The Impact of Charter Schools on Student Achievement

Caroline M. Hoxby*
and
Jonah E. Rockoff**
November, 2004

*Department of Economics, Harvard University, Cambridge, MA 02138. choxby@harvard.edu
**Columbia Business School, Uris 603, 3022 Broadway, New York, NY 10027; jonah.rockoff@columbia.edu

1 Introduction

In this study, we use data from the largest charter school system in the United States, which is located in Chicago, to investigate how students' achievement is affected by their attending charter schools. Determining how charter schools affect achievement is an important step in evaluating the state policies that have permitted almost 3000 charter schools to open in the United States since 1992, when the first was founded. Although charter schools enroll only a very small 1.5% of American students, 38 states have laws that support charter schools and charter enrollment continues to grow.[1]

There are a few things that all or most charter schools have in common. Like regular public schools, they are supported by public funds and may not charge tuition. Unlike regular public schools, they receive fees on a per student basis. Charter schools cannot select their students based on admissions tests or similar criteria. They obey many public school regulations, including testing and other requirements of states' accountability systems. On the other hand, charter schools are often exempt or partially exempt from regulations about teacher certification. Although all charter schools must be chartered by a public authority, the range of authorities depends on the state and may include a state board, school districts, and public universities.[2] The result is that charter schools are diverse. Most charter holders are non-profit organizations, teacher groups, or parent groups, but not all charter

[1] General information on charter schools and charter school laws is collected by the Center for Education Reform (www.edreform.com).

[2] Charter granting authority varies by state and is set by state law. Local school districts, state education departments, and other educational institutions (e.g., universities) are typically given the authority to grant charters.

holders manage their schools on a day-to-day basis. Many contract with school management organizations, which are most often non-profit but sometimes for-profit. Although all charter schools have open enrollment (if oversubscribed, they typically must hold lotteries) and a conventional academic curriculum, some charter schools have a curriculum that targets a certain student population, such as likely drop-outs, students who do badly in formal school settings, students who reject traditional curricula, or students interested in the arts.

Supporters cite two broad reasons why charter schools may provide higher quality education than traditional public schools. First, charter schools may be more flexible or innovative than regular public schools, and this may allow them to better serve student needs. Second, no student goes to a charter school unless his parents want him to go there, and funding is attached to individual students. Therefore, charter schools must attract parents in order to survive. The ability of parents to "vote with their feet" may be a form of accountability that raises school quality.[3]

Currently, there is very little credibly identified evidence on how students' achievement is affected by their attending charter schools. This may seem strange, given the importance of charter schools as a policy issue. However, researchers who attempt to provide evidence face a number of difficulties. Foremost is that charter schools are heterogeneous, as described above. Thus, we expect charter schools' "treatment" effects on student achievement to be heterogeneous. An evaluation of one group of charter schools can only shed light on the conduct of other charter schools with similar management and student populations.

Even if researchers choose to evaluate charter schools that are representative of a rea-

[3]Increased accountability, and competition, may also create pressure on traditional public schools to raise school quality. This issue, while important, is not the focus of this study.

sonable share of charter schools in the United States (as we do), they still face some other evaluation problems. Researchers want to know whether charter school students' achievement would have been different if they had not attended charter school. The counterfactual achievement is never directly observable, so charter schools must be evaluated by comparing the achievement of charter school students and other students. Identifying a good comparison group is important because students who apply to charter schools may be a non-random sample of students in the area. Students may apply to charter schools because (1) they are already doing badly in regular public school; (2) their performance is typical of their regular public school but it is a particularly bad school; (3) they are exceptionally able students who need resources or flexibility not offered by their regular public school; (4) their parents are highly motivated in a constructive (positive) way; or (5) their parents are highly motivated to intervene in a dysfunctional (negative) way. In short, students who apply to charter schools are likely to be self-selected, and a researcher who simply compares charter school students to all other local public school students is likely to produce results that suffer from self-selection bias.

In this study, we overcome the self-selection problems listed above by using the fact that state laws typically require charter schools to select students by lottery when the number of applicants exceeds the number of available places.[4] That is, our treatment group is composed of lotteried-in students and our control group is composed of lotteried-out students. Our empirical design, in other words, uses randomized assignment to treatment. The treatment and control groups should be similar on average, in both their observable and unobservable

[4]Of course, such a lottery is only binding when the number of applicants is greater than the number of students the school can accommodate.

characteristics. For this reason, we believe that the results of this study are as credible or more credible than any existing evidence on how charter schools affect student achievement.

Nevertheless, we wish to flag some issues that affect how we interpret the results. Use of lotteries eliminates self-selection problems between charter school applicants and non-applicants, but they do not guarantee that applicants are like non-applicants. It is possible that charter schools affect their applicants differently than they would affect students who decide not to apply. Each charter school may be capable of generating heterogeneous treatment effects, and we will see only treatment effects for the sort of student who applies. This is not a problem for policy makers' using the results, so long as the charter school law always lets students choose whether to apply to a charter school. We, as researchers, cannot claim to show how charter schools would affect the sort of student who never or rarely applies. What we can do (and do, in this study) is make the reader aware of the characteristics of students who are in our applicant pool, in order that the reader knows to whom our results may reasonably extrapolate.

Heterogeneous treatment effects may take other forms. For example, the effect of a charter school may depend on the age or grade at which a student enrolls, or the number of years for which a student has been enrolled. Also, the same charter school may have one effect on achievement in the first year that it opens and another effect on achievement once it has been operating for a few years. Policy makers that are interested in whether charter schools make sense as an "in-place" policy should focus mainly on how a charter school in operation for some years affects students who are typical of an entering student. (For instance, primary school students typically enter in kindergarten or 1st grade). However, a policy maker who was interested in the *transition* to charter schools might look at results that

indicate how a brand-new charter school affects the achievement of students who transfer from regular public schools in the middle of the primary or secondary grades. In this study, we focus mainly on results that are fairly typical of an in-place charter school, but we clarify throughout how much our results depend on charter schools' start-up years.

Studies with a randomized design face a few other complications. Not all students comply with the treatment that the lottery assigns to them. In our study, students who are lotteried-in may choose to stay in their regular public schools, may decide to attend a private school, or may even move outside the area altogether. Students who are lotteried-out cannot choose to attend the charter school, of course, but they may attend a school other than their regular public school. It will turn out that we observe some of the non-compliant students (those who attend a public school still in the local district, even if it is not their regularly assigned one), but students who attend a private school or move away are attritors whom we do not observe once they leave the district's schools altogether. A minor problem is created by students who are attending private schools when they apply to charter schools—if they are lotteried-out, we never observe their achievement. In addition, a student may comply with his initial lotteried-out treatment but then reapply to the charter school the next year and become a lotteried-in student. Such reapplicants are compliant, but they need to be compared to other reapplicants who are lotteried-out twice if we are to maintain the randomized design.

In this study, we analyze the achievement of students in the charter school system with the largest enrollment in the United States. The charter is held by the Chicago Charter Schools Foundation, which is a charitable organization, and the system is called the Chicago International Charter School ("CICS"). CICS draws students from the Chicago Public

School district (CPS), which is the third largest district in America (only New York City and Los Angeles Unified have larger enrollment). Almost all of the charter school students in Illinois attend school in Chicago, and more than half of charter school students in Chicago are enrolled at CICS schools. Currently, CICS includes seven schools with a total enrollment of 4,430 students in fall 2003. Five of the schools are primary schools (serving some or all of grades pre-kindergarten to eight), one of the schools serves all grades from kindergarten to twelve, and the final school serves grades nine through twelve.

CICS has its own management organization run its high school and one of its primary schools. Four CICS primary schools are managed by a non-profit organization, American Quality Schools. The final (kindergarten through grade twelve) school is managed by Edison Schools, which is for-profit. Thus, CICS represents a good part of the spectrum of school models and management models among charter schools. In addition, CICS students are fairly typical of students who attend charter schools located in highly urban areas: its students are mainly black or Hispanic and most participate in the federal Free and Reduced Lunch Program, which means that they come from households with incomes below 185 percent of the federal poverty line.[5]

In the summer of 2004, CICS schools had approximately 1700 more applicants than they could admit, given their space. Each school uses randomized lotteries to admit applicants when oversubscribed. CICS provides us with an excellent environment for investigating charter schools' effects, not only because it is representative of a key part of the charter school sector in the United States, but also because access to its data and CPS data allow us

[5]Detailed information about this charter school system and the students who attend is given in the next section.

to examine both lotteried-in and lotteried-out applicants. The data also let us address issues like non-compliance, attrition, and reapplication. Finally, we are able to examine whether the charter school treatment effect depends on a student's grade level, initial achievement, and the number of years the school has been operating.

2 The Schools of the Chicago Charter School Foundation

CPS has granted 15 charters to organizations to operate schools inside its district. This is the maximum number of charters allowed by Illinois state law.[6] One of the charters has been held by the Chicago Charter School Foundation since 1997 (renewed in 2002).[7] Charter schools in Illinois are free to establish their own missions and curricula, but they participate in the state's accountability system and have personnel restrictions that are similar to those of regular public schools. To pay for operational expenses, charter schools in Chicago receive a per-student fee equal to 75 percent of the average per-pupil spending in CPS.[8] The per pupil fee for the 2003-2004 school year was $5,279. Charter schools receive state and federal aid associated with disabled and other high-need students they enroll. Charter schools cannot charge tuition, but may collect reasonable fees for books and other materials. They can also accept donations. Illinois does not require local districts to provide charter schools with funding for startup costs, for the purchase of facilities, or for renovating buildings to make them appropriate for schools.[9] Most donations are from philanthropies and are

[6] In Illinois, local school districts (in this case Chicago Public Schools) have the authority to grant charters, but these charters are subject to approval by the state board of education. Complete information on Illinois charter school regulations can be found in Illinois Compiled Statutes, Chapter 105, Act 5, Article 27a. Illinois Compiled Statutes can be found online at http://www.legis.state.il.us/legislation/ilcs/ilcs.asp.

[7] Charters may be granted for between five and ten years, but are typically granted for five years.

[8] 75% is the minimum allowable by Illinois state law and 125% is the maximum.

[9] They do establish a fund for loans to charter schools to pay startup costs. However, these loans are restricted to $250 per student, and only one loan can be made to each charter school organization.

channeled into purchasing, leasing, and renovating buildings.

The Chicago Charter School Foundation places schools in neighborhoods where the population is disproportionately minority and low income. Within that loose constraint, they locate vacant buildings—often former private or parochial schools—suitable for schools, purchase or lease these facilities, and perform necessary renovations. The first two CICS schools began operating in the 1997-1998 school year, and a third began in the 1999-2000 school year. The remainder opened in 2000-01 or after. Our study focuses on the three oldest CICS schools: Longwood, Bucktown, and Prairie.[10] Longwood serves approximately 1200 students in Kindergarten through 12th grade. Bucktown and Prairie serve, respectively, 600 and 350 students in kindergarten through eighth grade. For these schools, we collected information on all students who participated in the lotteries held in the spring of 2000, 2001, and 2002. These students, whether lottereried-in or lotteried-out, were matched to CPS administrative data by the Consortium for Chicago School Research. The CPS data provide us with pre-application achievement data and, even more crucially, with post-application achievement data for lotteried-out students.

In Table 1, we show demographic and program participation information for students in the three CICS campuses we study, from the 2001-02 school year. For purposes of comparison, the table also shows information for all CPS students, other Chicago charter schools, and students in Chicago private schools.[11] For CICS students, it is important

[10] There were not enough lotteried-out students at other CICS schools in our current data to include them in this study. However, we hope include these schools in future analysis using students involved in the most recent lotteries.

[11] Information on other Chicago charter schools excludes the Youth Connections Charter, which is an umbrella organization for programs to help high school dropouts. Information of private schools comes from the Private School Universe Survey. Unfortunately, this survey only has information on students' ethnicity.

to base program participation numbers on students' prior classification when they were at CPS. This is because schools exercise discretion over the degree to which they participate in the federal lunch program and in how they classify students for special education and bilingual education services. Indeed, Cullen and Rivkin (2003) show that some parents switch schools in a deliberate attempt to change their child's classification. We want to compare all students against the same thresholds for entry into the lunch program, special education, and bilingual education. Therefore, we base the comparisons on students' prior classification at CPS.[12] One drawback with using prior information is that approximately 60% of CICS students were not enrolled in CPS prior to entering charter school, in part because many CICS students apply to kindergarten.

Overall, students at the three CICS schools were 74 percent black, 22 percent Hispanic, 81 percent in the federal lunch program, 10 percent in special education, and 16 percent in bilingual education. However, the three schools were not alike. Students at Longwood were 99 percent black; Bucktown's students were 33 percent black and 54 percent Hispanic; and Prairie's students were 55 percent black and 44 percent Hispanic. Based on their prior classification at CPS, 82 percent of Longwood's, 76 percent of Bucktown's, and 84 percent of Prairie's students participated in the federal lunch program. Based on their prior classification at CPS, 0.5 percent of Longwood students, 36 percent of Bucktown students and 38 percent of Prairie students received bilingual education; and 12 percent of Longwood

[12]Note that very few Black students receive bilingual education, but roughly 40% of Hispanic students do. Lunch program participation is an imperfect indicator of poverty because a student can be eligible for lunch yet attend a school that does not offer lunch or offers only a partial program. The newness and small size of some charter schools prevents them from participating in the federal lunch program, so participation understates poverty at some charter schools (though not necessarily CICS schools). In any case, we avoid the problem by using prior CPS participation in the lunch program.

students, 11 percent of Bucktown students, and 3 percent of Prairie students received special education services.

The CICS students we study were more likely to be black than the average CPS student (74 versus 51 percent), less likely to be Hispanic (22 versus 36 percent), similarly likely to be in the federal lunch program (81 versus 78 percent), similarly likely to be in special education (10 versus 12 percent), and similarly likely to be in bilingual education services (16 versus 14 percent). A characterization that is perhaps more accurate is that Longwood is most like very black Chicago schools, while Bucktown and Prairie are most like Chicago schools that are about evenly split between blacks and Hispanics, with a small share of non-Hispanic white students.

Although a fair number of students who apply to CICS schools after kindergarten are attending private schools or other non-CPS schools (such as other districts' schools) when they apply, CICS students do not look similar to the private school population of Chicago, largely because they are so much more likely to be black. Only 31 percent of private school students in Chicago are black, while 74 percent of CICS students are. 22 percent of Chicago's private school students and 22 percent of CICS students are Hispanic. Unfortunately, there is no information on the share of private school students who participate in special needs programs (or would participate in programs were they attending CPS). On the whole, the comparison between CICS and private school students suggests that, when CICS attracts a private school student, he or she is not the typical Chicago private school student.

Table 2 shows Census of Population information on the neighborhoods (i.e., census tract) in which the three CICS schools are located. For purposes of comparison, we also display the Census information for the city of Chicago as a whole. Information from both the 1990 and

2000 Censuses is presented.[13] The neighborhood around Longwood is much more black than Chicago as a whole: while Chicago was only about 37 percent black in 2000, the Longwood neighborhood was 98 percent black. Thus, it is not surprising that Longwood enrollment is 99 percent black. A relatively small share of Longwood families are reported as being in poverty (6 percent in 2000), but 82 percent of Longwood's students participated in the federal lunch program, which requires a family to be within 185 percent of the poverty line. It is difficult to reconcile the poverty numbers unless we conclude that families inaccurately report income to the Census or that Longwood draws very disproportionately from poor families in the neighborhood. The neighborhood around Bucktown was 2 percent black, 23 Hispanic, and 7 percent poor in 2000. In contrast, Bucktown's students were 33 percent black, 54 percent Hispanic, and 67 percent in the federal lunch program. It is fairly clear, therefore, that Bucktown is drawing disproportionate numbers of minority and poor students from its neighborhood. Finally, in 2000, the neighborhood around Prairie was 56 percent black, 41 percent Hispanic, and 31 percent poor. Prairie students had rather similar minority status: they were 55 percent black and 44 percent Hispanic. However, 89 percent of Prairie students participated in the federal lunch program.

Students who apply to charter schools may live anywhere in the city of Chicago, and those who attend may travel considerable distances. Figure 1 shows the cumulative distribution of the distance from each CICS school to the school its students would attend based on their

[13] One should keep in mind that the 2000 Census collected income information for 1999, which was a multiple decade low point for poverty, unemployment, and similar indicators in the United States. Thus, we expect improvements from 1990 to 2000 in Chicago neighborhoods that unless they deviated from the typical American experience. Indeed, we can see that throughout Chicago, the share of adults who were high school dropouts fell from 34 to 28 percent over the decade and the poverty rate fell from 18 to 17 percent over the decade.

attendance areas.[14] Prairie has by far the most local student population; more than half of its students' local schools are less than one mile away. This evidence reinforces what we have seen above: Prairie students are typical of their neighborhood. In contrast, the median distance for Longwood and Bucktown students is two and five miles, respectively. Figure 2 shows that, in our sample, more than 75 percent of students who attend traditional CPS schools live in the same attendance area as their school. However, non-CICS students who attend non-traditional CPS schools (i.e., magnet schools, CPS career academies, and non-CICS charter schools) travel about the same distance as do CICS students.[15] That is, CICS students travel about the same amount as other students in our sample who do not attend their neighborhood school.

Above, we observed that estimated effects of charter schools can only safely be extrapolated to students like those in the sample schools. Our results are thus most applicable to urban students who are black or Hispanic and who come from low-income households. However, they (or their parents) must have been motivated enough to apply to charter schools and (in some cases) travel a considerable distance to attend one.

[14] We do not have data on students' actual addresses. These distances are calculated using the latitude and longitude of school addresses. Note that, according to this measure, students are considered as living zero miles away from their local school. The average distance from a school to its attendance boundary is about one half mile.

[15] Non-traditional schools in CPS are: magnet schools, selective enrollment high schools, military academies, "career academies," charter schools (non-CICS), "academic prep centers," alternative schools for pregnant girls and at-risk students (i.e., those who have been expelled from other schools). Chicago has a school choice program that allows students to attend a traditional public school outside of their attendance area (see Cullen et al. 2003).

3 The Charter School Lotteries and Our Sample

In the late spring of each year, the Chicago Charter School Foundation holds lotteries among the applicants to each CICS school. Each lottery is specific to a school and grade. For instance, suppose that Bucktown has 60 kindergarten places available for 120 applicants and has five 2nd grade places available for 25 applicants. (It is normal for the most places to be available in kindergarten. Places in higher grades usually are only made available through student turnover.) For example, consider the Bucktown lotteries. Not only would there be a separate lottery for each grade, but the Bucktown lotteries would be separate from the Longwood and Prairie lotteries. In each lottery, applications are assigned a random number and ordered according to it. Using this ordering, the available places in each grade in each school are filled. If a student who is offered a place does not take it up, the place is offered to the student who is next in order on the list. Although 90 percent of places are filled immediately after the lottery is held, about 10 percent of the places are reoffered and are filled over the summer or even at the start of the school year (when some students who were offered places and initially accepted them fail to show up). Family and residential changes are common for students with the socio-economic profile of CICS students, so it is not surprising that about 10 percent of applicants who are offered CICS places do not actually take them up.[16]

Throughout this paper, it is useful to remember that it is the lottery number (or order) that is randomly assigned to a student. There are two reasonable ways to draw the line between the lotteried-in and lotteried-out. One can describe as lotteried-in all those students

[16] See Hanushek et al. (2001) for information on "turnover" among students from minority, low income families.

whose lottery numbers are good enough to ensure that they are offered places by the start of school year. All of the remaining applicants are then lotteried-out. Alternatively, one can view a late (summer or start of school year) offer of a CICS place as inferior to a spring offer of a CICS place. If parents whose child is not offered a place in the spring tend to make alternative plans and refuse late place offers if made, then a late offer is not equivalent to a spring offer, and it is reasonable to call those with spring offers the "lotteried-in," call those with no offer the "lotteried-out," and keep those with late offers in a separate category. On the whole, we feel that the tripartite classification makes the cleanest use of the randomized lotteries, and we hereafter focus on those with the spring offers and no offers as our lotteried-in and lotteried-out groups. However, our results are robust to the alternative reasonable classification of students.

We collected CICS applications for students in the lotteries held in spring 2000, 2001, and 2002 for the Longwood and Prairie campuses; and collected applications for the lotteries held in spring 2001 and 2002 for the Bucktown campus. The Consortium for Chicago School Research generously agreed to match students to the CPS database using their names, dates of birth, and the school and grade they were attending when they applied. 81 percent of the students who were lotteried-out and who claimed to be applying from a CPS school were matched to their CPS records. This is a high but not perfect match rate. If the probability of being matched is correlated with student characteristics, this will create non-random selection into our sample. We hope to prevent sample selection from affecting our results by controlling for the characteristics of students in our sample.

About 35 percent of applicants to CICS apply from a school other than a CPS school. 26 percent apply from a private school, and we are able to match 56 percent of such students to

CPS records, owing to their having enrolled at CPS prior to their private school enrollment. 8 percent of CICS applicants (especially applicants for kindergarten) apply from a daycare center. We are able to match 66 percent of these to the CPS database owing to their enrollment in a CPS pre-kindergarten or other program. 1 percent of CICS applicants apply from a public school outside the Chicago district, and we are able to match 60 percent of these to the CPS database owing to their prior enrollment in a CPS school. Overall, the proportion of students attending non-CPS schools is higher among the lotteried-out than among the *matched* lotteried-out. In order to balance unobserved characteristics of the lotteried-in and lotteried-out students, therefore, we generally limit our analysis to students who applied from a CPS school and could be matched with the CPS database at the time of their lottery. This is an important point, worthy of emphasis: we recognize that there are some CICS students for whom we do not have an effective control group of lotteried-out students. We are concerned that such CICS students would be disproportionately likely to have been in private or other non-CPS schools had they not been lotteried-in. Because we do not have a control group for them that we believe to be fully valid, we generally do not show achievement effects for such students.

Even among students who apply to CICS from a CPS school, some students do not comply with their intended treatment. That is, some students who apply to CICS from a CPS school and receive a spring offer of a CICS place do not take it up. Also, some lotteried-out students who apply to CICS from a CPS school do not continue to attend a CPS school. There is not a great deal that we can do about such non-compliers if they attrit from our sample. However, we can determine whether lotteried-in and lotteried-out students who apply from CPS (i.e., the group we focus on) experience differential attrition

rates. This is shown in Table 3. In column (1) of the table, we show that there is no statistically meaningful difference in attrition between lotteried-in and lotteried-out students in our focus group. Overall, approximately 6.5 percent of students atrit each year and just under 14% percent of students ever atrit.[17] In column (2) we show that students who had higher test scores in their lottery year are less likely to attrit.[18] (This result is probably due to the general correlation between test scores and family stability.) The crucial column is (3), in which we show that the relation of initial test scores with attrition is same for the lotteried-in students (coefficient of 0.994 with a standard error of 0.004) and lotteried-out students (coefficient of .995 with a standard error of 0.006). That is, the lotteried-out attritors are no more likely to be high scoring or low scoring than the lotteried-in attritors.

Finally, one might like to know whether the CICS lotteries were really random. Table 4 shows that they apparently were. The table shows the results of linear regressions of various student characteristics on a dummy variable for the student's having been lotteried-in or lotteried-out.[19] The top part of the table shows the results for our focus sample: students who were observed in CPS both before and after their lottery.[20] The bottom part of the table shows results for all students in our sample. Lotteried-in students do not have significantly higher or lower test scores than lotteried-out students, nor are they significantly more or less likely to be in special education, bilingual education, or receive free or reduced price lunch. This is true whether we look at our focus sample of students who applied from

[17] Note that, since our focus group only includes students observed the year after their lottery, and we cannot observe attrition in the final year, the median number of years students are "at risk" of attrition is 2.

[18] The p-value on the test score coefficient is .07.

[19] These regressions also include a fixed effect for each CICS-school year-grade combination, since this is the level at which being admitted is randomized.

[20] Our focus group consists of students observed in CPS before and after their lottery who apply while in 1st to 7th grade, and students who apply

CPS or whether we look at all of the students in our sample.

4 How the Charter Schools Affect the Student Population of the Regular Public Schools

One concern about charter schools is that they may disproportionately remove non-minority, non-poor, high achieving students from the regular public school system. There is little solid evidence about the consequences of changing peer composition, but it is possible that changes in peer composition would affect students who remained in regular public schools. Therefore, an interesting question is how the existence of CICS schools affects the student population of the regular public schools.

There are two ways to answer this question. Each has a slightly different counterfactual. First, we can take a simple approach and view each CICS school as a "helicopter drop" into a Chicago neighborhood. We can then compare CICS students to the students in CPS schools within some radius of the CICS school (we use three miles). This exercise assumes that all students would attend local schools in the absence of CICS and that the CICS school simply adds another local school to the mix. This simple exercise answers the question, "If the CICS school were to admit one more student and he or she were to be typical of existing students at that CICS school, how would the student who has left CPS differ from the average local CPS student?"

Carrying out this exercise, we find that students at the Longwood school are very similar to those at surrounding CPS schools on ethnicity (more than 90 percent black), participation in the free lunch program (roughly 80 percent), special education (14 percent in surrounding

schools versus 12 percent in Longwood), bilingual education (less than 1 percent). Their prior math test scores are somewhat lower (37 versus 42 percentile, 39 versus 38 percentile in reading). These measures are shown in table 5.[21]

Compared to their surrounding schools, Bucktown students are a bit more likely to be Hispanic (53 versus 47 percent), less likely to be Black (33 versus 39 percent), somewhat less likely to have received special education (10 versus 15 percent), and much more likely to have received bilingual education (36 versus 16 percent). They also have lower math scores (46 versus 54 percentile, 46 versus 47 percentile in reading). Students at the Prairie school differ the most from students in surrounding schools. They are much more likely to be Hispanic (44 versus 6 percent) and less likely to be black (55 versus 91 percent). They are also much less likely to have been in special education (3 versus 14 percent), much more likely to have received bilingual education (38 versus 1 percent), and have higher prior reading test scores (40 versus 36 percentile, 43 versus 41 percentile in math). However, we saw above that Prairie students are much more local than the 3 mile radius and they are representative of the school's immediate neighborhood.[22] In short, it appears that CICS schools may draw students who are more likely to be Hispanic (and receiving bilingual education) than the average local CPS student, but otherwise CICS schools draw students typical of the local population.[23]

[21] Summary statistics on CICS students, from table 1, are included for ease of comparison.

[22] Almost one half of the Hispanic students enrolled at CICS Prairie live in the attendance areas of Pullman Elementary and Curtis Elementary. Both schools had significant declines in their Hispanic population coincident with the opening of the Prairie campus.

[23] A second approach is to compare lotteried-out CICS applicants to the students in the schools that they attend. This approach recognizes that CICS applicants do not always stay in their local public school. Put another way, the thought experiment closest to removing the CICS presence from Chicago is to ask, "What if CICS lotteried-out all of its applicants because its number of places was zero?" To answer this question, we compare CICS students to the average characteristics of students in schools the lotteried-out students subsequently attend. This is because the lotteried-out students' behavior is the best indicator of what the

5 Charter Schools and Student Achievement

Because our evaluation of charter schools' effect is based on a design with randomized assignment to treatment, we start with the simplest appropriate estimation strategy. We then add features to deal with issues like compliance and attrition.

Suppose that applicants to charter schools apply from a regular public school (unless they are kindergarten or grade one applicants, in which case no prior school is expected), are offered a charter school place at random, and comply fully by attending the charter school if an offer is received and attending a regular public school if an offer is not received. Then, the average impact of charter schools on achievement across all applicants (β) could be identified through estimation of equation 1. Subsequent achievement for student i (A_i) is a function of admission to charter school ($Admitted_i$), a lottery fixed effect (α_j), an indicator variable for time t (θ_t), and other (orthogonal) factors (ε_i).[24] The lottery fixed effect is necessary because randomization occurs lottery by lottery, and selection into a lottery need not be random. The indicator for time t will pick up any changes in the Chicago environment over time that affect all students, whether in or out of charter schools (e.g., a district-wide change in emphasis towards the basic skills being tested).

$$A_{it} = \sum_j \alpha_j D_i^{(j)} + \beta Admitted_i + \theta_t + \varepsilon_i \tag{1}$$

lotteried-in students would be doing if CICS did not exist. These comparisons provide a very similar story to that shown in table 5. This suggests that more recent CICS applicants and enrollees would attend schools more closely resembling those in the surrounding area.

[24] $D_i^{(j)}$ is an indicator for student i having applied to lottery j. To be clear, a lottery consists of the CICS campus, school year, and grade to which the student first applied.

5.0.1 Non-Compliance

Let us now consider non-compliance while still assuming that no students attrit from the sample. If some students who are offered a charter school place do not enroll, then estimation of equation **??** via linear regression will yield an "intent to treat" (ITT) estimate: the effect of being offered a place at (but not necessarily enrolling in) charter school. It is also useful to estimate the impact of actually enrolling in charter school. If we assume that admission to charter schools only affects achievement for students who enroll, the effect of charter school enrollment on achievement can be estimated by instrumenting for an enrollment indicator variable with the offer of admission indicator variable.[25] The instrumental variables estimate is the average effect of charter schools on the achievement of students who comply with their initial assignment, or the "treatment on treated" (TOT) effect. The first and second stages of the instrumental variables estimation are:

$$Enrolled_i = \sum_j \delta_j D_i^{(j)} + \lambda Admitted_i + \kappa_t + \upsilon_i \qquad A_i = \sum_j \alpha_j D_i^{(j)} + \beta \widehat{Enrolled}_i + \theta_t + \varepsilon_i \quad (2)$$

We examine both ITT and TOT effects of charter schools. Policy makers will probably mainly be interested in the TOT effect; they would like to know the effect of actually enrolling in a charter school but do not intend to force students to attend a charter school when they are offered a place but would prefer not to accept it. We therefore discuss the TOT estimates below and include the ITT estimates in appendix tables.

[25] The assumption that being lotteried-in has no direct effect on achievement is needed in addition to our baseline assumption that lottery assignment is random.

5.0.2 Allowing for Small Samples

If each lottery had a large number of participants, the law of large numbers would ensure that the lotteried-in and lotteried-out students in each lottery had similar observable and unobservable characteristics. That is, the lotteried-in and lotteried-out groups would be fully balanced. Although the total number of observations in our sample is large, the lotteries are held at the school by grade level and some of them are therefore small. In the above equation, we are effectively restricting the initial difference between lotteried-in and lotteried-out groups to be zero. Because of the randomization, this is a reasonable restriction but could be violated simply because some lotteries are small. In such circumstances, it is a good idea to control for pre-existing observable differences between lotteried-in and lotteried-out students, including prior achievement. We can do this by including a set of control variables (X) for each student that were observable prior to the lottery and do not change over the sample period. The coefficient vector (β) will pick up differences in prior achievement and other characteristics between the lotteried-in and lotteried-out students that randomly occur. The coefficient on the interaction term (γ) will be the ITT estimate of the achievement effect of charter schools. This is shown by equation 3.

$$A_{it} = \sum_j \alpha_j D_i^{(j)} + \gamma Admitted_i + \theta_t + \beta X_i + \varepsilon_{it} \tag{3}$$

Naturally, there is an instrumental variables estimation that corresponds to the above equation and that gives us the TOT estimate of the effect of charter schools.

$$A_{it} = \sum_j \alpha_j D_i^{(j)} + \gamma \widehat{Enrolled}_i + \theta_t + \beta X_i + \varepsilon_{it} \tag{4}$$

5.0.3 Attrition and Retention

The plausibility of estimates from the randomized design depends on the randomization not having a direct effect on outcomes through the composition of the sample. Above, we emphasized that we have an excellent match rate when looking in the CPS database for lotteried-out students who applied from a CPS school. We also emphasized that, for students who applied from CPS schools, attrition from our sample does not differ by achievement for lotteried-in and lotteried-out students. In short, we are confident that, among students who apply to CICS from a CPS school, the randomized design generates unbiased estimates. It may be that the randomized design also generates unbiased estimates for students who apply to CICS from a non-CPS school. We cannot be confident about such an assertion, however, because we have lower match rates to the CPS database for such students and cannot conduct a thorough test for differential attrition on the basis of students' initial test scores.

Thus, we will show results for our focus sample of students who apply to CICS from a CPS school. One should interpret our results as the effect of CICS charter schools on students who would be in a CPS school at the time of their application and at least one year thereafter. In other words, one should think of our results as showing how charter schools affect public school students, not student who would otherwise be attending private schools. The typical kindergarten or first grade applicant does not have a prior school or prior test scores, so our focus sample for them will include all applicants to CICS.

Another manner in which sample selection might affect our results is if students are differentially likely to be held back in charter schools relative to CPS schools. For example,

suppose that low-achieving students in CPS schools are more likely to be held back. Since we only observe test scores up to grade eight, low-achieving students in charter schools will exit our sample more quickly than similar low-achieving students in CPS schools. In order to avoid any bias from such an effect, we restrict our estimation sample to student who, based on the grade to which they applied, should be in grade eight or lower during post-lottery years. Nevertheless, there are few students who meet this criterion, and removing this restriction does not noticeably change our results.

5.0.4 Grade of Entry Specific Effects

Students who enter charter schools at different grade levels may be affected differently by this change in educational institution. For example, because of their longer exposure to traditional CPS schools, older entering students may have greater difficulty adjusting to institutional differences at CICS. On the other hand, older students may be personally (as opposed to parentally) motivated to apply to CICS, and may benefit more from being lotteried-in.

Allowing for grade specific effects, we estimate an equation that allows the achievement effect to differ by the grade for which students applied to CICS:

$$A_{it} = \sum_j \alpha_j D_i^{(j)} + \sum_g \left(\gamma_g Admitted_i + \theta_{gt} + \beta X_i\right) * D_i^{(g)} + \varepsilon_{it} \tag{5}$$

where $D_i^{(g)}$ is an indicator variable for having applied to either: (1) kindergarten and 1st grade, (2) 2nd and 3rd grade , (3) 4th and 5th grade, and (4) 6th to 8th grade.[26] Since there

[26] Examining separately students who apply to kindergarten and first grade is useful since for this group we cannot empirically test for equality of achievement levels before their lottery. The other groupings were selecting to reflect general notions of early, middle, and upper elementary education. Note that we also

are no baseline test scores for students applying to kindergarten and 1st grade, pre-existing difference in achievement cannot be identified. The instrumental variables estimation that corresponds to the above equation and generates the TOT effect of charter school on achievement follows the same pattern as equations 2 and 4.

5.0.5 Year-of-Charter-School-Operation Effects and Time-in-Charter-School Effects

Because CICS charter schools are recent start-ups, we would like to allow the effect of charter schools on achievement to vary with the length of time that the school has been in operation. However, in our data, this is about equivalent to allowing the charter school effect on achievement to vary with the student's lottery cohort. That is, we would like to allow the achievement effect to be different for students who entered a CICS school after the 2000, 2001, and 2002 lotteries. Because students' achievement sometimes displays odd patterns after they have switched schools (an initial dip followed by a recovery is expected), we would also like to allow the effect of charter schools on achievement to vary with the length of time that a student has been enrolled at the charter school. That is, we would like to allow the achievement effect to be different for one year of charter school experience, two years of charter school experience, and so on.

If we had a long panel of data with charter schools beginning their operations in a wide variety of years, we could identify both year-of-charter-school-operation effects and time-in-charter-school effects. At this time, we cannot identify both sets of effects because we do not yet have a sufficiently long panel of data or sufficient variation in school start-up dates.

allow time effects (θ) to vary by grade grouping.

We therefore leave this for future analysis, when we will have a greater number of lotteries, test scores, and schools to examine.

5.1 "Treatment on Treated" Estimates of Charter School Effects

Our estimation strategy is shown by equation 5. That is, we measure the "treatment on treated" (TOT) effects of being enrolled in a charter school and allow the effects to vary by grade of entry into the charter school.[27] We show eight specifications, four for math and four for reading, in tables 6a and 6b, respectively. Full results of these TOT regressions and full results of ITT estimates are given in the appendix. In column (1) of these tables, we show a baseline specification that includes only lottery and time fixed effects.[28] In column (2) we include additional controls for student characteristics as measured before the admissions lotteries took place. These include gender, ethnicity, participation in the free lunch program, special education, or bilingual education, and whether or not the student had previously repeated a grade.

In columns (3) and (4) we add controls for students' prior achievement in two different ways. In column (3) we include students' most recent test score.[29] Because many students (e.g., those applying to kindergarten) do not have previous scores, we include a dummy variable for whether or not a student was tested prior to the lottery. In column (4) we make use of the fact that many students (e.g., those applying to upper elementary grades) have been tested more than once prior to their lottery. This additional information may

[27] Modifying our groupings does not affect the tenor of our results. For instance, we repeated our analysis changing groups to students applying for (1) kindergarten and 1st grade, (2) 2nd, 3rd, and 4th grade, (3) 5th and 6th grade, and (4) 7th and 8th grade.

[28] Time effects are allowed to vary by grade grouping.

[29] That is, we include the test score matching the subject of the dependent variable, math or reading.

help to better identify prior differences in achievement between lotteried-in and lotteried-out students. We use up to three previous test scores to predict a counterfactual post-lottery achievement level for each student, and we include this predicted score as a control variable, as well as a dummy variable for whether the predicted score is available.[30]

TOT estimates of charter school effects on math achievement are shown in table 6a.[31] For students who apply to kindergarten or grade one, we find positive but statistically insignificant improvements in math test scores of about five percentage points. These estimates are quite stable across the regressions. For students who apply to grades two or three, the results in columns (1) suggest that enrollment in CICS raises math scores by about 7 percentage points, but this coefficient is not statistically significant. However, as controls for student characteristics and achievement are included, this point estimate rises and, in column (4), is statistically significant with a p-value of .02. Coefficient estimates for students applying to grades four and five are also positive but not statistically significant, and range from about 4 to 7 percentages points, depending on the set of control variables. In contrast to students who applied for a lower or middle elementary grade, estimated effects

[30] We generate predicted counterfactual achievement scores in the following manner. We first take all achievement test scores in the four years prior to students' lotteries. Then we regress students' test scores in the year prior to their lottery on the (up to three) test scores that preceed it. We allow the estimated effect of previous tests to vary with the combination of previous tests available. For example, the effect of a test from two years prior is allowed to differ between students who have only two years of prior tests and students who have three years of prior tests. We assume that the pre-lottery relationship between current and prior test scores is constant across lotteries, and therefore include all students for which we have data, not just those in our focus group. Using only focus group students does not alter our results to a large degree, but decreases considerably the predictive power of this regression. Using the coefficients from these regressions, we predict students' counterfactual post-lottery scores using test scores from the three years prior to their lottery.

[31] As noted above, full results are shown in the appendix. In general, the relations between student characteristics and student achievement are as we might expect. For example, students who have repeated grades, received special education or participated in the free lunch program have lower test scores than other students, though students who participated in bilingual education do not. White students have higher test scores than either Black or Hispanic students, and female students have higher reading test scores than males. However, these coefficients move towards zero when controls for student achievement are added to the regressions.

on math scores for students applying for sixth, seventh, or eighth grade are negative and in two of the specifications these coefficients are statistically significant at the five percent level. Point estimates suggest that these students saw a drop in math achievement by about 4 percentage points relative to their peers who remained in CPS schools.

TOT estimates of charter school effects on reading achievement are shown in table 6b. For students who apply to kindergarten or grade one, we find positive and statistically significant improvements in reading test scores of about eleven percentage points. These estimates and their statistical significance are quite stable across the four specifications. For students who apply to grades two or three, our estimates suggest smaller positive effects on reading test scores, about three percentage points, but the standard errors are large and these effects are not statistically distinguishable from a zero effect of charter schools. Our estimates suggest that reading scores of students applying to grades four and five were not significantly affected by their entrance into these charter schools. The coefficient estimates for this group are generally small and statistically insignificant, and range from negative one percentage point to positive two and one half points. For students applying to the sixth, seventh, or eighth grade, we estimate that students entering charter schools ended up with slightly lower achievement scores than their peers in other Chicago public schools. Although these differences—about three percentage points—were not statistically significant, they are consistent with our findings for math achievement.

In general, we find positive and statistically significant charter school effects for students who applied to charter schools during their lower elementary grades, but negative and, in some cases, statistically significant effects for students who applied to charter schools in the upper elementary grades. For students applying to Kindergarten or first grade, we find that

charter school enrollment raised reading test scores by approximately 11 percentile points. For students applying to 2nd or 3rd grade, we find that enrollment raised math scores by approximately 10 percentile points. For students applying to 6th through 8th grade, we find that enrollment lowered math scores by approximately 4 percentage points. These results suggest that students who enter charter schools at younger ages may realize greater benefits from doing so than students who enter after having already attended traditional public elementary schools for a number of years.

There are a number of reasons why older enrollees may not see the same benefits as their younger counterparts. Upper elementary students may have greater difficulty adjusting to the educational environment of these charter schools. They may also have difficulty fitting in socially in a school where most in their grade have been attending since kindergarten or 1st grade. As we mentioned above, most of the available places in established charter schools are in kindergarten and the early elementary grades. In contrast, a student who enters charter school in eighth grade is a much rarer case. In addition, upper elementary applicants at the two primary schools we study face the prospect of switching schools again in the near future. This may hinder their ability or willingness to adapt to the charter school environment. Finally, because we can only observe student achievement through eighth grade, we can only observe short term charter school effects for students who enter in upper elementary grades. If the benefits of charter school enrollment grow over time, upper elementary applicants may not realize them or we may simply not be able to observe them. We hope to explore this issue in the future by examining time-in-charter-school effects. Unfortunately, with our data we may not be able address the mechanism that might cause charter schools to have differential impacts on older and younger entering students,

but this is an important issue for further research.

6 Conclusion

Our analysis of the Chicago International Charter Schools suggests that students who are lotteried-in and enroll in lower elementary grades have higher subsequent achievement than students who are lotteried-out and cannot therefore attend CICS. These positive effects of charter schools are not found for students who are lotteried-in to upper elementary grades. After a charter school is established, the vast majority of its students enter in the lower elementary grades, so the positive effects we find for these students is important in assessing the long run impact of CICS on its students. Nevertheless, the lack of a similar positive effect for students who enter in upper elementary grades should make one cautious in drawing overall conclusions.

Research on charter schools, like the schools themselves, is fairly new, but there are several careful studies to which our results can be compared. Sass (2004), Bifulco and Ladd (2004), and Hanushek et al. (2002) use panel data sets from (respectively) Florida, North Carolina, and Texas to examine the achievement of students who enter charter schools.[32] All three studies find that students who enroll in charter schools experience a drop in achievement relative to similar students in public schools This drop in achievement is restricted to the first few years of the charter schools' existence; students enrolled in charter schools that are more than two years old seem to learn at about the same rate as comparable public school students.

[32]To deal with non-random selection of students into charter schools, they control econometrically for differences in observable and fixed unobservable characteristics between students who do and do not enroll in charter schools.

The CICS schools in our analysis were founded at least two years prior to the lotteries for which we have data. Therefore, we examine the performance of students who have been exposed to charter schools that are young (four years old on average), but not brand-new start-ups with no years of experience or only one year of experience. Because charter school policies would eventually produce a group of schools with some experience (not a perpetual stream of brand-new start ups), it is most important to learn about charter schools that are young but not exclusively start-ups. Nevertheless, analysis of more data is the best way to understand the difference between the effect of being in a charter school longer and the effects of being in a charter school that is more experienced. We will explore these issues for newly founded CICS schools, using data from lotteries conducted in the summer of 2003 and 2004.

References

[1] Bifulco, Robert and Helen F. Ladd, "The Impacts of Charter Schools on Student Achievement: Evidence from North Carolina," Unpublished Manuscript, April, 2004.

[2] Cullen, Julie Berry and Steven G. Rivkin, "The Role of Special Education in School Choice," in The Economics of School Choice, Ed.: C. Hoxby (Chicago: University of Chicago Press, 2003).

[3] Cullen, Julie Berry, Brian A. Jacob and Steven Levitt, "The Effect of School Choice on Student Outcomes: Evidence from Randomized Lotteries," NBER Working Paper 10113, November, 2003.

[4] Hanushek, Eric A., John F. Kain and Steven G. Rivkin, "Disruption Versus Tiebout Improvement: The Costs and Benefits of Switching Schools," NBER Working Paper 8479, September, 2001.

[5] Hanushek, Eric A., John F. Kain and Steven G. Rivkin, "The Impact of Charter Schools on Academic Achievement," Working Paper, The Cecil and Ida Green Center for the Study of Science and Society, December, 2002.

[6] Sass, Tim, "Charter Schools and Academic Achievement in Florida," Unpublished Manuscript, February, 2004.

Figure 1: Distance from attendance area school to school, CICS students

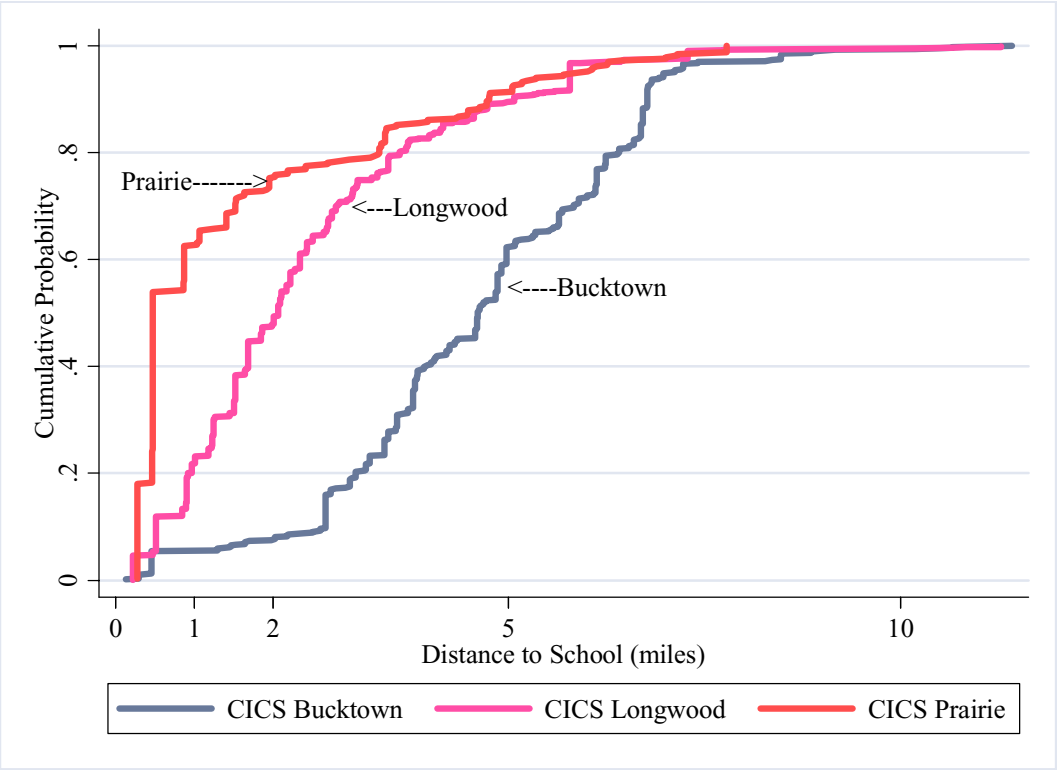

Figure 2: Distance from attendance area to school, CICS students and applicants in traditional and non-traditional CPS schools

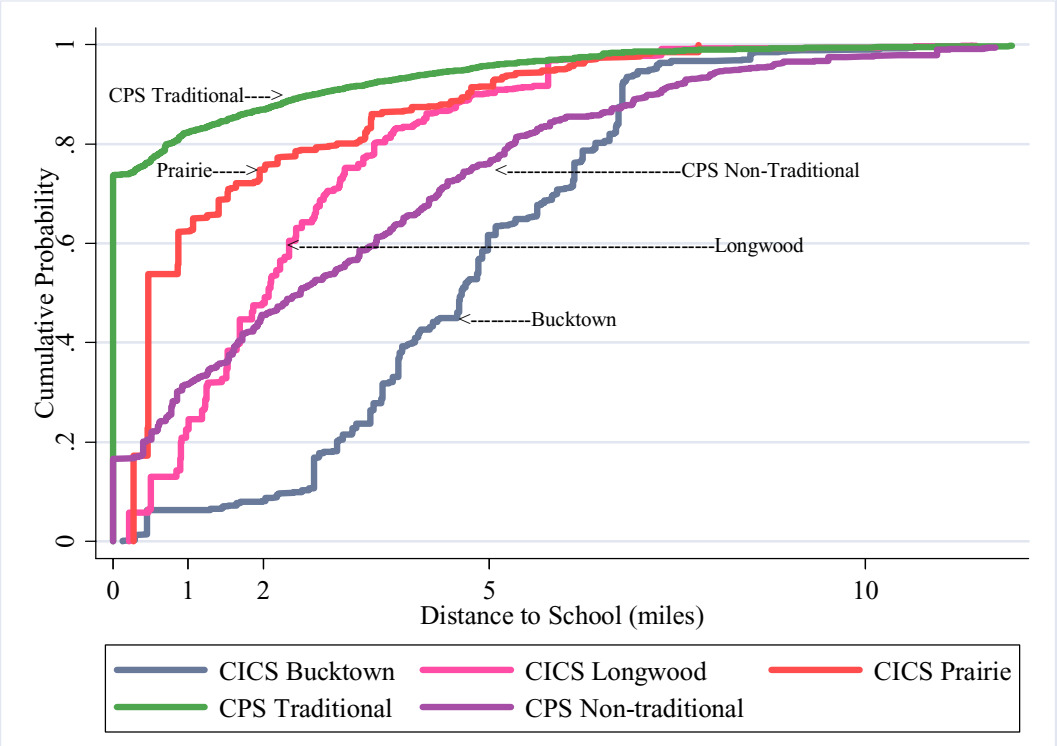

Table 1: Summary Statistics for CICS and other student populations, 2001-02

	CICS Bucktown	CICS Longwood	CICS Prairie	*All CPS*	*Other Charters*	*Private Schools*
Female	50.2%	53.0%	52.4%	*49.5%*	*55.4%*	*NA*
Black	33.3%	98.7%	54.4%	*51.3%*	*69.3%*	*29.2%*
Hispanic	53.3%	0.5%	44.4%	*35.8%*	*26.2%*	*21.6%*
Free/Reduced Lunch	76.4%	81.9%	84.0%	*78.0%*	*82.1%*	*NA*
Special Education	10.5%	12.2%	3.1%	*12.3%*	*9.5%*	*NA*
Bilingual Education	35.9%	0.5%	38.2%	*14.0%*	*2.3%*	*NA*
Number of Students	619	1,262	351	*437,418*	*3,715*	*87,135*

Note: CICS campus information comes from CPS data collected by the Consortium for Chicago School Research. Data on program participation is based on participation by students in CPS and before enrollment in CICS. All CPS and private school information come from the Common Core Data and the Private School Universe Survey, respectively. Both data sets are collected by the National Center for Educational Statistics. The Youth Connections Charter School is not included in the data on other charters; this is an umbrella organization for programs serving high school dropouts. Information on special education and bilingual education for charter schools comes from CPS Department of Research and Evaluation. In cells labeled "NA" the data is not available.

Table 2: CICS campus neighborhood characteristics

	Bucktown		Longwood		Prairie		*Chicago*	
	1990	2000	1990	2000	1990	2000	1990	2000
Black	2.2%	1.5%	96.8%	97.7%	55.6%	55.6%	*39.1%*	*36.8%*
Hispanic	51.5%	23.1%	0.3%	0.6%	40.0%	41.4%	*19.6%*	*26.0%*
% Not English at Home	53.6%	28.0%	2.9%	4.6%	42.6%	40.7%	*29.1%*	*35.5%*
% Spanish at Home	44.2%	17.1%	2.7%	3.1%	39.1%	39.6%	*17.4%*	*23.3%*
% HS Dropout (Age 25+)	41.6%	10.1%	27.7%	21.6%	54.5%	53.5%	*34.0%*	*28.2%*
% Families in Poverty	19.6%	7.0%	10.8%	5.9%	22.6%	31.4%	*18.3%*	*16.6%*

Note: Information taken from the 1990 and 2000 decennial census. CICS campus information is based on the census tract in which the school is located.

Table 3: Are Lotteried-in Students Differentially Likely to Atrit?

	(1)	(2)	(3)
Lotteried-in	0.919	0.918	0.900
	(0.142)	(0.142)	(0.165)
Student Has a Pre-Lottery Test Score		1.331	1.326
		(0.434)	(0.433)
Composite Score in Most Recent Pre-lottery Year		0.994	0.994
		(0.003)	(0.004)
Lotteried-in*Composite Score			1.001
			(0.006)
Observations	3942	3942	3942
Average Probability of Attrition	6.5%	6.5%	6.5%
Percentage of Students Who Atrit	13.8%	13.8%	13.8%

Coefficients are log-odds ratios for sample attrition, estimated with a cox proportional hazard model. Sample is limited to our focus group: students observed in CPS before and after their lottery who apply while in 1st to 7th grade, and students who apply below 1st grade who are observed after their lottery. Composite test score is the average of ITBS Math and Reading Scores. Standard errors in parentheses. All models are estimated with lottery fixed effects. * significant at 5%

Table 4: Are Lotteried-in and Lotteried-out Students Observably Similar?

	ITBS Math	ITBS Reading	Special Education	Free/Reduced Lunch	Bilingual Education
Focus Sample:					
Lotteried-in	0.577	0.899	-0.039	0.029	0.010
	(2.298)	(2.286)	(0.024)	(0.029)	(0.013)
Constant	39.980	40.185	0.129	0.783	0.044
	(0.890)*	(0.879)*	(0.010)*	(0.012)*	(0.005)*
Observations	1060	1058	1616	1616	1616
R-squared	0.05	0.05	0.05	0.13	0.37
Full Sample:					
Lotteried-in	-0.694	-1.190	0.025	-0.040	-0.002
	(1.965)	(1.950)	(0.020)	(0.026)	(0.012)
Constant	41.318	42.273	0.095	0.802	0.056
	(1.765)*	(1.754)*	(0.018)*	(0.023)*	(0.010)*
Observations	1415	1418	1988	1988	1988
R-squared	0.06	0.06	0.07	0.12	0.36

The Iowa Test of Basic Skills (ITBS) scores are available for grades 1-8. Our focus group consists of students observed in CPS before and after their lottery who apply while in 1st to 7th grade, and students who apply while below 1st grade and who are subsequently observed in CPS. The full sample includes students who applied while in 7th grade or below. Standard errors in parentheses. All regressions include lottery fixed effects. * significant at 5%

Table 5: Summary Statistics for Schools with 3 miles of CICS, 2001-02

	Schools Near Bucktown	*CICS Bucktown*	**Schools Near Longwood**	*CICS Longwood*	**Schools Near Prairie**	*CICS Prairie*
Black	**39.6%**	*33.3%*	**92.4%**	*98.7%*	**92.4%**	*54.4%*
Hispanic	**47.2%**	*53.3%*	**1.7%**	*0.5%*	**3.6%**	*44.4%*
Free/Reduced Lunch	**81.3%**	*76.4%*	**83.2%**	*81.9%*	**89.6%**	*84.0%*
Special Education	**14.3%**	*10.5%*	**14.6%**	*12.2%*	**13.5%**	*3.1%*
Bilingual Education	**16.3%**	*35.9%*	**0.3%**	*0.5%*	**1.1%**	*38.2%*
ITBS Math Percentile	**53.8%**	*46.4%*	**42.3%**	*37.0%*	**41.4%**	*42.5%*
ITBS Reading Percentile	**47.3%**	*46.0%*	**37.5%**	*39.1%*	**35.7%**	*39.8%*

Note: CICS campus information comes from CPS data collected by the Consortium for Chicago School Research. Information on gender, race, and free/reduced price lunch for students at nearby schools comes from the Common Core Data collected by the National Center for Educational Statistics. Information on special education and bilingual education for nearby schools comes from CPS Department of Research and Evaluation.

Table 6a: TOT Estimates of Math Effects by Grade Grouping

	Estimated Charter School Enrollment Effect			
Applied for KG or 1st Grade	4.62	5.68	5.44	5.27
	(4.58)	(4.36)	(4.39)	(4.45)
	[0.31]	[0.19]	[0.22]	[0.24]
Applied for 2nd or 3rd Grade	7.74	8.13	8.14	10.62
	(5.96)	(5.91)	(5.87)	(4.65)
	[0.19]	[0.17]	[0.17]	[0.02]
Applied for 4th or 5th Grade	7.25	6.53	5.27	3.75
	(6.09)	(5.45)	(4.21)	(2.76)
	[0.23]	[0.23]	[0.21]	[0.17]
Applied for 6th, 7th, or 8th Grade	-4.14	-7.18	-4.35	-4.30
	(3.80)	(3.68)	(2.80)	(1.90)
	[0.28]	[0.05]	[0.12]	[0.02]
Observations	3401	3401	3401	3401
R-squared	0.07	0.15	0.29	0.48
Pre-lottery Student Characteristics		√	√	√
Recent Pre-lottery Test Score			√	
Predicted Post-lottery Test Score				√
Lottery Fixed Effects	√	√	√	√
Grade Group*Year Fixed Effects	√	√	√	√

The dependent variable is percentile score on the Iowa Test of Basic Skills for tests taken subsequent to the students' admissions lotteries. Given are estimated coefficients on a dummy variable for being in a CICS charter, instrumented by a dummy variable for whether the student won admissions lottery. Standard errors (in parentheses) are clustered by student. P-values in brackets.

Table 6b: TOT Estimates of Reading Effects by Grade Grouping

	Estimated Charter School Enrollment Effect			
Applied for KG or 1st Grade	10.65	12.04	11.65	11.43
	(4.44)	(4.13)	(4.18)	(4.26)
	[0.02]	[0.00]	[0.01]	[0.01]
Applied for 2nd or 3rd Grade	2.77	3.50	3.57	3.08
	(5.90)	(5.69)	(5.69)	(4.13)
	[0.64]	[0.54]	[0.53]	[0.46]
Applied for 4th or 5th Grade	2.56	1.92	-0.87	1.86
	(5.94)	(5.32)	(4.16)	(2.89)
	[0.67]	[0.72]	[0.83]	[0.52]
Applied for 6th, 7th, or 8th Grade	-0.35	-3.08	-3.28	-2.74
	(3.24)	(3.03)	(2.39)	(1.82)
	[0.91]	[0.31]	[0.17]	[0.13]
Observations	3407	3407	3407	3407
R-squared	0.09	0.19	0.29	0.45
Pre-lottery Student Characteristics		√	√	√
Recent Pre-lottery Test Score			√	
Predicted Post-lottery Test Score				√
Lottery Fixed Effects	√	√	√	√
Grade Group*Year Fixed Effects	√	√	√	√

The dependent variable is percentile score on the Iowa Test of Basic Skills for tests taken subsequent to the students' admissions lotteries. Given are estimated coefficients on a dummy variable for being in a CICS charter, instrumented by a dummy variable for whether the student won admissions lottery. Standard errors (in parentheses) are clustered by student. P-values in brackets.

Table A.1: TOT Charter School Effects on Math by Grade Grouping

Charter School Effect (Applied for KG or 1st Grade	4.62	5.68	5.44	5.27
	(4.58)	(4.36)	(4.39)	(4.45)
Additional Charter Effect for Students Who…				
Applied for 2nd or 3rd Grade	3.12	2.45	2.70	5.35
	(7.51)	(7.29)	(7.27)	(6.40)
Applied for 4th or 5th Grade	2.63	0.85	-0.18	-1.52
	(7.62)	(6.97)	(6.08)	(5.24)
Applied for 6th, 7th, or 8th Grade	-8.76	-12.86	-9.80	-9.57
	(5.95)	(5.73)*	(5.24)	(4.86)*
Free Lunch		-7.53	-5.49	-2.34
		(1.89)*	(1.72)*	(1.32)
Special Education		-20.88	-14.43	-8.12
		(2.04)*	(1.83)*	(1.54)*
Bilingual Education		6.36	4.66	4.37
		(4.50)	(4.35)	(3.69)
Repeated Grades		-18.85	-11.67	-8.55
		(3.15)*	(3.62)*	(2.89)*
White		11.56	14.67	9.18
		(7.49)	(7.11)*	(6.09)
Hispanic		-0.55	-0.27	-2.05
		(4.06)	(3.79)	(3.65)
Female		1.53	1.78	0.29
		(1.30)	(1.18)	(0.96)
Recent Test Score is Available			-22.66	
			(2.45)*	
Recent Test Score			0.54	
			(0.03)*	
Predicted Post-Lottery Score is Available				-23.93
				(3.05)*
Predicted Post-Lottery Score				0.76
				(0.02)*
Constant	49.35	48.53	48.04	49.44
	(5.01)*	(4.04)*	(4.86)*	(4.10)*
Observations	3401	3401	3401	3401
R-squared	0.07	0.15	0.29	0.48

The dependent variable is percentile score on the Iowa Test of Basic Skills. Standard errors (in parentheses) are clustered by student. All regressions include lottery fixed effects and grade group by year fixed effects. * significant at 5% or below;

Table A.2: TOT Charter School Effects on Reading by Grade

Charter School Effect (Applied for KG or 1st Grade	10.65	12.04	11.65	11.43
	(4.44)*	(4.13)*	(4.18)*	(4.26)*
Additional Charter Effect for Students Who…				
Applied for 2nd or 3rd Grade	-7.88	-8.54	-8.08	-8.35
	(7.39)	(6.98)	(7.01)	(5.90)
Applied for 4th or 5th Grade	-8.09	-10.12	-12.52	-9.57
	(7.42)	(6.72)	(5.89)*	(5.14)
Applied for 6th, 7th, or 8th Grade	-11.00	-15.12	-14.93	-14.17
	(5.50)*	(5.15)*	(4.84)*	(4.65)*
Free Lunch		-9.40	-7.45	-4.94
		(1.67)*	(1.57)*	(1.34)*
Special Education		-20.10	-13.46	-7.28
		(1.72)*	(1.66)*	(1.42)*
Bilingual Education		9.82	10.44	9.96
		(3.92)*	(3.67)*	(3.21)*
Repeated Grades		-14.53	-10.81	-3.37
		(2.56)*	(2.60)*	(1.91)
White		16.90	14.83	13.08
		(7.12)*	(7.54)*	(6.09)*
Hispanic		-4.74	-4.18	-4.68
		(3.58)	(3.37)	(3.10)
Female		3.80	2.78	1.30
		(1.22)*	(1.12)*	(0.93)
Recent Test Score is Available			-19.73	
			(2.19)*	
Recent Test Score			0.47	
			(0.03)*	
Predicted Post-Lottery Score is Available				-25.75
				(2.88)*
Predicted Post-Lottery Score				0.73
				(0.02)*
Constant	54.75	50.43	53.11	53.80
	(5.07)*	(3.96)*	(4.99)*	(5.02)*
Observations	3407	3407	3407	3407
R-squared	0.09	0.19	0.29	0.45

The dependent variable is percentile score on the Iowa Test of Basic Skills. Standard errors (in parentheses) are clustered by student. All regressions include lottery fixed effects and grade group by year fixed effects. * significant at 5% or below;

Table A.3: ITT Charter School Effects on Math by Grade Grouping

	Math		Reading	
Effect of Admission (Applied for KG or 1st Grade)	3.51	4.25	4.07	3.93
	(3.48)	(3.31)	(3.33)	(3.38)
Additional Effect of Admission...for Students Who...				
Applied for 2nd or 3rd Grade	2.54	2.04	2.23	4.30
	(5.84)	(5.67)	(5.65)	(4.92)
Applied for 4th or 5th Grade	1.74	0.46	-0.26	-1.23
	(5.69)	(5.21)	(4.59)	(3.94)
Applied for 6th, 7th, or 8th Grade	-6.93	-10.16	-7.65	-7.45
	(4.70)	(4.51)*	(4.07)	(3.73)*
Free Lunch		-7.31	-5.30	-2.09
		(1.89)*	(1.72)*	(1.33)
Special Education		-20.69	-14.23	-7.80
		(2.04)*	(1.82)*	(1.53)*
Bilingual Education		6.17	4.49	4.26
		(4.53)	(4.34)	(3.70)
Repeated Grades		-19.23	-12.04	-8.92
		(3.24)*	(3.68)*	(2.96)*
White		11.48	14.54	8.85
		(7.32)	(7.01)*	(6.10)
Hispanic		0.40	0.58	-1.16
		(4.04)	(3.74)	(3.60)
Female		1.47	1.72	0.21
		(1.30)	(1.18)	(0.96)
Recent Test Score is Available				-23.98
				(3.11)*
Recent Test Score				0.76
				(0.02)*
Predicted Post-Lottery Score is Available	41.48	48.50	46.07	38.99
	(2.30)*	(2.81)*	(2.93)*	(3.46)*
Predicted Post-Lottery Score			-22.55	
			(2.45)*	
Constant			0.54	
			(0.03)*	
Observations	3401	3401	3401	3401
R-squared	0.07	0.15	0.29	0.48

The dependent variable is percentile score on the Iowa Test of Basic Skills. Standard errors (in parentheses) are clustered by student. All regressions include lottery fixed effects and grade group by year fixed effects. * significant at 5% or below;

Table A.4: ITT Charter School Effects on Reading by Grade Grouping

	Math		Reading	
Effect of Admission (Applied for KG or 1st Grade)	8.09	9.08	8.79	8.62
	(3.38)*	(3.15)*	(3.18)*	(3.24)*
Additional Effect of Admission...for Students Who...				
Applied for 2nd or 3rd Grade	-5.92	-6.39	-6.04	-6.26
	(5.75)	(5.45)	(5.47)	(4.56)
Applied for 4th or 5th Grade	-6.23	-7.71	-9.45	-7.29
	(5.50)	(4.98)	(4.38)*	(3.86)
Applied for 6th, 7th, or 8th Grade	-8.38	-11.59	-11.45	-10.85
	(4.32)	(4.04)*	(3.75)*	(3.57)*
Free Lunch		-9.27	-7.31	-4.81
		(1.67)*	(1.57)*	(1.33)*
Special Education		-19.83	-13.10	-7.01
		(1.71)*	(1.64)*	(1.40)*
Bilingual Education		9.82	10.57	9.95
		(3.97)*	(3.70)*	(3.26)*
Repeated Grades		-14.70	-10.92	-3.51
		(2.59)*	(2.62)*	(1.93)
White		16.68	14.45	12.88
		(7.07)*	(7.53)	(6.00)*
Hispanic		-4.00	-3.56	-3.99
		(3.56)	(3.33)	(3.08)
Female		3.79	2.77	1.29
		(1.22)*	(1.12)*	(0.93)
Recent Test Score is Available				-25.82
				(2.91)*
Recent Test Score				0.73
				(0.02)*
Predicted Post-Lottery Score is Available	39.18	45.60	44.45	40.84
	(2.85)*	(3.11)*	(3.19)*	(3.68)*
Predicted Post-Lottery Score			-19.88	
			(2.19)*	
Constant			0.47	
			(0.03)*	
Observations	3407	3407	3407	3407
R-squared	0.09	0.18	0.29	0.45

The dependent variable is percentile score on the Iowa Test of Basic Skills. Standard errors (in parentheses) are clustered by student. All regressions include lottery fixed effects and grade group by year fixed effects. * significant at 5% or below;