DRAFT: DO NOT QUOTE OR CITE WITHOUT PERMISSION

Do School Buses Make School Choice Work?

by

Amy Ellen Schwartz
Syracuse University

Samantha Trajkovski
Syracuse University

and

Jeffrey Zabel
Tufts University

March 31, 2019

Abstract

While school choice has been well studied, there is little literature on the role that transportation, namely school buses, plays in this decision. This study examines the effect of school buses on school choice decisions, using data on students and their eligibility for transportation assistance in New York City public schools in 2017. Using both conditional logit school choice models and regression discontinuity designs, we provide both descriptive and causal evidence on the impact of distance and bus availability, and how these two interact with one another, on school choice decisions. Our results indicate that distance deters students from choosing a school, as families are less likely to choose schools further from home, but school buses can partially overcome this impediment, particularly for charter schools in 3rd grade. These results will be useful for policy makers looking to leverage school transportation policy to improve school choice decisions, and ultimately student outcomes.

This research was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305A170270 awarded to Syracuse University (Schwartz) and Grant R305C100025 awarded to the Administrators of the Tulane Educational Fund. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.

We would like to thank the NYCDOE and the Office of Pupil Transportation for data access and their continued support for this project, Meryle Weinstein, Sarah Cordes, and Joanna Rae Bailey

for their wisdom and support, as well as seminar and conference participants at Tufts University, Syracuse University, AEFP, APPAM and UEA for useful comments and suggestions.

1. Introduction

While the growth in public school choice has reduced reliance on residential attendance zones to assign students to schools and increased the ability of students to attend a school other than their own zoned school, the "promise" of school choice to improve academic outcomes has, to some extent, remained elusive. A dismaying number of families enroll their children in a low-performing zoned school, even when higher performing alternatives – charter or district choice schools – are available. One oft-cited potential explanation is that *distance matters* – that is, the difficulty (or disutility) of commuting to a school farther away than the local zoned school outweighs the potential benefits of a better school – in which case, *improving transportation* (say, extending school bus services) is a potential solution and a crucial policy lever to making school choice deliver on its promise. Despite the intuitive appeal of both the explanation and the solution– and the persuasive anecdotal evidence supporting this view – there is little rigorous research examining the link between school choice, distance to school and pupil transportation.

This paper begins to close this gap using a unique comprehensive dataset on public school students, their school, residential location, and eligibility for pupil transportation in the New York City public school district for 2017. These data allow us to construct student school choice sets. Data on student school choice sets include individual- and school-level information and distances to each school in their choice set. We document the characteristics and variation in the observed choice sets for students in grades K and 3.

We then estimate a conditional logit school choice model that includes variables capturing both distance and eligibility for pupil transportation – that is, school buses. While this approach is well-grounded in the standard choice theoretical framework and offers an excellent description of actual school choice behavior, it does not necessarily provide a compelling

identification strategy for isolating the causal effects of school bus eligibility on the choice of school, beyond the potential for a rich set of control variables to minimize bias. To provide casual estimates of the impact of bus eligibility on school choice we use a regression discontinuity (RD) analysis based on the bus-eligibility distance cutoff.

We find that distance does significantly deter choice, but eligibility for a school bus can partially overcome this impediment, particularly for charter schools. Based on the conditional logit results, we find that the availability of a bus in 3rd grade for charter schools reduces the negative impact of living more than 1 mile from school between 20 and 33%. Based on the RD results, we find that bus eligibility in zoned schools is equivalent to reducing distance to school by around half a mile. This is quite large given that the average distance to school for kindergartners is 0.55 miles. For charter schools, we find that bus eligibility is equivalent to reducing distance to school 0.24 and 0.33 miles for kindergarten and 3rd grade, respectively. These results shed light on how distance matters and how school buses can help families exercise choice to access better schools for their children.

The remainder of this paper is organized as follows. We begin with a brief review of the literature focused on school choice and transportation, followed by Section 3, which describes school choice and transportation in New York City. Section 4 describes the data set construction and description, and we present empirical models in Section 5. Results are given in Section 6, followed by conclusions in Section 7.

2. Literature Review

The economic literature on school choice has simmered since Milton Friedman championed school vouchers – and the weakening of the "monopoly" of local public schools – as

a way to improve both equity and efficiency in education.[1] Much of the literature has focused on the impact of choice on student academic outcomes (see for example, Rouse (1998), Witte (1998), and Witte et al. (2014) on vouchers; Hastings et al., (2012), Cullen et al., (2005), on the impacts of the broader array of public alternatives to traditional zoned schools including charter schools, magnet schools, alternative schools, specialized schools).

A small, but growing literature focuses on school choice itself, on understanding why students (or families) choose one school among other, available choices. Many of these studies focus on the role of school quality and find students and their families have strong preferences for high performing schools, often stating quality as a reason for exercising school choice (Ruijs and Oosterbeek, 2019; Urban Institute, 2017; Burgess et al., 2015; Hastings et al., 2009; Black, 1999). Distance also appears to be an important factor in school choice decisions, as other work finds proximity to home a highly valued characteristic (Edwards, 2019; Ruijs and Oosterbeek, 2019; Lincove et al., 2018; Burgess et al., 2015; Hastings et al., 2005; Glazerman, 1998). This preference for schools close to home appears for students in all grades and all school types. At the same time, a growing body of research suggests families may be willing to travel to access higher quality schools. For example, in Washington DC, Glazerman and Dotter (2017) find families are willing to travel an additional 1.2 miles to attend a school that has a 10-point higher proficiency rate on state standardized tests. Outside the US, in Mexico, a mass transit expansion raised the demand for more elite and more distant schools for high income students (Dustan and Ngo, 2018).

In contrast, there is limited evidence describing the link between transportation, school choice, and student outcomes. Cordes and Schwartz (2018) examine the relationship between

[1] "The Role of Government in Education," Milton Friedman. From *Economics and the Public Interest,* ed. Robert A. Solo, 1955

transportation and school choice for elementary school students in New York City. They find bus riders are more likely to attend a choice school (rather than their zoned school). Furthermore, among students who attend choice schools, those taking the bus attend significantly better schools than those who commute on foot or rely upon another form of transportation, such as a family car. Additionally, two recent papers find that bus riders have lower rates of absenteeism than their peers that do not ride the bus. Gottfried (2017) finds that kindergartners taking the bus are absent about 0.4 fewer days per year, a statistically significant difference that may have small, but potentially meaningful effects on academic outcomes. Cordes et al. (2019) use New York City student-level administrative data on bus ridership and absenteeism to examine the link between bus riding and attendance rates. They find that bus riders are absent about one fewer day per year than peers that do not ride the bus, and that much of the absenteeism gap for bus riders is driven by differences between, rather than within, schools. They also find that the absenteeism gap for Black (1.8 fewer days absent) and Hispanic (1.4 days) bus riders is three to four times larger than for Asian (0.4 days) students and 20 to 25 times larger than for White (0.1 days) students.

The paper most closely related to our work is Edwards (2019), which examines factors that influence school choice decisions in Detroit. Edwards constructs a choice set of possible schools within the school districts serving Detroit students for grades K, 6 and 9, and explores how distance and school characteristics, especially those related to school quality, affect school choice decisions. Results indicate that students/families are more likely to choose schools closer to home and more likely to choose neighborhood schools over charter or choice schools. This result, combined with the fact that many of the highest quality schools serving Detroit are located outside of the city (Cowen et al., 2018), may suggest these families do not have access to the

high-quality schools even if they do prefer them. Our study improves on this framework by including transportation availability, along with distance from home to school. This enables us to shed light on how access to schools via transportation affects school choice decisions.

Lastly, this paper contributes to the growing literature in urban economics of the impact of transportation on various outcomes. Numerous studies find access to public transit improves job accessibility and employment (Fingleton and Szumilo, 2019; Mayer and Trevien, 2017; Boisjoly et al., 2017; Rotger and Nielsen, 2015; Holzer et al., 2003). There is mixed evidence on the effect of public transportation on land and housing values; some work finds access to new transit systems increases land and housing values (Billings, 2011; Kahn, 2007; Gibbons and Machin, 2008), while others find census tracts with greater access to public transit are more likely to be poor (Pathak et al., 2017; Glaeser et al., 2008). Additionally, public transit has been linked to reduced traffic congestion and accidents (Litchman-Sadot, 2019; Anderson, 2014) and has affected local crime (Phillips and Sandler, 2015; Billings et al., 2011). Lastly, and more important to our context, public transit effects school choice outcomes; the introduction of new subway lines or trains increases the likelihood students attend schools further from home (Dustan and Ngo, 2018; Herskovic, 2017). While all the previously discussed literature exploits expansions in public transportation, our work provides valuable insights into the important first step in understanding how extending transportation – and school buses, in particular - can shape school choice outcomes.

3. School Choice and Transportation in New York City

With over 1.1 million students, the New York City Department of Education (NYCDOE) oversees the nation's largest school district and its Office of Pupil Transportation (OPT) oversees

the largest pupil transportation operation in the country, including 9,500 school buses serving more than 100,000 students in more than 1,500 schools. This includes very dense urban areas such as in Manhattan and much lower-density neighborhoods dominated by single-family homes on Staten Island and portions of Brooklyn, Queens, and the Bronx.

3.1 Pupil Transportation in New York City

School transportation operations and policies are set by OPT. This includes determining eligibility for available services, contracting with vendors, developing and setting school bus routes and managing and oversight of subsidized MetroCards for students to use on public transit. Eligibility for transportation assistance depends upon the distance a student lives from school and the student's grade. As shown in Table 1, students in grades K-2 who live within a half mile from school are eligible for a half-fare MetroCard, which allows them to ride public buses with parents at a reduced price. Students living further than a half mile from school are eligible for either a full-fare MetroCard, which allows them up to three free rides daily on public buses or subways, or a school bus (if the school offers a bus). The distance threshold for transportation eligibility increases in third grade. For students in grades 3 through 6 (8 in Staten Island), students living within a half mile of school are not eligible for transportation assistance, those living between one-half and one mile away are eligible for a half-fare MetroCard, and those living more than a mile from school are eligible for a full-fare MetroCard or a school bus.[2]

Importantly, school administrators have considerable discretion over school bus services. In fact, school principals decide whether to offer school bus service at their own school. In 2015, only 57 percent of elementary and middle school principals chose to provide buses to their eligible students. That is, students who might be considered eligible for school bus service based

[2] Students may also be eligible for bus service based upon other criteria including disability, hazards, residence in temporary housing (following McKinney Vento). Bus service for special education students differs in eligibility rules and in services provided and is often "door to door" rather than from a bus stop.

upon the distance between home and school may not, in fact, be offered a school bus because their school does not provide school buses. "Distance eligible" students who do not take the school bus are issued a MetroCard allowing them free service on public transportation (city buses and subways) between home and school.

Following OPT guidelines, principals may suggest the locations of bus stops. These guidelines are: (1) bus routes may not exceed five miles (as driven through the streets); (2) there must be eleven eligible students at the time of creation to establish a route; and (3) charter school bus routes cannot cross borough boundaries and traditional public school routes cannot cross community school district boundaries. OPT then verifies distance eligibility and finalizes the location of bus stops.

3.2 School Choice in New York City

NYCDOE allows a considerable amount of elementary school choice. In some areas, open enrollment is a formal policy.[3] In others, each student is assigned a zoned school based upon their residential location, but an array of formal and informal policies and practices allow students to attend a different school. NYCDOE offers an extensive array of gifted and talented programs, magnet schools, charter schools and dual-language programs (among others) that do not rely on catchment areas, although there may be location based preferences.[4] In our study period, one of the sub-city districts (Community School Districts or CSD) eliminated attendance zones entirely, moving to CSD-wide open enrollment. Furthermore, families may seek a waiver from the principal of another zoned school to allow their child to attend because it is closer to a

[3] New York City divides elementary schools into 32 geographic community school districts, each with its own superintendent and some autonomy in setting educational policies. Three of these community school districts are designated as choice districts, allowing resident children to attend any school in that community school district.
[4] In addition, when students make a residential move to a different school zone, they can choose not to change schools. See "Your Options," InsideSchools, accessed September 6, 2018, https://insideschools.org/elementary/your-options.

parents' place of employment or after-school family care. We will refer to three types of schools; *zoned, charter* and *district choice,* where the latter includes all other traditional public schools (including magnet or specialty schools) as well as zoned schools in attendance zones other than the one where the student resides. Both zoned and district choice schools are financed and governed as traditional public schools. More than 40 percent of K-5 students attend a school other than their zoned school.

Since New York City's first charter school opened in 1999, the number has risen steadily and now serves roughly ten percent of public-school students (Sattin-Bajaj, 2018). Many of the charter schools were designed and located with an eye toward improving access to good quality schools in low-income areas and, as a result, they are disproportionately located in relatively low-income areas. Oversubscribed charter schools use lotteries to allocate admissions offers. Furthermore, charter schools in NYC typically give preference to students living in the same CSD as the charter school. Even in the event of oversubscription, charters still give priority to students living in the CSD of the charter school. (See Cordes and Laurito, 2019 for more on charter schools and school choice in NYC elementary and middle schools.)

4. Data Set Construction & Description

4.1 Data

We use rich longitudinal student-level administrative data from NYCDOE. This data has information on all NYC public elementary and middle school students, including sociodemographic characteristics such as gender, race/ethnicity, eligibility for free or reduced-price meals, limited English proficiency, participation in special education, residential location, and attendance rate. We merge this with administrative pupil transportation data from OPT on individual bus assignment for the universe of public-school students. Transportation variables

include a student's transportation assignment (bus or MetroCard), and a set of categorical variables capturing distance from home to school in the half mile distance categories in which OPT uses to determine transportation assistance eligibility. We use this data to define a key school-level variable in this study – bus availability. *Bus* is an indicator variable that takes a value of one if a school has 5 or more students assigned a bus by OPT.[5]

We match the student-level data to publicly available school-level data in the School Report Card (SRC) data from the New York State Education Department. The SRC contains school-level information such as the gender and racial/ethnic composition of students, total enrollment, and teacher characteristics, including years of experience and teacher education levels. It also includes school-level measures of academic performance, including English Language Arts (ELA) and math proficiency rates on NYS standardized tests; we use the average of these two in order to capture school performance and, ultimately, to distinguish high performing schools. Specifically, we define *high-performing* schools for our kindergarten analyses as those with average proficiency at or above the 75th percentile among NYC schools serving kindergarten, while *low-performing* schools are in the bottom 25th percentile of academic performance. We define high- and low-performing schools for our 3rd grade analyses similarly.

Lastly, we match a student's residential location (latitude and longitude, census tract, and borough) to the location of schools in their choice set, using school addresses (latitude and longitude) from the Common Core of data.[6] We then calculate the distance between student

[5] There must be at least one of these five students that does not have a transportation exception, under which OPT provides transportation services to distance ineligible students due to special circumstances, including medical conditions, hazardous travel conditions (such as unsafe traffic), emergency conditions, temporary housing, or special education.

[6] The Common Core is the National Center for Education Statistics' (NCES) comprehensive database on public elementary and secondary schools in the US, providing annual, descriptive data on staff and students at the school, school district, and state level. Data can be found at https://nces.ed.gov/ccd/

residence and each schooling option using *Open Source Routing Machine* (OSRM).[7] In addition to this continuous distance measure, we create four categorical variables capturing distance from residence to school, following the categories used to determine eligibility: *Distance_<0.5* = 1 for distance < 0.5 miles, *Distance_0.5to1* = 1 for distance 0.5 – 1 mile, *Distance_1to1.5* = 1 for distance 1 mile – 1.5 miles, and *Distance_>1.5* = 1 for distances greater than 1.5 miles.

4.2 Sample

Our analyses focus on two cohorts of students: 1) students in kindergarten, since this is typically the first year a student is enrolled in public school and so this is the first school choice made for these students, and 2) students in 3rd grade, since bus eligibility criteria change between grades 2 and 3, although they are consistent in grades K through 2. Table 2 presents descriptive statistics for student-level variables beginning with the sample of all students in kindergarten and 3rd grade cohorts in 2017. As shown, over half of NYC public school students are poor, with roughly 70 percent eligible for free or reduced-price lunch. These students are also predominately minority – Hispanics represent 40 percent, followed by 25 percent Black. Lastly, approximately 20 percent of students have limited English proficiency and 13 percent are students with disabilities.

We make several restrictions to create our analytic sample. First, we, exclude students in full time special education schools and ungraded special education classes because the school choice process, eligibility for and provisions of transportation differs significantly, often including door to door individualized service. Second, we exclude students in the CSD with open enrollment, described earlier, and those living in attendance zones where students can only

[7] OSRM uses geographic data on latitude and longitude to determine travel time and distance between two coordinate pairs using a user-imported map of NYC from *OpenStreetMaps*. We calculate the fastest walking route for each school in the student's choice set, which is also the shortest walking route (OSRM assumes a constant walking speed of 3 MPH).

go to their zoned school. Third, we exclude a small number of students who are missing data on zoned elementary school, zoned to multiple schools, attend a new school (due to missing school-level data) or attend a school serving no other students in their attendance zone.[8] Finally, we exclude a small number of students who live more than a mile away from their zoned school.[9] Our final sample consists of 58,450 kindergarten students and 60,256 third grade students.

As shown in Table 2, our sample is very similar to all NYC public school students in kindergarten and 3rd grade. Roughly 70 percent of students in our sample are eligible for free- or reduced-price lunch. Students are disproportionately Hispanic, at 38 percent, 22 percent of students are black, 18 percent are Asian, and 18 percent are white. Roughly 20 percent of students have limited English proficiency or a disability. Almost three quarters of students in our sample attend their zoned elementary school, while only one tenth attend a charter school. The remainder of students – approximately 17 percent –attend a choice school within their district.

Table 2 also provides student summary statistics by the type of school attended. To begin, there are significant differences between the students attending charter, district choice and zoned schools. Indeed, the composition of charter school students looks very different from zoned/district choice schools - charter schools enroll a higher percentage of black students, slightly greater percentage of low-income students (free- or reduced-price lunch), and a lower percentage of limited English proficient students. There is also variation in school performance across the three school types. Students attending charter schools have higher scoring peers – the average performance in a charter school is 0.45 (0.48 for 3rd grade), meaning 45 percent of the

[8] To some extent, these reflect individual idiosyncratic circumstances, such as residential mobility, location of parental employment, or placement in temporary housing, that are unlikely to be relevant to the larger groups. From a practical standpoint, this significantly reduces the number of schools in a choice set which facilitates the estimation of the conditional logit model.

[9] Note that there are very few students who live more than 1 mile from their zone school (1,331 students in kindergarten and 1,331 students in 3rd grade).

students scored proficient in ELA and math on NYS tests, which is higher than the average performance for zoned and district choice schools. As shown in Table 2, the average kindergarten student attending a zoned school lives 0.35 miles from school while the average distance to a charter or district choice school is more than a mile. Thus, students attending choice or charter schools travel further than students attending zoned schools.

As shown in the bottom half of Table 2, most third grade students attend school close to home. More than two thirds (0.68) of third graders attend school within a half mile of their residence. Roughly one in five (0.22) travel one half to one mile from home, and less than 10 percent of students attend schools further than a mile from their residence. Figures 1A and 1B graphically depict the distribution of distances to the schools students chose to attend.[10]

Table 3 presents descriptive statistics for the schools in our sample, by charter school status and grade. As suggested by the student characteristics in Table 2, the characteristics of the student body in charter schools is somewhat different than that of traditional public schools. Charters have a higher representation of black students (56 percent), while traditional public schools have higher percentages of Hispanic and white students (41 and 17 percent respectively). Traditional public schools also have higher proportions of limited English proficiency students and students with disabilities, potentially suggesting charters may not always be able to provide services necessary to accommodate these students. The composition of teachers also differs between the two options, charters have a higher percentage of inexperienced teachers and traditional public schools have a higher representation of teachers with higher levels of education. Last, and of most interest to our context, is the availability of the bus – 98 percent of

[10] The graphs only show the distance distribution for schools chosen between 0 and 3 miles from the student's residence. Very few students in either kindergarten or 3rd grade choose to attend schools further than 3 miles from home (588 students in kindergarten and 811 students in 3rd grade). These students are included in the samples used to estimate our models but are only removed from the graph for ease of presentation.

charter schools offer a bus to students, compared to 66 percent of traditional public schools. For charter schools, which may be located further from a student's home, providing buses may help families overcome the distance barrier, which has been found to play a significant role in school choice decisions.

4.3 Defining the Choice Set

A critical part of investigating school choice decisions is defining the choice set – that is, the set of schools a student considers when choosing a school to attend. In a city such as New York, the choice set is potentially quite large, including all of the 2,000 schools within in the city. However, many of these schools are prohibitively far away, do not serve the student's grade, or the student does not meet the admissions criteria (i.e. – schools that serve specialized populations in specific geographic areas). Thus, the "effective" choice set for any student is more limited.

We take an empirical approach to constructing the choice sets by defining it for each student based on the attendance zone in which they reside. Choice sets consist of all schools chosen by more than one student living within a given attendance zone.[11] Once we define the choice set of schools for each attendance zone, we match school-level characteristics on bus availability, enrollment, racial/ethnic composition, academic performance, and teacher quality measures from the previous year.

To create the choice sets, we begin with 2017 student-level NYCDOE data, which has information on the students' attendance zones for elementary school and the schools they currently attend. For each grade, we collapse the data to the attendance zone by school level to create a dataset which contains the number of students who attend each school in the attendance

[11] We also limited the choice set to schools chosen by at least five students living within a given attendance zone and this had little effect on the results.

zone. We then remove any attendance zone school combination in which there is only one student in attendance. Students who are zoned to multiple elementary schools or reside in districts with open enrollment (district 1 for elementary schools) are excluded from the choice set construction because they lack a unique zoned school to define the choice set. The remaining schools are what we refer to as the choice set.

Once we have created the basic choice set of schools for each grade and attendance zone, we merge in school-level data on bus availability (created using student-level data from OPT) and school-level characteristics from the SRC, both from 2016. We match the set of schools in the choice set to the student-level data by grade and attendance zone. Our final step is to calculate the distance between the student's residence and each school in their choice set.

To illustrate what a typical student choice set looks like based on our definition, Figure 2 maps a choice set for a randomly selected kindergarten student from our sample. The star indicates where the student lives, while the map markers represent the schools in the choice set. Black markers indicate zoned schools, dark grey markers indicate charter schools, and district choice schools are colored light grey. The school the student chooses to attend is a square shape, while map markers indicate other schools in the choice set. Lastly, schools that provide a bus for students have a circle icon within their map marker. This student has eight schools in his or her choice set – one zoned school, three district choice schools, and four charter schools. Five of these schools provide a bus. Although there are schools closer to the student's residence, this student chooses to attend his or her zoned school.

We collapse the data to the attendance zone by grade level to present summary statistics for the choice sets in Table 4. Both the kindergarten and 3rd grade samples have just over 580 unique choice sets. The average choice set includes approximately 8 schools. Figures 3A and

3B illustrate the distribution of the number of schools within each choice set for kindergarten and 3rd grade students, respectively. Kindergarten students have choice sets that range from 2 to 29 unique schools, whereas 3rd grade students have choice sets including anywhere from 2 to 34 schools. By construction, each choice set has one zoned school, but there is considerable variation in the number of charter and district choice schools. For example, the average choice set for kindergarten has 2 charter and 4 district choice options, with some choice sets having upwards of 17 charter or district choice schools for students to consider. The average performance of schools within the choice set is around 0.5, meaning half of the students in these schools scored proficient on ELA and math standardized tests, however, charter schools are higher performing (0.53) than district choice and zoned schools (0.45 and 0.39 respectively).[12]

By construction, the characteristics of choice sets described in Table 4 do not vary by student, meaning students in the same attendance zone are assigned the same choice set, with the same number of charter and district choice schools. However, the distance between a student's residence and each school varies within the choice set and is an important source of variation for our research question. We refer to this student-specific choice set as the student's choice set. In Table 5, we present descriptive statistics for the distance distributions for schools within each student's choice set.

On average, kindergarten students have 10.33 schools in their choice sets. Of these, 5 school choices are within a mile, and 5-6 choices are further than a mile from home. For each student, nearly half of all schools in their choice set are within a mile from their home, however there is considerable heterogeneity when we separate this by school type. 79 percent of zoned

[12] Appendix Figures 1A and 1B graph the variation in average school quality within the choice set for Kindergarten and 3rd grade respectively, while Appendix Figures 2A and 2B display the distribution of standard deviations Looking at Figure 2B, the distribution appears to be somewhat more spread compared to 2A, meaning there is more variation in terms of quality within the choice set for 3rd grade students.

schools are within a half mile of a student's residence, while less than 20 percent of charter or district choice schools are within this range. In fact, the average distance to a student's zoned school is 0.36 miles, while the average distance to a charter (district choice) school in the student's choice set is 1.77 (1.49) miles. Similar results hold for 3rd grade students. While students in both kindergarten and 3rd grade are more likely to be eligible for buses to charter and district choice schools since they are located further from home, they may also be less likely to attend these schools if they have strong preferences for proximity.

Because we have excluded the few students that live more than one mile from their zoned school, the 3rd grade students in our sample are never eligible for the bus. Hence, identification of the impact of bus eligibility on school choice for 3rd grade students only comes from charter and district choice schools.

4.4 Variation in School Performance in Student Choice Sets

Since an important goal of school choice is to provide students with the opportunity to attend higher quality schools, we present some basic statistics about the variation in school performance in students' choice sets. In Table 4, for both kindergarten and 3rd grade, the average performance of all schools within students' choice sets is 0.48, while the standard deviation in performance within the choice set is 0.16 on average.[13] The key is that there is significant variation around this mean; some students have considerably more choice in terms of school performance than others.

On average, 63% of schools in a student's set are of higher performance than their zoned school. Students have at least 2 high-performing options within their choice sets on average, and

[13] Appendix Figures 1A and 1B graph the variation in average school quality within the choice set for kindergarten and 3rd grade respectively, while Appendix Figures 2A and 2B display the distribution of standard deviations. Looking at Figure 2B, the distribution appears to be somewhat more spread compared to 2A, meaning there is more variation in terms of quality within the choice set for 3rd grade students.

some choice sets contain upwards of 9 or 11 high-performing options. Despite this availability of high-performing schools, very few students choose to attend these schools. This persists even when zoned schools are low-performing schools, reinforcing the story that students and their families prefer their zoned schools and are generally show little willingness to go to a higher quality school.

In Table 5, we present the distance distribution for high-performing schools, since a potential concern is that students may not have high-performing options close to home, which may decrease the likelihood of attending a high performing school. Students have fewer high-performing options in their choice set overall (as seen previously in Table 4), however the distances to these schools appear to be relatively evenly distributed throughout the choice set.

5. Models of School and Transportation Choice

In this section, we develop two models for analyzing the relationship between school choice, distance, and the availability of the school bus. First, we specify a school choice model based on McFadden's standard random utility model. In this case, students choose a school from their choice sets of schools, based upon the characteristics of the schools and their own, student specific characteristics. We estimate separate effects of the interaction of distance and the availability of a bus for zoned, charter and district choice schools.

While this approach is well-grounded in the standard choice theoretical framework and offers an excellent description of actual school choice behavior, it does not necessarily provide a compelling identification strategy for isolating the causal effects of school bus eligibility on the choice of school, beyond the potential for a rich set of control variables to minimize omitted variables bias. Thus, we develop a regression discontinuity framework that is based on the bus eligibility cutoffs for kindergarten (0.5 miles) and 3rd grade (1 mile). Identification is based on

choices of students below and above these bus eligibility cutoffs for zoned, charter, and district choice schools.

5.1 Conditional Choice Model

The underlying framework of the school choice model is McFadden's random utility model (1974). Assume that the utility for student *i* from choosing school *j* is

$$U_{ij} = w_j'\beta + \sum_{g=1}^{G} x_{ig} \cdot w_j'\alpha_g + \varepsilon_{ij} \qquad j = 1,\ldots, J_a \tag{1}$$

where w_j is a vector of M school-specific characteristics, x_i is a vector of G individual characteristics, and ε_{ij} is a stochastic error term. The individual (household) chooses school k from the J_a schools in the choice set $C_a = \{S_j; j = 1,\ldots, J_a\}$ for attendance zone *a* if it provides the maximum utility across all J_a choices

$$S_i = k \text{ if } U_{ik} > U_{ij}, \ \forall j \neq k \tag{2}$$

The probability that choice k is made by student *i* is

$$P\left(U_{ik} > U_{ij};\ \forall j \neq k\right) \tag{3}$$

To evaluate this probability, we need to assume a distribution for ε_{ij}. We follow McFadden (1974) and assume ε_{ij} has an i.i.d. Gumbel (type 1 extreme value) distribution

$$F\left(\varepsilon_{ij}\right) = \exp\left(-\exp\left(-\varepsilon_{ij}\right)\right)$$

It follows that

$$P\left(S_i = k|w, x_i\right) = \frac{\exp\left(w_k'\beta + \sum_{g=1}^{G} x_{ig} \cdot w_k'\alpha_g\right)}{\sum_{j=1}^{J_a} \exp\left(w_j'\beta + \sum_{g=1}^{G} x_{ig} \cdot w_j'\alpha_g\right)} + \qquad k = 1,\ldots, J_a \tag{4}$$

where $w = (w_1,\ldots,w_{Ja})$ includes school-specific information for all J_a schools. This is referred to as the conditional logit model. Note that this is different from the multinomial logit model, which includes individual characteristics (not interacted with school characteristics) and separate parameters for each choice. Here, individual characteristics are not separately included since they do not vary across choices (schools) but they can be interacted with school-specific variables. For each student in attendance zone a, there are J_a observations, one for each choice.

We estimate equation (4) where

$$w_k\beta + \sum_{g=1}^{G} x_{ig} w_j' \alpha_g = \beta_0 + \text{Sector}_k\beta_1 + \text{Distance}_{ik}\beta_2 + \text{Bus}_k\beta_3 + \text{School\_Characteristics}_k\beta_4 + \varepsilon_{ik} \quad (5)$$

and where $Sector_k$ is a vector of binary variables, *Charter* and *District Choice*, which indicate the sector or type of school within the choice set, with the reference group being zoned schools. $Distance_{ik}$ includes three binary indicators of the distance from student *i's* residence to school *k* mentioned earlier – *Distance_0.5to1, Distance_1to1.5 and Distance_>1.5,* with distance less than a half mile as the reference group. Bus_k is an indicator that school *k* offers a bus. Given the literature discussed above highlighting family preference for the close proximity of schools, we believe the coefficient estimates for these variables will be negative. *Bus* is an indicator variable equal to one if the school offers a bus for its students.

Lastly, $School\_Characteristics_k$ captures information about school quality and school environment for school *k*. School-level ELA and math proficiency rates speak to the academic quality of the school (we include the average of these two scores as a measure of academic performance). The percent of teachers with 3 or fewer years of experience and the percent of teachers with a Masters' or higher level of education capture teacher quality within the school. We include several controls for the school environment, including total enrollment, percent

free/reduced price lunch, percent students with disabilities, and percent limited English proficient. There is also information on the student racial/ethnic composition of schools since it has been shown to be influential in school choice decisions (Edwards, 2019; Glazerman, 1998).

Our preferred specification includes interactions between school type, distance, and bus availability. This enables us to explore the following question: "Is the bus important for students living further away from school and how does this relationship differ for zoned/charter/district choice schools (*Sector x Distance x Bus*)?" We estimate all models separately for students in kindergarten and third grade in 2017.

To establish the economic significance of the impacts on school choice, we need to calculate elasticities. Calculations are provided in the Appendix.

5.2 RD Model

While the conditional logit model will produce results that are indicative of the impact of distance and bus availability on school choice, these are not necessarily causal. One approach to identifying the causal impact of transportation on school choice is based on the regression discontinuity framework applied to the transportation eligibility cutoffs. In kindergarten, all students receive a half-fare MetroCard. Students living at least a half mile from the school they attend receive a full-fare MetroCard and are eligible to take the bus if the school provides a bus. In 3rd grade, students living between 0.5 and 1 mile from school receive a half-fare MetroCard. Students living at least 1 mile from the school they attend receive a full-fare MetroCard and are eligible to take the bus if the school provides a bus.[14]

[14] For the RD analysis, we exclude students with transportation exceptions, because the distance eligibility thresholds do not apply for these students. As discussed previously, OPT grants exceptions to distance ineligible students for special circumstances, for example, students with special education or students in temporary housing.

We are interested in estimating the causal impact of being bus eligible. The key variable is Bus = 1 if the distance to school is greater than the distance cutoff and the school offers a bus, 0 otherwise.[15]

We estimate a separate model for each of the three school types: zoned, charter, and district choice. The RD model is:

$$\begin{aligned}\text{Choice}_{is} = \alpha + f^{b}\left(\text{Distance}_{ij}, \beta_{b}\right)\cdot 1\left(\text{Distance}_{is} < C\right) + f^{a}\left(\text{Distance}_{ij}, \beta_{a}\right)\cdot 1\left(\text{Distance}_{is} \geq C\right) \\ + \tau \text{Bus}_{is} + X_{is}\delta + \eta_{s} + \varepsilon_{is}\end{aligned} \quad (6)$$

where C*hoice*$_{is}$ = 1 if student *i* chooses school *s*, 0 otherwise, *C* is the eligibility cutoff, $f^{b}(\cdot)$ and $f^{a}(\cdot)$ are higher-order polynomials in *Distance*, and *1(Distance*$_{is}$ < *C)* is an indicator that *Distance*$_{is}$ is less than *C*; hence there are separate distance polynomials for before and after the distance cutoff. We also include school and student characteristics as controls, X_{is}.

Our situation is different from a standard RD framework since individual schools have multiple observations for each student whose distance to the school is in the distance bandwidth. We acknowledge this by including η_s, unobserved school effects, in equation (6). In this case, we are limiting comparisons to students who are on both sides of the distance cutoff for the same school.[16]

[15] One caveat is that students who attend a district choice (charter) school and are bus eligible but live in a different CSD (borough) are not offered a bus. Bus eligibility rules can be found on the NYCDOE's website at https://www.schools.nyc.gov/school-life/transportation/bus-eligibility

[16] Students can be in the sample more than once if they are within the bandwidth distance from more than one school, but we do not include individual student FEs in the RD framework as students can be on both sides of the cutoff for different schools. Furthermore, none of the schools may be the choice school for a given student so the dependent variable is always zero and hence provides no information about how bus eligibility affects school choice.

6. Results

6.1 Conditional Logit Results

We begin with a parsimonious model including indicators for district choice and charter schools. The results are in Table 6 where standard errors are in parentheses and own-elasticities are in brackets below the coefficient estimates. Columns (1) and (4) show that kindergarten (3rd grade) families are 157% (167%) less likely to choose a charter school and 274% (305%) less likely to choose a district choice school than their zoned school within their choice set. This reflects that fact that most students attend their zoned school. However, when controlling for *Distance* (results in columns (2) and (5)), the magnitudes of the coefficient estimates fall, indicating that the preference for zoned school is partially driven by the preference for proximity. The results indicate that students are less likely to choose schools further from home; the distance impact is monotonically declining and is very similar for kindergarten and 3rd grade, and it is large with semi-elasticities of around -0.35, -0.55, and -0.75 for the 3 distance bins. Moreover, conditional on distance, offering a bus increases the likelihood that students attend the school by 10% for both kindergarten and 3rd grade, as seen in columns (3) and (6) of Table 6.

These first set of results show that students prefer to attend schools closer to home, but the availability of a bus can help ameliorate some of the negative effects of distance on school choice. How do the effects of distance or bus availability differ by zoned, charter, and district choice schools? Our next set of results, presented in Table 7, explores this question by adding triple interactions in the model to allow the impact on school choice to differ by distance, bus availability, and school type. Columns (1) and (3) provide results without controls and columns (2) and (4) add in school characteristics.

First, consider kindergarten families. For zoned schools that do not have a bus, the impact on school choice from living between 0.5 and 1 mile from school compared to living within 0.5 miles of school is -0.559 (the coefficient estimate for *Dist 0.5-1*Zoned*). For zoned schools that do have a bus, this impact is -0.524; the presence of a bus leads to a small and not significant increase of 0.035 (the coefficient estimate for *Dist 0.5-1*Zoned*Bus*) in the impact on school choice.

While the effect of bus availability does little to moderate the effect of distance for zoned schools, we find a larger impact for district choice schools. For district choice schools that do not have a bus, the impact on school choice of living between 0.5 and 1 mile from school versus living within 0.5 miles of school is -1.164. However, for district choice schools that do have a bus, this impact is -0.986, a significant (at 1%) difference of 0.178 (the coefficient estimate for *Dist 0.5-1*District Choice*Bus*). The semi-elasticity is 0.081. This represents a 15.3% decline in this distance-related impact on school choice. As we move further away, the impact is -1.511 for district choice schools without a bus of living between 1 and 1.5 miles from school compared to living within 0.5 miles of school. For district choice schools that do have a bus, this impact is -0.1342, a significant (at 10%) difference of 0.169 (the coefficient estimate for *Dist 1-1.5* District Choice*Bus*). This represents an 11.2% decline in this impact.

Next, consider the results for 3rd grade. For charter schools that do not have a bus, the impact on school choice of living between 0.5 and 1 mile from school rather than living within 0.5 miles of school is -0.863 (the semi-elasticity is large; -0.382). The impact for charter schools with a bus at this distance is smaller (-0.755), although this difference, 0.108 (the coefficient estimate for *Dist 0.5-1*Charter*Bus*) is insignificant. This is consistent with our expectations

that the bus should not have an effect at this distance since the cutoff for bus eligibility is 1 mile for 3rd grade.

However, for charter schools 1 mile away or further from the 3rd grade student's residence, we do find the bus has a positive and significant effect on the likelihood a student chooses that school. For charter schools without a bus, the impact on school choice of living between 1 and 1.5 miles from school versus living within 0.5 miles of school is -1.525. The effect of the bus for charter schools at this distance is large and significant at the 5% level; 0.493 (the coefficient estimate for *Dist 1-1.5*Charter*Bus*) reducing the impact to -1.032, which is a 32.6% decline in the effect. The semi-elasticity is also large; 0.253. Furthermore, the decline in the impact on school choice from having a bus for charter schools that are more than 1.5 miles from home is 20.7% (the semi-elasticity is 0.193)

Lastly, we find a puzzling result for district choice schools between 0.5 and 1 mile away for the student's residence. For district choice schools without a bus at this distance, the impact on school choice is -1.329, with a large semi-elasticity of -0.643. Although 3rd grade students are not eligible for the bus at this distance, the impact for district choice schools with a bus is -1.038, a significant difference of 0.291. While this result is contrary to our expectations, we believe it may be picking up a hold-over effect from the fact that students are eligible for the bus at this distance in 2nd grade.

We then add school level characteristics to the model to examine if the results are sensitive to these controls. The results are in columns (2) and (4) of Table 7. The effects of distance and bus availability are little changed by the inclusion of these controls, although school characteristics do influence school choice decisions. School quality and enrollment both have a positive, statistically, and economically significant impact on choice for both kindergarten and

3rd grades. Racial composition of the school is important for school choice decisions, and students are more likely to choose schools with higher percentages of Hispanic and white students. Students are less likely to select schools with higher percentages of free/reduced price lunch students or students with disabilities. Lastly, teacher quality measures do not appear to be influential in school choice decisions.

Taken together, we find distance is very important to students deciding which school to attend, and they are less likely to attend schools further from home. However, the availability of transportation to school, mainly through schools offering busing, can help to moderate this negative effect of distance. We find that bus eligibility has a significant impact on the decision to attend a district choice school among kindergarten families, but the impact is less than a 10% increase. There is a much larger impact among charter schools in 3rd grade, with a semi-elasticity of around 0.2 – 0.25. This is approaching the distance impact of living 0.5 to 1 mile from school relative to living less than 0.5 miles from school (the semi-elasticity is -0.38). We find that school characteristics, especially those pertaining to academic performance and racial/ethnic composition, also influence school choice decisions.

6.2 RD Results

Before turning to the RD model to estimate a causal impact of bus eligibility on the decision to attend a particular school, we regress *Choice* on 0.05-mile distance bins for kindergarten and 3rd grade for the different school types to see how distance affects school choice. The left-out group is those living within 0.1 miles of school.[17] Results are shown in Appendix Table 1 and Figure 4. For kindergarten, the negative impact of distance on school choice is much greater (in magnitude) for choice and charter schools, where the impact is

[17] Rather than doing this using separate polynomials before and after the cutoff, we take a different approach and create distance bins of 0.05 mile length, which is roughly the size of a city block. We use this approach because we believe this is a better way to understand the effects of distance on school choice in this setting.

similar, than for zoned schools. Compared to living within 0.1 miles from school, living 1 mile from school reduces the probability of school choice by 0.2 for charter and district choice schools whereas it reduces the probability by 0.1 for zoned schools. This difference is even larger when compared to the probability of choosing a zoned, charter, and district choice school; 0.74, 0.06, and 0.05, respectively. For all three school types, the distance impact tends to level out after about 0.65 miles.

For 3rd grade, the impact of distance on the probability of school choice for district choice schools is very similar to that for kindergarten and 3rd grade whereas the impact is more moderate in 3rd grade than in kindergarten for charter schools. Living 1 mile away from school (relative to living less than 0.1 miles) reduces the probability of attending a district choice school by 0.2, but only reduces the probability of attending a charter school by 0.14.

Next, we estimate the RD model (equation 6) that includes the bus eligibility variable, polynomials in distance before and after the cutoff, a set of student and school controls, and school fixed effects.[18] We choose a bandwidth of 0.25 miles around the distance cutoff.[19] The results are presented in Table 8.

For kindergarten, we see that the impact of bus eligibility on the probability of school choice is positive and significant at the 5% level for zoned and charter schools. While the point estimate is larger for zoned schools, the semi-elasticity is larger for charter schools, 0.41 compared to 0.05 for zoned schools. Based on the distance effects given in Appendix Table 1, the impact of living 0.65 – 0.7 miles from school (where the impact levels off) relative to 0 – 0.10 miles from school is -0.104 (-0.193) for zoned (charter) schools. Then the coefficient

[18] Student controls include gender, race/ethnicity, student disability status, limited English proficiency, and no English spoken at home. School controls include measures of academic performance, enrollment, student racial/ethnic composition, and teacher quality.
[19] We also use bandwidths of ± 0.5 and ± 0.1 miles and the results are similar.

estimate of 0.035 (0.029) for bus eligibility in zoned (charter) schools is equivalent to reducing distance to school by 0.54 miles (0.24 miles).[20] This impact is particularly large for zoned schools. The impact for district choice schools is small and not significant.

For 3rd grade, we only estimate bus eligibility effects for charter and zoned schools since so few students are more than a mile from their zoned school (the cutoff for bus eligibility). Again, we see that the impact of the bus on the probability of school choice is positive, significant and large in magnitude for charter schools; 0.029 (the semi-elasticity is 0.58). Based on the distance effects given in Appendix Table 1, the impact of living 0.65 – 0.7 miles from school relative to 0 – 0.10 miles from school is -0.139 for charter schools. Then the coefficient estimate of 0.029 for bus eligibility is equivalent to reducing distance to school by 0.33 miles. The impact for district choice schools is small in magnitude.

Finally, we interact *Bus* with the indicator of high performing schools to determine if the impact of bus eligibility is related to school quality. The results are in the second panel of Table 8. We find that the impact of bus eligibility is larger for high-performing schools relative to lower-performing schools for zoned and charter schools in kindergarten. But there is no difference for charter schools in 3rd grade (there is no difference for district choice schools in either grade). This is evidence that offering a bus in kindergarten can be particularly effective for getting students to choose higher quality schools that are further away from home.

7. Conclusion

The "promise" of school choice to improve academic outcomes has, to a large extent, not been fulfilled. One explanation is that distance to school matters; travelling to a school farther

[20] The calculation for zoned schools is 0.035/0.104 divided by 0.625 (the difference in the midpoint of the 0.65-0.70 and 0-0.10 distance intervals). A similar calculation holds for charter schools.

away than the local zoned school outweighs the potential benefits of a better school. In this paper, we look at whether the availability of a school bus can switch the net benefits in favor of choosing a higher performing school that is farther away than the local zoned school. This adds to the relatively small literature on the link between school choice, distance to school and pupil transportation.

We model the school choice and transportation decisions using a conditional logit specification and provide casual estimates using a regression discontinuity analysis based on the bus eligibility distance cutoff. We estimate these models using a comprehensive dataset on students and their transportation choices in the New York City public school district for 2017. We focus on kindergarten and 3rd grade as the former is the first school choice decision for families and the latter because the bus eligibility criterion changes in that grade.

Using the conditional logit model, we find that distance matters and the bus can overcome this negative effect of distance, particularly for 3rd grade charter schools. The semi-elasticity with respect to school choice is around 0.2 – 0.25 and this a approaching the absolute value of the semi-elasticity for the impact on school choice of living 0.5 – 1 mile away from school versus living less than 0.5 miles away from school; 0.38.

The RD results support those from the conditional logit model; bus eligibility matters. In fact, the impact is quite large for kindergarten zoned schools; equivalent to living 0.54 miles closer to school. The impact of bus eligibility is significant in both kindergarten and 3rd grade for charter schools; equivalent to living 0.24 and 0.33 miles closer to school, respectively. In terms of providing an incentive to choose a higher quality school that is further from home, we find that offering a bus in high-performing zoned and charter schools can be particularly effective.

Thirty-five percent of traditional public schools – zoned schools, magnet schools, or specialty schools – do not offer the bus in NYC. Our results suggest that expanding access to school buses or relaxing the bus eligibility rules would induce more students to attend a school other than their zoned school – a charter school or another school in the district. Whether or not this would lead to better matches between students and schools or better outcomes for students is a matter for future studies.

References

Billings, S. B. (2011). Estimating the value of a new transit option. *Regional Science and Urban Economics*, 41(6), 525-536.

Billings, S. B., Leland, S., & Swindell, D. (2011). The effects of the announcement and opening of light rail transit stations on neighborhood crime. *Journal of Urban Affairs*, 33(5), 549-566.

Black, S. (1999). Do better schools matter? Parental valuation of elementary education. *Quarterly Journal of Economics*, 114, 577-599.

Boisjoly, G., Moreno-Monroy, A. I., & El-Geneidy, A. (2017). Informality and accessibility to jobs by public transit: Evidence from the Sao Paulo Metropolitan Region. *Journal of Transport Geography,* 64, 89-96.

Burgess, S., Greaves, E., Vignoles, A., & Wilson, D. (2015). What Parents Want: School Preferences and School Choice. *The Economic Journal,* 125(587), 1262-1289.

Cowen, J., Sanderson Edwards, D., Sattin-Bajaj, C., & Cosby, M. (2018). Motor City Miles: Student Travel to Schools in and Around Detroit. Washington DC: Urban Institute.

Cordes, S. and M.A. Laurito (2019) The Effects of Charter Schools on Neighborhood and School Segregation Evidence from New York City. Working Paper.

Cordes, S. A., Leardo, M., Rick, C., & Schwartz, A. E. (2019). "Can School Buses Drive Down (Chronic) Absenteeism?" in M. Gottfried and E. Hutt (Eds.), Addressing Absenteeism. Cambridge, Massachusetts: Harvard Education Press.

Cullen, J. B., Jacob, B. A., & Levitt, S. D. (2005). The Impact of School Choice on Student Outcomes: An Analysis of the Chicago Public Schools. *Journal of Public Economics,* 89(5-6), 729-760.

Dustan, A., & Ngo., D. K. L. (2018). Commuting to educational opportunity? School choice effects of mass transit expansion in Mexico City. *Economics of Education Review*, 63, 116-133.

Edwards, D.S. 2019. Just Out of Reach: Estimating Relationships Between School Location, Quality, and Choice in Detroit, Presented at Association for Public Policy and Management International Conference. Barcelona, Spain.

Fingleton, B., & Szumilo, N. (2019). Simulating the impact of transport infrastructure investment on wages: A dynamic spatial panel model approach. *Regional Sciences and Urban Economics,* 75, 148-164.

Gibbons, S., & Machin, S. (2008). Valuing school quality, better transport, and lower crime: Evidence from house prices. *Oxford Review of Economic Policy*, 24(1), 99-119.

Glaeser, E. L., Kahn, M. E., & Rappaport, J. (2008). Why do the poor live in cities? The role of public transportation. *Journal or Urban Economics,* 63(1), 1-24.

Glazerman, S., & Dotter, D. (2017). Market Signals: Evidence on the Determinants and Consequences of School Choice from a Citywide Lottery. *Educational Evaluation and Policy Analysis,* 39(4), 593-619.

Glazerman, S. M. (1998). School Quality and Social Stratification: The Determinants and Consequences of Parental School Choice. *Presented at the American Educational Research Association Annual Meeting.*

Gottfried, Michael A. 2017. Linking Getting to School with Going to School, *Educational Evaluation and Policy Analysis* 39(4): 571–92.

Hastings, J. S., Neilson, C. A., & Zimmerman, S. D. (2012). The Effect of School Choice on Intrinsic Motivation and Academic Outcomes. National Bureau of Economic Research Working Paper No. 18324. Cambridge: National Bureau of Economic Research.

Hastings, J. S., & Weinstein, J. M. (2008). Information, School Choice, and Academic Achievement: Evidence from Two Experiments. *The Quarterly Journal of Economics,* 123(4), 1373-1414.

Hastings, J. S, Kane, Thomas, J., & Staiger, D. O. (2005). Parental Preferences and School Competition: Evidence from a Public School Choice Program. National Bureau of Economic Research Working Paper No. 11805. Cambridge: National Bureau of Economic Research.

Herskovic, L. (2017). The effect of subway access on school choice. Working paper.

Holzer, H. J., Quigley, J. M., & Raphael, S. (2003). Public transit and the spatial distribution of minority employment: Evidence from a natural experiment. *Journal of Policy Analysis and Management,* 22(3), 415-441.

Kahn, M. E. (2007). Gentrification trends in new transit-oriented communities: Evidence from 14 cities that expanded and build rail systems. *Real Estate Economics,* 35(2), 155-182.

Lichtman-Sadot, S. (2019). Can public transportation reduce accidents? Evidence from the introduction of late-night buses in Israeli cities. *Regional Science and Urban Economics*, 74, 99-117.

Lincove, J., Cowen, J., & Imbrogno, J. (2018). What's in Your Portfolio? How Parents Rank Traditional Public, Private, and Charter Schools in Post-Katrina New Orleans' Citywide System of School Choice. *Education and Finance Policy,* 13(2), 194-226.

Mayer, T., & Trevien, C. (2017). The impact of urban public transportation evidence from the Paris region. *Journal of Urban Economics,* 102, 1-21.

Pathak, R., Wyczalkowski, C. K., & Huang, X. (2017). Public Transit access and the changing spatial distribution of poverty. *Regional Science and Urban Economics*, 66, 198-212.
Phillips, D. C., & Sandler, D. (2015). Does public transport spread crime? Evidence from temporary rail station closures. *Regional Science and Urban Economics,* 52, 13-26.

Rotger, G. P., & Neilsen, T. S. (2015). Effects of job accessibility improved by public transport system: Natural experimental evidence from the Copenhagen metro. *European Journal of Transport and Infrastructure Research,* 15(4), 419-441.

Rouse, C. E. (1998). Private School Vouchers and Student Achievement: An Evaluation of the Milwaukee Parental Choice Program. *The Quarterly Journal of Economics,* 113(2) 553-602.

Ruijs, N., & Oosterbeek, H. (2019). School Choice in Amsterdam: Which Schools Are Chosen When Choice Is Free? *Education and Finance Policy*, 14(1), 1-30.

Sattin-Bajaj, C. (2018). It's Hard to Separate Choice from Transportation, Perspectives on Student Transportation Policy from Three Choice-Rich Cities. Urban Institute Research Report. Washington, DC: Urban Institute.

Urban Institute Student Transportation Working Group. (2017) Student Transportation and Educational Access. Washington, DC: Urban Institute.

U.S. Department of Education. Institute of Education Sciences, National Center for Education Statistics.

Witte, J. F. (1998). The Milwaukee Voucher Program. *Education Evaluation and Policy Analysis,* 20(4), 229-251.

Witte, J. F., Wolf, P. J, Cowen, J. M., Carlson, D. E., & Fleming, D. J. (2014). High Stakes Choice: Achievement and Accountability on the Nation's Oldest Urban Voucher Program. *Educational Evaluation and Policy Analysis,* 36(4), 437-456.

Figure 1A: Distribution of Distance to Chosen School for Kindergarten Students

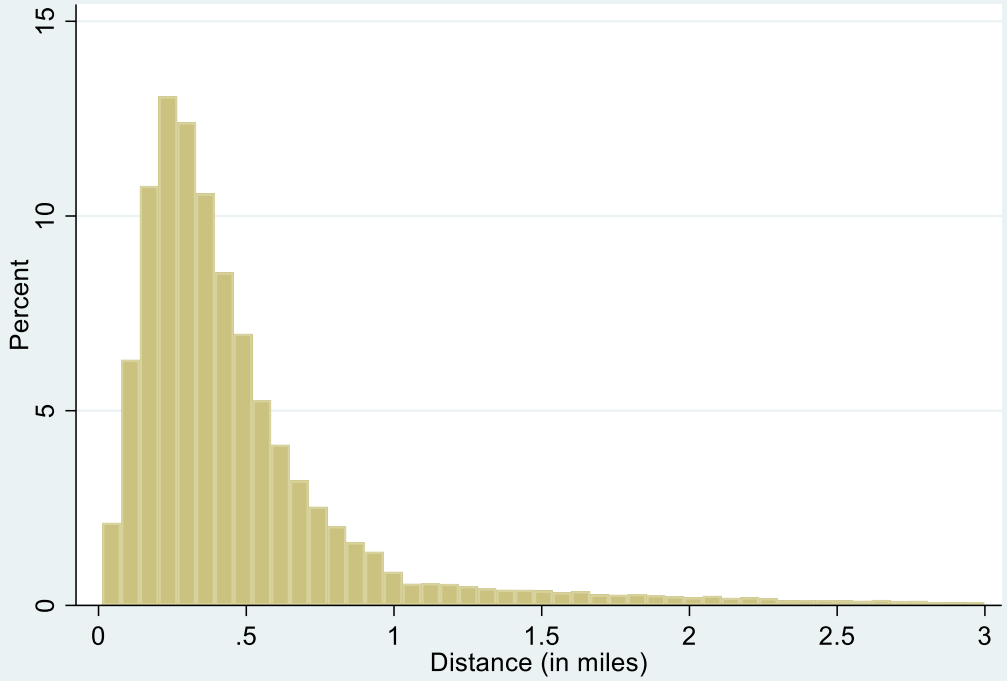


Figure 1B: Distribution of Distance to Chosen School for Grade 3 Students

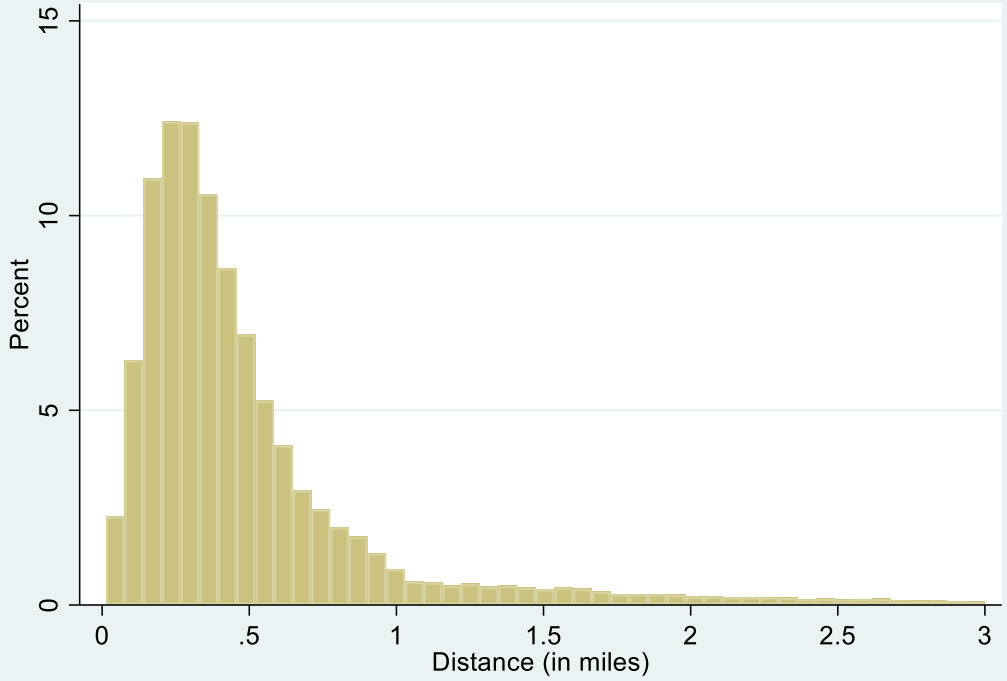


Figure 2: Example Choice Set for Kindergarten

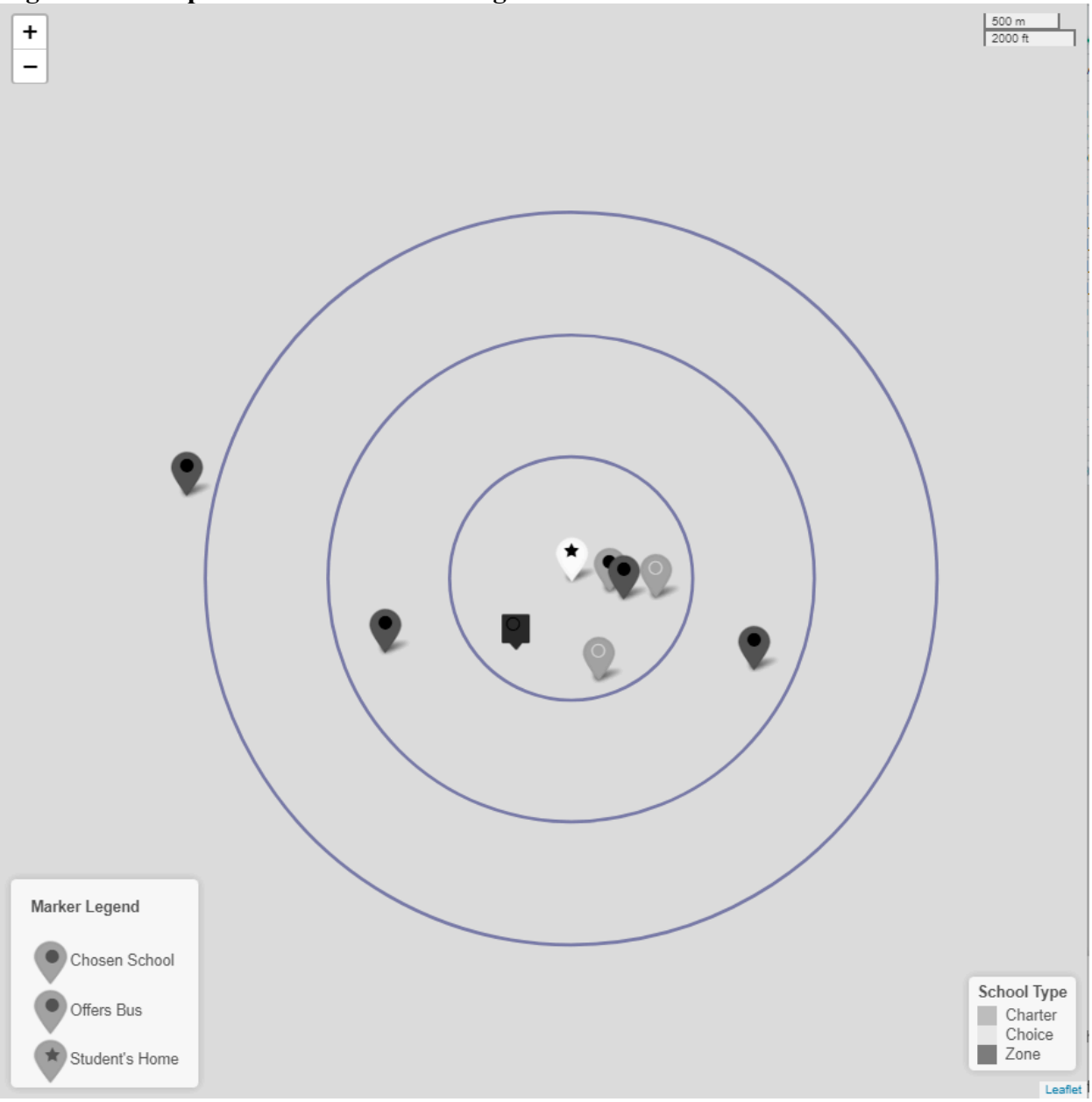


Figure 3A: Distribution of Number of Schools in a Choice Set for Kingergarten

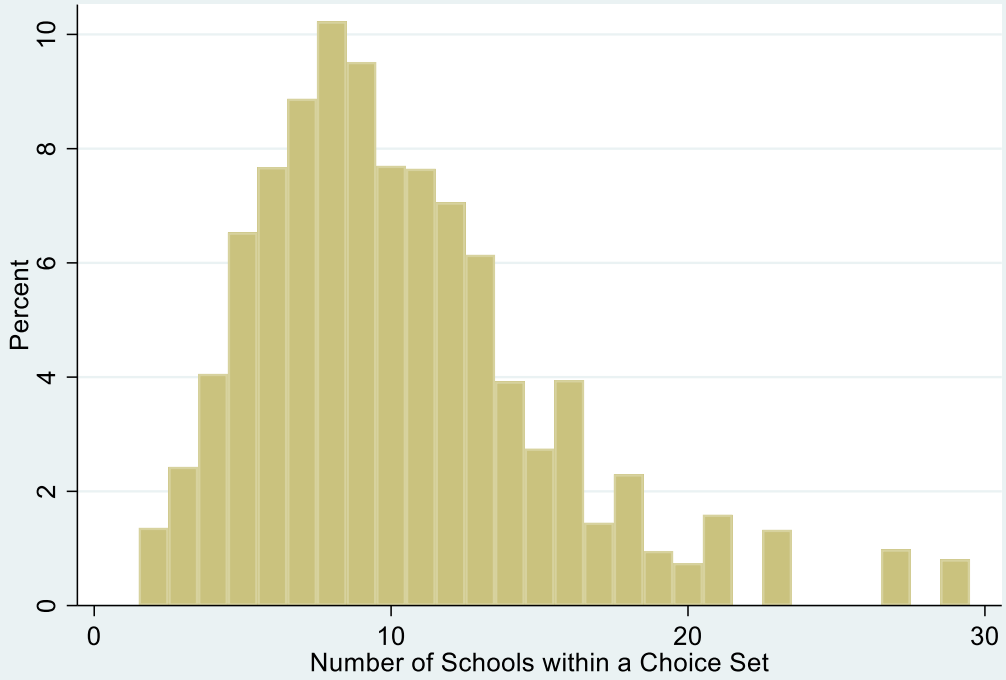


Figure 3B: Distribution of the Number of Schools in a Choice Set for 3rd Grade

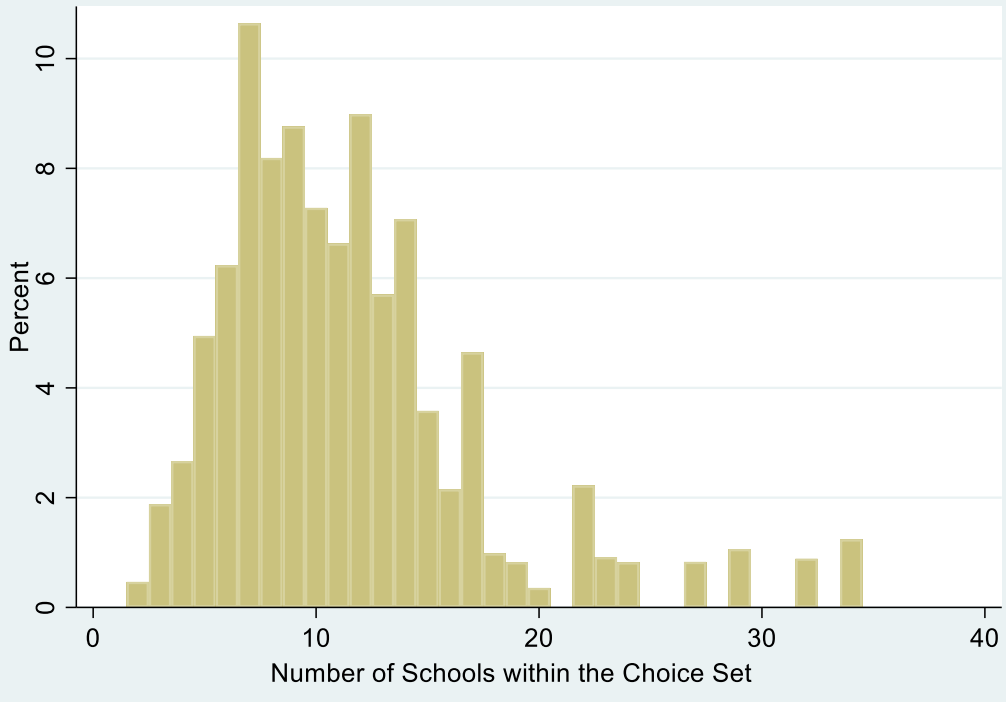
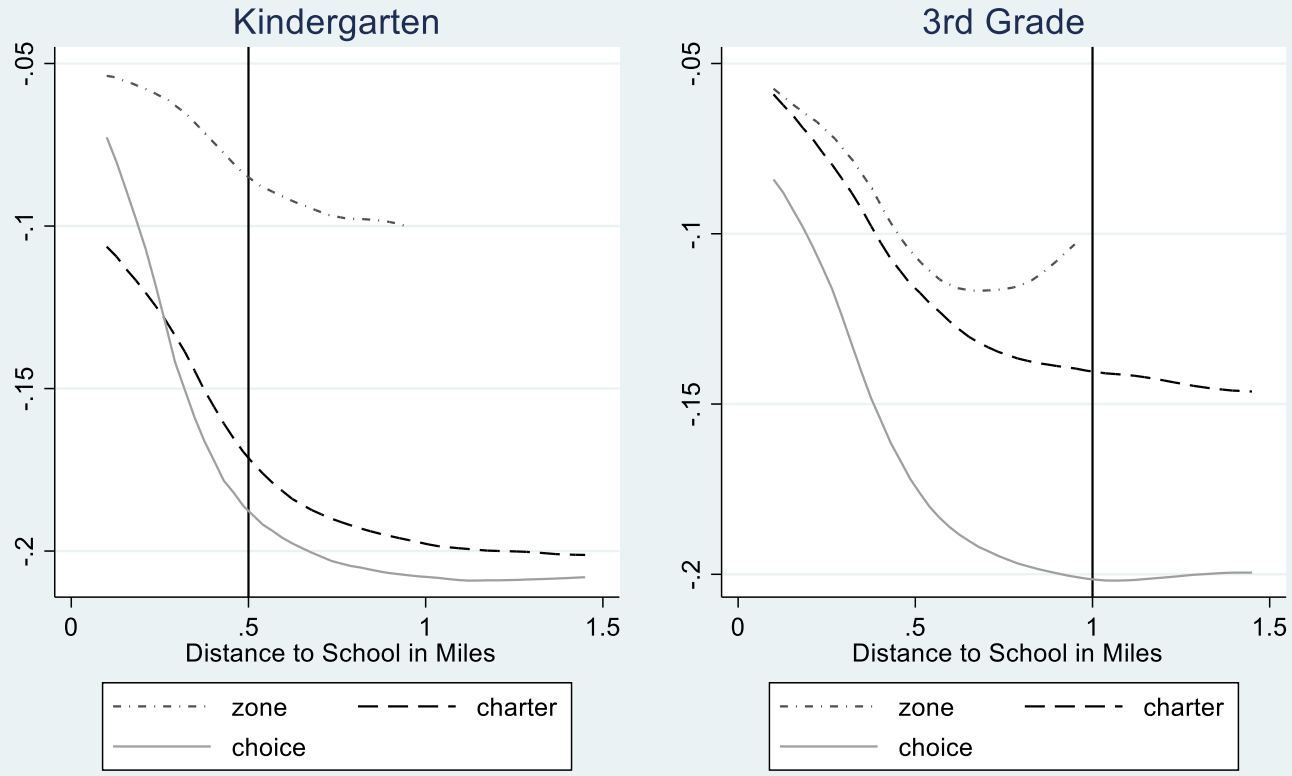


Figure 4: Impacts of Distance on Probability of School Choice



Note: Impact relative to being 0-0.1 miles from school
Vertical solid line at 0.5 and 1 miles is the bus eligibility cutoff

Table 1: Transportation Assistance Eligibility Rules

	Distance between Home and School			
Grade	A) <.5 miles	B) .5-1 mile	C) 1-1.5 miles	D) ≥1.5 miles
K-2	Half-Fare MC	Full-Fare MC or School Bus	Full-Fare MC or School Bus	Full-Fare MC or School Bus
3-6	Not Eligible	Half-Fare MC	Full-Fare MC or School Bus	Full-Fare MC or School Bus
7-12	Not Eligible	Half-Fare MC	Half-Fare MC	Full-Fare MC

Table 2: Characteristics of Students

Panel A: Kindergarten	(1) All Students	(2) Analytic Sample	(3) Zoned	(4) District Choice	(5) Charter
Female	0.50	0.49	0.49	0.50	0.51
Black	0.24	0.22	0.17	0.23	0.54
White	0.17	0.18	0.20	0.18	0.07
Asian	0.19	0.18	0.23	0.21	0.06
Hispanic	0.40	0.38	0.40	0.37	0.33
Limited English Proficiency	0.21	0.21	0.23	0.19	0.11
Student with Disabilities	0.13	0.16	0.16	0.14	0.14
Free or Reduced-Price Lunch	0.69	0.68	0.68	0.65	0.77
Average Peer Performance		0.42	0.42	0.41	0.45
Distance to School		0.55	0.35	1.05	1.18
Distance to School<0.5 Mile		0.68	0.80	0.38	0.30
Distance to School 0.5-1 Mile		0.22	0.20	0.29	0.26
Distance to School 1-1.5 Mile		0.04	0	0.13	0.17
Distance to School >1.5 Miles		0.06	0	0.20	0.27
Number of Unique Students	81,216	58,450	42,779	9,765	5,906
Panel B: 3rd Grade	(1) All Students	(2) Analytic Sample	(3) Zoned	(4) District Choice	(5) Charter
Female	0.50	0.49	0.49	0.50	0.50
Black	0.25	0.23	0.17	0.25	0.57
White	0.16	0.17	0.18	0.19	0.07
Asian	0.19	0.18	0.22	0.20	0.06
Hispanic	0.40	0.39	0.40	0.36	0.31
Limited English Proficiency	0.16	0.17	0.19	0.13	0.06
Student with Disabilities	0.16	0.20	0.20	0.19	0.17
Free or Reduced-Price Lunch	0.70	0.70	0.70	0.66	0.75
Performance of School		0.42	0.41	0.44	0.48
Distance to School		0.58	0.35	1.10	1.35

Table 2 Continued

Distance to School<0.5 Mile		0.67	0.80	0.37	0.26
Distance to School 0.5-1 Mile		0.22	0.20	0.28	0.25
Distance to School 1-1.5 Mile		0.04	0	0.13	0.18
Distance to School >1.5 Miles		0.07	0	0.22	0.31
Number of Unique Students	80,551	60,256	43,547	10,940	5,769

Notes: Summary statistics are presented for students in kindergarten and 3rd grade in 2017. Students enrolled in special education (District 75 or ungraded special education) or students who live in district wide choice districts (districts 1, 7, and 23) are not included in the sample. We exclude students who attend a school that opened in 2017 and students whose zoned schools are further than one mile away from their residence from this sample. Additionally, we do not include students who were the only one to attend a school within their attendance zone. The first column presents summary statistics for all kindergarten and 3rd grade students in NYC in 2017. Some of these students are dropped from our sample due to the restrictions described above, and thus we do not calculate the distance between their home and school.

Table 3: Characteristics of Schools

Panel 1: Kindergarten	**Traditional Public Schools**	**Charter Schools**
ELA Proficiency	0.39	0.48
Math Proficiency	0.39	0.54
School Performance	0.39	0.51
K-2 Schools (missing proficiency rates)	0.04	0.12
Enrollment (in hundreds)	6.41	4.89
Percent Black Students	26.36	55.60
Percent Hispanic Students	40.79	34.86
Percent White Students	16.54	5.08
Percent Free/Reduced Price Lunch	66.50	67.24
Percent Students with Disabilities	21.93	16.39
Percent Limited English Proficiency	14.96	6.76
Teachers < 3 Years of Experience	11.41	30.83
Teachers with Masters' or Higher Edu	47.53	7.41
Bus	0.65	0.98
Number of Schools	**746**	**143**
Panel 2: 3rd Grade	**Traditional Public Schools**	**Charter Schools**
ELA Proficiency	0.39	0.48
Math Proficiency	0.39	0.54
School Performance	0.39	0.51
Phasing in 3rd Grade	0.01	0.09
Enrollment (in hundreds)	6.54	5.04
Percent Black Students	26.35	55.57
Percent Hispanic Students	40.43	34.73
Percent White Students	16.69	5.11
Percent Free/Reduced Price Lunch	66.24	66.99
Percent Students with Disabilities	22.01	16.64
Percent Limited English Proficiency	14.57	6.57
Teachers < 3 Years of Experience	11.10	30.54
Teachers with Masters' or Higher Edu	47.65	7.21
Bus	0.66	0.98
Number of Schools	**730**	**138**

Notes: Schools that opened in 2017 were removed from the choice sets due to missing 2016 SRC data (15 schools). For our kindergarten sample, schools missing school performance data only offer instruction for grades K-2, and thus do not administer reading or math tests to these students. In our 3rd grade sample, 2017 is the first year these schools began offering 3rd grade instruction, although the schools have been open in previous years offering instruction for other grades.

Table 4: Characteristics of Choice Sets

Panel A: Kindergarten	**N**	**Mean**	**Min**	**Max**
Number of Schools in Choice Set				
All Schools	582	7.44	2	29
Zoned Schools	582	1	1	1
Charter Schools	582	2.35	0	17
District Choice Schools	582	4.07	0	17
Average Performance of				
All Schools in Choice Set	582	0.53	0.12	0.99
Zoned School	582	0.39	0.07	0.94
Charter Schools	362	0.51	0.12	0.98
District Choice Schools	570	0.46	0.10	0.97
Standard Deviation of Performance	578	0.04	0.01	0.30
High Performing Schools	582	2.12	0	9
Low Performing Schools	582	1.12	0	6
Higher Performing than Zoned School	582	0.62	0	1

Panel B: 3rd Grade	**N**	**Mean**	**Min**	**Max**
Number of Schools in Choice Set				
All Schools	587	8.27	2	34
Zoned Schools	587	1	1	1
Charter Schools	587	2.49	0	18
District Choice Schools	587	4.78	0	20
Average Performance of				
All Schools in Choice Set	587	0.48	0.20	0.92
Zoned School	587	0.39	0.07	0.89
Charter Schools	373	0.54	0.19	0.96
District Choice Schools	581	0.45	0.14	0.96
Standard Deviation of Performance	588	0.17	0.01	0.34
High Performing Schools	587	2.60	0	11
Low Performing Schools	587	1.31	0	8
Higher Performing than Zoned School	587	0.65	0	1

Notes: Each choice set must contain a zoned school, however they do not always include charter or district choice options, hence the number of choice sets with these schools is smaller for both kindergarten and 3rd grade. Additionally, schools may be missing school performance (the average of ELA and math proficiency rates for the school) if the school does not offer 3rd grade instruction, or if it is the first year 3rd grade is offered in the school. Thus, the number of choice sets summarizing the standard deviation in performance is smaller, due to choice sets with only one school with non-missing performance.

Table 5: Characteristics of Student's Choice Sets

	Kindergarten		3rd Grade	
	Mean	SD	Mean	SD
Average Number of Schools	10.33	4.99	11.46	5.95
<0.5 Miles	2.14	1.41	2.14	1.38
0.5-1 Mile	2.56	1.62	2.72	1.66
1-1.5 Miles	1.98	1.25	2.09	1.36
>1.5 Miles	3.33	2.40	3.74	2.83
Average Number of High Performing Schools	4.07	2.02	4.59	2.25
<0.5 Miles	1.30	0.65	1.33	0.68
0.5-1 Mile	1.35	0.61	1.44	0.75
1-1.5 Miles	1.33	0.59	1.40	0.71
>1.5 Miles	1.92	1.21	2.12	1.36
Percent of Schools				
<0.5 Miles	0.23	0.42	0.21	0.41
0.5-1 Mile	0.28	0.45	0.27	0.44
1-1.5 Miles	0.16	0.37	0.17	0.38
>1.5 Miles	0.33	0.37	0.35	0.48
Zoned Schools				
Average Distance to Zoned School	0.36	0.19	0.36	0.19
Percent <0.5 Miles	0.79	0.41	0.79	0.41
Percent 0.5-1 Mile	0.21	0.41	0.21	0.41
Charter Schools				
Average Distance to Charter School	1.77	1.45	1.96	1.67
Percent <0.5 Miles	0.12	0.32	0.11	0.31
Percent 0.5-1 Mile	0.22	0.42	0.20	0.40
Percent 1-1.5 Miles	0.19	0.39	0.19	0.39
Percent >1.5 Miles Away	0.47	0.50	0.50	0.50
District Choice Schools				
Average Distance to District Choice School	1.49	1.48	1.55	1.56
Percent <0.5 Miles	0.17	0.37	0.15	0.35
Percent 0.5-1 Mile	0.32	0.47	0.31	0.46
Percent 1-1.5 Miles	0.18	0.39	0.19	0.39
Percent >1.5 Miles Away	0.33	0.47	0.35	0.48

Notes: Data is at the student choice set level, with 469,885 observations for kindergarten and 539,615 observations for 3rd grade. District choice schools are traditional public schools other than their own zoned schools or charter schools.

Table 6 – Conditional Logit Results

	Kindergarten			3rd Grade		
	(1)	(2)	(3)	(4)	(5)	(6)
School Type						
Charter	-2.672***	-1.797***	-1.890***	-2.788***	-1.881***	-1.963***
	(0.015)	(0.018)	(0.020)	(0.015)	(0.018)	(0.020)
	[-1.571]	[-0.935]	[-0.988]	[-1.669]	[-1.005]	[-1.054]
Choice	-2.949***	-2.288***	-2.305***	-3.006***	-2.308***	-2.318***
	(0.012)	(0.014)	(0.014)	(0.011)	(0.014)	(0.014)
	[-2.738]	[-1.769]	[-1.783]	[-3.049]	[-1.924]	[-1.935]
Distance						
0.5-1 Miles		-0.765***	-0.784***		-0.789***	-0.807***
		(0.016)	(0.016)		(0.016)	(0.016)
		[-0.352]	[-0.359]		[-0.380]	[-0.388]
1-1.5 Miles		-1.222***	-1.232***		-1.252***	-1.263***
		(0.027)	(0.027)		(0.026)	(0.026)
		[-0.543]	[-0.546]		[-0.580]	[-0.584]
≥1.5 Miles		-1.535***	-1.541***		-1.513***	-1.515***
		(0.024)	(0.024)		(0.023)	(0.023)
		[-0.743]	[-0.745]		[-0.775]	[-0.775]
Bus			0.235***			0.209***
			(0.017)			(0.017)
			[0.103]			[0.097]
Observations	469,885	469,885	469,885	539,615	539,615	539,615

Notes: Standard errors are presented in parentheses and elasticities are presented in brackets. Standard errors are clustered at the student level. District choice schools are traditional public schools other than their own zoned schools or charter schools.

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

Table 7: Conditional Logit with Interactions

	Kindergarten		3rd Grade	
VARIABLES	(1)	(2)	(3)	(4)
Type of School				
Charter School	-1.626***	-1.954***	-1.593***	-1.966***
	(0.135)	(0.139)	(0.124)	(0.129)
	[-0.824]	[-1.010]	[-0.828]	[-1.037]
District Choice School	-2.029***	-2.067***	-2.004***	-2.022***
	(0.029)	(0.029)	(0.028)	(0.028)
	[-1.467]	[-1.488]	[-1.540]	[-1.533]
Zoned School				
Dist 0.5-1*Zoned School	-0.559***	-0.572***	-0.493***	-0.522***
	(0.059)	(0.060)	(0.060)	(0.060)
	[-0.229]	[-0.231]	[-0.214]	[-0.222]
Bus*Zoned School	0.244***	0.135***	0.221***	0.091***
	(0.023)	(0.023)	(0.022)	(0.023)
	[0.119]	[0.063]	[0.112]	[0.044]
Dist 0.5-1*Zoned*Bus	0.035	0.038	-0.060	-0.043
	(0.065)	(0.065)	(0.065)	(0.065)
	[0.016]	[0.017]	[-0.028]	[-0.020]
Charter School				
Dist 0.5-1*Charter	-0.955***	-0.809***	-0.863***	-0.760***
	(0.230)	(0.230)	(0.204)	(0.204)
	[-0.405]	[-0.340]	[-0.382]	[-0.333]
Dist 1-1.5*Charter	-1.311***	-1.219***	-1.525***	-1.392***
	(0.303)	(0.303)	(0.228)	(0.228)
	[-0.539]	[-0.496]	[-0.644]	[-0.582]
Dist>1.5*Charter	-1.651***	-1.541***	-1.870***	-1.727***
	(0.275)	(0.275)	(0.194)	(0.194)
	[-0.698]	[-0.643]	[-0.824]	[-0.748]
Bus*Charter School	0.060	0.199	-0.166	0.022
	(0.137)	(0.137)	(0.126)	(0.127)
	[0.027]	[0.089]	[-0.079]	[0.010]
Dist 0.5-1*Charter*Bus	0.103	-0.034	0.108	0.032
	(0.233)	(0.233)	(0.207)	(0.207)
	[0.047]	[-0.015]	[0.052]	[0.015]
Dist 1-1.5*Charter*Bus	0.147	0.082	0.493**	0.410*
	(0.306)	(0.306)	(0.232)	(0.232)
	[0.067]	[0.037]	[0.253]	[0.204]

Table 7 Continued

Dist>1.5*Charter*Bus	0.018	-0.066	0.387**	0.302
	(0.277)	(0.277)	(0.197)	(0.197)
	[0.008]	[-0.029]	[0.193]	[0.147]
District Choice School				
Dist 0.5-1* District Choice	-1.164***	-1.185***	-1.329***	-1.370***
	(0.049)	(0.049)	(0.047)	(0.047)
	[-0.533]	[-0.537]	[-0.643]	[-0.655]
Dist 1-1.5* District Choice	-1.511***	-1.575***	-1.530***	-1.635***
	(0.096)	(0.096)	(0.083)	(0.084)
	[-0.640]	[-0.659]	[-0.676]	[-0.711]
Dist>1.5* District Choice	-1.444***	-1.516***	-1.589***	-1.647***
	(0.083)	(0.084)	(0.065)	(0.066)
	[-0.641]	[-0.667]	[-0.751]	[-0.767]
Bus* District Choice School	0.085**	0.042	0.066*	0.008
	(0.035)	(0.035)	(0.034)	(0.034)
	[0.038]	[0.019]	[0.031]	[0.004]
Dist 0.5-1* District Choice*Bus	0.178***	0.166***	0.291***	0.279***
	(0.058)	(0.058)	(0.055)	(0.055)
	[0.081]	[0.075]	[0.142]	[0.134]
Dist 1-1.5* District Choice*Bus	0.169*	0.162	0.071	0.080
	(0.102)	(0.103)	(0.090)	(0.091)
	[0.078]	[0.074]	[0.034]	[0.038]
Dist>1.5* District Choice*Bus	-0.088	-0.108	0.022	-0.066
	(0.089)	(0.090)	(0.072)	(0.072)
	[-0.039]	[-0.048]	[0.010]	[-0.031]
School Characteristics				
School Quality		0.441***		0.357***
		(0.052)		(0.051)
		[0.164]		[0.141]
Enrollment		0.039***		0.054***
		(0.002)		(0.002)
		[0.211]		[0.325]
Percent Black Students		-0.001		-0.003***
		(0.001)		(0.001)
		[-0.257]		[-0.067]
Percent Hispanic Students		0.006***		0.002***
		(0.001)		(0.001)
		[0.177]		[0.059]

Table 7 Continued

Percent White Students		0.009***		0.005***
		(0.001)		(0.001)
		[0.137]		[0.071]
Percent F/RPL		-0.001***		-0.003***
		(0.000)		(0.000)
		[-0.066]		[-0.164]
Percent SWD		-0.011***		-0.008***
		(0.002)		(0.001)
		[-0.173]		[-0.132]
Percent LEP		0.002***		0.002
		(0.001)		(0.001)
		[0.022]		[0.016]
Teachers<3 Yrs Exp		0.003***		0.002***
		(0.001)		(0.001)
		[0.042]		[0.035]
Teachers with Master's +		0.000		-0.000
		(0.001)		(0.001)
		[0.009]		[-0.009]
Observations	469,885	469,885	539,615	539,615

Notes: Standard errors are presented in parentheses and elasticities are presented in brackets. Standard errors are clustered at the student level. Some schools are missing ELA and math proficiency rates. In the kindergarten sample, the only schools missing this data are K-2 schools. In the 3rd grade sample, this is because these schools are just beginning to offer 3rd grade in 2017, but they have been open in previous years for other grades. Zoned schools is an indicator for zoned elementary schools, while district choice schools are traditional public schools other than their own zoned schools or charter schools.

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

Table 8: RD Results for the Impact of the Bus on School Choice by School Type

Panel A: Baseline Model

	Kindergarten			3rd Grade	
	(1)	(2)	(3)	(4)	(5)
	Zoned	Charter	District Choice	Charter	District Choice
Bus	0.035**	0.029**	-0.003	0.029***	-0.005*
	(0.018)	(0.013)	(0.005)	(0.008)	(0.003)
	[0.047]	[0.414]	[-0.060]	[0.725]	[-0.25]
Observations	33,661	24,612	78,363	27,893	73,534
R-Squared	0.010	0.012	0.013	0.005	0.003
Mean	0.74	0.07	0.05	0.04	0.02

Panel B: Heterogeneous Effects by School Performance

	Kindergarten			3rd Grade	
	(1)	(2)	(3)	(4)	(5)
	Zoned	Charter	District Choice	Charter	District Choice
Bus*High Performing	0.063***	0.038**	-0.004	0.030***	-0.003
	(0.019)	(0.016)	(0.011)	(0.010)	(0.004)
	[0.085]	[0.543]	[-0.080]	[0.750]	[-0.150]
Bus*Lower Performing	0.022	0.025*	-0.002	0.028***	-0.005**
	(0.019)	(0.013)	(0.005)	(0.008)	(0.003)
	[0.030]	[0.357]	[-0.040]	[0.700]	[-0.250]
Observations	33,661	24,612	78,363	27,893	73,534
R-Squared	0.018	0.012	0.014	0.005	0.003
Mean	0.74	0.07	0.05	0.04	0.02

Notes: Robust standard errors presented in parentheses. All results estimated using a 0.25 bandwidth (distance range 0.25-0.75 miles for kindergarten students and 0.75-1.25 for 3rd grade students) with distance and distance squared on either side of the bus eligibility threshold. Models also include student characteristics (race/ethnicity, gender, student disability status, limited English proficiency, and primary language spoken at home) and school fixed effects. In Panel B, high performing schools are schools whose average ELA and math proficiency rates are in the 75th percentile of performance. Lower performance schools are those which have an average ELA and math proficiency rate below the 75th percentile.

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

Appendix

A.1 Calculating Elasticities

To establish the economic significance of the impacts on school choice, we need to calculate elasticities. For continuous variables, the marginal impacts are

$$\text{Own effect: } \frac{\partial P_k(w,x)}{\partial w_{km}} = \beta_m \cdot P_k(w,x) \cdot \left(1 - P_k(w,x)\right) \;\; k = 1,\ldots,J_a, \;\; m = 1,\ldots,M$$

and

$$\text{Cross effect: } \frac{\partial P_k(w,x)}{\partial w_{jm}} = -\beta_m \cdot P_k(w,x) \cdot P_j(w,x) \;\; j \neq k, \;\; m = 1,\ldots,M$$

where $P_k(w,x) = P(s_i = k | w_k, x_i)$ and M is the number of explanatory variables. Typically, these are evaluated for each individual and the average is taken. But note that there is a separate impact for a marginal increase in w_m for each potential choice as marginally increasing w_m can have a different effect on P_k. Essentially, we have a MxM matrix of impacts for a given attribute. But because we do not differentiate between choices, we have two impacts to calculate: the own effects and cross effects.

The elasticity is (multiplying by w_{km}/P_j)

$$\frac{\partial \log P_j(w,x)}{\partial \log w_{km}} = w_{km}\beta_m \cdot \left(1(j = k) - P_j(w,x)\right) \;\; j = 1,\ldots,K, \;\; m = 1,\ldots,M$$

where 1(j=k) is the indicator for j = k. Again, we have an own- and cross-elasticity for each attribute that are evaluated by taking averages across all individuals and choices.

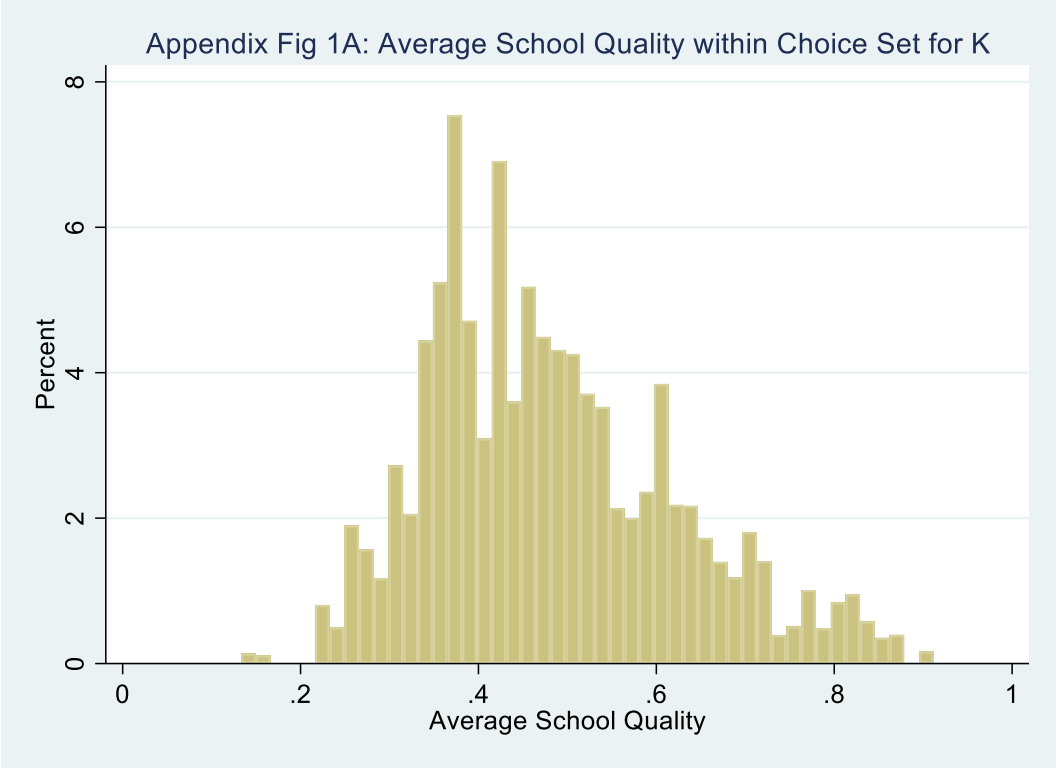
For binary variables w, we calculate the difference in probabilities for w=1 and w=0

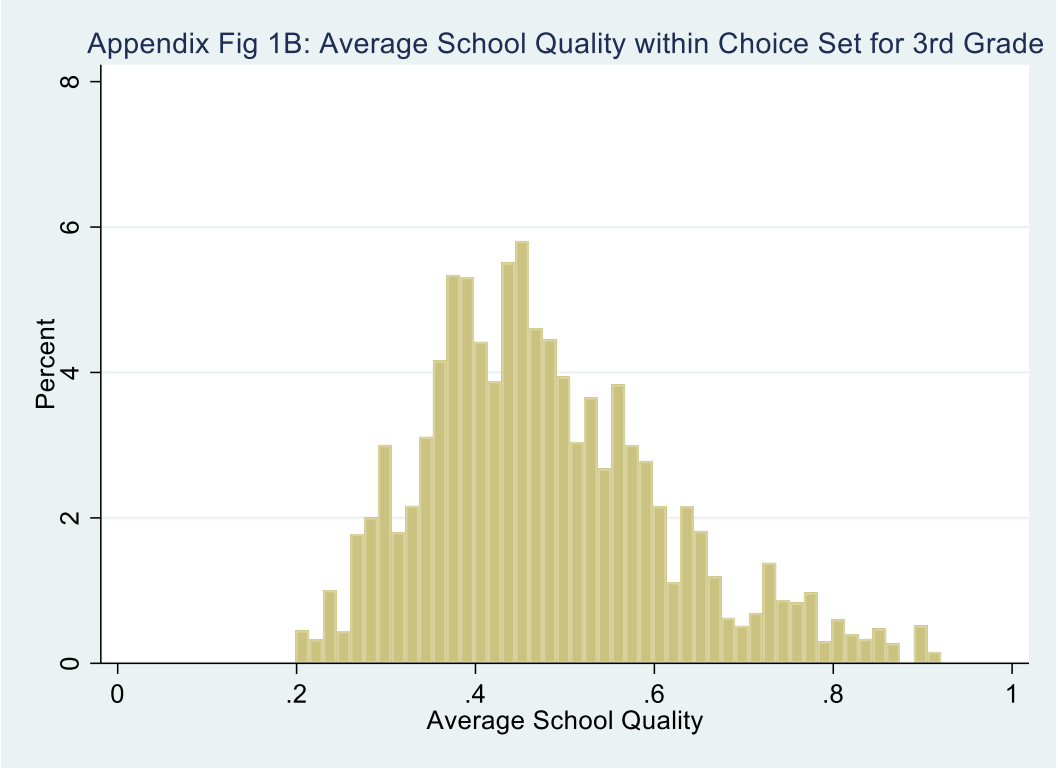
$$\text{Own effect: } = P(s_i = k|w_{km} = 1, w, x_i) - P(s_i = k|w_{km} = 0, w, x_i)$$
$$= \frac{\exp(\beta w_{k,p\neq m})\exp(\beta_m)}{\sum_{j\neq k}^{K}\left(\exp(\beta w_j)\right) + \exp(\beta w_{k,p\neq m})\exp(\beta_m)} - \frac{\exp(\beta w_{k,l\neq m})}{\sum_{j\neq k}^{K}\left(\exp(\beta w_j)\right) + \exp(\beta w_{k,p\neq m})} \qquad m = 1,\ldots,M$$

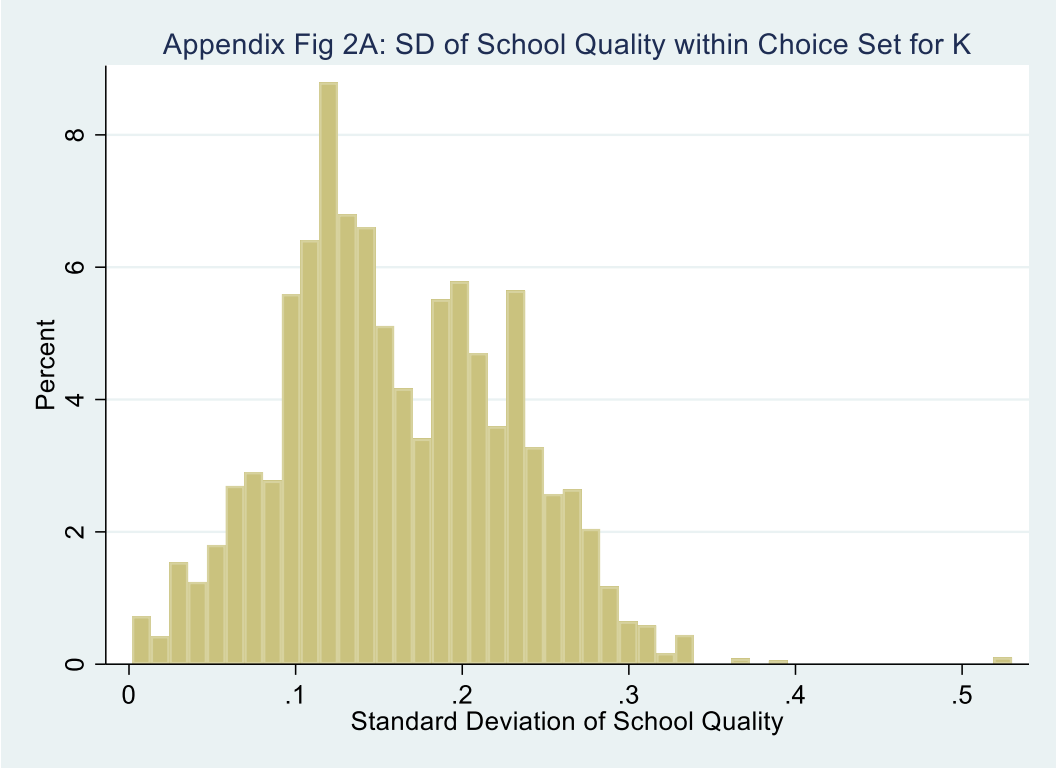
and

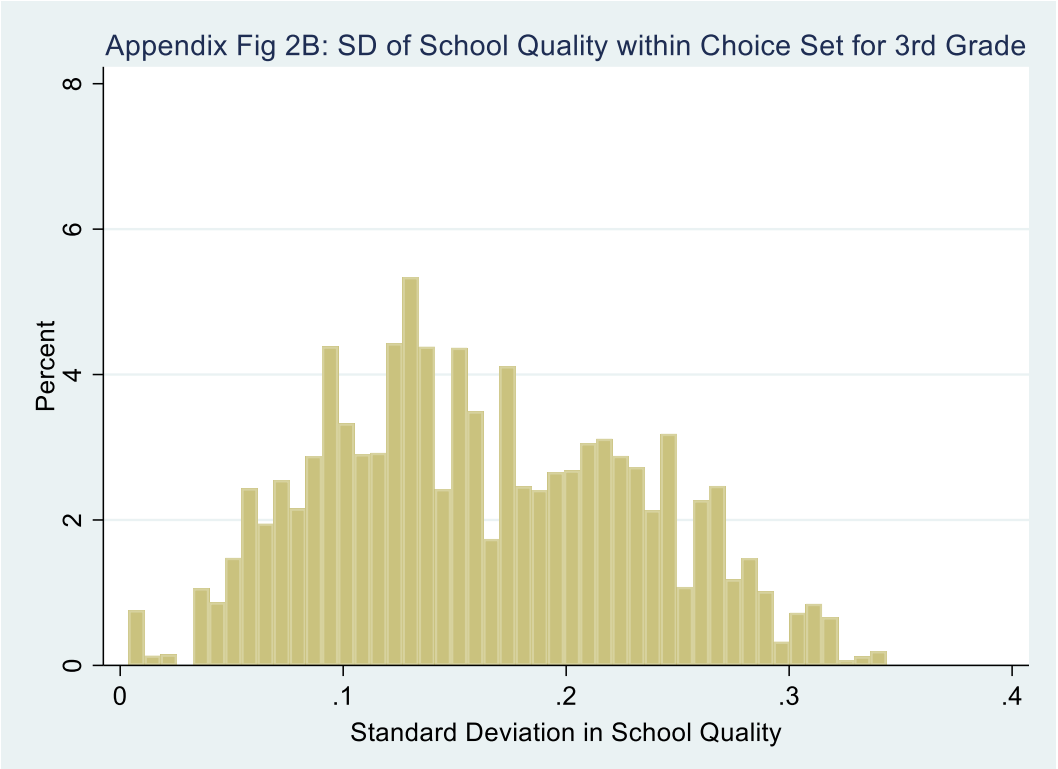
$$\text{Cross effect: } = P(s_i = j|w_{km} = 1, w, x_i) - P(s_i = j|w_{km} = 0, w, x_i)$$
$$= \frac{\exp(\beta w_j)}{\sum_{h\neq k}^{K}\left(\exp(\beta w_h)\right) + \exp(\beta w_{k,p\neq m})\exp(\beta_m)} - \frac{\exp(\beta w_j)}{\sum_{h\neq k}^{K}\left(\exp(\beta w_h)\right) + \exp(\beta w_{k,p\neq m})} \qquad j \neq k,\ m = 1,\ldots,M$$

The semi-elasticity would be (the mean of) these expressions divided by the mean of P.


Appendix Fig 1A: Average School Quality within Choice Set for K
Percent
0
2
4
6
8
0
.2
.4
.6
.8
1
Average School Quality


Appendix Fig 1B: Average School Quality within Choice Set for 3rd Grade
Percent
0
2
4
6
8
0
.2
.4
.6
.8
1
Average School Quality


Appendix Fig 2A: SD of School Quality within Choice Set for K
Percent
0
2
4
6
8
0
.1
.2
.3
.4
.5
Standard Deviation of School Quality


Appendix Fig 2B: SD of School Quality within Choice Set for 3rd Grade
Percent
0
2
4
6
8
0
.1
.2
.3
.4
Standard Deviation in School Quality

Appendix Table 1: Distance Effects - School Choice Models by School Type

	Kindergarten			3rd Grade		
	(1) Zoned	(2) Charter	(3) District Choice	(4) Zoned	(5) Charter	(6) District Choice
dist10_15	-0.042***	-0.074***	-0.023	-0.021**	-0.032	-0.063***
	(0.010)	(0.028)	(0.022)	(0.010)	(0.027)	(0.022)
dist15_20	-0.057***	-0.106***	-0.080***	-0.049***	-0.039	-0.069***
	(0.010)	(0.025)	(0.020)	(0.010)	(0.024)	(0.021)
dist20_25	-0.055***	-0.103***	-0.112***	-0.068***	-0.062***	-0.095***
	(0.009)	(0.025)	(0.019)	(0.010)	(0.024)	(0.020)
dist25_30	-0.053***	-0.123***	-0.123***	-0.066***	-0.087***	-0.115***
	(0.010)	(0.024)	(0.019)	(0.010)	(0.023)	(0.020)
dist30_35	-0.072***	-0.143***	-0.152***	-0.081***	-0.093***	-0.123***
	(0.010)	(0.024)	(0.018)	(0.010)	(0.023)	(0.020)
dist35_40	-0.051***	-0.145***	-0.165***	-0.078***	-0.082***	-0.146***
	(0.010)	(0.024)	(0.018)	(0.010)	(0.023)	(0.020)
dist40_45	-0.077***	-0.158***	-0.176***	-0.095***	-0.109***	-0.163***
	(0.010)	(0.024)	(0.018)	(0.011)	(0.023)	(0.020)
dist45_50	-0.075***	-0.164***	-0.182***	-0.087***	-0.117***	-0.170***
	(0.011)	(0.024)	(0.018)	(0.011)	(0.023)	(0.020)
dist50_55	-0.082***	-0.181***	-0.192***	-0.086***	-0.122***	-0.181***
	(0.012)	(0.024)	(0.018)	(0.012)	(0.022)	(0.020)
dist55_60	-0.103***	-0.186***	-0.193***	-0.126***	-0.121***	-0.181***
	(0.013)	(0.024)	(0.018)	(0.013)	(0.022)	(0.020)
dist60_65	-0.105***	-0.184***	-0.197***	-0.142***	-0.130***	-0.188***
	(0.014)	(0.024)	(0.018)	(0.014)	(0.022)	(0.020)
dist65_70	-0.104***	-0.192***	-0.202***	-0.139***	-0.139***	-0.195***
	(0.015)	(0.024)	(0.018)	(0.016)	(0.022)	(0.020)
dist70_75	-0.102***	-0.186***	-0.198***	-0.155***	-0.127***	-0.193***
	(0.016)	(0.024)	(0.018)	(0.017)	(0.022)	(0.020)
dist75_80	-0.078***	-0.185***	-0.205***	-0.120***	-0.133***	-0.198***
	(0.017)	(0.024)	(0.018)	(0.018)	(0.022)	(0.020)
dist80_85	-0.079***	-0.197***	-0.206***	-0.096***	-0.140***	-0.196***
	(0.020)	(0.023)	(0.018)	(0.020)	(0.022)	(0.020)
dist85_90	-0.094***	-0.194***	-0.209***	-0.104***	-0.144***	-0.197***
	(0.022)	(0.024)	(0.018)	(0.022)	(0.022)	(0.020)
dist90_95	-0.119***	-0.193***	-0.205***	-0.083***	-0.145***	-0.201***
	(0.025)	(0.023)	(0.018)	(0.025)	(0.022)	(0.020)
dist95_100	-0.113***	-0.200***	-0.205***	-0.091***	-0.139***	-0.202***
	(0.029)	(0.023)	(0.018)	(0.028)	(0.022)	(0.020)
dist100_105		-0.204***	-0.209***		-0.136***	-0.202***
		(0.023)	(0.018)		(0.022)	(0.020)
dist105_110		-0.199***	-0.210***		-0.138***	-0.204***
		(0.024)	(0.018)		(0.022)	(0.020)
dist110_115		-0.194***	-0.210***		-0.138***	-0.201***
		(0.024)	(0.018)		(0.022)	(0.020)
dist115_120		-0.200***	-0.208***		-0.145***	-0.204***
		(0.024)	(0.018)		(0.022)	(0.020)

Appendix Table 1 Continued

dist120_125		-0.197***	-0.209***		-0.142***	-0.200***
		(0.024)	(0.018)		(0.022)	(0.020)
dist125_130		-0.208***	-0.209***		-0.148***	-0.198***
		(0.023)	(0.018)		(0.022)	(0.020)
dist130_135		-0.198***	-0.208***		-0.145***	-0.201***
		(0.024)	(0.018)		(0.022)	(0.020)
dist135_140		-0.198***	-0.211***		-0.144***	-0.199***
		(0.024)	(0.018)		(0.022)	(0.020)
dist140_145		-0.204***	-0.207***		-0.151***	-0.201***
		(0.024)	(0.018)		(0.022)	(0.020)
dist145_150		-0.201***	-0.207***		-0.145***	-0.198***
		(0.024)	(0.018)		(0.022)	(0.020)
Observations	54,822	66,654	167,760	55,113	68,118	191,448
R-Squared	0.003	0.018	0.023	0.006	0.014	0.024

Notes: Robust standard errors presented in parentheses. The reference group for all models is students within 0.10 miles from school.

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