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Public School Choice and Student Achievement in the District of Columbia

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Abstract

This study examines the multi-faceted public school choice environment in the District of Columbia and the effects of alternative public schools on the achievement levels of students who exercise this type of school choice. The results indicate that students who attend out-of-boundary public schools and charter schools significantly outperform similar students who attend in-boundary public schools in both reading and math tests. We rely on instrumental variables framework to disentangle the underlying reasons behind this achievement gap and find that the observed differences are likely due to the positive effects of alternative public schools.

Introduction

One of the longstanding and highly debated proposals to improve primary and secondary public education in the United States is to expand schooling options available to parents with the use of school choice reforms. Such reforms extend the traditional Tiebout choice, in which residential choice implies school choice, by providing various alternatives to the household's 'neighborhood' public school. These alternatives include private schools (via e.g. private school voucher programs), new publicly funded schools (charter and magnet schools), or other traditional public schools (open enrollment programs which make out-of-boundary schools available to nonresidents).

Many leading economists advocate that such market-based educational systems (market-based in the sense that parents 'shop' for schools) are efficiency-enhancing because they induce competition between schools and potentially produce better student-school matches.[1] Furthermore, increasing parental choice can also be regarded as increasing equality of opportunity, since it serves to level the playing field in terms of access to high-quality education for disadvantaged students who cannot otherwise afford the higher-quality schooling options. Opponents, on the other hand, argue that school choice reforms hinder the progress of low-performing public schools by attracting the 'best' students (i.e. cream-skimming effect) and withholding much needed funds as students depart and enrollment numbers decline.[2]

Increasing parental choice, especially in the form of alternative public schooling options (e.g. open enrollment and charter schools), has been one of the leading themes of recent educational policy in the United States. As of 2010, 33 states had passed legislation mandating school districts to implement intra-district or inter-district school choice programs, which allow parents to send their children to traditional public schools outside of the neighborhoods they reside (ECS 2010). Furthermore,

[1] Some examples are Friedman (1955), Becker (1995) and Hoxby (2003).
[2] Epple and Romano (1998, 2003).

since the enactment of the first charter school legislation in Minnesota in 1991, the number of charter schools nationwide has soared from 2 in 1992 to 4,400 in 2007, serving approximately 1.3 million students (3 percent of all public school students in the United States). There is also an increasing trend in the percentage of households participating in public school choice programs. Between 1993 and 2007, the percentage of students attending a public school other than their neighborhood school increased from 11 percent to 16 percent in the United States (Aud et al. 2010). In 2007, nearly one-fourth of all inner-city primary and secondary school students nationwide attended a 'chosen' public school.

Do students who attend alternative public schooling options outperform 'similar' students who stay behind in standardized tests and if so, how much of the difference can be attributed to public school choice? In this paper, we address these questions using the multi-faceted school choice environment in the District of Columbia (DC). DC has been one of the frontrunners in terms of the variety and number of alternative public schooling options made available to parents.[3] Currently, the District of Columbia Public Schools (DCPS) offers an expansive intra-district school choice program that enables each public school student to apply for a seat in any public school in DC regardless of his/her residential location. Furthermore, each student has the right to submit an application to any of the 99 charter school campuses that serves the student's grade. During the 2008-09 school year only 34 percent of the public school students in DC attended their in-boundary public schools whereas 31 percent attended an out-of-boundary public school and 35 percent attended a charter school (out of 73,177 total students in DCPS or public charters). Another appealing feature of DC for this analysis is

[3] For a detailed descriptive analysis of the public school choice environment in the District of Columbia, see Ozek (2010).

that economically disadvantaged students, who typically constitute the target student group of school choice programs, constitute a disproportionately high fraction of DC public school students.[4]

We are reluctant to simply compare test scores of students at neighborhood schools to those at out-of-boundary schools and charter schools, because of the highly selective nature of exercising choice. Using the entire elementary and middle school student population attending 4th through 8th grades in 2008 and 2009 in DC public schools (traditional and charter), ordinary regression estimates suggest that students who attend alternative public schooling options indeed outperform comparable students (controlling for student differences along observable dimensions) who stay in their assigned public schools by one-tenth of the standard deviation in reading and math tests. However, this finding does not necessarily reflect pure benefits of choice on achievement as the former group is expected to differ from the latter in ways that we do not observe (e.g. parental involvement, educational motivation) that simultaneously affect the decision to exercise choice and student achievement.[5] That is, if we were to randomly assign a student to one of those school types, the expected difference is not well estimated by this simple regression.

Two empirical approaches dominate the previous literature on the effects of public school choice on student achievement, yielding mixed results. Some studies that employ instrumental variables technique suggest benefits of choice on achievement (Evans and Schwab 1995), whereas others find little or no benefits associated with public school choice (Cullen, Jacob, and Levitt 2005; Sander 1996; and Neal 1997). Another line of research makes use of random lotteries, which are typically conducted to determine assignments at 'over-demanded' schools, as a means of finding the causal link between access to sought-after public schools and student outcomes. Comparing highly-demanded traditional

[4] Specifically, in the 2007-08 school year 63 percent of all public school students in DC were free or reduced-price lunch (FRL) eligible, compared to the nationwide inner-city school district average of 56 percent (NCES 2008).
[5] In fact, Cullen et al. (2005) provided substantial evidence that 9th graders in Chicago Public Schools who opt out of their assigned high schools differ considerably from those who stay behind, along the responses of a survey conducted at the end of the 8th grade.

public high school lottery-winners and losers along various dimensions in Chicago Public Schools, Cullen et al. 2006) reveal no significant effect on traditional academic measures; yet find some benefits on behavioral outcomes such as disciplinary incidents. On the other hand, recent studies on charter schools in New York City and Boston reveal significant benefits associated with attending sought-after public charter schools on student test scores (Abdulkadiroglu et al. 2009 and Hoxby and Murarka 2009).[6]

This study utilizes the former strategy and employs proximity to alternative public schooling options as a source of exogenous variation that underlies why some students exercise choice and others do not. First, we show that proximity to public alternatives is a significant predictor of opting out of the in-boundary public school. Results using an Instrumental Variables technique, instrumenting for school type with measures of distance to schools, indicate that the observed benefits of exercising school choice on student achievement are even stronger when selection is taken into account, with differences estimated to be about half again as large as the simple regression estimates.

Public School Choice in DC: Policy Background

In order to estimate the effects of public school choice on student achievement, we examine the school choice environment in DC. Currently, based on residential address and grade level, each student residing in DC is assigned an 'in-boundary' public school, for which her admission is guaranteed.[7] There are two mechanisms through which a student is allowed to attend a public school other than her in-boundary school: the intra-district choice program operated by DCPS and charter schools controlled and regulated by the District of Columbia Public Charter School Board (DC-PCSB). These two mechanisms provide numerous public schooling opportunities and enable each student to apply for a seat in any public

[6] Using propensity score matching, another recent study by Witte et al. (2010) finds 'few' significant effects of charter school attendance on achievement growth in reading and math. For a brief review of the literature on charter school effectiveness as well as policy suggestions as to how to increase the number of effective charter schools, please see the recent Brookings Institution report on charter schools by Dynarski et al. (2010).

[7] Since the 2009-10 school year, students also have had the right to attend 'destination' schools, into which their current DCPS school feeds, even if they are different from their neighborhood schools.

school (traditional or charter) within the boundaries of DC, regardless of her residential location. Table 1 presents the number of public schools by grades served for 2008-09, displaying the extent of public school choice in DC.

Under the current intra-district school choice plan of DCPS, any student who does not wish to attend his/her 'in-boundary' public school can participate in the out-of-boundary lottery by submitting a list of preferred public schools to DCPS, which can include any traditional public school that serves the student's grade. Given the submitted student preferences, a single random lottery is conducted and applicants at each school and grade are ranked first by their 'priority category' and then by their lottery outcomes.[8] Each student is then admitted to his/her highest choice for which she has high enough priority ranking and placed in the waiting list for her other preferred schools.

In addition to the traditional public schooling options provided by the intra-district choice program, each student has the right to submit an application to any charter school that serves the student's grade. If the number of applicants exceeds the number of available seats at a given charter school-grade, the school conducts a public lottery to determine assignments. Once a student is admitted to an out-of-boundary or a charter school, he/she has the right to attend that school until the terminal grade. Figure 1 presents public school locations in DC by ward for 2008-09 school year.

Data

For this study, we constructed a unique dataset that covers all PS-12 public school students (traditional and charter) for school years between 2000-01 and 2008-09 in DC. The dataset comprise three major components: Multi-year Enrollment Audit Database (MEAD), which includes student characteristics (e.g. ethnicity, gender, free or reduced lunch eligibility, student name) for every public school student

[8] Under the current open enrollment plan, the following priority categories are used in DCPS: (1) applicants who have siblings attending that school; (2) applicants who live in the walk-zone (within 3 blocks for elementary school students and 5 blocks for middle and high school students); and (3) all others.

between 2001 and 2009; DC Comprehensive Assessment System (DC CAS), which contains detailed standardized test scores in reading and math for all students in tested grades (3 through 8 and 10) for years between 2007 and 2009; and residential addresses for all public school students in 2008 and 2009. We restrict the analysis to elementary and middle school students in grades 4 through 8 to avoid the selection bias due to high school drop-outs, and to those with non-missing residential addresses, since we use addresses to identify in-boundary schools and to construct the instrument. These restrictions leave 38,458 observations.

The descriptive statistics presented in Table 2 indicate that nearly 70 percent of all students in the sample come from economically disadvantaged families and 95 percent are racial/ethnic minorities, generating an interesting case to examine in school choice context. Only 37 percent of the sample attended their in-boundary public schools, whereas 34 percent attended a charter school and 29 percent took advantage of the intra-district choice program and attended an out-of-boundary traditional public school (out of boundary attendance is greater at older ages). Students who exercise public school choice, on average, perform better in standardized tests, are similar in terms of free or reduced lunch eligibility and are slightly more likely to be black compared to those who attend their in-boundary public schools.

Furthermore, public school choice programs in DC seem to be reaching out to their target student groups – economically disadvantaged students and students of racial and ethnic minorities. Approximately two-thirds of all black students exercise public school choice by opting out of their in-boundary schools whereas 60 percent of white students attend their zoned traditional public schools.[9] Findings also suggest that students residing in high-poverty areas tend to take advantage of the alternative schooling options at significantly higher rates compared to others. For instance, only 33

[9] Participation rates also indicate considerable variation across wards of residence: 85 percent of all students in Ward 3 attend their zoned public schools whereas 74 percent of students residing in Ward 5 exercise public school choice.

percent of students residing in census tracts with median household income lower than $40,000 attend their assigned traditional public schools whereas that number is 73 percent for those with census tract median income higher than $60,000.

Empirical Framework

In this study, we address two questions regarding public school choice. First, we examine whether students who exercise choice outperform 'similar' student who attend their in-boundary public schools. Second, we attempt to determine how much of this difference can be attributed to public school choice rather than unobserved student characteristics. In order to answer the former question, we estimate the following equation using OLS:

$$y_{it} = \beta_0 + \beta_1 OB_{it} + \beta_2 CH_{it} + \beta_3 PA_{it} + \beta_4 X_{it} + \beta_5 R_{it} + \beta_6 H_{it} + \varepsilon_{it} \quad (1)$$

where y_{it} represents the end-of-year test score of student *i* during year *t* standardized to mean zero and unit variance; OB_{it} and CH_{it} are indicators for students who attend out-of-boundary public and charter schools in year *t*; PA_{it} represents the vector of previous achievement variables; X_{it} denote the student characteristics; R_{it} represents student's residential characteristics; and H_{it} represents household characteristics.[10]

[10] Previous achievement variables include prior year standardized reading and math scores and proficiency indicators; student characteristics include race/ethnicity, gender, free or reduced price lunch eligibility, English proficiency, special education and grade retention indicators, indicators for whether the student's in-boundary school was closed or merged at the end of the previous school year, and the number of in-boundary public schools assigned to those students as well as grade and year fixed effects; residential characteristics include the population density, percent of population under 17, percent homeowner, log median income at the census tract level, property and violent crime rates per 1,000 residents at the neighborhood cluster level, average reading and math scores, number of traditional public and charter schools, percent with less than high school degree, with high school degree, with less than college degree, and with college degree at the census tract block level, number of waitlisted students at the in-boundary school before 2009-10 school year, log driving distance to the in-boundary school, and ward fixed-effects; and household characteristics include average prior year reading and math scores, number of school-aged children, number of children attending out-of-boundary public or charter schools at the household level.

Despite the extensive set of covariates we employ in this analysis, it is hard to draw a causal link between school choice and achievement due to other unobservable student characteristics such as parental involvement and educational motivation that are likely to affect the decision to exercise choice as well as student outcomes simultaneously. Therefore, in order to address the second question, we rely on instrumental variables approach and exploit proximity to alternative schooling options as a source of exogenous variation that affects student outcomes only through its effect on school choice decision. Proximity is expected to be a strong predictor of exercising alternative public schooling options in DC, since, regardless of the type of public school a student attends (in-boundary public, out-of-boundary public or a charter school), residence-to-school transportation is not provided unless the student has special needs.

Naturally, households' residential choices as well as school locations, especially for charter schools, are not random. While complete residential stratification by educational 'tastes' as predicted by the Tiebout model is not typical, differences in unobserved household characteristics such as parental involvement across residential locations are commonly observed in practice. Likewise, differences in household characteristics might also explain why public schools, especially charter schools, are concentrated in certain regions as observed in Figure 1. Therefore, it is quite likely that proximity to public alternatives is correlated with the error term in (1), which, in turn, leads to biased estimates in the IV framework. We deal with this issue using an extensive set of residential controls such as ward fixed-effects and various covariates capturing differences in demographics, education, income, crime rate, in-boundary school quality, student achievement and availability of public schooling options across neighborhood clusters, census tracts and census tract blocks. The implicit assumption we make throughout the rest of the analysis is that these covariates are sufficient to capture all unobserved

factors that affect student achievement and are correlated with proximity to alternative public schooling options.[11]

There are two other important limitations of this study. First, this study ignores the possibility that, in the absence of choice, students could exercise Tiebout choice, i.e. could opt out of their in-boundary schools by relocating, or take advantage of private schooling options[12]. This limitation makes it hard to compare the well-being of the opt-out students in the presence and the absence of public school choice. Furthermore, if the increasing competition between public schools, which is expected to affect low-performing public schools disproportionately, leads to an improvement in the overall quality of public education, the IV results will provide underestimates of the true impact of opting out on test scores.

In order to exploit the binary nature of the endogenous variable in the IV analysis and improve efficiency, we utilize the two stage procedure proposed by Wooldridge (2002) in the estimation. We first estimate the following first stage equations using probit:

$$OB_{it} = \beta_0 + \beta_1 Z_{it} + \beta_2 PA_{it} + \beta_3 X_{it} + \beta_4 R_{it} + \beta_5 H_{it} + \varepsilon_{it} \quad (2)$$

$$CH_{it} = \beta_0 + \beta_1 Z_{it} + \beta_2 PA_{it} + \beta_3 X_{it} + \beta_4 R_{it} + \beta_5 H_{it} + \varepsilon_{it} \quad (3)$$

where Z_{it} represents the vector of instruments, i.e. log driving distance to the closest out-of-boundary public school and log driving distance to the closest charter school. We then obtain the first stage predicted probabilities and use them as instruments in the second stage. Given that the conventional IV assumptions are satisfied, this approach provides consistent estimates regardless of the model chosen for the first stage (i.e. probit or logit), and produces the efficient IV estimator if the chosen model is correct.

[11] A common practice in the literature to provide evidence of instrument exogeneity in this context is to test whether the instrument has any statistically significant impact on some 'uncontrolled' student characteristics (e.g. survey responses as in Cullen et. al. 2005). Unfortunately, due to data limitations, this approach is not feasible in this study.

[12] Roughly 20% of the entire K-12 student body in DC attends private schools.

Results

We first estimate equation (1) using OLS to determine whether students who attend alternative public schooling options actually outperform their 'staying' peers. Table 3 presents the estimates for β_1 and β_2, which indicate that students who attend out-of-boundary public schools score 9 percent of the standard deviation better in reading and 7 percent better in math compared to 'similar' students who attend their in-boundary public schools. Similar findings emerge for charter school students as well: those who attend charter schools outperform their 'staying' peers by one-tenth of the standard deviation in reading and 13 percent of the standard deviation in math.

Another interesting question in this context is whether these observed differences in student performance vary with respect to income and education levels of the students' residential neighborhoods. The findings presented in Table 4 suggest that the achievement gap between 'traveling' and 'staying' students is larger in 'disadvantaged' neighborhoods. While the estimates across neighborhoods are often statistically indistinguishable, the monotonically increasing pattern of point estimates for both β_1 and β_2 as we move from high education/ high income neighborhoods to the opposite side of the spectrum is apparent. For instance, in census tract blocks with more than 80 percent holding a high school degree, students who attend an out-of-boundary public school score roughly 4 percent of the standard deviation better in reading (5 percent in math) than 'similar' students who stay and both of these differences are statistically insignificant at conventional levels. On the contrary, in census tract blocks with less than 60 percent holding a high school degree, this achievement gap is statistically significant and equivalent to one-tenth of the standard deviation in both reading and math.

This pattern is even more evident for students attending charter schools. Charter school students residing in census tracts with median income less than $25,000 score 13 and 18 percent of the standard deviation higher in reading and math respectively compared to similar students who attend

their in-boundary public schools. On the other hand, there is no significant achievement gap between these two groups in census tracts with median income higher than $35,000. Similar results emerge when we use average education level to identify 'disadvantaged' neighborhoods.

There are two possible ways these findings can be interpreted. First, the observed differences in achievement between 'traveling' and 'staying' students might represent the actual benefits of public school choice programs. In that case, given the estimates presented in Table 4, one can also claim that these programs accomplish their ultimate goal of improving the achievement levels of disadvantaged students. However, these findings might also be the reflections of unobserved differences in student characteristics that simultaneously effect school choice decisions and student outcomes. In order to disentangle these two possibilities, we rely on IV framework.

Before focusing on the effects of public school choice on student achievement, we first examine the underlying determinants of exercising alternative public schooling, and estimate the first stage equations given in (2) and (3) using probit. Table 5 displays the marginal effect estimates for the notable covariates. Compared to whites, black students are 9 percent less likely to attend an out-of-boundary public school and 7 percent more likely to attend charter schools, and free or reduced lunch eligible students are significantly more likely to attend out-of-boundary public schools. The results also indicate that in-boundary school quality, which is partially captured by the number of waitlisted students at the beginning of the 2009-10 school year is an important factor in school choice decisions as expected. More specifically, one standard deviation increase in the number of waitlisted students at the in-boundary school reduces the likelihood of attending an alternative traditional public school by 6.5 percent and charter school by 4 percent.

In the District of Columbia, all public school students, regardless of the type of public school they attend (in-boundary, out-of-boundary or charter), are required to provide their own residence-to-school transportation unless the student has special needs. Given that the in-boundary public school is

0.08 miles closer to the average student than the closest out-of-boundary school and is 0.23 miles closer than the closest charter school, this requirement creates an additional cost for students who exercise choice. The findings reflect that this cost is realized by households when making their choices. For instance, all else constant, a 10 percent increase in the driving distance to the in-boundary school (corresponds to 0.08 miles at the mean) leads to a 77 percent increase in the probability of attending an out-of-boundary public school (38 percent for charter school attendance). More importantly for the IV analysis, distance to alternative public schools also matters: a 10 percent increase in the driving distance to the closest out-of-boundary public school (0.09 miles at the mean) decreases the probability of attending these schools by 80 percent and increases the likelihood of charter school attendance by 20 percent. Similarly, proximity to charter schools has a significant positive effect on charter school attendance and a negative impact on alternative traditional public schools. Number of school-aged children is also instrumental in households' school choices, which possibly reflect households' cost considerations. For instance, compared to students without any school-aged siblings, students with a sibling are 13 percent and students with 2 or more siblings are 22 percent less likely to attend an out-of-boundary public school. Likewise, the last two groups of students are 21 and 34 percent less likely to attend a charter school.

Another policy that seems to affect public school choice decisions is the sibling priority that is used in traditional public and charter school assignments. In other words, having an 'anchor' sibling attending a 'choice' public school has a significant effect on a student's likelihood of attending those schools. More specifically, students who have one sibling attending an out-of-boundary public school are 45 percent and students with 2 siblings attending these schools are 65 percent more likely to attend an out-of-boundary public school. Similarly, those with one sibling attending a charter school are 57 percent and students with 2 or more siblings attending a charter school are 68 percent more likely to

attend a charter school. Naturally, other than the effect of the sibling priority policy, these findings might also be reflecting educational preferences of households.

Finally, we turn our attention to the second stage results, which are reported in Table 6. The first stage test of joint significance reinforces the earlier finding that proximity to alternative public schools is strongly correlated with the likelihood of attending these schools.[13] The second stage estimates provide evidence that, aside from the effect of self-selection along unobservables, public school choice programs have a significant positive impact on the achievement levels of students taking advantage of these programs. Attending an out-of-boundary school, on average, leads to a 19 percent of the standard deviation increase in reading and 14 percent of the standard deviation increase in math compared to similar students who attend their in-boundary schools. Likewise, attending a charter school is associated with 16 and 15 percent of the standard deviation increases in reading and math respectively. The OLS point estimates are included in the IV confidence intervals, but the IV point estimates are substantially higher than OLS estimates and the lower bound of the OLS confidence interval is typically not included in the IV confidence interval, offering some evidence that OLS does not overstate the relative advantage of alternative public school options, and may even understate the advantage.

Conclusion

Public school choice programs such as open enrollment and charter schools, which break the link between parents' residential and school choices, have become increasingly popular nationwide during the last two decades. The main objective of such policies is to design a market-based public education system that improves economic efficiency by allowing parents to 'shop' for schools without relocating, in part by inducing competition between public schools.

[13] We repeat the same analysis using proximity to public transportation options (e.g. closest metro station, bus stop) as the instrument. While the first stage is weaker, the main conclusions remain unchanged.

This study examines the public school choice environment in the District of Columbia and the effects of public alternatives on the achievement levels of students who exercise this type of choice. Currently, by means of the open enrollment program and charter schools, any public school student in DC is allowed to apply for a seat in any public school within the boundaries of the district. Raw percentages reveal that households, especially in disadvantaged neighborhoods, take advantage of these alternative options. During the 2008-09 school year, only 34 percent of the public school students in DC attended their in-boundary public schools whereas 31 percent attended an out-of-boundary public school and 35 percent attended a charter school.

Using a two-year panel of all public school students in DC attending grades 3 through 8, simple regression analyses reveal that students who attend alternative public schools, on average, outperform similar students who attend their in-boundary public schools in reading and math tests by about a tenth of a standard deviation. Yet, such estimates might not necessarily reflect the contribution of public alternatives on exercising students' achievement levels, since unobservable student characteristics such as parental involvement and educational motivation might also explain these observed differences. In order to deal with this selection issue, we rely on instrumental variables framework and exploit student's residential proximity as a source of exogenous variation that affects student outcomes through its impact on the likelihood of choice participation.

The Instrumental Variables results indicate that the observed benefits of exercising school choice on student achievement are even stronger when selection is taken into account. On average, students who attend out-of-boundary public schools outperform 'similar' students who stay behind by 19 and 14 percent of the standard deviation, whereas those who attend charter schools score 15 and 16 percent of the standard deviation better in reading and math respectively. Students at these ages

typically gain about a third of a standard deviation per year on the current-year test, so these differences represent gains comparable to about six months of instruction.[14]

The gains estimated using Instrumental Variables are "local average treatment effects" and represent gains to those induced to attend an alternative public school by its proximity, i.e. we are not estimating gains for those who would not have attended an alternative public school regardless of its distance nor those who would have attended an alternative public school regardless of its distance. The target students here are in some sense "marginal" participants in alternative public schooling options, and one might expect that if all participants were rational, the marginal participants would have lower gains than the average participant. On the other hand, if there are substantial fixed costs to adjustment, or if those students who stand to gain most from alternative public schooling options are least well-informed about their potential gains, the gains of marginal participants could exceed the average participant's.

[14] Authors' calculations using ECLS-K data; results available on request.

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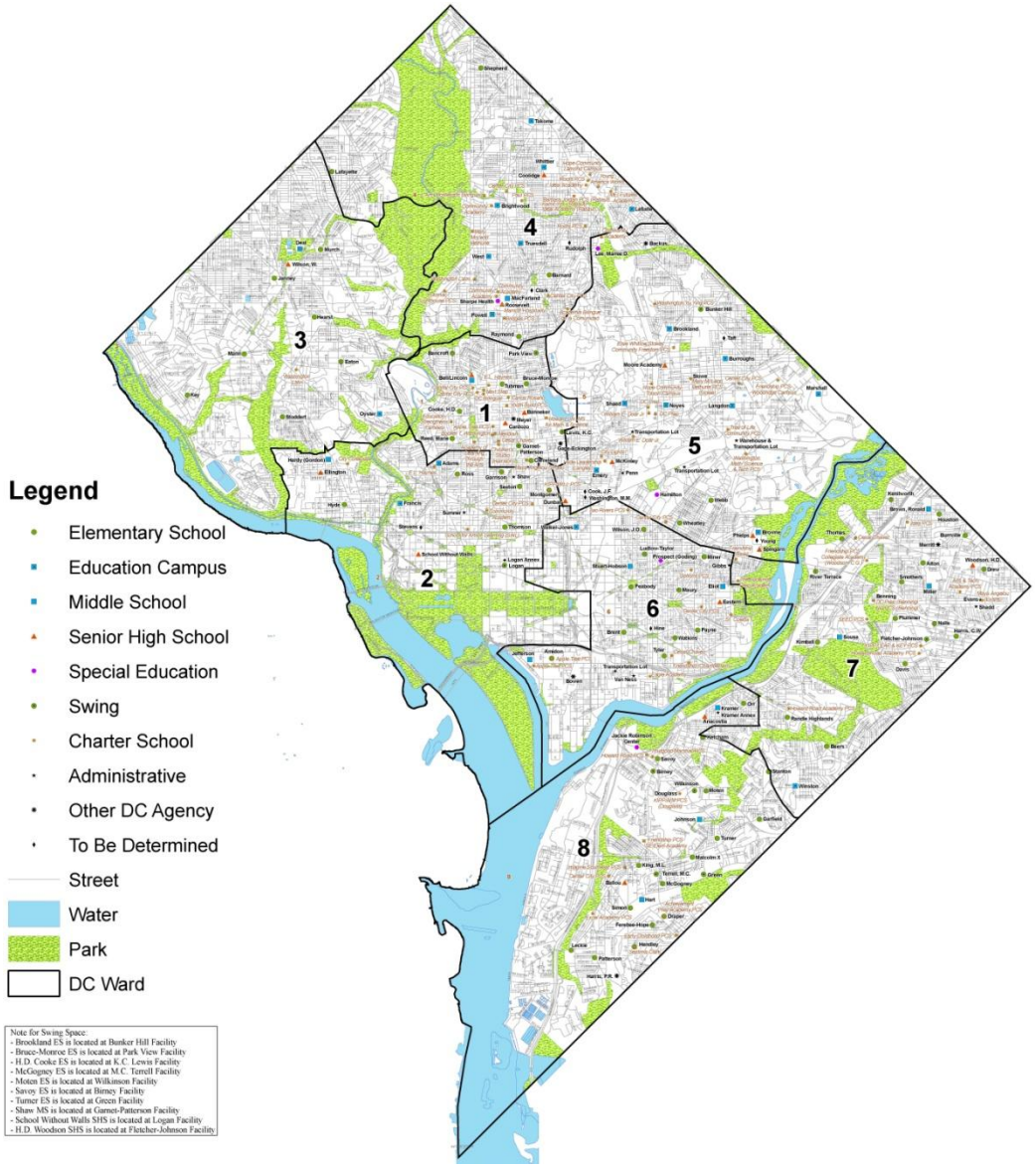
Tables and Figures

Table 1. Number of Public School Campuses in DC by Grades Served: 2008-09

	Grade														
	PS	**PK**	**KG**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Traditional Public	68	90	89	89	90	90	89	88	54	42	31	30	28	27	25
Charter	31	49	48	44	43	42	42	46	49	42	37	22	20	19	28
Total	99	139	137	133	133	132	131	134	103	84	68	52	48	46	53

Figure 1. Public Schools in DC, by Ward: 2008-2009



Source: http://dcps.dc.gov/DCPS/maps accessed on 10/08/2009.

Table 2. Descriptive Statistics Public School Students in DC - Grades 4-8

		By School Type		
	All Students	In-Boundary	Out-of-Boundary	Charter
Standardized reading score	0.018	-0.074	0.026	0.103
	(0.986)	(1.074)	(1.015)	(0.854)
Standardized math score	0.021	-0.088	0.013	0.139
	(0.992)	(1.054)	(1.01)	(0.895)
Attending out-of-boundary school	0.291			
	(0.454)			
Attending charter school	0.353			
	(0.478)			
Free or reduced lunch eligible	0.694	0.709	0.658	0.708
	(0.461)	(0.454)	(0.474)	(0.455)
White	0.048	0.085	0.033	0.023
	(0.214)	(0.279)	(0.18)	(0.15)
Black	0.843	0.805	0.825	0.898
	(0.363)	(0.396)	(0.38)	(0.303)
N	38,458	13,667	11,206	13,585

Table 3. Effects of Alternative Public Schools on Achievement OLS Results

	Reading Score	Math Score
Attending an out-of-boundary public school	0.085***	0.074***
	(0.021)	(0.023)
Attending a charter school	0.096***	0.13***
	(0.033)	(0.042)
N	37,799	37,767

Notes: For each regression, test scores are standardized to mean zero and unit variance. All regressions include the covariates listed in footnote 10. Robust standard errors, two-way clustered at the school and attendance area levels as described in Cameron et al. (2010), are given in the parentheses. *, ** and *** represent statistical significance at 10, 5 and 1 percent respectively.

Table 4. Effects of Alternative Public Schools on Achievement by Neighborhood Income Level OLS Results

	Reading Score		
	By Census Tract Median Household Income		
	> $35,000	$25,000-$35,000	< $25,000
Attending an out-of-boundary public school	0.076**	0.07***	0.099***
	(0.032)	(0.027)	(0.034)
	[0.269]	[0.296]	[0.283]
Attending a charter school	0.042	0.07**	0.135***
	(0.045)	(0.036)	(0.041)
	[0.289]	[0.383]	[0.375]

	Math Score		
	By Census Tract Median Household Income		
	> $35,000	$25,000-$35,000	< $25,000
Attending an out-of-boundary public school	0.07**	0.054*	0.089**
	(0.031)	(0.03)	(0.038)
Attending a charter school	0.05	0.1**	0.178***
	(0.046)	(0.043)	(0.053)
N	6,593	14,476	16,341

	Reading Score			
	By Census Block % Without HS Degree			
	< %20	%20-%30	%30-%40	> %40
Attending an out-of-boundary public school	0.041	0.057**	0.11***	0.104***
	(0.037)	(0.029)	(0.033)	(0.025)
	[0.264]	[0.303]	[0.289]	[0.279]
Attending a charter school	-0.006	0.085**	0.126***	0.127***
	(0.037)	(0.036)	(0.042)	(0.036)
	[0.288]	[0.372]	[0.406]	[0.348]

	Math Score			
	By Census Block % Without HS Degree			
	< %20	%20-%30	%30-%40	> %40
Attending an out-of-boundary public school	0.054	0.046	0.076**	0.104***
	(0.033)	(0.031)	(0.036)	(0.03)
Attending a charter school	0.049	0.113***	0.133***	0.185***
	(0.044)	(0.043)	(0.05)	(0.051)
N	6,231	9,305	11,949	9,943

Notes: For each regression, test scores are standardized to mean zero and unit variance. All regressions include the covariates listed in footnote 10. Robust standard errors, two-way clustered at the school and attendance area levels as described in Cameron et al. (2010), are given in the parentheses. Number of observations in each subgroup is given in brackets. *, ** and *** represent statistical significance at 10, 5 and 1 percent respectively.

Table 5. Who Attends Alternative Public Schooling Options? Probit Results – Marginal Effects

	Attending an out-of-boundary public	Attending a charter school
Black	-0.092***	0.066**
	(0.036)	(0.028)
Hispanic	0.029	-0.039
	(0.033)	(0.03)
Free or reduced lunch eligible	-0.075***	0.008
	(0.008)	(0.008)
Number of waitlisted students at the in-boundary	-0.005***	-0.003***
	(0.001)	(0.001)
Ln(distance to the in-boundary school)	0.077***	0.038***
	(0.009)	(0.008)
Ln(distance to the closest out-of-boundary)	-0.079***	0.021***
	(0.009)	(0.008)
Ln(distance to the closest charter)	0.016*	-0.059***
	(0.009)	(0.008)
Has one sibling	-0.128***	-0.210***
	(0.013)	(0.008)
Has 2 or more siblings	-0.221***	-0.335***
	(0.014)	(0.009)
Has one sibling attending out-of-boundary	0.445***	-0.017
	(0.022)	(0.013)
Has 2 or more siblings attending out-of-boundary	0.623***	0.016
	(0.026)	(0.02)
Has one sibling attending charter	-0.086***	0.574***
	(0.012)	(0.013)
Has 2 or more siblings attending charter	-0.089***	0.683***
	(0.022)	(0.011)
N	37,491	37,491

Notes: All regressions include the covariates listed in footnote 10. Robust standard errors, clustered at the attendance area level, are given in the parentheses. *, ** and *** represent statistical significance at 10, 5 and 1 percent respectively.

Table 6. Impact of Alternative Public Schools on Achievement IV Estimates

	Reading Score	Math Score
Attending an out-of-boundary public school	0.192***	0.140**
	(0.067)	(0.063)
Attending an out-of-boundary charter school	0.162**	0.152*
	(0.075)	(0.088)
F-stat of joint significance (excluded instruments)	25.04	16.06
N	37,799	37,767

Notes: For each regression, test scores are standardized to mean zero and unit variance. All regressions include the covariates listed in footnote 10. Robust standard errors, two-way clustered at the school and attendance area levels as described in Cameron et al. (2010), are given in the parentheses. *, ** and *** represent statistical significance at 10, 5 and 1 percent respectively.

Appendix. Estimating Expected Gains from ECLS-K

We use theta scores (revised per http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2010052) from the ECLS-K (Tourangeau et al. 2009) as approximately normally distributed measures of generic test score performance. The gains per year can be estimated as the weighted mean change in theta score from round 4 (end of grade 2) to round 5 (end of grade 3), from round 5 (end of grade 3) to round 6 (end of grade 5), and from round 6 (end of grade 5) to round 7 (end of grade 8). We divide these mean gains by the standard deviation of scores at the end date, and by the number of years elapsed, i.e. the gains between the end of grade 5 and the end of grade 8 are divided by the standard deviation of scores in grade 8 and the three years elapsed to give an average annual gain in standard deviation units. We also repeat this exercise, reweighting the original sample to represent the race and low-income status of the DC public school population (called re-raking in the survey methodology literature). More economically disadvantaged students like those in DC public schools start with scores below the national average, but exhibit comparable growth over time within their distribution.

	National	Distribution	Reweighted	Distribution
Grade	Math	Reading	Math	Reading
K-1	1.74	1.85	1.77	1.79
1-3	0.855	1.08	0.872	1.08
3-5	0.473	0.429	0.453	0.434
5-8	0.241	0.225	0.240	0.175
3-8	0.370	0.339	0.362	0.324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