Education Finance and Policy Just Accepted MS.
doi:10.1162/EDFP_a_00240

In Pursuit of the Common Good: The Spillover Effects of Charter Schools on Public School Students in New York City

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Acknowledgements: I thank Amy Ellen Schwartz, Leanna Stiefel, Ingrid Gould Ellen, Sean P. Corcoran, Jeffrey Zabel, Agustina Laurito, and Emilyn Ruble Whitesell for their invaluable feedback, advice, and support. Thank you to Meryle Weinstein for her encouragement and her help with data, logistics, and technical support. I also thank seminar participants at the Institute for Education and Social Policy, NYU Wagner, Urban Economics Association, and the Association for Education Finance and Policy annual meetings for helpful advice. This work was supported by the Spencer Foundation, Grant #201100049. All conclusions are the author's alone.

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doi:10.1162/EDFP_a_00240

Abstract

A particularly controversial topic in current education policy is the expansion of the charter school sector. This paper analyzes the spillover effects of charter schools on traditional public school (TPS) students in New York City. I exploit variation in both the timing of charter school entry and distance to the nearest charter school to obtain credibly causal estimates of the impacts of charter schools on TPS student performance and I am among the first to estimate the impacts of charter school co-location. I further add to the literature by exploring potential mechanisms for these findings with school-level data on per pupil expenditures (PPE), parent, and teacher perception of schools. Briefly, I find that charter schools significantly increase TPS student performance in both English Language Arts and math and decrease the probability of grade retention. Effects increase with charter school proximity and are largest in TPSs co-located with charter schools. Potential explanations for improved performance include increased PPE, academic expectations, student engagement, and a more respectful and safe school environment after charter entry. The findings suggest that more charter schools in NYC may be beneficial at the margin and that co-location may be mutually beneficial for charter and traditional public schools.

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<A> I. Introduction

One of the most controversial topics in current education policy is the expansion of the charter school sector, which at 6.2 percent of all public schools and 4.6 percent of all students represents a small but growing share of the national education market (Snyder and Dillow, 2015). Charter school advocates argue that expansion will benefit not only charter school students, but also students attending nearby traditional public schools (TPSs) because TPSs will respond to increased competition or information transfers from charter schools by improving practices or efficiency. Detractors of expansion argue that charter schools negatively affect TPS student performance by sapping needed resources and siphoning off motivated students from under-resourced schools that are often already serving poor and low-performing students.

In addition to this more general debate about charter school expansion, many large urban districts such as New York City (NYC), Los Angeles, and San Diego are engaging in the practice of co-location, where charter schools and TPSs share the same physical building, sometimes operating on different floors and often sharing spaces such as gymnasiums and cafeterias. While co-location may be financially beneficial to charter schools, which are not responsible for certain costs such as utilities and janitorial services (New York City Independent Budget Office, 2010), the effect of co-location on TPS students is unclear. On the one hand, having charter schools operate in the same building may increase competitive pressures or information transfers and thereby improve TPS student performance. On the other hand, co-location may lead to overcrowding and loss of spaces such as libraries, ultimately harming student performance.

Despite these heated debates, empirical evidence on the direction and magnitude of charter school spillovers on TPS students is inconclusive and evidence on the effects of co-location and the mechanisms through which spillovers might occur is largely nonexistent. In this

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paper I add to the literature using especially rich data on students in the nation's largest school district, NYC, to obtain credibly causal estimates of the spillover effects of charter schools on neighboring TPS students and TPS students in co-located schools. I use a difference-in-difference strategy that identifies charter school effects from two separate sources of variation: the timing of charter entry across neighborhoods and the distance to the nearest charter school within a one mile radius. To address concerns about endogenous student movement after charter school entry, I use an intent-to-treat (ITT) analysis that fixes students in their original schools.

Then, I am among the first to explore school-level factors that might explain charter school effects on TPS student performance. In particular, I examine the relationship between charter school entry and TPS demographics, per pupil expenditures (PPE), and parent and teacher responses to school climate surveys to investigate whether changes in these school-level factors might explain observed charter school spillovers. While myriad studies examine the effects of charter schools on TPS demographics, the effects on other important school-level factors such school resources, climate, and school practices are not well studied.

My empirical strategy is similar to that employed in prior literature, but adapted to address some of the weaknesses of past studies for identifying spillover effects of charter schools in an urban context like NYC. First, most prior analyses examine effects over large distances, thereby underestimating the impact of charter schools on the performance of those students attending TPSs in the same *neighborhoods* where charter schools locate and providing few predictions about the effects of being located in the same *building* as a charter school. To the extent that demand for charter schools is driven by family characteristics (such as SES) and existing TPS characteristics (such as quality), charter school location may reflect the geographic distribution of these characteristics across neighborhoods within a district. In a dense urban

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environment such as NYC, neighborhoods comprise a much finer level of geography than previously analyzed, which I address by focusing on spillovers within one mile of each TPS. Second, by failing to account for endogenous student movement after charter school entry, many prior studies are at risk of conflating changes in TPS student *composition* with changes in TPS student *performance*. I address this concern by conducting an ITT analysis, where I fix students in the first school they are observed attending. Finally, an important contribution is my ability to explore multiple school-level mechanisms through which spillovers might occur.

While the majority of students continue to be educated in TPSs, the rapid growth of the charter sector across the country means that an increasing number of TPS students attend schools exposed to nearby charter schools. Of particular concern is that charter schools negatively affect surrounding TPS students, in which case there is a strong argument for curtailing the growth of the charter sector. Of much less concern is that charter schools have positive or no effects on TPSs, in which case there is little reason to limit future charter expansion and, all else equal, might even suggest policies to promote additional charter schools. Similarly, as co-location becomes more common in urban districts, which are often faced with space constraints, it is important to understand the impacts of this practice on TPS student performance.

Briefly, I find that the introduction of charter schools within one mile of a TPS increases the performance of TPS students on the order of 0.02 standard deviations (sds) in both math and English Language Arts (ELA). As predicted by theories of competition or information transfers, these effects increase with proximity to the charter school and are largest among students in co-located schools, where performance increases by 0.09 sds in math and 0.06 sds in ELA. In addition, retention decreases between 20-40 percent in TPSs located within 1 mile of a charter school. School-level responses that might explain these positive spillovers include higher per

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PPE and changes in school practices such as higher academic expectations, student engagement, and levels of respect and cleanliness at the school, as reported on parent and teacher surveys.

The remainder of this paper is organized as follows. Section II reviews the literature, Section III contains a description of the data, Section IV describes the empirical models and measures, and Section V discusses the results. Section VI describes why charter schools might affect TPS student performance and discussion of results from the mechanisms analysis follows in Section VII. Section VIII concludes with implications for policy and areas for future research.

<A> II. Literature Review

<B> A. Effects of Charter Schools on Public School Student Achievement

Evidence regarding the impacts of charter schools on TPS student performance is quite mixed. While some studies find small negative effects on performance (Bettinger, 2005), others find small positive (Hoxby, 2003; Sass, 2006; Booker et. al, 2008) or no significant effects (Bifulco and Ladd, 2006).[1] Almost all of this research, however, is either conducted at the district level or examines the effects of charter schools within a wide radius of public schools (2.5 to 10 miles). While such analyses are most likely appropriate for their context—small and less densely populated urban and suburban districts—this body of work provides limited insight into how charter schools affect the performance of students in a *large urban* district who attend TPSs located in the same neighborhood as a charter school. If urban charter school spillovers are concentrated in nearby schools, then findings from prior analyses may well be an underestimate of charter school impacts because outcomes of students attending nearby TPSs (who are most affected) are averaged with outcomes of students further away (who are less affected).

[1] Another, more recent literature uses charter school lotteries to examine the effects of charter schools on charter school student performance. This literature is not described in detail here because it does not address charter school effects on TPS student performance and is therefore not relevant for this analysis. For examples of this literature see Hoxby, Murarka, and Kang (2009), Angrist et al. (2010) and Dobbie and Fryer (2011).

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Two recent studies (Cremata and Raymond, 2014; Winters, 2012) use an alternative measure of charter school exposure by constructing public school-specific measures of competition based on the percentage of students in a given TPS who attrit to a charter school. Cremata and Raymond (2014) find that charter school quality is positively related to student test score growth, whereas Winters (2012) finds no or positive effects of charter schools. There are some concerns inherent in this measure of competition, however, because public school attrition may actually be an *outcome* of charter school entry. That is, after a charter school opens, underperforming students may be more likely to exercise their new choice option to leave their current TPS because they are dissatisfied with their education there. In this case, the measure of competition used in these analyses is endogenous and the positive results reflect pure compositional changes in students attending nearby TPSs rather than true performance gains.

Finally, Imberman (2011) uses an instrumental variables strategy to examine the spillovers of charter schools in a large urban school district in the southwest and finds that charter school exposure leads to significant declines in performance. More specifically, he instruments for charter school exposure with the characteristics of buildings within a 1.5 mile radius of each TPS, limits his exposure measure to charter enrollments in overlapping grades, and accounts for endogenous school switching using student fixed effects. This strategy does not address time-varying reasons for mobility between TPSs, however. If, for example, charter schools *change* parental perceptions of public schools in a way that leads to differential mobility, this will be captured in the estimate of charter school effects. Rather than relying on a fixed effects strategy, I address student switching using an ITT analysis that fixes students in the first TPS they are observed attending.

With the exception of Imberman (2011) and Jinnai (2014), most prior research does not

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restrict analyses to charter and public schools that serve overlapping grades. This would also lead to an underestimate of charter school spillovers, as competition for students is predicted to be strongest among schools serving the same student body. Consistent with this reasoning, Jinnai (2014) finds a significant positive relationship between charter school entry and student performance. Identification is based off students who remain in the same public school before and after charter school entry, however, which will lead to biased estimates if such students are not a random selection from the TPS student population, which I address with my ITT analysis.

<B> B. Models of Charter School Location

Bifulco and Buerger (2015) examine whether financial incentives influence charter location in several New York state school districts. They find evidence that charter schools behave as profit maximizers by locating near those families with the highest demand. Several other studies examining the location decisions of charter school operators find that charter schools tend to locate in neighborhoods with lower performing schools, lower household income, and more diverse populations (Henig and MacDonald, 2002; Glomm, Harris, and Lo, 2005; Stoddard and Corcoran, 2007; Ferreyra and Kosenok, 2014).

Together, these findings suggest that charter school location is unlikely to be random. Rather, charter school operators may select locations to systematically attract students with specific socio-demographic characteristics. Since such characteristics tend to be relatively concentrated in urban areas, separating charter school from neighborhood effects requires that charter school spillovers be studied at a neighborhood level.

<B> C. Literature on Charter Schools and TPS Composition and Inputs

Most prior work exploring the effects of charter schools on public school student composition finds that charter school students are more likely to be black, less likely to be white, more likely to have college educated parents, and tend to be lower performing than their public

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school peers (Booker, Zimmer and Buddin, 2005; Bifulco and Ladd, 2006). These results imply that changes in TPS composition in response to charter school will work in the opposite direction (i.e. TPS students are less likely to be black, less likely to have college educated parents, etc.). Multiple studies also find that charter school students are less likely to be eligible for special education services or to be limited English proficient than TPS students in the same district and that special education students and English Language learners are less likely to apply to charter schools in NYC (Budding and Zimmer, 2005; Sass, 2006; Hoxby, Murarka, and Kang, 2009; Tuttle et al. 2010; Buckley and Sattin-Bajaj, 2011; Lake, Gross, and Denice, 2012). In one of the few studies explicitly examining the implications of charter schools for *TPS* student composition, Bifulco and Ladd (2007) find that, on average, TPS students across the state of North Carolina are less likely to be black, more likely to be white, have less educated parents, and are slightly higher performing than students who ever attend a charter school.

While informative, these prior studies focus primarily on charter school or macro-level TPS student composition and do not provide clear expectations of what compositional changes might be expected to occur at the school-level. If charter schools tend to locate in neighborhoods that are not demographically representative of the entire district, previous findings could simply be an artifact of charter school location rather than evidence that charter schools systematically attract particular types of students from TPSs. Whether and how charter schools affect the composition of nearby TPSs is ultimately an empirical question.

Prior studies on the effects of charter schools on TPS resources is largely limited to the effects of charter schools on teacher labor markets, which tend to find that teachers in charter schools are more likely to be inexperienced, less likely to have tenure, and less likely to be licensed than teachers in public schools. Findings about academic qualifications such as

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competitiveness of undergraduate institutions and course taking in math and science are mixed (Podgursky and Ballou, 2001; Hoxby, 2002; Baker and Dickerson, 2006; Carruthers, 2010).

In more recent work, Jackson (2012) and Carruthers (2010) examine the effect of charter school entry on the distribution of teachers in North Carolina TPSs. Using a difference-in-differences strategy, both studies find that teachers who exit TPSs to work in charter schools tend to be lower quality than those teachers who remain in the TPS system, which could potentially lead to better TPS student outcomes after charter school entry. Both studies examine teacher responses in a large labor market (the state of North Carolina), however, and their findings may not accurately predict teacher responses to charter school entry within a single district such as NYC where movement between schools is likely easier.

<A> III. Data and Measures

<B> A. Data

Data come from five sources: NYC Department of Education (NYCDOE) student-level data files, NYC school report cards (SRCs), the common core of data (CCD), NYC school based expenditure reports (SBER), and the NYC Learning Environment Survey (NYCLES). Student-level administrative records from the NYCDOE contain detailed student demographic and program information including race, nativity, grade, residence borough, attendance, free and reduced price lunch program eligibility, and indicators of whether a student is limited English proficient (LEP), enrolled in part time special education, a recent immigrant, or does not speak English at home. Important for this analysis, these data also contain individual level test scores and a unique student identification number, which allow me to follow students for all years they remain enrolled in NYC public schools and control for prior performance.

Data on charter school openings, grade spans, and locations (latitude and longitude) are

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obtained from the SRC data and CCD. SRC data also contain information on the percent of teachers with master's degrees and teachers with more than two years of experience in their current school. The SBER data contain school level information on PPE, converted to 2010 dollars using the consumer price index. These data are used in the mechanisms analysis.

Data on parent and teacher perceptions of TPSs come from the NYCLES, which has been administered to all teachers and parents across all grades since 2007.[2] These survey data are used in the mechanisms analysis and are discussed in greater detail in section 6.

<B> B. Sample

The main sample covers academic year (AY) 1996-97 to AY 2009-10 and includes students in grades 3-5 currently attending TPSs that are ever located in the same community school district (CSD) as a charter school with at least one overlapping grade, where elementary schools are defined as any TPS including a fourth grade.[3] I limit my analysis to CSDs with charter schools because, beginning in AY 2007-08, all charter schools in NYC were required to offer an admissions preference to students who live in the same CSD where a charter school is located, and prior to AY 2007-08, many charter schools voluntarily adopted this practice. Therefore, charter schools located within the same CSD represent the most relevant form of competition to TPSs.[4] I focus on elementary schools because charter school penetration was (and still is) highest in the elementary grades.[5] The final analysis sample includes those students with at least two test

[2] The NYCLES is the largest survey of its type administered in the U.S. and is also administered to students in grades 6-12. As of 2010, 77 percent of elementary school teachers and 66 percent of elementary school parents responded to the survey.
[3] Note that this excludes any students currently enrolled in a charter school. This is done both because the focus of this paper is on charter spillovers on those students who remain in TPSs and because for the majority of my sample period (prior to 2007), I am unable to observe students once they move to a charter school.
[4] For more information see http://www.nyccharterschools.org/enrollment-faq#8
[5] I exclude Staten Island and all schools serving exclusively special education students from the sample. This is because no charter schools operated in Staten Island during this period and schools serving only special education students would not face competition from charter schools because of their specialized nature.

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scores in ELA and math since preferred models include controls for prior test scores. This results in a total of 876,731 unique students attending 584 unique elementary schools over the 14 year period. As a robustness check I estimate models on two alternative samples: continuously enrolled students in grades 3-5 and students in grades 3-5 in all NYC elementary schools.

<B> C. Measures

<C> 1. Neighborhoods

The neighborhood measure is designed to meet two key criteria. First, a neighborhood should be large enough so that it is plausible for other schooling options to exist within its boundaries. Second, a neighborhood should be small enough so that it does not include schools that a student has very little likelihood of attending. That is, a neighborhood should contain only salient alternative schooling options facing the students in a particular TPS.

To meet these criteria, I define neighborhoods using a 1 mile radius around each TPS, which corresponds to the NYCDOE definition of walk distances for students in grades 3-6.[6] This distance also corresponds to the distance that most charter school students actually travel to school, as 75 percent of charter school students attended a school within 1 mile of their building of residence in AY 2011-2012 (author's calculations). From both a school transportation and empirical perspective then, these radii should capture a relevant set of alternative schools for a given TPS student.[7] Online Appendix Figure A.1 displays an example of a one mile radius around PS 241 in Harlem.[8] It contains 36 other TPSs and 10 charter schools (i.e., alternative options exist within this boundary). In addition, it is plausible that all of these schools are salient

[6] Students who live within 1 mile of their school are not eligible for full-fare transportation, but may receive half-fare cards good for use on buses only (General Education Transportation, 2017).
[7] This is also consistent with a growing body of research that finds distance from home is an important determinant of school choice. For examples see Harris and Larson, 2015; Schwartz, et al. 2013; and Hastings et al. 2006.
[8] Available in a separate online appendix that can be accessed on *Education Finance and Policy*'s website at www.mitpressjournals.org/efp.

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alternatives. Finally, I restrict this neighborhood measure to include only TPSs and charters located in the same CSD due to preferential admissions policies.

<C> 2. Charter School Exposure

A second key measure is charter school exposure, which I capture in multiple ways. The most basic is an indicator of whether there is *any* charter school located in the same neighborhood as a student's TPS. This indicator takes a value of one for students attending a TPS located within 1 mile of a charter school serving overlapping grades in the same CSD.

One concern with constructing an exposure measure relative to a student's current school is that student movement into (or out of) a TPS after charter school entry may be endogenous. For example, more motivated families may move their child to a different TPS after a charter school opens nearby because they are concerned about negative spillovers on their child's education. This would leave a lower performing group of students in nearby TPSs and lead to an underestimate of charter school effects. While such mobility between schools is part of the policy effect (or average total effect) of charter schools on TPS student performance, it is problematic when trying to identify the causal effect of charter schools on TPS student performance.[9] To address this concern, I use an ITT analysis, where a student is fixed in the first TPS that I observe him/her attending. That is, if a student is first observed attending a TPS that *ever* has a charter school located within 1 mile, that student is coded as exposed to a charter school in all years after a charter school opens nearby that TPS, whether or not that student exits to attend another TPS not located near a charter school.[10] Note that once a student exits to attend a charter school, he is no longer included in the sample, so that the ITT analysis addresses both

[9] For discussion of policy effects, see Todd and Wolpin, 2003.
[10] Comparing the average performance of students in affected schools who switch TPSs before any charter school opened in NYC with performance of those students who switch TPSs after charters open in NYC reveals no obvious pattern of differential switching, which also lessens concern about endogeneity.

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switching between TPSs and switching from a TPS to a charter in response to charter entry.[11] This ITT approach also addresses concerns that I am identifying changes in student composition rather than performance, since the performance of each student is "fixed" with his original school and compared to his original school mates as long as he remains in a NYC TPS.

A second measure of exposure uses the Euclidian distance between each TPS and the nearest charter school, allowing the effects of exposure to vary with charter school proximity.[12] This measure introduces an additional source of variation in charter school exposure. To fully understand this, it is useful to re-examine Online Appendix Figure A.1. Note that there is no variation between TPSs within the radius in terms of whether *any* charter school is located within 1 mile (the first measure of charter school exposure), but there *is* variation in how far each TPS is from the nearest charter school. To the extent that charter schools compete with TPSs, theory predicts that effects will increase with charter school proximity. I then examine the effects of co-location by adding an indicator of whether a TPS is co-located (shares a building) with a charter.

<C> 3. Student-level outcomes

Student-level outcomes are measured using performance on state ELA and math exams, attendance, and grade retention. Test scores are standardized by grade and year to have a mean of 0 and standard deviation of one; attendance is measured as the percent of days a student is present at school (from 0-100 percent); and grade retention is an indicator of whether a student is in the same grade in t as he was in t-1.

[11] Students who move from a charter to a TPS are assigned to the first TPS they attend after leaving a charter school. Only about 10,000 students make such a move and their performance is similar to their peers who begin in a TPS, so their inclusion is unlikely to affect my results.
[12] Studies comparing Euclidian distance to travel times and travel distances find that there are only marginal gains in predictive accuracy by using either of the latter two measures (see Fortney, et al. 2000; Phibbs and Luft, 1995). I use Euclidian rather than travel distances to simplify computation.

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<A> IV. Empirical Strategy

The primary obstacle to identifying the spillover effects of charter schools on nearby TPS students is the non-random location of charter schools across NYC. In particular, charter schools tend to locate in neighborhoods with high concentrations of poor students (See Online Appendix Figure A.2). Since such students tend to be lower performing than their peers even in the absence of nearby charter schools, cross-sectional comparisons of exposed and unexposed students will yield downwardly biased estimates of charter school impacts.

To address non-random charter school location, I use a difference-in-difference strategy that exploits variation in both the timing of charter entry across neighborhoods and the precise location of charter schools within neighborhoods. Charter school effects are then identified by two separate sources of variation. First, I compare the outcomes of students after a charter school opens near their TPS to the outcomes of students in schools where no new charter opens nearby. Second, I compare the outcomes of students in TPSs located closer to a charter school with the outcomes of students in TPSs located further away from a charter school.[13] My baseline model is as follows:

$$(1) \qquad \mathrm{Y_{ist}} = \alpha + \beta\mathrm{CHARTER}_{st} + \mathbf{X'}_{it}\boldsymbol{\theta} + \gamma\mathrm{Y_{ist-1}} + \delta_g + \varphi_s + \mu_t + \varepsilon_{ist}$$

where Y is an outcome for student i, first observed in school s, at time t, **X** is a vector of student characteristics including gender, race, free and reduced price lunch eligibility, receipt of special education services, and limited English proficiency, $\mathrm{Y_{ist-1}}$ are lagged test scores, δ are grade effects, φ are school fixed effects, μ are year fixed effects, and ε is the usual error term. CHARTER is an indicator equal to one in every year that a charter school with overlapping

[13] A similar approach is used by Figlio and Hart (2014) to examine the competitive effects of vouchers on public school student performance and Jackson (2012) to explore the effects of charter school entry on TPS teacher characteristics.

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grades locates in the neighborhood of school s.[14] The coefficient of interest is β, which captures the spillover effect of charter schools on TPS student performance. Standard errors are clustered at the school-year level because if charter schools affect student performance through school-level responses, the errors of students in the same school-year will be correlated.

School fixed effects limit comparisons to students who experience varying levels of charter school exposure *within the same school*, thus accounting for all time-invariant characteristics of schools, including those that are correlated with the location of a charter school and the performance of students in nearby TPSs. Such characteristics might include the spatial attributes of a school (i.e. whether nearby buildings are suitable for housing a charter school, whether it is located near the water, etc.) as well as the average levels of student characteristics (race, free lunch eligibility, etc.) in that school over time. Year effects control for any factors that affect all NYC public schools in a given year such as the appointment of a new chancellor, changes in curriculum, etc. Lagged test scores capture student ability and control for prior school and family inputs into a student's learning experience. In this model, charter school effects are identified by the variation in the timing of charter entry into the neighborhood of a particular TPS and can reasonably be interpreted as causal effects if, conditional on student-level covariates, grade, school, and year effects, the year of charter school entry is as good as random.

It is possible, however, that the timing of charter entry into the neighborhood of a particular TPS may be correlated with pre-existing trends in both school- and student-level performance, in which case the estimates from equation (1) will be biased. For example, charter schools may attempt to maximize demand for their services by opening near schools where

[14] Since I am using an ITT analysis, s indexes the first school that student, i, is ever observed attending. It is also possible for this indicator to turn "off" if a nearby charter school closes or if a school no longer serves overlapping grades with the charter school, which occurs in 20 TPSs.

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performance is declining, which might produce a spurious positive relationship due to mean reversion. Alternatively, charter schools may be more likely to locate in gentrifying neighborhoods where performance is increasing, which would produce a spurious negative relationship between charter school entry and TPS student performance for similar reasons.

An empirical exploration of this possibility reveals that there are no significant performance trends in either subject in the years immediately prior to charter school entry (Online Appendix Table B.1). Moreover, 3 or more years prior to entry, there are opposing trends in the two subjects, with scores on an upward trajectory in math and a downward trajectory in ELA. Although this suggests that the precise timing of charter school entry is unlikely to reflect attempts to maximize demand or performance, to control for the trends that do appear 3 or more years prior to entry, I augment equation (1) with school-specific indicators for 3 years prior to entry (YR-3), 4-6 years prior to entry (YR-4to6), and 7-9 years prior to entry (YR-7to9), and 10 or more years prior to entry (YR-10PLS) to my baseline model.[15] In this preferred specification, my comparison period is 1-2 years prior to charter school entry.

Next, I examine whether charter school spillovers vary by distance:

(2)
$$\mathrm{Y_{ist}} = \alpha + \beta_1 \mathrm{CHARTER}_{st} + \beta_2 \mathrm{CHARTERDIST}_{st} + \mathbf{X'_{\mathit{it}}\theta} + \gamma \mathrm{Y_{ist-1}} + \tau_1 YR - 3_{st} + \tau_2 \mathrm{YR} - 4\mathrm{to}6_{st} + \tau_3 \mathrm{YR} - 7\mathrm{to}9_{st} + \tau_4 \mathrm{YR} - 10\mathrm{PLS}_{st} + \delta_\mathrm{g} + \varphi_\mathrm{s} + \mu_\mathrm{t} + \varepsilon_\mathrm{ist}$$

Where all variables are as described in model (1) or in the text and CHARTERDIST is the Euclidean distance between each TPS and the closest charter school within 1 mile. In this model, β_1 is the effect of having any charter school in the neighborhood of a TPS, while β_2 is the effect of increasing the distance between a TPS and the nearest charter school in that neighborhood. A negative coefficient on β_2 indicates that public school student outcomes

[15] Figlio and Hart (2014) use a similar strategy.

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increase with *decreasing distance* (increasing proximity) to the nearest charter school. I also estimate models where I allow the effect of distance to vary by adding distance to nearest charter school squared. Finally, I estimate a distance gradient by replacing the continuous measure, CHARTDIST, with separate, mutually exclusive distance indicators: CO-LOCATED, ½ MILE, and 1 MILE, where CO-LOCATED is equal to 1 if the closest charter is located in the same building as a TPS, ½ MILE is equal to 1 if the closest charter is located more than 0 and up to ½ miles from a TPS, and 1 MILE is equal to 1 if the closest charter is located more than ½ and up to 1 mile from the TPS. I also estimate a distance gradient of charter school spillovers for TPSs located up to 3 miles from the closest charter school.[16]

<A> V. Results

<B> A. Charter Schools and Public School Student Performance

Consistent with prior evidence about non-random charter school location, Table 1 shows that TPSs in CSDS that *ever* have a charter school are more disadvantaged on a number of measures. At baseline, these TPSs have lower percentages of teachers with master's degrees and with more than two years of experience at the school, higher shares of free lunch eligible, black, Hispanic, and special education students, and lower shares of Asian and white students as compared to TPSs in CSDS that never have a charter school. Furthermore, students in these schools are significantly lower performing than students in CSDs that never have a charter. This suggests that TPS students in CSDs that never have a charter school are likely to be an inappropriate counterfactual, which is why they are omitted from my primary analyses.

Also consistent with prior evidence that charter schools tend to locate in neighborhoods with lower performing schools, Column 1 of Table 2 shows that raw differences in performance

[16] I do not estimate a gradient for distances greater than 3 miles because over 90% of TPSs are located within 3 miles of the closest charter in the same CSD.

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between exposed and unexposed students are large and negative in both math and ELA (-0.182 and -0.186 sds, respectively). Moving from the least to most controlled specifications (left to right) highlights the importance of accounting for non-random charter location—adding controls for student characteristics and lagged test scores shrinks the difference in performance by almost 17 percent, and in school fixed effects models that compare outcomes for students attending the same school before and after charter school entry, differences become positive and statistically significant in both subjects (Column 3).

To the extent that charter schools choose to locate near TPSs where performance is already declining or improving, however, the estimates presented in Columns 1-3 may be biased relationship. Once pre-trend controls are added, the positive effect in math declines slightly (consistent with empirical evidence of increasing math performance 3+ years prior to entry) and increases in ELA (consistent with empirical evidence of decreasing math performance prior to charter entry). Notably, despite opposing trends in ELA and math performance three or more years prior to charter school entry, estimates for performance both subjects are positive and significant after charter school entry.

In these models, attending a TPS within 1 mile of a charter increases student performance in math and ELA by 0.015 sds. Furthermore, these effects appear to increase with proximity. More specifically, students in TPSs located ½ mile from the closest charter school perform 0.019 sds better in math and 0.016 sds better in ELA, and this effect increases by 0.004 sds in both subjects for each 0.1 mile closer the charter school is located.[17] The findings from the quadratic specifications (Column 6), are similar. Charter school exposure significantly increases the performance of students attending nearby TPSs and the effect increases with proximity to the

[17] To find the effect for any distance, add the coefficient on post charter within 1 mile and distance to charter times that distance. For example to get the effect in math: 0.019 = 0.035+0.5*(-0.038).

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closest charter school, with effects dissipating around 0.67 miles in both subjects.

To ease interpretation and examine the effects of co-location, the remainder of the discussion focuses on the results from models that estimate charter school effects using a distance gradient (Table 3). Similar to the results using a continuous distance measure, charter school effects are positive and increasing with charter school proximity in both subjects. After charter school entry, students attending a co-located schools perform 0.083 sds better in math and 0.059 sds better in ELA, while those students in TPSs between 0 and ½ mile from the nearest charter school perform 0.021 sds higher in math and 0.020 sds higher in ELA. There are no significant effects of charter schools on students in TPSs located further than 0.5 miles from the nearest charter school, and when the distance gradient is expanded up to 3 miles, there is no evidence of negative spillovers on TPSs that are located further away from charter schools.

<B> B. Alternative Outcomes

While test scores are often studied because of their ready availability and documented link to later life outcomes, they do not represent the full range of potential charter school spillovers. It could be that charter school entry changes TPS practices in ways that are translated into changes in attendance or grade retention. Estimates of charter school spillovers on these other outcomes are presented in Columns 5-8 of Table 3.

It appears that charter schools may have small positive effects on attendance, increasing TPS student attendance by 0.268 percentage points in co-located schools and 0.134 percentage points in schools between ½ and 1 mile from a charter school. Note these effects are quite small, however, as average student attendance in the sample is 92.4%. There are, however, large and meaningful reductions in student retention as a result of charter school entry. Students in co-located schools are 1.2 percentage points less likely to be retained, students in TPSs located

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between 0 and ½ mile of a charter school are 1.0 percentage point less likely to be retained, and students in TPSs located between ½ and 1 mile from a charter are 0.6 percentage points less likely to be retained in grade than students with no charter school in the neighborhood. While these effects may seem small in magnitude, they translate into meaningful reductions—between 20 and 40 percent off the baseline grade retention rate of 3.0 among students in this sample. This decrease in grade retention might indicate that the performance gains from Columns 1-4 are concentrated among students who would otherwise be on the margin of passing exams. Alternatively, the reduction in grade retention could result from factors unrelated to test scores such as efforts by TPS administrators to keep students who would otherwise be retained in grade from exiting to start at a nearby charter school on grade level.

<B> C. Heterogeneous Impacts

In addition to estimating the average effect of charter schools on TPS student performance, I also examine whether these effects vary by the number of nearby charter schools, charter school operator, and student characteristics.

<C> 1. Number of Charter Schools

Theories of competition would predict that a larger charter school market share should lead to larger effects on performance. To examine this possibility, I re-estimate equation (2) and add indicators for two, three, four, and five or more charter schools located within a one mile radius of the TPS. The estimated coefficients on these indicators can be interpreted as the impact of two, three, four, and five or more charter schools *above and beyond* the impact of having only one charter school located in the same neighborhood (Online Appendix Table B.2). Consistent with theory, students in TPSs with three or more charter schools perform significantly better in math and are significantly less likely to be retained than students in TPSs with only one charter

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school in the neighborhood and the effect is monotonically increasing in the number of nearby charter schools.

<C> 2. Charter School Quality

Both theories of competition and information transfer suggest that the effects of charter schools on TPS performance are likely to vary with charter school quality. Specifically, one would expect TPSs to exhibit stronger responses to high quality than average or low quality charter schools. I therefore examine whether the effects of charters on TPSs vary with charter school quality, which I define in two ways. First, I use 4th grade proficiency on standardized reading and math exams, where charter schools are classified as "high performing" if average proficiency in ELA and math is above the 75th percentile for the city in the prior year.[18] One challenge with this approach, however, is that charter schools must have students enrolled in the 4th grade in order to assess quality by this metric. Since many charter schools scale up enrollments starting in kindergarten, they will not have tested students until several years after opening. Therefore, I also employ a different measure of quality where I define "high quality" charter schools as those belonging to well-known and respected Charter Management Organizations (CMOs) such as KIPP, Success Academies, Uncommon, etc. As shown in Table 4, there is suggestive evidence that TPSs are more responsive to high quality charter schools. While spillover effects remain positive for students in co-located TPSs and TPSs within ½ mile of the nearest charter, the effects in ELA are significantly greater in those TPSs located within ½ mile of a high quality charter school. The finding that co-located TPSs do not respond as strongly to the quality of co-located charter schools may reflect the reality that having a charter school in the same building places pressures on the TPS regardless of charter performance,

[18] I focus on 4th grade proficiency because this is the only grade for which reporting was mandatory in the earliest years of my sample. I use proficiency in the prior year to give TPSs time to respond to the information.

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whereas those TPSs located further away feel stronger pressure from high performing charters.

<C> 3. Student Characteristics

A commonly expressed concern is that charter school expansion will be particularly harmful for at-risk TPS students. I therefore explore the differential impacts of charters on multiple subgroups, stratifying the sample based on student characteristics. As shown in Table 5, charter schools entry increases math performance among all subgroups of TPS students except Hispanic students, Asian students, and students who are ever classified as LEP, who experience no significant effect with the exception of Asian students in TPSs located between 0 and ½ mile of a charter school. Perhaps more striking is that charter schools may be particularly beneficial to students who are ever poor or eligible for special education services, who represent particularly at-risk groups. Results for ELA are generally in the same direction, but less significant, with the exception of Hispanic students who experience significant gains in ELA performance after charter school entry (Appendix Table 2). This indicates that charter schools tend to increase or at the very least, do not harm, the performance of at-risk student populations in nearby TPSs.

<B> D. Robustness

One possible concern with the main findings is that the positive effect attributed to charter school entry is actually an artifact of TPS students exiting to attend a charter school, receiving a charter school "bump," and then returning to the public schools, or of students beginning their education in a charter school and then returning to public schools. In this case, my estimates would be identifying the effects of attending a charter school and returning to the TPS system, rather than spillover effects of charter schools on students who remain in TPSs. To address this concern, I employ two strategies. First, I limit the sample to students who are continuously enrolled in a NYC TPS, i.e. those students who never exit or enter NYC TPSs

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between grades 3 and 5. This excludes both those students who exit to attend another type of school, charter or otherwise, as well as those students who enter a TPS from a charter school. Second, I examine the effect of charter school entry on the probability that students exit NYC TPSs to attend a charter school, private school, or a school in another district. As seen in Columns 2 and 6 of Table 6, the effects of charter schools on continuously enrolled students are nearly identical to if not slightly larger than the effects on the full sample. Models estimating the effects of charter schools on TPS exit (column 9) find small, significant impacts on the probability of exit from NYC TPSs among students who attend a TPS within ½ or 1 mile of a charter school, but these estimates are small compared to the base exit rate of 8.1 percent. Overall, these results suggest my estimates are not capturing the effects of attending a charter school and then returning to a TPS. While my ITT analysis should address concerns about compositional shifts in TPS students, these results provide further evidence that estimates do not reflect attrition from the sample, as findings are similar among continuously enrolled students.[19]

Next, I estimate my models on a sample of all TPS students in grades 3-5 (Columns 3 and 7), regardless of whether there is a charter located in the CSD in order to rule out that my results are driven by my sample selection. Estimates using this larger sample of schools are if anything, larger. Overall, the findings of positive spillovers are robust to alternative samples: effects are positive and significant for having a charter school in the same neighborhood as a TPS and increasing with proximity to the nearest charter school.

Of particular concern might be that the large positive estimates of charter school effects in co-located schools reflect unobserved differences in those TPSs that have sufficient space to

[19] An examination of the distribution of students in affected TPSs who move before and after 2000 also reveals no evidence of endogeneity due to differential attrition from public schools after charter school.

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co-locate with a charter school. Specifically, one might be concerned that performance in these schools was already declining prior to charter school entry and my estimates reflect regression to the mean. I examine this possibility two ways. First, I do so empirically by examining whether there are any observed trends in performance in the years immediately prior to co-location. Results from this analysis show no significant trends in performance in the two years immediately prior to co-location (Online Appendix Table B.3). To the extent there are more distal trends (3 or more years prior to entry) they are moving in opposing directions in ELA and math and are controlled for in my model. Since I find positive and significant effects of co-location in both subjects, this lessens concerns that my co-location results reflect regression to the mean. As a second strategy, I examine the effects of TPS co-location with other TPSs because charter schools and TPSs undergo a similar application and review process prior to co-location.[20] To do so, I re-estimate my models adding an indicator equal to 1 if a TPS is co-located with another TPS. While the effect of charter co-location remains, there is no significant impact of TPS co-location with another TPS (Table 6, Columns 4 and 8), suggesting that there may be something specific about being co-located with a *charter* school that leads to student performance gains.[21]

As a final check that results do not reflect regression to the mean or other neighborhood trends, I conduct a placebo test where I make the "treatment" one or two years prior to a charter opening in the neighborhood of a TPS. If I am simply picking up regression to the mean or other neighborhood trends, then I would expect to see "effects" of charters in years prior to entry. In all models, placebo treatment is not significantly related to student performance, indicating that

[20]If anything, the application process for charter schools is somewhat more difficult, as charter schools must also include a plan for how space will be shared with the TPS.
[21] There are 45 unique public elementary schools co-located with another TPS in my sample, which is roughly twice the number of TPSs co-located with a charter school.

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results from the main analysis are detecting a real effect (Online Appendix Table B.4).

Taken as a whole, these results indicate that charter schools have a positive effect on performance and a negative effect on grade retention of elementary school students attending nearby TPSs, with no meaningful effect on either attendance or exit. Next, I explore school-level responses to charter school entry that might explain these results.

<A> VI. Why Might Charter Schools Matter for TPS Performance?

To better understand how school-level responses to charter schools might positively affect individual TPS student performance, it is useful to consider a standard student-level education production function

(3) $$Y_{it} = f(F_{it}, P_{it}, S_{it}, F_i^{(t)}, P_i^{(t)}, S_i^{(t)}, I_i)$$

Where Y represents an educational outcome such as achievement or attainment for student i at time t, and *F*, *P*, and *S* are vectors of family characteristics (such as SES), peer inputs (such as average performance), and school characteristics (such as class size), respectively. Each of these components affects current outcomes in two ways: through the level of inputs experienced at time t (F_{it}, P_{it}, and S_{it}) and through prior levels of these inputs cumulative to time t ($F_i^{(t)}, P_i^{(t)}, S_i^{(t)}$). This model indicates that a student's outcome at any period is a function of his current and prior family background, peers, schools attended, and his own innate abilities (I).

Careful consideration of this education production function reveals two main pathways through which charter schools could have spillover effects on TPS students. First, charter schools may cause changes to the level of current inputs such as the mix or behavior of parents who send their children to TPSs (F); the mix of students attending a nearby TPS (P); and the level of school resources such as per pupil expenditures, class size, or teacher quality (S). Second, charter schools may cause changes in the process, *f()*, through which inputs are translated into outcomes.

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Changing mix of TPS Parents: Due to accountability pressures, charter school operators may actively seek out more motivated parents from the TPS system through application and enrollment practices, leaving a less involved and possibly less vocal group of parents in the public schools, and ultimately decreasing school quality. Alternatively, charter school operators might do little to actively attract parents, but the parents who choose to leave TPSs may be those who are the most dissatisfied with their school, leaving behind a population that is more satisfied and involved with their child's school. Finally, charter schools might directly influence parental perceptions if TPSs respond to charter school entry by changing school practices.

While it is challenging to empirically isolate this mechanism, suggestive evidence can be obtained from examining responses to the NYCLES, which asks parents questions about perceived teacher quality, expectations set by the school, etc. To the extent that charter school entry changes the mix of parents who send their children to TPSs or their attitudes about the school, responses to these questions will change after charter entry. The results from this analysis are among the first evidence of the effects of charter schools on parents' perceptions of TPSs.

Changes in the mix of students attending TPSs: In response to accountability pressures, it is reasonable to believe that charter schools aim to maximize outputs such as test scores or proficiency rates subject to student ability and school resources. One way to accomplish this goal is by attracting high performing students and/or students requiring few if any additional resources, such as full price lunch or general education students.[22] Another strategy might be to attract those students who are low cost relative to their peers, but are eligible for additional funds, such as reduced price lunch students (who receive Title I) and recent immigrants (who

[22] The term general education refers to those students who are not enrolled in full time special education. Such students may be eligible for part-time special education services, however.

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receive immigrant funds).[23] If charter schools disproportionately attract these types of students through recruitment practices or course offerings, charter school entry will affect the group of classroom and school peers to whom TPS students are exposed, with implications for performance. Empirically, this mechanism would be evidenced by changes in TPS school composition following charter school entry.

*Changes in TPS resources: C*harter schools may also affect TPS resources including per pupil expenditures, class sizes, and teacher quality through changes in the number and composition of TPS students. In New York State, base education funds are allocated on a per pupil basis to all public schools (both TPS and charter), such that changing enrollments will have no effect on per pupil expenditures from these sources. If charter schools decrease public school enrollments, however, then certain semi-fixed resources such as categorical aid and teachers will be spread over fewer students, resulting in higher per pupil expenditures and smaller class sizes.[24] Additionally, charter schools may change the teacher composition in nearby TPSs by systematically attracting certain types of teachers from surrounding TPSs. This may occur if charter schools offer differences in salary, school culture, working conditions, etc. Empirically, this mechanism would be evidenced by changes in enrollment, per pupil expenditures, pupil-teacher ratios, and teacher characteristics following charter school entry.

Changes in Efficiency: One theoretical prediction from the school choice literature is that TPSs will respond to increased competition for students through increased efficiency. Efficiency gains could be realized through altered practices such as changes in curricula, re-allocation of

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[23] Research on NYC finds that on average, recent immigrants outperform their peers. See, Schwartz and Stiefel, 2006.

[24] While these resources are not "fixed" in the traditional sense, schools *must* employ a minimum number of teachers per grade because of laws mandating maximum student-teacher ratios. As an extreme case, a school would have to employ one teacher whether there were two or fifteen students enrolled in a grade. In the school with only two students per grade, this teacher's salary is divided over a smaller number of students, resulting in higher PPE.

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instructional time, professional development, etc. While curricular and instructional changes are not directly observed, I can explore this mechanism empirically using teacher responses to the NYCLES. The NYCLES asks teachers questions on the variety of course offerings, participation in professional development, teacher collaboration, etc., which will provide the first evidence on how TPS teacher perceptions respond to charter school entry and suggestive evidence as to whether charter school entry leads to changes in school practices.

<A> VII. Evidence on Mechanisms

To explore school-level mechanisms for charter school spillover effects, I estimate a school-level model of equation (2) where Y is a school-level characteristic, resource measure, parent, or teacher survey response. In models all models I omit lagged test scores and in models examining school composition and per pupil expenditures, I also omit controls for student characteristics (because these are the outcomes). School-level characteristics are calculated by aggregating individual student-level data, parent survey responses, and teacher survey responses. Coefficient estimates in these models can be interpreted as the relationship between charter school entry and characteristics of the average TPS. To be clear, these estimates are meant to provide descriptive, rather than causal evidence.

<B> A. Student Characteristics

Table 7 shows the relationship between charter school entry and school demographics and resources. Each row of this table is the result from a separate regression where a specific school input is the dependent variable and P-values are adjusted for multiple hypothesis testing using a Bonferroni adjustment. Among TPSs within ½ and 1 mile of a charter school, charter school entry leads to significant decreases in general education enrollment (approximately 16 students). In co-located schools, charter school entry leads to a significant 11.5 student decrease

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in special education enrollment, but no change in the *percentage* of special education students, which is consist with general education and special education enrollment declining at roughly similar rates. In general, however, there appear to be no significant demographic changes in schools that might explain improved student performance.

<B> B. School Resources

A more likely explanation for increases in TPS student performance is changes in TPS financial resources. Specifically, all TPSs experience a significant increase in instructional PPE that is increasing with charter school proximity: co-located TPSs experience an 8.9 percent increase, TPSs within 0 to ½ mile experience a 4.4 percent increase, and TPSs within ½ to 1 mile experience a 2.0 percent increase after charter school entry. To put these estimates in perspective, instructional expenditures increased by an average 7 percent per year over the sample period. These point estimates, therefore, are equivalent to approximately 50-125 percent of a full year's growth in expenditures. Breaking these down further, co-located charter schools experience a significant increase in expenditures on other staff (35.3 percent), whereas TPSs located with 0 to ½ mile of a charter school experience a 3.4 percent increase in expenditures on classroom teachers and higher instructional PPE on leadership, which might suggest changes in leadership. Finally, while insignificant, coefficients on pupil-teacher ratios are all negative. Since pupil-teacher ratios are likely a noisy proxy for class size, this is suggestive that TPS students may also experience smaller classes after charter school entry. There is no significant change in teacher characteristics. Overall, these results indicate that increases in TPS student performance may reflect, in part, higher PPE on instruction following the entry of a charter into the neighborhood. Such increases may reflect a number of factors such as a reduction in class sizes or a more experienced TPS teacher labor force after charter entry.

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<B> C. Parent Perceptions

Charter schools may also affect more "non-traditional" TPS inputs such as parents, which I explore across five different indices of parental perceptions: academic expectations, communication, parental engagement, student engagement, and school safety. These indices are based on the domains described in the documentation for the NYCLES (for specific questions answered by parents, see Online Appendix Table B.5). For each of these analyses, I limit the sample to schools with a parent response rate of at least 10 percent over all four years of the survey, and weight analyses by response rates. Missing or "not applicable" responses are dropped, although results are similar when these responses are re-coded as zeros.[25]

There is suggestive evidence that after charter school entry, parents report significantly higher student engagement and parents in co-located schools also report significantly lower levels of the school being unsafe (Table 7). While none of the other indicators are statistically significant, in general they are positive and monotonically increasing with charter school proximity. Although no specific components of these indices are statistically significant, the direction tends to indicate improved perceptions after charter entry (Online Appendix Table B.6).

This provides suggestive evidence that improved test scores could reflect changes in school practices, such as improving student engagement. Alternatively, higher test scores could reflect a more positive and involved group of parents remaining in TPSs after charter entry.

<B> D. Teacher Perceptions

Next, I provide the first evidence on how charter school entry may be related to changes in teacher perceptions of TPS practices. Similar to the analysis of parent survey responses, I limit the sample for teacher surveys to schools with a teacher response rate of at least 15 percent over

[25] 10 percent corresponds to the 1st percentile of parent response rates across all 4 years.

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all four years of the survey, and weight analyses by response rates. Missing or "not applicable" responses are dropped, although results are similar when these are recoded as zeros.[26] Teacher responses are combined to create five indices: academic expectations, communication, engagement, school respect and discipline, and school safety in keeping with the classifications described in the NYCLES documentation (specific questions are shown in Online Appendix Table B.7).

Similar to parent perceptions, teacher perceptions are marginally more positive after charter school entry. Teachers in co-located schools report higher levels of academic expectations and more respect and cleanliness after charter school entry (Table 9). While there is no significant difference on any of the individual indicators, the direction of coefficients tends to indicate perceptions improve after charter school entry (Online Appendix Table B.8). In general, however, parent and teacher perceptions move in the same direction after charter school entry, suggesting that TPSs may respond to charter school entry with changes in school practices.

<A> VIII. Conclusions and Implications

Overall, these findings suggest that charter schools have small positive spillovers on public school students, increasing math and ELA performance by 0.02 sds and decreasing grade retention between 20-40 percent. Further, these positive spillovers increase with proximity to the charter school and are largest in co-located schools where TPS student performance increases by 0.06-0.08 sds in both subjects. These results are robust to different samples and specifications. Further, the effects of co-location appear to be specific to *charter* schools, as students in TPSs co-located with other TPSs do not experience similar performance gains.

Positive effects may be explained by a combination of increased instructional PPE and

[26] 15 percent corresponds to the 1st percentile of teacher response rates across all 4 years.

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changes in practices as evidenced by parent and teacher survey responses. Although survey results are only suggestive (i.e. they are not objective measures of expectations, curriculum alignment, etc.), this is the first time such data are employed in an attempt to examine the relationship between charter schools and parents' and teachers' perceptions in order to shed light on potential mechanisms. Future research should more fully explore these mechanisms, in particular the finding of increased PPE to determine whether these might be explained by smaller class sizes or changes in the composition of the TPS teaching force.

One natural question from these findings is whether the increase in TPS student performance among exposed schools comes at a cost to other students in the city. An examination of trends in citywide performance between 2000 and 2009 shows that this does not appear to be the case (Online Appendix Figure A.3), as citywide proficiency in both ELA and math continued to increase over this period of charter school expansion. This, combined with estimates of no charter school effects on TPSs located up to 3 miles from the closest charter school indicate that the positive spillovers of charter schools on nearby TPS students did not come at the detriment of students across the city.

The implications of this research for policy are twofold. First, charter schools appear to have small positive effects, or at the very least, no significant negative effects on nearby TPS student performance. This suggests that rather than capping the number of charter schools, it may be beneficial (and certainly not harmful) to allow for further expansion in NYC at the margin. Second, results show that co-location may actually be a good policy for both charter and public schools in NYC. While charter schools benefit from the relationship financially, public school students appear to benefit from improved performance and higher PPE.

There are several important areas for future research on charter school spillovers such as

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exploring whether performance gains and school-level responses are maintained over the long run and examining whether charter schools affect students who *live* nearby through changes in property values and residential segregation patterns.

In addition, the spillover effects of charter schools in NYC found here may reflect important institutional and contextual factors such as the process for charter school authorization in New York, requirements that NYC school budgets operate within a corridor of the previous fiscal year's budget, and the relatively small fraction (about 5 percent) of NYC public school students in grades K-8 attending charter schools during this time period.[27] Therefore, future work should examine the spillover effects of charter schools in districts with differing institutional contexts and where they constitute a larger market share, such as New Orleans, Philadelphia, and Denver. In this way, research can help to better inform under what conditions charter schools may benefit or do no harm to other public school students.

[27] For example, in academic year (AY) 2003-2004, the floor was set at -2.50 percent of the FY 2003 budget and the ceiling was established at +2.25 percent of the FY03 budget (Preliminary FY 2004 Initial School Allocation, 2004). Therefore, if a school falls below its floor due to declining enrollments, the floor would become the current fiscal year's budget, resulting in increased per pupil expenditures. This provision was in effect during the entire sample period, but may buffer TPSs from immediate budget impacts of losing students to charter schools.

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doi:10.1162/EDFP_a_00240

Tables

Table 1. Average Characteristics, Community School Districts with and without Charter Schools within ½ and 1 mile, AY 1998-1999

	Never Charter in CSD	Ever Charter in CSD
Total Spending PP	**11,086**	**11,805**
Instructional Spending PP	**5,886**	**6,164**
% Teachers with MA	**84.3**	**76.9**
% teachers >2 yrs. exp. in school	**67.4**	**61.4**
Pupil-teacher ratio	17.7	18.1
Enrollment per school	**734**	**597**
ELA z-score	**0.255**	**-0.105**
Math z-score	**0.320**	**-0.125**
Percent		
Free lunch	**63.7**	**79.0**
Reduced price lunch	**9.7**	**5.6**
Black	**15.0**	**44.2**
Hispanic	**33.6**	**39.9**
Asian	**22.6**	**6.2**
White	**28.7**	**9.5**
Special Ed.	**6.7**	**7.4**
Lang. other than English at home	**59.3**	**37.5**
LEP	**11.4**	**9.8**
Recent Immigrant	**10.7**	**5.8**
Number of Schools	209	699
Number of Students	17,040	16,681

Notes: Never charter in CSD includes all schools located in a CSD where no charter school opened during the sample period. Ever charter in CSD includes all schools located in a CSD where at least one charter school opened during the sample period. Average characteristics are calculated only for those schools that were operating in the 1998-99 academic year. Bold indicates that the differences between never and ever charter in CSD schools are significantly different at the 0.05 level.

Education Finance and Policy Just Accepted MS.
doi:10.1162/EDFP_a_00240

Table 2: Effects of Charter Schools, any charter within 1 mi., AY 1997-2010, grades 3-5

Panel A: Math	(1)	(2)	(3)	(4)	(5)	(6)
Charter w/n 1 mile	-0.182***	-0.030***	0.020***	0.015***	0.035***	0.063***
	(0.011)	(0.004)	(0.005)	(0.005)	(0.009)	(0.013)
Dist. to charter					-0.038***	-0.185***
					(0.014)	(0.052)
Dist. to charter sq.						0.145***
						(0.050)
3 years pre charter				-0.019***	-0.019***	-0.019***
				(0.007)	(0.007)	(0.007)
4-6 years pre				-0.014**	-0.014**	-0.014**
				(0.006)	(0.006)	(0.006)
7-9 years pre				-0.035***	-0.036***	-0.036***
				(0.008)	(0.008)	(0.008)
10+ years pre				-0.058***	-0.060***	-0.059***
				(0.012)	(0.012)	(0.012)
Observations	1,902,662	1,902,662	1,902,662	1,902,662	1,902,662	1,902,662
R-squared	0.025	0.431	0.444	0.444	0.444	0.444
Panel B: ELA	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Charter w/n 1 mile	-0.186***	-0.038***	0.008**	0.015***	0.036***	0.060***
	(0.010)	(0.004)	(0.004)	(0.005)	(0.008)	(0.011)
Dist. to charter					-0.041***	-0.166***
					(0.012)	(0.047)
Dist. to charter sq.						0.124***
						(0.045)
3 years pre charter				0.010	0.010	0.010
				(0.006)	(0.006)	(0.006)
4-6 years pre				0.014***	0.014***	0.014***
				(0.005)	(0.005)	(0.005)
7-9 years pre				0.012*	0.011	0.011*
				(0.007)	(0.007)	(0.007)
10+ years pre				0.001	-0.000	0.000
				(0.009)	(0.009)	(0.009)
Student Char.	N	Y	Y	Y	Y	Y
Lagged test scores	N	Y	Y	Y	Y	Y
School Effects	N	N	Y	Y	Y	Y
Observations	1,823,691	1,823,691	1,823,691	1,823,691	1,823,691	1,823,691
R-squared	0.027	0.386	0.401	0.401	0.401	0.401

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

Notes: Charter equals 1 in any year there is a charter school located within one mile of a student's TPS. Distance to charter is the Euclidian distance (in miles) between the student's TPS and the nearest charter within 1 mile. A negative coefficient indicates that the effect of charters increases with proximity. All models control for borough, grade, and year. Models in columns 2-6 control for race, gender, free/reduced price lunch, special education, LEP, nativity, recent immigrant status, and lagged test scores. Standard errors are clustered at the school-year level.

Education Finance and Policy Just Accepted MS.
doi:10.1162/EDFP_a_00240

Table 3: Effects of Charter Schools on test scores by proximity with pre-trends, AY 1997-2010, students in Grades 3-5

	Math		ELA		Attendance		Retention	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Charter								
Co-located	0.083**	0.082**	0.059*	0.057*	0.268***	0.279***	-0.011***	-0.012***
	(0.035)	(0.035)	(0.032)	(0.032)	(0.067)	(0.072)	(0.004)	(0.004)
½ mile	0.021***	0.021***	0.020***	0.018***	0.051	0.059	-0.009***	-0.010***
	(0.006)	(0.007)	(0.006)	(0.006)	(0.044)	(0.049)	(0.001)	(0.001)
1 mile	0.008	0.007	0.009	0.007	0.134**	0.143**	-0.005***	-0.006***
	(0.006)	(0.006)	(0.005)	(0.006)	(0.054)	(0.060)	(0.001)	(0.001)
1 ½ mile		-0.007		-0.009		0.042		-0.002*
		(0.008)		(0.007)		(0.052)		(0.001)
2 miles		0.007		0.000		0.032		-0.004***
		(0.008)		(0.008)		(0.053)		(0.001)
2 ½ miles		0.003		-0.013		-0.046		-0.002
		(0.013)		(0.013)		(0.063)		(0.002)
3 miles		-0.007		0.007		-0.013		-0.004
		(0.014)		(0.014)		(0.054)		(0.002)
Observations	1,902,662	1,902,662	1,823,691	1,823,691	1,307,052	1,307,052	1,962,504	1,962,504
R-squared	0.444	0.444	0.401	0.401	0.993	0.993	0.214	0.214

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

Notes: All distance indicators are mutually exclusive. Co-located charter equals 1 for a student in all years that a charter school is open in the same building as the first school he is observed attending. Charter within ½ mile equals 1 for a student in all years that the closest charter school is located more than 0 but less than ½ mile from the TPS he was first observed attending. Charter within 1 mile equals 1 for a student in all years that the closest charter school is located more than ½ but less than 1 mile from the TPS he was first observed attending. All other indicators are measured analogously. All models contain individual-level controls for race, gender, free and reduced price lunch eligibility, special education, LEP, nativity, recent immigrant, lagged test scores, residence borough, grade, year, school effects, and controls 3, 4-6, 7-9, and 10 or more years prior to charter school entry (1-2 years prior is the omitted category). Standard errors are clustered at the school-year level.

Education Finance and Policy Just Accepted MS.
doi:10.1162/EDFP_a_00240

Table 4: Effects of Charter Schools on test scores by proximity and charter school quality, with pre-trends, AY 1997-2010, students in Grades 3-5

	High Performing		Well Known CMO	
	Math	ELA	Math	ELA
	(1)	(2)	(3)	(4)
Charter				
Co-located	0.099**	0.076**	0.081*	0.056
	(0.038)	(0.034)	(0.049)	(0.045)
Co-located*High perf.	-0.102	-0.109	0.007	0.011
	(0.085)	(0.103)	(0.057)	(0.054)
Within ½ mile	0.022***	0.018***	0.019***	0.014**
	(0.006)	(0.006)	(0.007)	(0.006)
Within ½ mile*High perf.	-0.007	0.017*	0.016	0.041***
	(0.011)	(0.010)	(0.013)	(0.011)
Within 1 mile	0.008	0.008	0.008	0.010*
	(0.006)	(0.006)	(0.006)	(0.006)
Within 1 mile*High perf.	0.001	0.005	0.001	-0.009
	(0.011)	(0.010)	(0.015)	(0.014)
Observations	1,902,662	1,823,691	1,902,662	1,823,691
R-squared	0.444	0.401	0.444	0.401

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

Notes: All distance indicators are mutually exclusive. Co-located charter equals 1 for a student in all years that a charter school is open in the same building as the first school he is observed attending. Charter within ½ mile equals 1 for a student in all years that the closest charter school is located more than 0 but less than ½ mile from the TPS he was first observed attending. Charter within 1 mile equals 1 for a student in all years that the closest charter school is located more than ½ but less than 1 mile from the TPS he was first observed attending. High performing charters are defined as those schools where average proficiency in ELA and math is above the 75th percentile for the city in the previous year. Well-known/respected CMOs are defined as those CMOs with a reputation for improving student performance, such as Success, KIPP, Uncommon, etc. All models contain individual-level controls for race, gender, free and reduced price lunch eligibility, special education, LEP, nativity, recent immigrant, lagged test scores, residence borough, grade, year, school effects, and controls 3, 4-6, 7-9, and 10 or more years prior to charter school entry (1-2 years prior is the omitted category).Standard errors are clustered at the school-year level.

Education Finance and Policy Just Accepted MS.
doi:10.1162/EDFP_a_00240

Table 5. Subgroup Analyses, Effects of Charter Schools on math scores, any charter within 1 mile with pre-trends, AY 1997-2010

					Poor		Spec. Ed.		LEP	
	Black	Hispanic	White	Asian	Ever	Never	Ever	Never	Ever	Never
	(1)	(2)	(3)	(4)	(5)	(6)	(7)		(8)	
Charter										
Co-located	0.118***	0.017	0.449**	0.035	0.073**	0.000	0.079**	0.072**	-0.005	0.087**
	(0.040)	(0.038)	(0.178)	(0.116)	(0.034)	(0.073)	(0.040)	(0.036)	(0.040)	(0.038)
Within ½ mile	0.034***	0.001	0.011	-0.051***	0.013**	0.049**	0.025**	0.018***	-0.004	0.020***
	(0.008)	(0.008)	(0.024)	(0.018)	(0.006)	(0.019)	(0.010)	(0.006)	(0.015)	(0.006)
Within 1 mile	0.013*	0.001	0.019	-0.015	0.002	0.020	0.003	0.007	0.002	0.007
	(0.008)	(0.008)	(0.021)	(0.013)	(0.006)	(0.018)	(0.009)	(0.006)	(0.013)	(0.006)
Observations	812,426	753,192	166,969	163,698	1,720,455	182,207	233,280	1,669,382	194,441	1,708,221
R-squared	0.379	0.395	0.437	0.409	0.415	0.462	0.349	0.440	0.291	0.439

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

Notes: All distance indicators are mutually exclusive. Co-located charter equals 1 for a student in all years that a charter school is open in the same building as the first school he is observed attending. Charter within ½ mile equals 1 for a student in all years that the closest charter school is located more than 0 but less than ½ mile from the TPS he was first observed attending. Charter within 1 mile equals 1 for a student in all years that the closest charter school is located more than ½ but less than 1 mile from the TPS he was first observed attending. All models contain individual-level controls for gender, recent immigrant, lagged test scores, residence borough, grade, year, school effects, controls for 3, 4-6, and 7-9 years prior to charter entry (10-14 years is the omitted category), and where appropriate, controls for race, free and reduced price lunch eligibility, special education status, and LEP. Standard errors are clustered at the school-year level.

Education Finance and Policy Just Accepted MS.
doi:10.1162/EDFP_a_00240

Table 6. Robustness Checks, Effects of Charter Schools on test scores, any charter within 1 mile with pre-trends, AY 1997-2010

	Math				ELA				
	Main results	Cont. enrolled	All schools	Co-located Pub. School	Main results	Cont. enrolled	All schools	Co-located Pub. School	Exit from DOE
	(1)	(2)	(3)		(5)	(6)	(7)	(8)	
Charter									
Co-located	0.083**	0.086**	0.082**	0.083**	0.059*	0.063**	0.062*	0.058*	0.002
	(0.035)	(0.036)	(0.035)	(0.035)	(0.032)	(0.032)	(0.032)	(0.032)	(0.005)
Within ½ mile	0.021***	0.021***	0.019***	0.021***	0.020***	0.020***	0.021***	0.020***	0.003***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.001)
Within 1 mile	0.008	0.009	0.006	0.008	0.009	0.010*	0.010*	0.009	0.002**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)	(0.005)	(0.005)	(0.001)
Co-located w/ TPS				0.008				0.021	
				(0.017)				(0.025)	
Observations	1,902,662	1,837,930	2,569,674	1,902,662	1,823,691	1,762,507	2,449,218	1,823,691	1,957,632
R-squared	0.444	0.446	0.469	0.444	0.401	0.404	0.418	0.401	0.034

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

Notes: All distance indicators are mutually exclusive. Co-located charter equals 1 for a student in all years that a charter school is open in the same building as the first school he is observed attending. Charter within ½ mile equals 1 for a student in all years that the closest charter school is located more than 0 but less than ½ mile from the TPS he was first observed attending. Charter within 1 mile equals 1 for a student in all years that the closest charter school is located more than ½ but less than 1 mile from the TPS he was first observed attending. Co-located with TPS equals 1 for a student in all years that another TPS is located in the same building as the TPS he was first observed attending. All models contain individual-level controls for race, gender, free and reduced price lunch eligibility, special education, LEP, recent immigrant, lagged test scores, residence borough, grade, year, school effects, and controls for three, 4-6, and 7-9 years prior to charter opening (1-2 years prior is the omitted category). Continuously enrolled includes only those students who are enrolled in a NYC TPS for every year between grades 3 and 5. All schools includes students in grades 3-5 in all NYC TPSs, including those located in a CSD where a charter school never opens during the sample period. Standard errors are clustered at the school-year level.

Education Finance and Policy Just Accepted MS.
doi:10.1162/EDFP_a_00240

Table 7: Relationship between charter school entry and TPS characteristics, any charter within 1 mile with pre-trends, AY 1997-2010

Charter within Dependent variable:	Co-located	Adj. p	½ mi.	Adj. p	1 mile	Adj. p
School Demographics						
Enrollment	-22.904	1.000	-15.054	0.464	-18.533**	0.020
General Education	-11.397	0.000	-12.133	0.000	-16.580**	0.033
Special Education	-11.505***	0.001	-2.922	0.502	-1.953	1.000
Grades 3-5	-30.041*	0.082	-13.354*	0.076	-9.454	1.000
Percent						
Black	-1.571	1.000	-0.774	1.000	-0.349	1.000
Hispanic	2.794	0.364	0.951	0.489	0.336	1.000
Asian	-0.975***	0.006	-0.824***	0.006	-0.397	0.445
White	-0.110	1.000	0.712**	0.029	0.455	1.000
Free lunch	-0.517	1.000	-6.402***	0.001	-3.733	0.333
Red. Price lunch	0.646	1.000	0.532	1.000	-0.297	1.000
SPED	1.108	1.000	0.511	0.708	0.111	1.000
Non-English at home	1.995	1.000	0.149	1.000	0.125	1.000
LEP	0.023	1.000	0.324	1.000	0.157	1.000
Recent immigrant	-0.101	1.000	0.408	0.491	0.075	1.000
School Resources						
Log PPE	0.073	0.330	0.039***	0.000	0.018	0.144
Direct	0.080	0.341	0.043***	0.000	0.020	0.131
Instruction	0.089***	0.002	0.044***	0.000	0.020*	0.074
Classroom teach	0.050	0.569	0.034***	0.000	0.014	1.000
Other staff	0.353***	0.003	0.083	1.000	0.056	1.000
Contract instruction	0.284	1.000	0.174	0.543	0.062	1.000
Instructional	0.033	1.000	0.055	0.136	0.046*	0.077
Support						
Leadership	0.111	1.000	0.051**	0.011	0.014	1.000
Pupil-teacher ratio	-0.604	1.000	-0.332	1.000	-0.362	1.000
Percent						
Teachers w/ master's	-2.196	1.000	0.763	1.000	1.075	1.000
Teachers w/ >2 yrs. in school	0.689	1.000	1.321	1.000	0.886	1.000
Number of observations	6,611					

*** p<0.01, ** p<0.05, * p<0.1

Notes: All distance indicators are mutually exclusive. Co-located charter equals for TPSs in all years that a charter school is operating in the same building. Charter within ½ mile equals 1 for TPSs in all years that the closest charter school is located more than 0 but less than ½ mile from the TPS. Charter within 1 mile equals 1 for TPSs in all years that the closest charter school is located more than ½ but less than 1 mile from the TPS. Each row reports results from a separate school level regression with controls for 3, 4-6, and 7-9 years prior to charter opening (1-2 years prior is the omitted category), year effects, and school effects. Standard errors are clustered at the school level. Adjusted p-values are p-values corrected for multiple hypothesis testing using the Bonferroni correction.

Education Finance and Policy Just Accepted MS.
doi:10.1162/EDFP_a_00240

Table 8: Relationship between charter school entry and parents' perceptions of TPS, any charter within 1 mile with pre-trends, AY 2007-2010

	Academic Expectations	Communication	Parent Engagement	Student Engagement	Respect and Cleanliness	School Unsafe
	(1)	(2)	(3)	(4)	(5)	(6)
Charter						
Within 1 mile	0.031	0.078	0.026	0.117*	-0.007	-0.050*
	(0.041)	(0.075)	(0.035)	(0.069)	(0.032)	(0.030)
Within ½ mile	0.019	0.054	0.007	0.098*	-0.017	-0.013
	(0.022)	(0.044)	(0.018)	(0.051)	(0.016)	(0.012)
Co-located	-0.024	-0.040	-0.038**	0.013	-0.020	0.009
	(0.021)	(0.040)	(0.018)	(0.052)	(0.013)	(0.009)
Observations	2,019	2,019	2,019	2,019	2,019	2,019
R-squared	0.825	0.823	0.840	0.896	0.991	0.816

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

Notes: All distance indicators are mutually exclusive. Co-located charter equals for TPSs in all years that a charter school is operating in the same building. Charter within ½ mile equals 1 for TPSs in all years that the closest charter school is located more than 0 but less than ½ mile from the TPS. Charter within 1 mile equals 1 for TPSs in all years that the closest charter school is located more than ½ but less than 1 mile from the TPS. Models also contain controls for percent black, percent Hispanic, percent Asian/other, percent free lunch eligible, percent reduced price lunch eligible, percent of LEP students, percent of recent immigrant students, percent special education, total school enrollment, year effects, and school effects Sample includes only those schools with at least a 10 percent response rate to the parent survey in all four years. Analyses are weighted by response rate.

Education Finance and Policy Just Accepted MS.
doi:10.1162/EDFP_a_00240

Appendix

Table A.1. Subgroup Analyses, Effects of Charter Schools on ELA scores, any charter within 1 mile with pre-trends, AY 1997-2010

					Poor		Spec. Ed.		LEP	
	Black	Hispanic	White	Asian	Ever	Never	Ever	Never	Ever	Never
	(1)	(2)	(3)	(4)	(5)	(6)	(7)		(8)	
Charter										
Co-located	0.097***	0.011	0.142	0.033	0.049	0.003	0.073*	0.042	0.043	0.045
	(0.037)	(0.040)	(0.112)	(0.083)	(0.031)	(0.112)	(0.038)	(0.033)	(0.054)	(0.031)
½ mile	0.040***	0.016**	-0.021	-0.054***	0.017***	0.008	0.015	0.018***	-0.008	0.018***
	(0.007)	(0.007)	(0.025)	(0.017)	(0.006)	(0.019)	(0.010)	(0.006)	(0.016)	(0.006)
1 mile	0.017**	0.012*	-0.002	-0.010	0.005	0.016	0.011	0.007	-0.004	0.009
	(0.007)	(0.007)	(0.022)	(0.013)	(0.005)	(0.018)	(0.010)	(0.006)	(0.013)	(0.005)
Observations	808,144	689,144	164,378	155,736	1,643,460	180,231	224,955	1,598,736	119,103	1,704,588
R-squared	0.338	0.361	0.405	0.384	0.369	0.409	0.301	0.392	0.242	0.389

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

Notes: All distance indicators are mutually exclusive. Co-located charter equals 1 for a student in all years that a charter school is open in the same building as the first school he is observed attending. Charter within ½ mile equals 1 for a student in all years that the closest charter school is located more than 0 but less than ½ mile from the TPS he was first observed attending. Charter within 1 mile equals 1 for a student in all years that the closest charter school is located more than ½ but less than 1 mile from the TPS he was first observed attending. All models contain individual-level controls for gender, recent immigrant, lagged test scores, residence borough, grade, year, school effects, controls 3, 4-6, and 7-9 years prior to charter opening (1-2 years prior is the omitted category), and where appropriate, controls for race, free and reduced price lunch eligibility, special education status, and LEP. Standard errors are clustered at the school-year level.

Education Finance and Policy Just Accepted MS.
doi:10.1162/EDFP_a_00240

Table A.2: Relationship between charter school entry and teachers' perceptions of TPS, any charter within 1 mile with pre-trends, AY 2007-2010

	Academic Expectations	Communication	Teacher Engagement	Respect and Cleanliness	School Unsafe
	(1)	(2)	(4)	(5)	(6)
Charter					
Co-located	0.509**	0.305	0.268	0.355**	0.107
	(0.232)	(0.191)	(0.204)	(0.181)	(0.142)
½ mile	0.089	0.028	0.100	0.127	0.121*
	(0.114)	(0.094)	(0.100)	(0.089)	(0.070)
1 mile	-0.008	-0.004	-0.032	0.068	-0.010
	(0.099)	(0.082)	(0.087)	(0.077)	(0.061)
Observations	2,011	2,011	2,011	2,011	2,011
R-squared	0.741	0.745	0.760	0.767	0.943

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

Notes: All distance measures are mutually exclusive. Co-located charter equals 1 for TPSs in all years that a charter school is operating in the same building. Charter within ½ mile equals 1 for TPSs in all years that the closest charter school is located more than 0 but less than ½ mile from the TPS. Charter within 1 mile equals 1 for TPSs in all years that the closest charter school is located more than ½ but less than 1 mile from the TPS. Models also contain controls for percent black, percent Hispanic, percent Asian/other, percent free lunch eligible, percent reduced price lunch eligible, percent on students who speak a language other than English at home, percent of LEP students, percent of recent immigrant students, percent special education, total school enrollment, year effects, and school effects. Sample includes only those schools with at least a 15 percent response rate to the teacher survey in all four years. Standard errors are clustered by school. All regressions are weighted by response rate