Observations	8,595	2,633	63,756	654	179
	R-squared	0.169	0.207	0.099	0.327	0.625
Panel D: Enrolled half-time	Years brick & mortar	-0.004	-0.014**	-0.003	-0.044***	0.003
		(0.003)	(0.006)	(0.004)	(0.014)	(0.026)
	Years cyber	0.053***	0.057*	0.019***	0.061	0.006
		(0.016)	(0.031)	(0.006)	(0.058)	(0.066)
	Observations	8,595	2,633	63,756	654	179
	R-squared	0.133	0.165	0.060	0.232	0.599
Panel E: Enrolled in 4 year	Years brick & mortar	0.032***	0.028***	0.010**	0.008	0.041
		(0.004)	(0.008)	(0.004)	(0.016)	(0.026)
	Years cyber	-0.112***	-0.084**	-0.069***	-0.040	-0.100
		(0.017)	(0.035)	(0.007)	(0.057)	(0.084)
	Observations	8,595	2,633	63,756	654	179
	R-squared	0.220	0.285	0.230	0.436	0.684
Panel F: Enrolled in 2 year	Years brick & mortar	-0.025***	-0.018**	-0.010**	-0.011	-0.050*
		(0.004)	(0.008)	(0.005)	(0.017)	(0.028)
	Years cyber	0.098***	0.061**	0.065***	0.020	0.065
		(0.017)	(0.029)	(0.007)	(0.062)	(0.078)
	Observations	8,595	2,633	63,756	654	179
	R-squared	0.201	0.279	0.028	0.406	0.663

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Years brick & mortar is the number of years between grades 9 & 12 enrolled in a brick & mortar charter, years cyber charter is defined analogously. Models also include controls for third order polynomials of 8th grade reading and math scores, 8th grade free or reduced price lunch eligibility, special education status, English language learner status, gifted status, an indicator for whether student repeated 8th grade, total number of years enrolled in a charter prior to grade 9, an indicator for whether 8th grade school is a charter, third order polynomials of 8th grade reading and math scores, and indicators for missing 8th grade reading and math scores. Models also control for 8th grade zoned school x cohort x race x gender fixed effects. Standard errors clustered at the student level.

Table 10: Effects of Charter Middle Schools on Academic Outcomes, AY 2014-2017, Grades 6-8, By Race & Gender.

	Econ. Disadvantaged	Non-poor	SPED	Gen Ed.	EL	Non-EL
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Math						
Years brick & mortar	0.012**	-0.039***	0.006	-0.002	0.082***	-0.004
	(0.005)	(0.010)	(0.019)	(0.005)	(0.025)	(0.005)
Years cyber charter	-0.219***	-0.311***	-0.232***	-0.276***	0.021	-0.276***
	(0.013)	(0.018)	(0.032)	(0.011)	(0.082)	(0.011)
Observations	104,027	99,939	15,266	188,700	7,658	196,308
R-squared	0.254	0.235	0.466	0.345	0.448	0.342
Panel B: Reading						
Years brick & mortar	0.035***	-0.006	0.019	0.025***	0.086***	0.023***
	(0.006)	(0.010)	(0.020)	(0.005)	(0.025)	(0.005)
Years cyber	-0.174***	-0.227***	-0.194***	-0.209***	0.040	-0.212***
	(0.016)	(0.019)	(0.035)	(0.013)	(0.085)	(0.012)
Observations	103,719	99,821	15,221	188,319	7,637	195,903
R-squared	0.238	0.245	0.472	0.329	0.430	0.332
Panel C: Chronic Absenteeism						
Years brick & mortar	-0.025***	-0.008***	-0.026***	-0.020***	-0.004	-0.021***
	(0.003)	(0.003)	(0.008)	(0.002)	(0.009)	(0.002)
Years cyber	0.013***	0.025***	0.018	0.020***	-0.046	0.020***
	(0.005)	(0.004)	(0.011)	(0.003)	(0.034)	(0.003)
Observations	109,367	103,091	18,233	194,225	8,052	204,406
R-squared	0.089	0.091	0.271	0.107	0.232	0.106

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Years brick & mortar is the number of years between grades 3 & 5 enrolled in a brick & mortar charter, years cyber charter is defined analogously. Models also include controls for kindergarten grade free or reduced price lunch eligibility, special education status, English language learner status, gifted status, an indicator for whether student repeated kindergarten, total number of years enrolled in a charter prior to grade 3, and an indicator for whether kindergarten grade school is a charter. Models also control for kindergarten zoned school x cohort x race x gender fixed effects. Standard errors clustered at the student level.

Table 11: Effects of Charter Middle Schools on Academic Outcomes, AY 2014-2017, Grades 6-8, Economically Disadvantaged, SPED, and EL.

	Econ. Disadvantaged	Non-poor	SPED	Gen Ed.	EL	Non-EL
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Math						
Years brick & mortar	0.025***	-0.030***	0.046***	0.011***	0.046***	0.014***
	(0.003)	(0.006)	(0.006)	(0.003)	(0.009)	(0.002)
Years cyber charter	-0.123***	-0.171***	-0.088***	-0.156***	-0.058	-0.142***
	(0.006)	(0.008)	(0.012)	(0.005)	(0.040)	(0.005)
Observations	192,044	186,866	56,145	322,765	11,151	367,759
R-squared	0.646	0.680	0.728	0.700	0.640	0.713
Panel B: Reading						
Years brick & mortar	0.039***	-0.016***	0.056***	0.024***	0.068***	0.026***
	(0.003)	(0.006)	(0.007)	(0.003)	(0.011)	(0.003)
Years cyber	-0.080***	-0.128***	-0.066***	-0.111***	-0.085**	-0.099***
	(0.006)	(0.007)	(0.012)	(0.005)	(0.043)	(0.005)
Observations	192,015	186,952	56,138	322,829	11,128	367,839
R-squared	0.648	0.637	0.717	0.661	0.632	0.689
Panel C: Chronic Absenteeism						
Years brick & mortar	-0.030***	-0.005*	-0.022***	-0.025***	-0.029***	-0.025***
	(0.002)	(0.003)	(0.005)	(0.002)	(0.008)	(0.002)
Years cyber	0.001	0.005*	0.006	0.003	-0.005	0.003
	(0.004)	(0.003)	(0.006)	(0.002)	(0.031)	(0.002)
Observations	204,210	192,404	64,633	331,981	11,900	384,714
R-squared	0.101	0.079	0.226	0.128	0.240	0.128

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Years brick & mortar is the number of years between grades 3 & 5 enrolled in a brick & mortar charter, years cyber charter is defined analogously. Models also include controls for kindergarten grade free or reduced price lunch eligibility, special education status, English language learner status, gifted status, an indicator for whether student repeated kindergarten, total number of years enrolled in a charter prior to grade 3, and an indicator for whether kindergarten grade school is a charter. Models also control for kindergarten zoned school x cohort x race x gender fixed effects. Standard errors clustered at the student level.

Table 12: Effects of Charter High Schools on Academic Outcomes, AY 2014-2017, Grades 9-12, Economically Disadvantaged, SPED, and EL.

	Econ. Disadvantaged	Non-poor	SPED	Gen Ed.	EL	Non-EL
	(1)	(2)	(3)	(4)	(5)	
Panel A: Algebra						
Years brick & mortar	0.025***	-0.022**	-0.011	0.016***	0.061**	0.012***
	(0.005)	(0.009)	(0.013)	(0.005)	(0.024)	(0.005)
Years cyber charter	-0.089***	-0.090***	-0.095***	-0.089***	-0.107	-0.087***
	(0.010)	(0.010)	(0.020)	(0.007)	(0.079)	(0.007)
Observations	24,096	41,947	8,452	57,591	1,079	64,964
R-squared	0.719	0.665	0.710	0.681	0.719	0.712
Panel B: Biology						
Years brick & mortar	0.032***	-0.026***	-0.010	0.021***	0.064***	0.015***
	(0.005)	(0.010)	(0.013)	(0.005)	(0.024)	(0.005)
Years cyber	-0.067***	-0.095***	-0.052***	-0.087***	0.001	-0.081***
	(0.009)	(0.010)	(0.018)	(0.007)	(0.059)	(0.007)
Observations	23,476	41,832	8,308	57,000	1,011	64,297
R-squared	0.665	0.637	0.683	0.670	0.621	0.688
Panel C: Literature						
Years brick & mortar	0.042***	0.017*	0.014	0.041***	0.055*	0.036***
	(0.006)	(0.010)	(0.015)	(0.006)	(0.031)	(0.005)
Years cyber	-0.042***	-0.056***	-0.041**	-0.052***	-0.059	-0.050***
	(0.010)	(0.010)	(0.020)	(0.007)	(0.089)	(0.007)
Observations	23,671	41,932	8,370	57,233	1,040	64,563
R-squared	0.658	0.626	0.678	0.630	0.664	0.669
Panel D: Chronic Absenteeism						
Years brick & mortar	-0.019***	0.015***	-0.009**	-0.009***	-0.000	-0.010***
	(0.002)	(0.003)	(0.005)	(0.002)	(0.008)	(0.002)
Years cyber	-0.012***	0.009***	0.001	0.000	0.026	0.001
	(0.003)	(0.003)	(0.006)	(0.002)	(0.029)	(0.002)
Observations	208,696	338,156	79,244	467,608	10,148	536,704
R-squared	0.114	0.083	0.196	0.158	0.234	0.157

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Years brick & mortar is the number of years between grades 3 & 5 enrolled in a brick & mortar charter, years cyber charter is defined analogously. Models also include controls for kindergarten grade free or reduced price lunch eligibility, special education status, English language learner status, gifted status, an indicator for whether student repeated kindergarten, total number of years enrolled in a charter prior to grade 3, and an indicator for whether kindergarten grade school is a charter. Models also control for kindergarten zoned school x cohort x race x gender fixed effects. Standard errors clustered at the student level.

percentage points in middle school, and 1.9 percentage points in high school. Cyber charter schools have negative effects on test scores for all groups, with no consistent effects on chronic absenteeism.

Brick and mortar charters have positive impacts on full-time enrollment among economically disadvantaged (1.4 percentage points per year of enrollment), general education students (0.7 percentage points per year of enrollment), and non-EL students (0.8 percentage points per year of enrollment) with no impacts for other groups (**Table 13, Panel D**). Charter schools also have the largest positive impacts on 4-year enrollment and negative impacts on 2-year enrollment for these same groups. As with test scores, the impacts of cyber charter schools on post-secondary outcomes do not vary substantially across groups.

> Charter schools appear to be most effective for black, Hispanic, and economically disadvantaged students.

Table 13: Effects of Charter High Schools on Attainment, AY 2014-2017, Grades 9-12, Economically Disadvantaged, SPED, and EL.

		Econ. Disadvantaged	Non-poor	SPED	Gen Ed.	EL	Non-EL
		(1)	(2)	(3)	(4)	(5)	
Panel A: Graduated	Years brick & mortar	0.080***	0.095***	0.086***	0.083***	0.105***	0.081***
		(0.001)	(0.002)	(0.003)	(0.001)	(0.005)	(0.001)
	Years cyber charter	0.045***	0.076***	0.052***	0.058***	-0.017	0.056***
		(0.002)	(0.002)	(0.004)	(0.002)	(0.013)	(0.002)
	Observations	209,890	338,874	79,644	469,120	10,237	538,527
	R-squared	0.033	0.010	0.036	0.018	0.076	0.019
Panel B: Enrolled in any postsecondary	Years brick & mortar	0.005*	-0.001	0.020*	0.002	-0.033	0.003
		(0.003)	(0.003)	(0.011)	(0.002)	(0.022)	(0.002)
	Years cyber	-0.033***	-0.018***	-0.018	-0.024***	-0.268**	-0.024***
		(0.009)	(0.006)	(0.026)	(0.005)	(0.118)	(0.005)
	Observations	20,587	60,973	6,115	75,445	846	80,714
	R-squared	0.169	0.083	0.347	0.101	0.474	0.099
Panel C: Enrolled full-time	Years brick & mortar	0.014***	-0.003	0.002	0.007***	0.004	0.008***
		(0.003)	(0.003)	(0.013)	(0.002)	(0.023)	(0.002)
	Years cyber	-0.050***	-0.038***	-0.051*	-0.043***	-0.140	-0.045***
		(0.009)	(0.006)	(0.027)	(0.005)	(0.101)	(0.005)
	Observations	20,587	60,973	6,115	75,445	846	80,714
	R-squared	0.217	0.122	0.403	0.144	0.567	0.151
Panel D: Enrolled half-time	Years brick & mortar	-0.007**	0.001	0.002	-0.004	-0.024	-0.004*
		(0.003)	(0.004)	(0.011)	(0.002)	(0.019)	(0.002)
	Years cyber	0.030***	0.022***	0.041*	0.026***	-0.031	0.027***
		(0.010)	(0.006)	(0.024)	(0.005)	(0.157)	(0.005)
	Observations	20,587	60,973	6,115	75,445	846	80,714
	R-squared	0.188	0.074	0.317	0.080	0.539	0.079
Panel E: Enrolled in 4 year	Years brick & mortar	0.029***	0.015***	0.019	0.024***	-0.005	0.025***
		(0.003)	(0.004)	(0.012)	(0.003)	(0.024)	(0.003)
	Years cyber	-0.090***	-0.062***	-0.046*	-0.080***	0.035	-0.078***
		(0.011)	(0.007)	(0.024)	(0.006)	(0.139)	(0.006)
	Observations	20,587	60,973	6,115	75,445	846	80,714
	R-squared	0.297	0.229	0.463	0.231	0.643	0.250
Panel F: Enrolled in 2 year	Years brick & mortar	-0.022***	-0.012***	-0.019	-0.019***	0.010	-0.020***
		(0.004)	(0.005)	(0.012)	(0.003)	(0.022)	(0.003)
	Years cyber	0.076***	0.058***	0.061**	0.069***	-0.079	0.068***
		(0.010)	(0.007)	(0.024)	(0.006)	(0.112)	(0.006)
	Observations	20,587	60,973	6,115	75,445	846	80,714
	R-squared	0.291	0.197	0.442	0.201	0.657	0.216

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Years brick & mortar is the number of years between grades 9 & 12 enrolled in a brick & mortar charter, years cyber charter is defined analogously. Models also include controls for third order polynomials of 8th grade reading and math scores, 8th grade free or reduced price lunch eligibility, special education status, English language learner status, gifted status, an indicator for whether student repeated 8th grade, total number of years enrolled in a charter prior to grade 9, an indicator for whether 8th grade school is a charter, third order polynomials of 8th grade reading and math scores, and indicators for missing 8th grade reading and math scores. Models also control for 8th grade zoned school x cohort x race x gender fixed effects. Standard errors clustered at the student level.

Discussion and Implication

Overall, the effects of charter schools on student outcomes in Pennsylvania are mixed. On average, charter schools have negative or no impacts on test scores, but positive impacts on other outcomes including attendance, chronic absenteeism, and high school graduation. While charter schools have only small or no effects on enrollment in post-secondary education, they do appear to affect the type and intensity of enrollment—shifting students away from less than half-time time enrollment and from 2- to 4-year institutions. These findings are consistent with prior work on the effect of charter schools on attainment and post-secondary outcomes. However, these averages mask considerable variation by charter school type and characteristics. Most notably, when impacts are disaggregated for brick and mortar versus cyber charter schools, I find that brick and mortar charters have positive impacts, whereas cyber charter schools have negative impacts across almost all outcomes. Each additional year in a cyber charter school decreases test scores, increases the probability of chronic absenteeism, and decreases the probability of enrolling in any form of post-secondary education. While attending a cyber charter school increases the probability of high school graduation, this appears to be the only positive impact of these schools. I also find that urban charter schools have positive impacts across a range of outcomes, whereas suburban and rural charter schools have no or negative impacts, which is consistent with prior research. CMOs tend to be more effective than independent charter schools in terms of attendance and graduation but have no effect on test scores.

Finally, I find evidence that charter schools are more effective for certain student groups than others. For example, charter schools appear to be most effective for black, Hispanic, and economically disadvantaged students. While charter schools appear particularly detrimental for white students' test scores, they do not have negative effects on other outcomes such as chronic absenteeism and have positive effects on high school graduation. These findings have important implications for future research. First, future research should seek to understand why cyber charter schools are so much less effective than brick and mortar schools. In addition, more research should examine the longer term effects of charter schools including college persistence and employment.

Works Cited

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

Ahn, J., & McEachin, A. (2017). Student enrollment patterns and achievement in Ohio's online charter schools. *Educational Researcher,* 46(1), 44-57.

Angrist, J. D., Cohodes, S. R., Dynarski, S. M., Pathak, P. A., & Walters, C. R. (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.

Angrist, J. D., Pathak, P. A., & Walters, C. R. (2013). Explaining charter school effectiveness. *American Economic Journal: Applied Economics,* 5(4), 1-27.

Booker, K., Sass, T. R., Gill, B., & Zimmer, R. (2011). The effects of charter high schools on educational attainment. *Journal of Labor Economics,* 29(2), 377-415.

CREDO. (2011). *Charter school performance in Pennsylvania,* Stanford, CA: CREDO, downloaded from credo.stanford.edu.

CREDO. (2019). *Charter school performance in Pennsylvania,* Stanford, CA: CREDO, downloaded from credo.stanford.edu.

Davis, M., & Heller, B. (2017). "No Excuses" charter schools and college enrollment: New evidence from a high school network in Chicago. *Education Finance and Policy,* (Just Accepted), 1-57.

Dobbie, W., & Fryer Jr, R. G. (2011). Are high-quality schools enough to increase achievement among the poor? Evidence from the Harlem Children's Zone. *American Economic Journal: Applied Economics,* 3(3), 158-87.

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

Dobbie, W. S., & Fryer Jr, R. G. (2016). *Charter schools and labor market outcomes* (No. w22502). National Bureau of Economic Research.

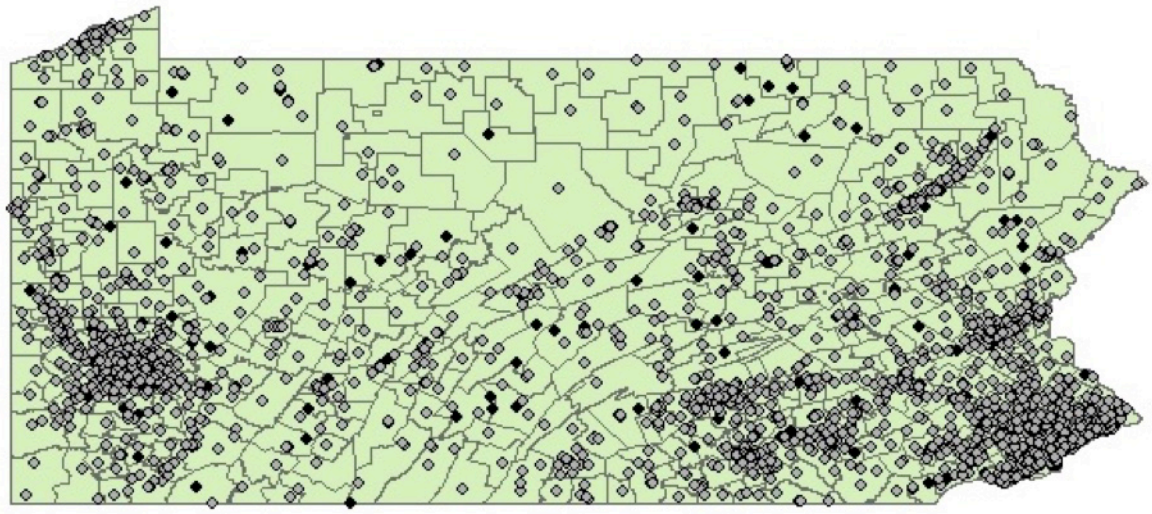
Lueken, M., Ritter, G., & Beck, D. (2015). Value-added in a virtual learning environment: An evaluation of a virtual charter school. *Journal of Online Learning Research,* 1(3), 305-335.

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

Zimmer, R., Gill, B., Booker, K., Lavertu, S., & Sass, T. R. (2009). Charter schools in eight states: *Effects on achievement, attainment, integration, and competition.* Rand Corporation.

Appendix

Figure 1. Schools in Elementary Sample.

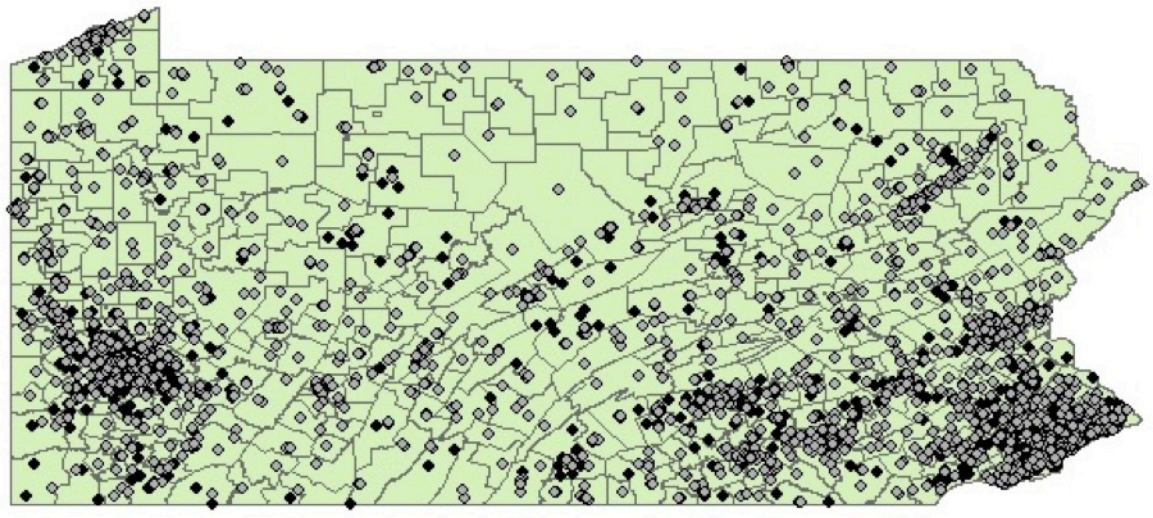


◇ Elementary Schools in Sample

◆ Elementary Schools Not in Sample

Notes: Elementary schools in sample include all elementary schools that have at least one traditional public and one charter school student of the same gender and race who are zoned to attend that school in kindergarten in 2011 or 2012.

Figure 2. Schools in Middle School Sample.

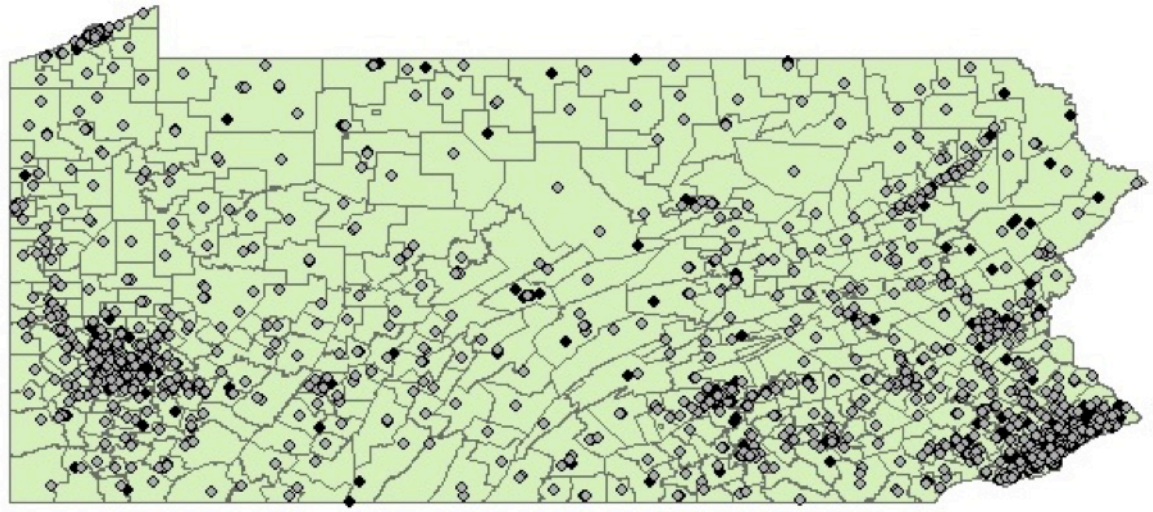


◆ Middle Schools in Sample

◆ Middle Schools Not in Sample

Notes: Elementary schools in sample include all elementary schools that have at least one traditional public and one charter school student of the same gender and race who are zoned to attend that school in kindergarten in 2011 or 2012.

Figure 3. Schools in High School Sample.



◇ High Schools in Sample

◆ High Schools Not in Sample

Notes: High schools in sample include all middle schools that have at least one traditional public and one charter school student of the same gender and race who are zoned to attend that school in eighth grade in 2011 or 2012. High schools not in sample are schools that eighth graders were zoned to attend in 2011 or 2012, but that did not include at least one traditional public and charter school student.

Appendix Table 1. Baseline Characteristics, Elementary, Middle, and High School Cohorts.

	Sample Students			
	Non-charter mean	All charter	Brick & Mortar Charter	Cyber Charter
	(1)	(2)	(3)	(4)
Panel A: Kindergarten				
Free lunch	0.443	-0.001	-0.005*	0.011***
Reduced price lunch	0.042	0.002	0.001	0.006**
Special Ed.	0.093	-0.001	-0.002	0.005*
EL	0.034	-0.004***	-0.005***	-0.002
Gifted	0.002	0.000	0.000	-0.000
Kindergarten repeater	0.011	0.002***	-0.001	0.013***
N		72,780		
Panel B: 4th Grade				
Free lunch	0.404	0.002	0.001	0.007**
Reduced price lunch	0.055	0.002**	0.003***	0.000
Special Ed.	0.162	-0.004***	-0.001	-0.013***
EL	0.026	-0.001	0.000	-0.005***
Gifted	0.040	0.001*	0.001*	0.012***
4th grade repeater	0.005	-0.000	-0.001***	0.001
Missing 4th Grade reading	0.049	-0.000	-0.000	-0.000
Missing 4th Grade math	0.039	-0.000	-0.000	0.001
4th Grade reading	-0.051	0.010***	0.013***	-0.003
4th Grade math	-0.039	-0.012***	-0.000	-0.055***
N			133,104	
Panel C: 8th Grade				
Free lunch	0.299	0.004***	-0.000	0.011***
Reduced price lunch	0.057	0.001	0.001	0.001
Special Ed.	0.147	-0.006***	-0.002	-0.016***
EL	0.016	-0.001	0.000	0.003***
Gifted	0.059	-0.000	-0.004***	0.006***
8th grade repeater	0.004	0.000	-0.001***	0.002***
Missing 8th Grade reading	0.050	-0.001*	-0.000	-0.001**
Missing 8th Grade math	0.050	-0.000	-0.001	0.001
8th Grade reading	0.077	0.001	-0.001	0.005
8th Grade math	0.072	-0.039***	-0.018***	-0.078***
Observations		147,164		

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Table reports regression estimates of correlation between charter school enrollment and baseline variables. Column 1 reports the mean of each variable for non-charter students. Column 2 reports the coefficient and standard error on years in any charter school controlling for other baseline controls and baseline zoned school x gender x race x cohort effects. Columns 3 and 4 report the coefficient and standard error from a single regression that separates estimates for years in brick and mortar and years in cyber charter school.

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