ABSTRACT

Title of dissertation: CONTRACTING OUT PUBLIC SCHOOLS AND ACADEMIC PERFORMANCE: EVIDENCE FROM COLOMBIA

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Contracting out public schools to private institutions is an instrument for reforming public education as it may facilitate academic innovation and improve student academic performance through higher school accountability and autonomy. The degree of autonomy that different providers have may vary substantially depending on the contractual and institutional arrangements they are subject to. In principle, contractual differences should generate different sets of incentives for providers that may ultimately affect student academic performance. One can expect, for example, that programs with limited achievement accountability rules might invest sub-optimally in resources aiming at improving the academic performance of their students.

In this dissertation, I evaluate short- and longer-run achievement effects of the *Colegios en Concesión* (CEC) program, a large-scale initiative implemented in 2000 in Bogota, Colombia, which contracted out the administration of some traditional public schools (TPS) to reputed, not-for-profit private schools and

universities. This program allows participating schools to operate outside public schools' collective bargaining provisions in return for being accountable, among other things, for the academic performance of their students in the ICFES test, a high-stakes college entry national standardized test.

The major empirical challenge in studies of alternative school models is selection bias. Students who attend CEC schools may differ in a number of ways from public school students. To overcome potential selection bias of CEC attendance, I exploit variation in distance from a student's residence to the closest CEC institution as an instrument for CEC attendance. While distance may in theory be correlated with unobservable characteristics of students, I demonstrate using a variety of empirical strategies that this instrument is conditionally exogenous of unobserved determinants of academic achievement.

I first evaluate the effects of attending a CEC school on ICFES test scores. Instrumental variables results indicate that CEC students exhibit important and significant gains in test scores on the ICFES test. That is, the two-stage least squares estimates obtained indicate that CEC students score 0.6 and 0.2 standard deviations higher in math and verbal tests, respectively, relative to TPS students. I provide evidence that the positive test score results of CEC attendance are not driven by unintended strategic responses by CEC schools such as excluding low-performing students from the pool of test-takers or via test specialization in the curriculum, or by significant differences in education inputs such as teachers' education, student-teacher ratios, or expenditures per student. I also provide suggestive auxiliary evidence that the estimated results are a consequence of an

institutional arrangement that makes CEC schools accountable for the academic performance of their students.

I also evaluate whether attending a CEC school translates into longer-run gains in potentially more meaningful outcomes such as increasing the probability of investing in post-secondary schooling, attending a more selective tertiary institution, or being admitted in high-return academic programs. The results on college attendance indicate that CEC students exhibit a significantly higher probability of attending a higher education institution and to attend a vocational program relative to TPS students. Moreover, CEC students have a slightly higher probability of attending a selective public institution and are not more likely to drop out from college relative to TPS students.

The overall results provide compelling evidence that the contractual arrangement that defines the operation of CEC schools are successful at improving the academic performance of their students relative to TPS.

CONTRACTING OUT PUBLIC SCHOOLS AND ACADEMIC PERFORMANCE: EVIDENCE FROM COLOMBIA

by

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Dedication

Siempre me ha gustado la idea de elogiar a la dificultad con la vida misma. (Así también me enamoré de ti. Luchando en la corriente de un amor temeroso que se perdía entre palabras ausentes). No fueron pocas las veces del discurso de motivación ante las dificultades de estos años de estudio. Tan presentes. Tan copiosas. Estamos aquí a pesar de haber desconfiado tanto. De esa terrible manía de atribuirle lo propio a la suerte y lo impropio a sí mismos. Pero hoy no. Hoy quiero celebrar que hallamos tomado una de las mejores decisiones de nuestras vidas. Pese a los costos. Enormes. Pese a las lágrimas y a algunos momentos para el olvido. Pero juntos. Juntos, porque solo ni a palo. Aprendiendo a cocinar. A conocernos en otra lengua y a hacer amigos de mundos ajenos. A disfrutar de todo ese tiempo juntos que siempre se queda corto. Porque siempre me quedan faltando minutos para estar contigo. Pidiéndole tiempo al juez al final del encuentro diario. A ti, mi Carito, te dedico esta disertación.

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To my parents, I owe a powerful idea. A beautiful idea that was never explicitly taught, yet too present to be overlooked: that there is nothing more satisfactory in life than helping others —within our own limitations. Perhaps I should not be surprised by how much this has defined my professional journey and I hope it will keep defining my research agenda. Finally, I want to thank my mother and my sister Cristina for believing so much in me and letting me know it. For their unconditional support that always keeps me hopeful that everything —no matter what— is going to be alright.

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1.1. Introduction

The question of whether private schools provide better education than public schools has been a long and much debated issue. This question is, for example, at the center of the debate over the effects on academic performance of vouchers, charter schools, and other programs that allow the participation of the private sector in the provision of public education.

In order to improve the quality of public education, policy makers and researchers have examined the way in which public education is provided. Proponents of public-private partnerships in education argue that the political institutions that govern public schools inhibit the existence of academically effective organizations, as services are provided by organized labor unions that tend to put too much weight on the welfare of their members in detriment of education quality (Chubb and Moe, [1990]). Opponents, on the other hand, assert that due to contractual incompleteness, contractors engage in cost-saving strategies that affect those aspects of quality which are essentially non-contractible and

tend to avoid problem (i.e. unprofitable) students that the public authorities are responsible for serving. It has also been argued that private schools may have curriculums that do not fully reflect the social goals of education such as serving as an agent of socialization into a common set of moral values (Benveniste, et. al, [2003]).

While the movement towards choice and decentralization in public education has included programs as varied as vouchers, magnet/pilot schools, and intra-district plans, contracted-out public schools appear to be one of the most replicated strategies among the reform initiatives.[1] Unlike voucher programs —where the control over the quality of education provided by participating schools is mostly left to private users— contracting out public schools is an attractive choice to policy makers as it allows the state to retain a fair measure of control over service delivery by monitoring performance, imposing penalties or by replacing providers in case of performance failure. To some extent, charter schools in the Unites States and in Alberta (Canada), Academies in England, Free schools in Sweden, and CEC schools in Bogota (Colombia) are salient examples of this type of education provision. That is, initiatives aiming at broadening the decision-making autonomy of schools and promoting accountability, while remaining under —admittedly varying levels of— public control.

In the literature on public-private partnerships in education, both charter schools in the US and voucher programs in Latin America have received spe-

[1] Charter schools in the US are a prominent example of this type of strategies with more than 5500 institutions by 2010 up from 1,200 schools in 1999 —a five-fold increase (Center for Education Reform, www.edreform.com last visited on May 15, 2011).

cial attention. Charter schools in the United States are privately run schools, partially funded by the state and attended by choice. With greater flexibility, charter schools are able to run longer school days, have an academic curriculum different from public schools, and finance their activities through a mix of public and private funds. Also, they are able to operate outside teachers' collective bargaining provisions that constrain seniority and tenure conditions in traditional public schools (for a description of US charter school experiences see, for example, Hoxby [2009], Matthews [2009], and Wilson [2008]). Nevertheless, as I explain in more detail below, the evidence on charter schools in the US is rather mixed with positive effects being found for some schools and some grades only.

The evidence on voucher programs in Latin America is not conclusive either. Using panel data for a large voucher program in Chile, Hsieh and Urquiola (2006) find no positive effects on mean test scores, repetition rates, or years of schooling. They find, however, evidence of increased sorting, as the best public school students moved to private schools. A second voucher program that has received attention in the literature is the lottery-allocated PACES program during the 1990s in Colombia (King, [1997]; Angrist et al, [2002]; Angrist et al, [2006]; Bettinger et al [2010]), one of the largest voucher school programs to have ever been implemented. The short- and long-run goals of this program were to rapidly raise secondary-school enrollment rates through private academic institutions and to improve the education quality through school competition for voucher recipients (Kling et al [1998]). Angrist et al (2002) found that lotteried-in students were more likely to finish 8th grade —mainly because they were less

likely to repeat grades— and to score higher on achievement tests.[2] Moreover, Angrist et al (2006) find that voucher winners were 15 to 20 percent more likely to graduate from high school than lotteried-out participants. Interestingly, these results seem to have been driven by students who switched to more expensive private schools but who would have attended *private* schools had they not received a school voucher. In fact, 85% of lottery losers started secondary school in a private institution. What these results indicate is that lottery participants did not come from low-income families, perhaps the group of first-order importance for this type of programs.

The inconclusive evidence on the effectiveness of the private provision of public education has been used by some authors to question all forms of public-private partnerships in education such as charter school programs (Benveniste, et. al, [2003]; Levin, [2003]; Ravitch, [2010]). However, perhaps what the mixed evidence on these public-private partnerships in education suggests is that the debate on education provision should not be so much about privately versus publicly run schools but about designing the right incentives in order to induce public schools to be responsible for the academic performance of their students —for example, by creating school accountability policies for both school administrators and teachers.

In this dissertation, I study the short- and longer-run causal effects of the *Colegios en Concesión* (henceforth, CEC) Program, an initiative implemented in Bogota (Colombia) in the year 2000 that aimed at improving the quality of ed-

[2] The effect on test scores is significant at a 10% confidence level.

ucation imparted by public schools by contracting out some public schools to private operators while retaining a fair amount of control over the services provided.

1.2. The Colegios en Concesión (CEC) Program

The ability of the Department of Education of Bogota (hereafter, SED) to implement policies that improve academic performance depends, to a great extent, on its ability to direct and coordinate the actions of the complex public education sector in Bogotá, which consists of more than 26,000 teachers operating within a national collective bargaining agreement. The existing institutional arrangement leaves the SED with little room to introduce major changes aimed at improving quality of education. First, wages are determined through a bargaining process between the teachers union and the national government —not the local government— and are determined by education and tenure as opposed to performance. Second, the SED has little ability to coordinate the actions of traditional public schools (hereafter, TPS) through school principals, and principals themselves do not have social or legal instruments to exert authority and demand the fulfillment of assigned tasks to teachers. Indeed, although the SED has the power to appoint and transfer school principals and teachers, dismissals or other disciplinary sanctions are the responsibility of the Ranking Board, a committee where teachers' interests had traditionally been over-represented (Gandour et. al, [2000]).

These institutional limitations prompted the creation of the CEC school program. The argument was that this program would allow the SED to be able to monitor and demand academic quality in some schools given the lack of high power incentives to encourage teacher cooperation in TPS. Thus, all the new public schools constructed by the SED between 1999 and 2003 were contracted out to private academic institutions. The SED established 15-year contracts with private schools and universities through a bidding process based on the superior academic results of their own institutions in the ICFES test, the proposed profile of potential teachers and yearly cost per-student. A total of 16 schools opened primary school grades (grades 1 to 5) in April 2000 and then added secondary education (grades 6 to 11) the year after. Six more schools began operating in March 2001, providing up to 10th grade that year and graduating their first class in 2002. The last 3 schools opened in 2003 for all academic grades.

The CEC program is of interest for a number of reasons. First, to the best of my knowledge, this initiative is one of the largest programs of its kind to have been implemented by a local administration in a developing country, serving more than 40,000 students in all academic grades (from pre- to high-school).

Second, the CEC program is a publicly designed program aimed at improving education quality. In fact, this program is the first education policy in Colombia designed to hold public schools accountable for the academic performance of their students. This is unlike similar public-private partnerships like U.S. charter schools, which have been implemented as a *private* response to public education. The Center for Education Reform, a U.S. charter advocate, states

that "Virtually anyone can submit an application to open and operate a charter school: parents, educators, museums, civic groups, business leaders, service organizations and teachers have started schools in United States". As a result, charter schools in the U.S. are diverse and many are specifically created to be an alternative for those interested in subjects missing in traditional education: special arts or music programs, language, adult education, dropout prevention programs, and special education needs (Hoxby and Rockoff, [2004]). As a result, some charters may not see academic performance as their primary goal.

An implication of the CEC program as a public policy is that all CEC schools are very similar along most relevant dimensions. First, the geographic location of each contracted out school was chosen by the Department of Education (SED) according to the demand for public education. As a result, all CEC schools were located in low-income areas of the city where excess demand for public education was highest. Second, the SED constructed all of these schools and made them similar in terms of their physical characteristics. Third, CEC schools must follow the same academic curriculum of TPS so that, other things equal, there should be no difference in academic achievement due to differential academic content. Fourth, CECs do not get to choose their own students but instead have to take those students allocated by the SED. Fifth, expenditures per student are practically the same as those of TPS. For the purpose of this study, a clear methodological advantage of having a relatively homogeneous program is that it reduces concerns about estimating their joint effect on academic performance. Also, the fact that CEC schools are similar to TPS in dimensions such as

academic curriculum and per-student expenditures allows us to rule out some of the mechanisms behind academic performance.

On the other hand, CEC schools are different from TPS in some important ways. First, CEC schools are able to hire teachers at regulated salaries on ten-month renewable contracts from a non-unionized pool of applicants. That is, unlike TPS, CEC schools have the flexibility to hire and fire teachers as needed on a yearly basis. In addition, the contracts establish that teachers should have at least a college degree in Education and have some years of relevant experience. Teacher wages are regulated by law so that CEC teachers earn at least what TPS teachers earn according to education level and experience. Interestingly, given the differences in job stability for public and CEC teachers, CEC school teachers often find it optimal to move to TPS, with some CEC schools having turnover rates of as much as 40% per year. Second, while many TPS provide either primary or secondary grades, CEC schools provide all academic grades, a strategy that not only aims to reduce dropouts, but perhaps more importantly a strategy that provides incentives for long run student investments by the school. Third, the average CEC school has better school facilities than the average TPS as a result of being more recently built by the SED. Nevertheless, as many as fifty new TPS constructed after 2004 and located in similar low-income neighborhoods (see Figure 1.1) have facilities comparable to CEC schools.[3]

[3] These new schools were not contracted out since the CEC program was phased out in 2004 with the election of a new city mayor.

1.2.1. CEC School Evaluations

Perhaps the most important difference between CEC and TPS schools is that the former are subject to performance evaluations by organizations contracted by SED for this purpose. Importantly, only after 2007 a standardized and more comprehensive annual evaluation was implemented —including additional indicators in terms of a national standardized test known as ICFES. The ICFES test[4] is a high-stakes, multiple-subject, Colombian national standardized test taken by the vast majority of high school students in their last year of high school and serves as the main criterion to determine admission into higher education institutions.

Before 2007, the evaluations conducted did not aim at becoming a regular instrument for tracking CEC performance partly since these were conducted by different organizations with different methodological approaches. Starting in 2007, the current evaluation has used quantitative and qualitative indicators on multiple outcomes related to academic quality such as student academic achievement, teachers' education and experience, participation of students, parents and teachers in school bodies, quantity and quality of food provision, and transfer and dropout rates. As shown in Table 1.1, the current methodology is divided into components and each component is in turn divided into indicators. Note that both indicators and components are weighted in order to generate a composite grade for each CEC school. An important feature of the current

[4] The current name of this test is SABER 11

evaluation method is that it allows for individual school comparisons over time.

Regarding the academic achievement component (with 20% of the weight), the current evaluation looks at each CEC school average performance on the ICFES test using a weighted average of their overall and relative performance. The overall measure —receiving 40% of the weight within the academic performance component— ranks all private and public schools in the country according to their average performance in the ICFES test in 7 achievement levels. Since 2004, the average CEC school has been placed in the fourth level with very little variation over time. Whereas the average CEC school in the period 2004-2007 was placed in level 4.44, this figure was 4.59 for the 2008-2010 period. As reference, the 2008 average CEC ICFES score difference between any two adjacent levels is 0.2 standard deviations. This may be an indication of how difficult it may be to move to a higher achievement level. This may be partly explained by the fact that this indicator does not control for SES differences between schools. Thus, in order to move to a higher achievement level, schools need to improve their performance relative to all schools including private schools.

The contracts with CEC providers recognize that overall performance is an imperfect measure of school quality as academic achievement is highly correlated with students' background. Indeed, the contracts state that the SED can unilaterally break the contract whenever a school's average results in the ICFES test are worse than the performance of the average TPS in their locality for two consecutive years.[5] Consequently, the current evaluation takes this indicator into

[5] Bogota is administratively divided in 20 localities and there are CEC schools in 10 of them.

account. In Figure 1.2, I show differences in means between each CEC school and the average TPS in their locality for both 2007 and 2008. For both years, the horizontal axis is sorted in ascending order of the 2008 CEC-TPS ICFES difference to facilitate visualization. Note, first, that for 2008, seven CEC schools have scores statistically higher than the average TPS in their locality. Also, for the remaining schools, the difference in means is not statistically different from zero at a 95% confidence level. Moreover, although four CEC schools in 2007 did perform below the average TPS in their locality, they managed to improve their performance in 2008. What these results suggest is that defining academic achievement relative to TPS in the same locality as stated in the provision contracts is a condition that not all CEC schools easily achieve.

In Figures 1.3 to 1.5, I present the evolution of the current evaluation for the period 2007 to 2009. Figure 1.3 shows the results in percentage terms on the academic achievement component for all CEC schools for these years, where the horizontal axis represents each one of the CEC schools. As shown, the vast majority of schools have consistently maintained or improved their academic performance in these three years. However, that many schools are scoring just 60% in this component suggests there may be some room for improvement in this area. Moreover, note that the positive trend in time is not only occurring in the academic component. The results are indeed similar in all components, including —as shown in Figure 1.4— the one related to having low drop-out rates or the quality and quantity of the food provided to students. The overall grade for each CEC school in Figure 1.5 just confirms the pattern. I interpret

these results as evidence that CEC schools are taking the current evaluation seriously, partly to comply with contractual demands, but also because they may be interested in showing merits in case they apply for contract renewal in the years to come.[6]

1.2.2. Related Literature

Charter Schools

The CEC program has features in common with some charter school experiences in the US and therefore serves as a framework to compare the estimated effects of CEC attendance with those of charter school programs. Both CEC and US charter programs are supported by public funds, receive students interested in public education, cannot select their own students, and are not subject to teacher collective bargaining agreements. However, unlike CEC schools, charter schools are responsible for finding their own students, may target students interested in non-standard education programs (e.g., arts, music, language, special education, etc.), and are partially funded by private donors.[7] CEC schools, on the other hand, are required to take the students allocated by the SED, have the same academic curriculum TPS have, and are fully funded by public resources.

Most of the recent studies on charter schools use admission lotteries to circumvent the concerns about non-random selection. There is mixed evidence in the lottery-based literature of charter school attendance on academic achieve-

[6] The first contracts will expire in 2014.

[7] For example, the Harlem Children Zone Charter in New York City spends 25% more than the median per-pupil expenditure in New York State public schools (Dobbie and Fryer [2009]).

ment, usually with positive effects being found for some grades only. The overall evidence indicates that charter school students score from 0.3 to 0.4 standard deviations higher than lottery losers in math tests per year of treatment and around 0.1 to 0.2 standard deviations higher in reading tests per year (Angrist et. al [2010]; Abdulkadiroglu et. al, [2009]; Dobbie and Fryer, [2009]; Hoxby and Murarka, [2009]; Hoxby and Rockoff, [2004]). It is important to keep in mind, however, that charter schools that are forced to use lotteries to determine admission may be the most effective charter schools —those that parents find more appealing and continue to operate. As a result, the reported estimated effects may not speak of the overall effect of charter school attendance.

In turn, studies that have used panel data to account for unobserved time invariant student characteristics in the US find that charters students experience poor test score growth in the first years after enrollment but later recover from this initial disruption, with no significant gain in test scores from charter school attendance after some time (Saas, [2004]; Bifulco and Ladd, [2004]; Hanushek et. al, [2007]; Booker et. al [2007]). There is some evidence, however, of positive charter effects on school attendance and lower disciplinary sanctions (Imberman, [2009b]).

Test-Based Accountability

A second group of educational programs that have similarities to the CEC school program are those that impose sanctions on low-performing public schools.[8]

[8] In the US, for example, the No Child Left Behind Act of 2001 (NCLB) established penalties for failing to meet performance standards in all states. In particular, the NCLB requires states

The existing literature has traditionally focused on school responses to increased accountability, in particular, to what extent higher academic results are driven by unintended strategic responses by affected schools. An example of a positive response to increased accountability is Chiang (2009). Using a regression discontinuity design and data from public schools in Florida, this study finds that threatened elementary schools raised math and reading test scores in 0.12 and 0.1 standard deviations, respectively, by raising spending on technology, curricular improvements, and teacher training.

Although schools face a powerful incentive to raise their academic performance ratings by reforming the inputs and processes of the educational production, most of the existing evidence suggests that schools opt to strategically respond to the accountability system in ways not intended by policy makers. That is, by raising test scores without contributing to students' knowledge and skills. Examples of these responses are to reclassify low-performing students into special education, or to impose longer disciplinary sanctions near testing dates so that these students do not affect school average test results (Deere and Strayer, [2001]; Figlio and Getzler, [2002]; Cullen and Reback, [2002]; Jacob, [2005]; Figlio, [2006]). Moreover, there is also evidence that higher test score results have been driven by increasing test-preparation at the expense of low-stakes subjects such as the natural sciences (Koretz and Barron, [1998]; Jacob, [2005]), or through teacher cheating (Jacob and Levitt, [2003]). This literature stresses the impor-

to test students in grades 3 to 8 each year and to judge school performance on the basis of these test scores.

tance of assessing potential strategic responses by CEC schools when interpreting the estimated effects of CEC attendance on test scores.

CEC School Program

There have been two previous evaluations of the CEC school program in Bogotá. First, Sarmiento et al. (2005) surveyed 22 CEC schools as well as to 10 TPS with similar characteristics. That study concludes that CEC schools have a better academic environment, have more autonomy to manage both teachers and resources, and are more exposed to supervision by the SED. Barrera (2005), using a propensity score matching strategy, finds that CEC schools have lower dropout rates compared to similar TPS. He also finds evidence that students from CEC school students score 1 to 2 more points in the ICFES test relative to TPS students. Both of these studies are early evaluations of the effects of the program, which may be problematic given that students graduating from CEC schools in the first years of the program spent most of their elementary and middle school years at TPS.

1.3. Short-Run Effects of CEC attendance

In this dissertation, I start by examining the effects of attending a CEC school on test scores using data for all TPS and CEC students in Bogotá who took the ICFES test in the second semester of 2008.

The major empirical challenge in studies of alternative school models is selection bias. Students who attend CEC schools may differ in a number of

ways from public school students. Some of this bias is eliminated by controlling for observable student and family characteristics, but the possibility of bias remains from unobserved variables that determine school choice such as a student's ability, motivation or some other features of family background. For example, higher unobserved motivation among parents of CEC schools can erroneously lead to the conclusion that CEC schools raise academic achievement relative to traditional public schools even if there is no difference in the quality of these schools. Alternatively, estimates of the effects of CEC schools on achievement could be downward biased if CEC families have unobserved lower socioeconomic conditions relative to families of students attending traditional public schools.

Therefore, establishing the causal effects of CEC school attendance on academic achievement requires an exogenous source of variation in school choice. Basic economic models of education choice suggest that schooling decisions are based on the costs and benefits of alternative choices. In this dissertation, I exploit geographic differences in accessibility to CEC schools as a source of exogenous variation. Using administrative data on student and school addresses, I conduct an instrumental variables approach that uses a function of residential distance to the closest CEC school as an instrument for CEC attendance. As I explain in detail in Chapter 2, the proposed instrument solves the unobserved selection problem as long as the distance of a student's residence to the closest CEC school has a strong effect on the probability of attending a CEC school, without affecting student outcomes directly conditional on other exoge-

nous covariates. Intuitively, differential distances to CEC schools induce quasi-experimental differences in transportation and opportunity costs of attending a given CEC school, differences that are especially important for students with low socioeconomic background for whom the decrease in costs due to CEC proximity may induce CEC school attendance.

While residential distance to the closest CEC school may in theory be correlated with unobservable characteristics of students, I demonstrate using a variety of empirical strategies that the proposed instrument is likely to be conditionally uncorrelated to unobserved determinants of academic performance in this context. The most important factor driving this conditional exogeneity is that all CEC schools were constructed in neighborhoods with excess demand for public education in the poorest areas of the city.[9] Thus, conditional on residing in these areas, I show that the distance from a student's residence to the closest CEC school is not correlated with observed family or student determinants of academic performance and, therefore, it is likely to be uncorrelated with unobserved determinants as well. Moreover, to further check for the direct effect of distance on academic achievement, I perform a reduced-form placebo test using students' test scores for the year 2000, one year before any CEC school graduated their first class and show that CEC schools were not systematically located in areas of the city with higher probabilities of success. In fact, if anything, the results indicate that my instrumental variables estimates are lower bounds of the

[9] The city's Department of Education (SED) was responsible for locating and constructing all CEC schools in Bogotá. As a result, selected providers did not have any influence on the location of the schools.

true causal effect on test scores as CEC schools may have been placed in neighborhoods with unobserved lower than average socio-economic characteristics.

I show that, relative to public school students, CEC students scores are around 0.6 and 0.25 standard deviations higher in math and verbal test scores, respectively. Taken at face value, these effects reduce by a half the public-private school achievement gap in math and verbal test scores, a significant effect considering the large differences in socio-economic characteristics between these two population groups. The estimated results are significantly higher than OLS estimates for CEC attendance, suggesting that the observed association between CEC attendance and test scores is not driven by omitted variables such as higher ability or highly motivated families among CEC students. Instead, the evidence points to the possibility that the unobserved variables that determine selection into CEC schools are negatively associated with academic performance.

Unlike some programs that have implemented test-based accountability practices in public schools in the US (Koretz and Barron [1998]; Figlio and Getzler [2002]; Cullen and Reback [2002]; Jacob [2003, 2004]), I show that the higher performance exhibited by CEC students are not driven by strategic responses by CEC schools such as forcing low-performing students to either transfer or dropout from CEC schools, or by preventing students in some other way from taking the test. I also provide evidence that the estimated effects are not driven by specializing in high-stakes subjects such as math and reading at the expense of ignoring other critical areas of learning like the natural sciences. First, unlike most standardized tests, ICFES test evaluates students on most of the curriculum

subjects determined by the Colombian Ministry of Education,[10] which reduces the effectiveness of test preparation. Second, neither the schools nor their students have incentives to exert more effort on only some specific subjects. From the point of view of the schools, the academic requirements defined in the provision contracts are based on their students' ICFES composite test scores, calculated for each student as a weighted average of all test sections. For the students, ICFES composite test score serves as the main admission criterion to higher education institutions in Colombia (ICFES, 1999). My instrumental variables results indicate that attending a CEC school increases composite test scores by 0.3 standard deviations relative to public school students, suggesting that CEC schools are not specializing in certain academic subjects.

1.4. Longer-Run Effects of CEC attendance

Interestingly, most studies on the effects of contracting out public schools focus mostly on the short-run effects of attending privately run public schools on test scores, with most of the existing evidence coming from evaluating US charter schools (Angrist et. al [2010]; Abdulkadiroglu et. al, [2009]; Dobbie and Fryer, [2009]; Hoxby and Murarka, [2009]; Hoxby and Rockoff, [2004]; Saas, [2004]; Bifulco and Ladd, [2004]; Hanushek et. al, [2007]; Booker et. al [2007]). Missing from these studies is an assessment of longer-run outcomes of attending such schools such as earnings and college enrollment —outcomes that are more

[10] ICFES test evaluates students on Math, Verbal, Biology, Chemistry, Physics, History, Geography, Philosophy, and English.

clearly tied to economic success.

In Chapter 3, I examine some longer-run effects of attending a CEC school. Given that the ICFES test is a compulsory requirement for students intending to enroll in college in Colombia and serves as the primary college admission criterion (ICFES 1999), it seems natural to evaluate whether CEC students have been able to translate higher ICFES test scores into high school graduation rates and higher college enrollment rates relative to Traditional Public School (TPS) students. The latter outcome is a relevant long term measure of school performance given that the returns from college in Colombia have been estimated to be twice as large as the returns from primary and secondary school (World Bank, 2003).

In addition to this outcome, I also consider whether students who attended CEC schools are more likely to be admitted at selective universities as there is causal evidence for Colombia showing that students who attend selective universities are more likely to have formal employment and have higher earnings than students attending non-selective institutions (Saavedra, [2008]). However, low-fee charging, selective, public universities in Colombia have managed to keep a low number of admitted students (World Bank, 2003). As a result, low-income students who traditionally graduate from TPS and CEC schools have a hard time competing with private school students for admission into selective, public institutions. Therefore, some public schools may be aiming at placing their students in two-year vocational programs, specifically designed to increase students' odds of getting formal employment. Thus, as a third outcome, I look at the probability of enrolling in 2-year technical and technological programs

relative to TPS students.

Lastly, I look at the college dropout behavior of CEC students. In Colombia, 50% of the students who enroll in higher education institutions drop out from their programs (MEN, 2010). While part of this may be due to financial considerations —including inadequate student financial aid for low-income students— it is often argued that the low-quality of secondary education is also an important reason for dropping out from college.

To construct these higher education outcomes, I use administrative data from the Ministry of Education on college enrollment which has student-level information on institution and program enrollment as well as dropout behavior. Using the same identification strategy described above, I find that that CEC students in 2007 were 12 percentage points more likely to enroll in college. This represents more than a 50% increase over the average college enrollment rate for this sample.

I also find that 2007 CEC students are one percentage point more likely to attend a selective and public institution compared to TPS students —a relatively large effect compared to an unconditional mean of 3%. IV results also show that CEC students are almost 8.8 and 6.5 percentage points more likely to attend a vocational program than TPS students in the 2007 and the 2007-2008 samples, respectively. These results represent more than an 85% increase compared to the unconditional means of 2-year programs. This is a relevant outcome given that, according to the Ministry of Education, 74% of the graduates from technological programs in Colombia have formal employment —just 3 percentage points fewer

than graduates from 5-year colleges and universities in the 2001-2009 period (MEN, 2011). Also, graduates from technology programs have earnings equal to 75% the earnings of university graduates.

Lastly, regarding the probability of dropping out in the first two semesters after enrolling in higher education, I find that there is not a meaningful difference in the college dropout probability.

1.5. Conclusion

In this dissertation, I evaluate a governance structure that aims at improving education quality while allowing the state to retain a fair amount of control over the services provided. This governance structure can be broadly characterized by elements of the contract design and the institutional framework in which the contracts are implemented. This program allows the SED to hold the CEC schools accountable for the academic achievement of their students. Moreover, the contractual arrangement aims to reduce quality-shading cost reductions by CEC providers in a series of ways, including selecting non-profit organizations with strong reputations.

I provide strong evidence in terms of higher test scores by CEC program participants and some evidence on positive longer-run effects —especially, in terms of higher college enrollment rate. The evidence, however, indicates that the higher college participation is, to a great extent, explained by a higher probability of enrolling in two-year vocational programs. While there is some evi-

dence that graduates from vocational programs may enjoy better labor market outcomes, for example, in terms of the probability of being formally employed, admission into vocational programs imposes lower requirements in terms of ICFES test scores as admission into these programs is not as competitive.

What these results indicate is that the higher rates of college participation are not necessarily due to the better academic performance of CEC students and may be explained by alternative mechanisms. For example, the higher participation in vocational programs by CEC students is consistent with the intention of some CEC schools to provide terminal vocational courses in order to smooth out their students' entrance to vocational programs at higher education institutions. Therefore, it will be interesting in the future to look at other labor market outcomes such as wages and employment which may be more relevant to evaluate the full impact of this program.

Finally, it is also worth keeping in mind that the 2008 data on college enrollment seems to be incomplete given the striking difference in enrollment relative to 2007. Then, some of the results presented here on higher education —particularly the ones using 2008 data— are to be considered preliminary as this requires a better understanding of this discrepancy.

Tab. 1.1. Evaluation Methodology since 2007

Component	Selected Indicators	Weight
Pedagogical Model	Participation of Students, Teachers, Principals, and Concesionnaires in school government, school manual, and pedagogical proposals Availability and Accessibility of education materials	40%
Non-Academic Indicators	Dropout Rate Failing Rate Food Provision Quality and Quantity	20%
Academic Performance	Absolute performance in ICFES test Relative Performance in ICFES test	20%
Other	Programs for community and parental participation in school activities Institutional organization	20%

Source: IDEP (2010).

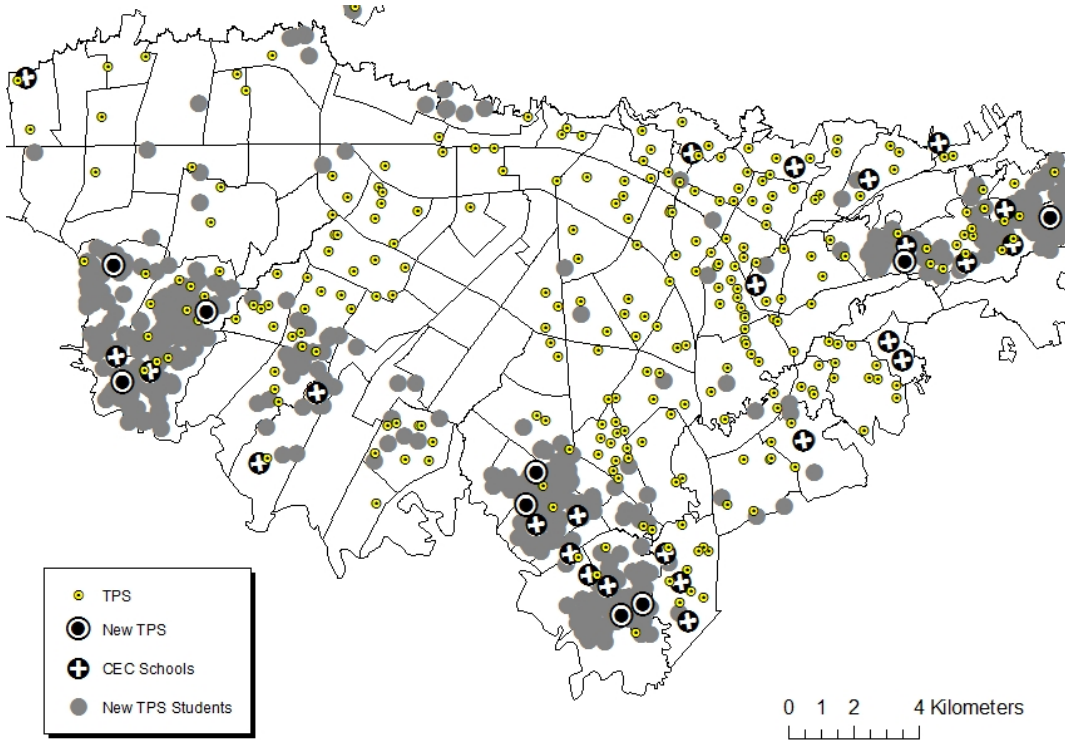


Fig. 1.1. Location of TPS, New TPS, and CEC Schools

Notes: This figure shows the location of all public and CEC schools in the city as well as the students residences by type of school attended. CEC and TPS students' residences are depicted with dark and light gray dots, respectively. CEC and TPS locations are represented with crossed black dots and hollow circles, respectively.

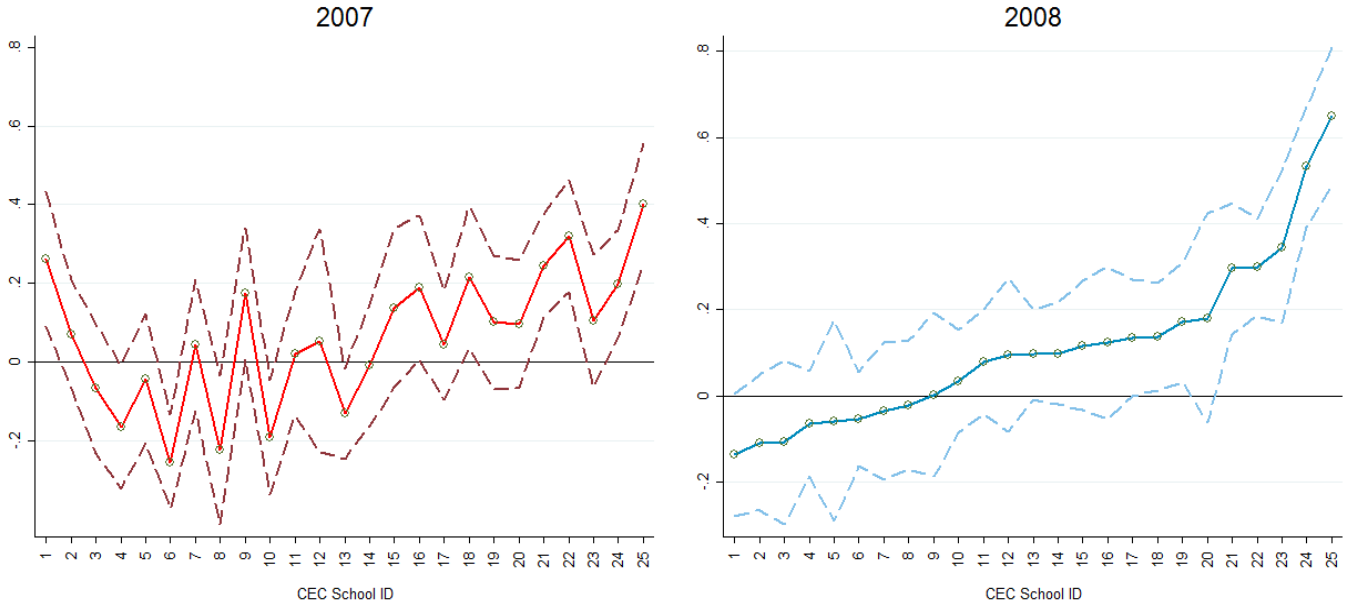


Fig. 1.2. CEC's ICFES Performance Relative to TPS in same Locality

Notes: This figure shows confidence intervals for the composite ICFES scores difference between each CEC and all TPS located in the same locality. For both years, CEC schools are sorted in ascending order of the 2008 CEC-TPS ICFES difference to facilitate visualization.

Fig. 1.3. CEC Academic Performance Component 2007-2009

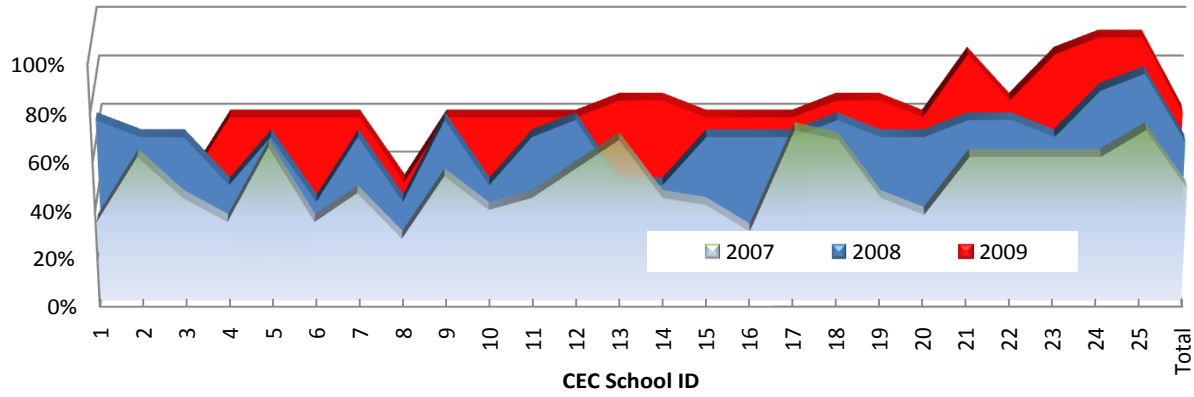


Fig. 1.4. CEC Non-Academic Indicators 2007-2009

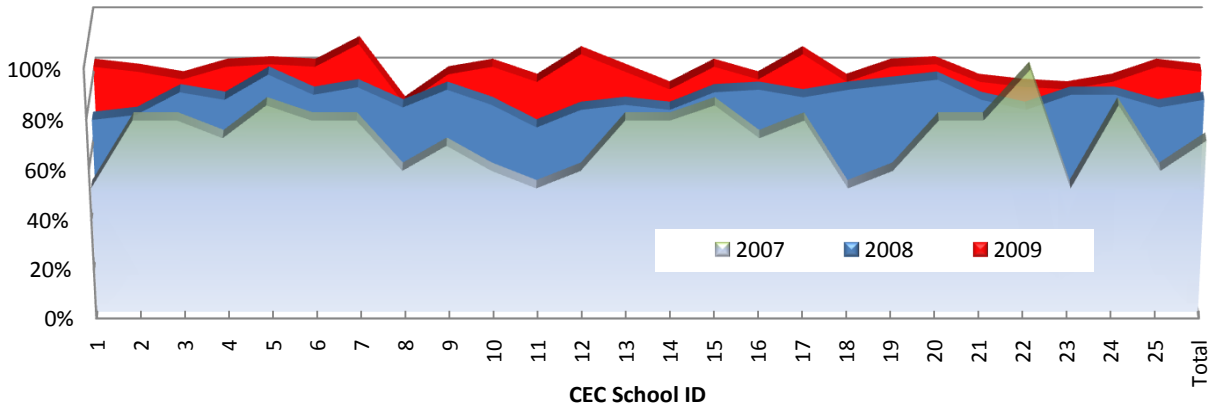
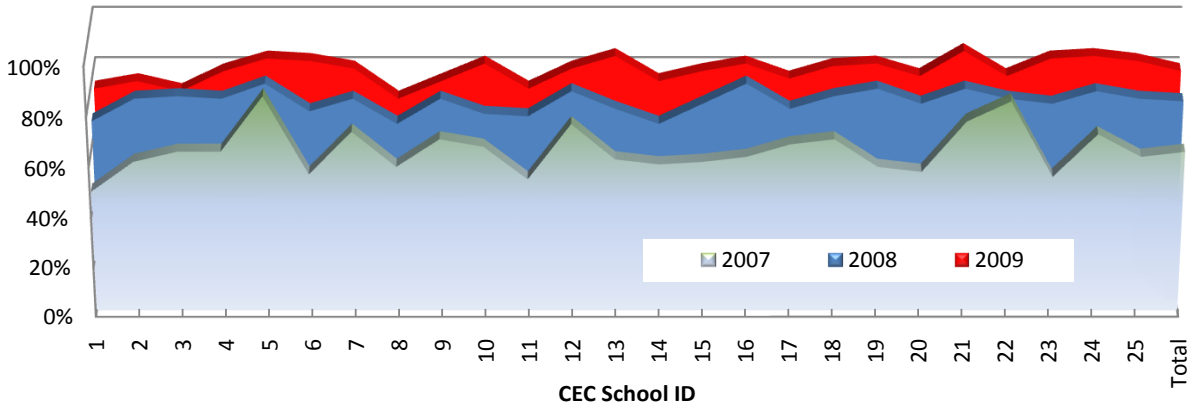


Fig. 1.5. CEC Overall Evaluation 2007-2009



Source: "Resultados de la III fase de Evaluación a Colegios en Concesión". IDEP (2010).

2. SHORT-RUN EFFECTS OF THE CEC PROGRAM

2.1. Introduction

In this chapter, I assess the causal effect of attending CEC schools in Bogota, Colombia, on the ICFES test, a national standardized test taken by the vast majority of high school graduates in their last year of high school. For this, I use data for all public and CEC students in Bogota who took the ICFES test and graduated in the second semester of 2008. Two main reasons support choosing data from this school year. First, CEC students graduating in 2008 are likely to have attended the same CEC school through all their secondary school years (middle and high school).[1] This point is important for at least two reasons. Cunha et al., (2006) show that the returns to education investments are higher the earlier these occur in the life cycle since they raise skill attainment at later stages and facilitate the productivity of later investments. In addition to this, the education production function depends on *cumulative* inputs (Hanushek [2006]). The second reason behind the choice of the 2008 cohort is that, unlike previous years, the ICFES test collected a large set of variables on student SES characteristics, which I use repeatedly in the empirical analysis.

[1] Secondary education in Colombia runs from 6th to 11th grades with middle school comprising 6th- to 9th and high school 10th and 11th grades.

As is customary in studies of school choice, we need to pay close attention to the potential selection of program participants. Indeed, students who attend CEC schools may differ in a number of ways from traditional public school (henceforth, TPS) students. In this dissertation, I exploit geographic differences in accessibility to CEC schools as a potential source of exogenous variation. In particular, I use an administrative dataset that allows me to conduct an instrumental variables approach, using distance to the closest CEC school to construct an instrument for CEC attendance. The proposed instrument solves the unobserved selection problem as long as the distance of a student residence to the closest CEC school has a strong effect on the probability of attending a CEC school, but does not affect student outcomes directly conditional on other exogenous covariates. Thus, special attention is paid to show that proposed instrument is likely to be conditionally uncorrelated to unobserved determinants of academic performance.

The two-stage least squares estimates obtained indicate that CEC students score 0.6 and 0.2 standard deviations higher in math and verbal tests, respectively, relative to public school students. As reference, these effects reduce by a half the public-private school achievement gap in math and verbal test scores, a significant effect considering the large differences in socio-economic characteristics between these two population groups. The estimated results are significantly higher than OLS estimates for CEC attendance, suggesting that the observed association between CEC attendance and test scores is not driven by omitted variables such as higher ability or highly motivated families among CEC students.

Instead, the evidence points to the possibility that the unobserved variables that determine selection into CEC schools are negatively associated with academic performance. I also show that that my instrumental variables results are not explained by treatment effect heterogeneity by students' income levels. Lastly, I provide evidence that the estimated results are not driven by unintended strategic responses by CEC schools, such as excluding low-performing students from the pool of test-takers or via test specialization in the curriculum.

The rest of this chapter is organized as follows. Section 2.2 describes the institutional framework of Bogota's public education system and briefly summarizes the literature on related school programs. Section 2.3 introduces the data sources and presents some descriptive statistics of the population of interest. Sections 2.4 and 2.5 describe the empirical strategy and the estimation results. Section 2.6 checks for the robustness of the results. Section 2.7 discusses the evidence on strategic responses to test-based accountability and the plausible mechanisms through which CEC schools are able to achieve higher academic results than TPS. Section 2.8 concludes.

2.2. Background

2.2.1. Public Education Sector in Bogotá

There were 1.6 million children enrolled in primary or secondary school in Bogotá in 2008. Of these, 1.1 million children were part of the public education system: 80% of them attended more than 340 TPS, 5% attended 25 CEC schools

and the remaining 15% attended 332 private schools paid by the City's Department of Education (SED, hereafter) for taking public school students unable to obtain a seat in existing public schools.[2]

Public schools in Bogotá largely educate the children of low income families. As expected, families self-select into schools according to their economic means, which leaves the public schools with students from the bottom of the income distribution. For example, data on student socioeconomic characteristics collected at registration for ICFES test shows that 67% of students attending a public school come from families with a monthly household income less than two times the monthly minimum wage; this figure is just 30% for students attending private schools.

Families applying for a public or CEC school for the first time must provide a preference-ranked list of up to four schools.[3] Before allocating children to schools, the SED sorts students according to the socioeconomic means of their families. That is, students from the most economically disadvantaged households are allocated first to their most preferred options. If no seats are available for the preferred choices, students are placed in the closest available school to their residence with available seats. It is worth noting that this process is the same for students attending either public or CEC schools. That is, neither TPS or CEC schools can select their students using admission tests or similar criteria.

[2] This initiative is different from a voucher program since students are not free to choose the private school they attend, but must attend the one to which they are assigned by the SED. Students enrolled in participating private schools usually reside in areas with excess demand for public education.

[3] Students currently enrolled in a given school are guaranteed a place in their current academic institution.

As a result of the admission process, public schools exhibit important differences in the observed characteristics of their students and, very likely, in their unobserved characteristics as well. On the one hand, the allocation algorithm gives priority to families with the lowest socioeconomic status (SES). That is, for two students applying to a given school, the one with the lowest SES is more likely to attend it. Thus, over subscribed schools could systematically get students with lower than average SES. On the other hand, the SED allows students to apply to their most preferred institutions, which may lead to selection of most informed or motivated parents into better public schools. Consequently, it is unclear which selection mechanism dominates in this context and, in particular, what exactly leads students to attend a CEC school. Because of this, in order to estimate a causal effect of CEC attendance on academic achievement, an identification strategy must account for the potential selection of CEC program participants into CEC schools.

2.3. Data

Administrative data for this chapter come from three main sources. The first source is ICFES, a public organization in charge of designing and administering standardized tests for all schools and universities in Colombia. For the purposes of this study, we use the test known as Exámen de Estado (commonly known as the ICFES test), taken by most high school students in their last year of school, which evaluates them on the multiple subjects mentioned above. A

rich set of demographic data on students and their families is collected at the time of test registration, three months before the test is taken. Self-reported demographic information includes, for example, gender, age, parents' education, number of household members, asset ownership (e.g., car, computer, cell phone, TV, etc), household income, and residential address. In this chapter, I use the 2008 ICFES results from students attending either TPS or CEC schools and set to graduate in the second semester of 2008. Using data from 2008, six years after the last CEC school started operating, allows me to estimate the cumulative effect of CEC school attendance for students who presumably attended these schools all their middle and high school years at these schools.[4]

The initial sample of public and CEC students graduating in the second semester of 2008 has 50,199 observations. After excluding students who attend night, technical, rural or military public institutions (because of concerns with the unobservable characteristics of these students) as well as observations with missing data for at least one of the variables (different from home address), I am left with 39,282 observations. The percentage of missing observations over total observations is around 6% for both CEC and TPS indicating that public students are not more likely to fail to report their personal information than CEC students (Table 2.1).

The second administrative data source comes from UAECD (*Unidad Administrativa de Catastro Distrital*), a local government organization responsible for

[4] Dropout and transfer rates from these schools are very low as shown in Figure 2.3 (Section 2.7). Thus, even though individual years of exposure to treatment for each student is not available, data at the school level indicates this should not be a concern.

maintaining a database of all legal buildings in Bogotá for urban planning and tax purposes. UAECD uses a geographic information system (GIS) that assigns coordinates (i.e., latitude and longitude) for all buildings in the city. Thus, using the residential address reported by students at the time of ICFES registration, I am able to calculate the distance from a student's home to both actual and potential TPS and CEC schools in the city.[5] As shown in Table 2.1, I am able to match 85% of students' addresses as reported at ICFES registration to addresses in the UAECD database.[6] In general, the absence of meaningful demographic differences between the matched and unmatched samples suggests that we are not left with a non-random sample of students, something that could bias the estimated effects if, for example, students with lower SES are more likely to misreport their home address. The final regression sample has 33,413 observations, including 31,783 public and 1,630 CEC students.

Table 2.2 presents descriptive statistics for the year 2008 for public and CEC students. Panel A includes all the students used later for estimation (which I hereafter refer as *the full sample*). The results indicate that, relative to students from TPS, CEC students have slightly larger families, have less educated parents, and come from lower income households. Moreover, CEC students are more likely to live in low-strata neighborhoods. The stratum scheme is a six-level classification used by the local government to characterize the socio-economic

[5] Matching student addresses with the UAECD database requires addresses to be written in the same way UAECD addresses are written. Given that less than 15% of the addresses were exactly matched, a Stata program was created to standardize students addresses

[6] It is comforting that there are no economically significant differences in the demographic characteristics of the matched and unmatched samples as shown in Table 2.11 in Appendix C. The same patterns persist when looking at public and CEC students respectively.

characteristics of a given dwelling. The higher the stratum, the better the socioeconomic status of the dwelling. In general, residents of dwellings in the first two strata are considered the urban poor and pay, for example, subsidized prices for public utilities such as water and electricity. Whereas 94% of CEC students live in the lowest two strata of the city, 66% of public students do, indicating that the average CEC student lives in a neighborhood with very low socioeconomic conditions. Thus, even though the average TPS student comes from a low SES household, the average CEC school student has an even lower socio-economic background. These figures are not surprising given that CEC schools were systematically located in strata 1 and 2 neighborhoods in peripheral areas of the city, as shown in Figure 2.1.

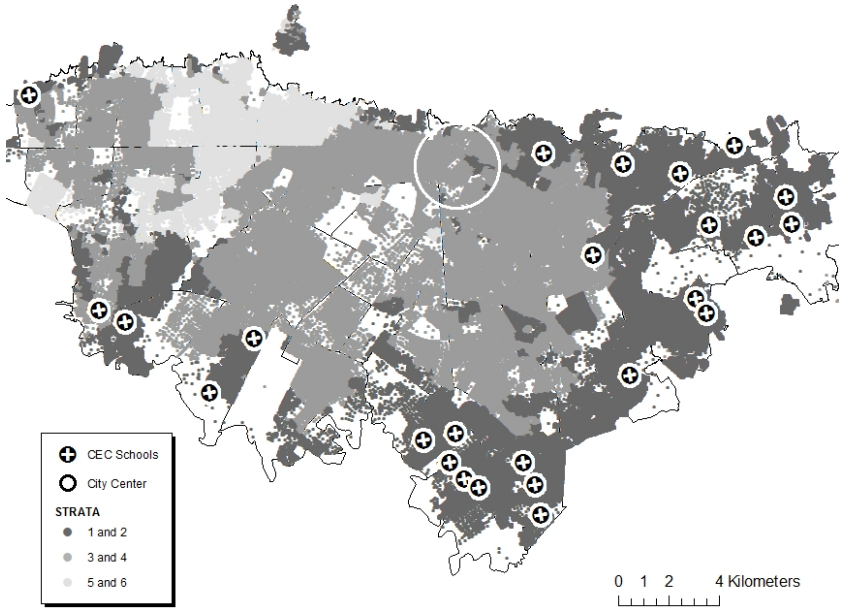


Fig. 2.1. Location of CEC Schools

Notes: This figure shows the location of all the residential units and the 25 CEC schools in Bogotá. Residential units are characterized by their stratum index. Stratum is a categorical index running from 1 to 6 and summarizes the socio-economic status of the dwelling and its neighborhood, 1 being the lowest. Dark gray areas correspond to strata 1 and 2 neighborhoods, medium gray to strata 3 and 4, and light gray to strata 5 and 6.

To compare the socioeconomic characteristics of CEC and TPS students living close to CEC schools, I select all students living in UPZs with nearby CEC schools (henceforth, the UPZ sample —see Figure 2.4). UPZs are subdivisions of the city which are used by the local administration for urban planning purposes. The 120 UPZs in the city are defined in such a way that the urban and economic characteristics of the housing units within them are very similar. Panel B of Table 2.2 presents descriptive statistics for public and CEC students in the UPZ sample. As shown, public and CEC students from the UPZ sample are very similar along most observable dimensions. This happens because the socioeconomic characteristics of TPS in Panel B are worse than those in Panel A. For example, the average *public* student in the UPZ sample has more family members and lower educated parents, lives in a lower stratum dwelling, and has a lower income relative to the average public student in the full sample. These figures provide evidence that CEC schools were located in economically deprived areas of the city.

The last data source used in this chapter is the school surveys C600 for the year 2008 conducted by DANE (the Colombian national department of statistics). These surveys have detailed information for each school in the country on the number and education level of teachers by academic grade, number of students per grade, and the number of students who dropout or transfer at each grade. This information is used later in Section 7 when I consider potential explanations for CEC school higher academic performance.

2.4. Empirical Strategy

2.4.1. Structural Equation

I begin by estimating the average differences in ICFES test scores as a function of CEC school attendance, controlling for other student, family, and neighborhood characteristics. The structural equation for the outcome of interest Y for student i in UPZ u is given by:

$$Y_{iu} = \rho D_{iu} + \gamma_u + X_i\Gamma + \epsilon_{iu} \tag{2.1}$$

where γ_u is a UPZ fixed effect and X_i is a vector of potential observable determinants of academic performance, which includes all the socio-economic variables described in Table 2.2. The regressor of interest, D_{iu}, is an indicator variable that equals 1 if a student attends a CEC school and is 0 otherwise.

To estimate the causal effect of CEC school attendance on academic performance, the decision to attend a CEC school must be uncorrelated with unobserved determinants of academic performance captured in the error term, ϵ_{iu}, conditional on UPZ fixed effects and observable characteristics, X_i. If unobservable variables that determine the selection mechanism are omitted, estimates of CEC attendance (ρ) derived from OLS regressions in Equation 2.1 would be inconsistent.

2.4.2. *Estimating the Causal Effect of CEC School Attendance*

As stated above, the set of rules used by the SED to allocate students into schools may facilitate self-selection of highly motivated students into CEC schools since students are first assigned according to their stated school preferences. Were this the case, OLS estimates of CEC attendance would be upward biased. On the other hand, the student allocation algorithm gives placement priority to students with the lowest socioeconomic characteristics. In fact, the evidence presented in Table 2.2 leans toward the possibility of negative selection into CEC schools. That is, compared to the average TPS student, CEC school students come from families with observably lower SES and live in low-income neighborhoods. It is entirely possible, then, that there are other unobservable characteristics which are both positively correlated with CEC school attendance and negatively correlated with academic performance. In this case, OLS estimates would be biased towards zero.

A consistent estimate for the effect of CEC attendance on academic performance can be recovered if there is at least one variable Z that, in addition to being uncorrelated with the error term in Equation 2.1, is also a strong predictor of the probability of attending a CEC school in the following first stage regression

$$D_{iu} = \alpha Z_i + \lambda_u + X_i\beta + \mu_{iu} \tag{2.2}$$

where D_{iu} is the indicator variable for CEC attendance of individual i in UPZ u, λ_u is a UPZ fixed effect, X_i is a vector of the student's socioeconomic characteristics and μ_{iu} is an error term. The causal effect of CEC attendance on academic achievement then can be estimated using Two-Stage Least Squares (hereafter, 2SLS).

Note that, although a properly defined education production function should include school level variables that affect academic performance (e.g., teacher quality, student-teacher ratios, school facilities, ect.), the only school-level variable included in this model is the CEC attendance variable D_{iu}. As a result, this variable should be interpreted as the aggregate effect of attending a CEC school on achievement without explicitly pinning down the mechanisms at work. Two reasons drive this methodological decision. First, including school level variables will further complicate the identification strategy and the interpretation of the results as more instruments will be needed for every additional school level variable included. Second, even with additional valid instruments, including additional school level variables will prevent us from estimating the aggregate effect of participating in the CEC school program, which is one of the main goals of this research project. Nevertheless, I devote a great deal of attention to the differences in school level inputs in Section 2.7 and discuss what may be (and may not be) the mechanisms behind the estimated results.

2.4.3. Using Distance to the Closest CEC School as an Instrument

To estimate the causal effect of attending a CEC school on academic achievement, I exploit variation in distance from a student's residence to the closest CEC institution to construct an instrument for CEC attendance. For a function of distance to the closest CEC school to be a good instrument for CEC attendance, two conditions are required. First, the distance of a student's residence to the closest CEC school should have a strong effect on the probability of attending a CEC school. Second, for instrument validity, 2SLS should retain only the variation in the probability of CEC attendance that is generated by the quasi-experimental variation generated by the instrument. Intuitively, 2SLS allows us to compare the academic performance of students who differ in their propensity to attend a CEC school just because they reside various distances from these institutions. That is, distance to the closest CEC school should not be correlated with other unobserved determinants of academic performance. In this section, I show that the proposed distance instrument is both a valid and relevant instrument for CEC attendance.

An Instrument for CEC Attendance

The idea of using distance as an instrument has been exploited before. In the economics of education literature, Card (1993) estimated the returns to schooling using variation in college proximity. Distance-based instruments have also been exploited in the health economics literature (McClellan, [1994]; Kessler and

McClellan, [2000]; Freedman, [2010]), in studies of the effects of child subsidies on children wellbeing (Herbst and Tekin, [2010]), and the impact of community nurseries on low-income children nutrition in Colombia (Attanasio, [2010]).

There are different ways to implement distance to the closest CEC as an instrument for CEC school attendance. For the empirical strategy, I define the instrument in terms of distance to the closest CEC school relative to the closest TPS. Two main reasons justify this decision. First, a relative distance instrument should have more power for those students who, in spite of living far from a CEC school, live even further away from a TPS. Second, it allows me to define a categorical instrument that takes the value of 1 if a student lives closer to a CEC school than to a TPS (i.e., for negative relative distances) and 0 otherwise. That is,

$$Z_i = \mathbf{1}\{RD_i < 0\}, \text{ where } RD_i = \underset{c \in CEC}{Min}(d_{ic}) - \underset{p \in TPS}{Min}(d_{ip}) \tag{2.3}$$

and d_{ij} is the distance from student's i residence to school $j \in [c, p]$

Using a categorical instrument is partly driven by the non-linear relationship between relative distance to CEC school and CEC attendance probability. That is, relative distance in meters should be a strong predictor for CEC attendance only for students living within a certain distance from a CEC school, and be rather ineffective for students who live relatively far from it. Figure 2.5 presents evidence on this point. It shows the fraction of total students attending a CEC school who live within a given interval of relative distance. This figure

shows that whenever a student lives closer to a CEC than to a TPS (i.e., relative distance is negative), there is a higher probability of attending a CEC school. More importantly, for almost all the distance intervals for which a student lives closer to a TPS than to a CEC school (i.e. positive relative distance), the fraction of CEC students is not only small, but also non-decreasing in relative distance.

To account for these non-linearities in the CEC attendance probability, I could partition the continuous instrument into several categorical variables for different intervals of relative distance. As it turns out, however, using a single categorical instrument that takes the value of 1 for students who live relatively closer to CEC schools (and 0 otherwise), exhibits the strongest effect on the probability of attending a CEC school as indicated by the F-test statistic in the first-stage specifications compared to a wide range of alternatives, including specifications with high order polynomials or multiple categorical instruments.

Instrument Relevance

Basic Economic models of education suggests that the school choice decision by a household is made by maximizing the difference between the expected returns and costs of attending a given school. The expected returns to attending a school are a function of the quality of the education provided. In turn, the costs of attending a public school are mainly determined by transportation and opportunity costs for both the students and their parents who usually need to walk their young children to school. Note that both of these costs are increasing in the distance from a student's residence to a given school.

The expected returns to attending a given school depend on the information set available to households. However, there is only partial public information on the quality of public schools in Bogotá. In fact, the only existing source of public information on school quality is average ICFES test scores at the school level, available online for each of the test subjects. Even if parents of public school students use this information to guide their school choice decision, Table 2.2 shows that unconditional test score means for CEC schools are less than 0.1 standard deviations higher relative to TPS. Moreover, given that few cohorts have graduated from CEC schools, there is also limited information from this source that might significantly affect the expectation of the returns to CEC school attendance. Thus, given the information set available to public school users, the expected returns to attending a CEC school may not be very different from attending a TPS.

On the other hand, transportation and opportunity costs of sending a child to a school far from home can be prohibitive for most of these households. Monthly public transportation expenditures for a single person represent 15% of a monthly minimum wage. Also, due to traffic congestion, the average speed of public transportation in the city is around 14MPH,[7] meaning that having to commute to a school far from home may significantly reduce the time that both children and their parents could otherwise use for work or housework. It can be argued that some households could find it optimal to assume one-time res-

[7] Source: Instituto de Estudios Urbanos, Universidad Nacional. www.redBogotá.com last visited on October 10, 2010.

idence reallocation costs in order to reduce the costs of attending a preferred school. There is no evidence, however, that housing and school locations in Bogotá are jointly determined by public student households. The 2007 Encuesta de Calidad de Vida, a locality-representative household survey in Bogotá, shows that, even though 21% of the households change their residence every 2 years, just 4% of them move due to education or health considerations.

This simple framework suggests that parents' maximization problem in the current environment boils down to sending their children to schools where it is less costly to do so, that is, to schools close to their residence. Figure 2.6 shows the proportion of students in the sample who live within a given distance interval from the school they actually attend. Approximately 15% of all students in the sample live within 300 meters (0.18 miles) from their school. Moreover, the cumulative distribution for both CEC and TPS students shows that 73% of them live fewer than 2000 meters (1.24 miles) from the school they attend. I interpret this as evidence that residential distance to schools determine the set of potential schools available to low income students in Bogotá.

More importantly, this framework suggests that functions of distance to the closest CEC school could be used as an instrument for CEC school attendance as differential distances to CEC schools generates quasi-experimental differences in the costs of attending a given CEC school. The empirical evidence supports the idea that living close to a CEC school is a strong predictor of the probability of attending a CEC school. First, Figure 2.7 shows that CEC students' residences (dark gray dots) cluster around CEC school locations (crossed black dots). More-

over, data collected by five of the 25 CEC schools on students' transportation choices indicates that around 90% of CEC students walk to school and for 95% of them it takes less than 25 minutes to get to school as shown in Figure 2.8. A third piece of evidence is presented in Figure 2.2, which shows the distribution of students living at various relative distances from the closest CEC school. The figure shows that the empirical distribution for CEC students stochastically dominates the TPS distribution for negative values of relative distance (i.e., the closest CEC school is closer than the closest TPS). In contrast, those living closer to a TPS relative to a CEC school are more likely to attend the former. This figure motivates the use of the categorical instrument previously defined.

More formally, first stage results presented in Section 5 show there is, in fact, a strong statistical relationship between distance to the closest CEC and CEC attendance probability.

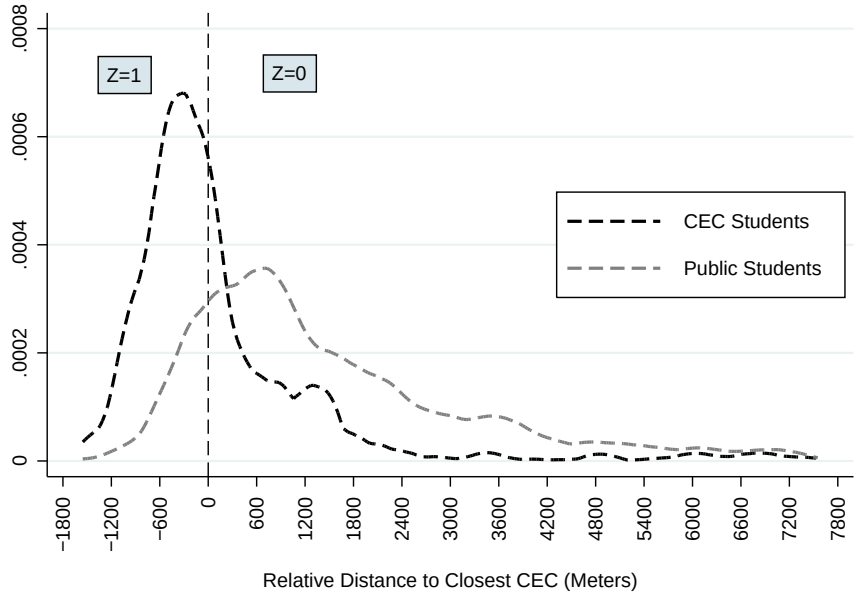


Fig. 2.2. Distribution of Relative Distance to Closest CEC

Notes: This figure shows the empirical distributions of relative distance in meters for both CEC and TPS students. Relative distance is defined as the distance to the closest CEC school minus the distance to the closest TPS. The figure graphically depicts the categorical instrument defined in Equation 3.1.

Instrument Validity

The second condition for distance to be a good instrument for CEC attendance is that the only relationship between the outcomes of interest and the instrument is through the first stage. This condition, known as the exclusion restriction, implies that the instrument should be uncorrelated with unobserved determinants of academic achievement. One concern is that families jointly determine their school choice and residence. Card's (1995) college proximity instrument, for example, has been questioned on grounds of the joint decision between schooling and residence in the US since families with a higher taste for education may also choose to live near a college institution (Kling, 2001). Although the validity of an instrument is a non-testable condition, Altonji et al (2005) argue that if an in-

strument is uncorrelated with a rich set of observable characteristics, it is likely to be uncorrelated with unobserved outcome determinants.

To check for instrument exogeneity, Table 2.3 reports coefficients from OLS regressions of the socio-economic characteristics indicated in each row on the instrument, for specifications with and without UPZ fixed effects. The results in Column (2), which correspond to a specification without UPZ fixed effects and uses all the observations in the full sample, shows that living relatively closer to a CEC school is correlated with some of the students' observable characteristics such as low parent education levels, living in stratum 2, not living in stratum 3, coming from a low monthly income household, and less likely to have a computer, home internet service or a car. These results are not surprising as they just confirm that CEC schools were located in low-income areas of the city. In fact, after conditioning on UPZ fixed effects in Column (3), the results indicate that relative distance is not systematically correlated with student socioeconomic characteristics. Moreover, using observations only from the UPZ sample, which is an alternative way of controlling for neighborhood characteristics near CEC schools, confirms the absence of correlation between the instrument and the rest of the exogenous covariates. I interpret this as evidence that the proposed relative distance instrument is exogenous conditional on UPZ fixed effects.

2.5. Results

This section estimates 2SLS specifications of CEC attendance on academic achievement. To account for the possibility of correlation of student outcomes within a given neighborhood, all regression estimates are clustered at the UPZ level using a paired bootstrap strategy that samples at the UPZ level.

2.5.1. First Stage Estimates

In this section I present the first stage estimates of the effect of living relatively closer to a CEC school than to a TPS on the probability of CEC attendance. I provide evidence that the instrument is strongly correlated with attending a CEC school and additional evidence that the proposed instrument satisfies the exclusion restriction.

Table 2.4 shows the estimates of linear probability models for CEC school attendance on the categorical relative distance instrument and different sets of exogenous regressors.[8] Columns (1) to (3) show the results for the full regression sample. Column (1), which only includes the instrument as a regressor, indicates that living closer to a CEC than to a TPS increases the probability of attending a CEC by 17 percentage points. Once UPZ fixed effects are added in Column (2), the estimated effect is reduced to 10 percentage points. Furthermore, adding the rich set of exogenous covariates in Column (3) do not change the point estimates of the instruments. I interpret the stability of these estimates as evidence in favor

[8] The full set of first stage estimates are presented in Table 2.9 of Appendix B.

of the exclusion restriction conditional on UPZ fixed effects.

At the bottom of the table, I also report the correct prediction rate for these linear probability models as well as F-statistics on the excluded instrument to assess the relevance of the instrument. The F-statistics for the specifications with UPZ fixed effects using the full sample are 27.64 and 27.83, well above the conventional critical values to assess finite sample bias due to weak instruments. Moreover, the correct prediction rates of these two specifications are above 71%. That is, both measures suggest that the proposed instrument is a strong predictor of CEC attendance. The results for Panel B, which includes only students living in UPZs with nearby CEC schools, largely replicate the results of the full sample, although the instrument is even stronger for this sample, as indicated by the large F-statistics in all three specifications in Columns (4) to (6).

2.5.2. 2SLS Estimates

Table 2.5 presents both OLS and 2SLS results of CEC school attendance on math, verbal, and the composite ICFES test scores measured in number of standard deviations for both the full and UPZ samples and for different sets of exogenous covariates and UPZ fixed effects.

I report OLS and 2SLS estimates of CEC attendance on test scores in Table 2.5. OLS estimates for all specifications (no covariates, UPZ fixed effects only, and covariates along with UPZ fixed effects) in both samples indicate that CEC students score 0.16, 0.18, and 0.13 standard deviations higher than TPS students in math, verbal, and the composite ICFES tests, respectively.

Drawing from evidence I have provided that relative distance to a CEC school is exogenous conditional on UPZ fixed effects, I first focus on the results from Column (2), using observations from the full sample. 2SLS estimates show that attending a CEC school increases math, verbal, and the composite test scores by 0.52sd, 0.15sd, and 0.3sd, respectively, relative to TPS students, although the effect on the verbal test is imprecise. The 2SLS results in Column (3) shows that CEC attendance estimates are practically insensitive to the inclusion of the remaining exogenous covariates. As before, the stability of the estimates in Column (3) provides evidence on instrument exogeneity conditional on UPZ fixed effects. Moreover, the 2SLS estimates using observations from the UPZ sample exhibit very similar magnitudes and significance levels.

The lower gains in verbal test scores suggests that CEC schools have a stronger impact on some academic fields than others. Interestingly, this fact is consistent with the results found in both the charter school and test-based accountability literature in the US, where the gains in math are always larger than the gains in verbal test scores (see, for example, Abdulkadiroglu et. al., 2009; Chiang, 2009; Dobbie and Fryer, 2009; Jacob, 2005;). Note also that 2SLS estimates for the math and the composite tests are more than 4 and 3 times larger than the OLS estimates, respectively. This supports the claim that students attending CEC schools are different from public students in some unobservable dimensions that negatively affect test scores, which causes the OLS estimates to be downward biased. More formally, a Hausman exogeneity test of the equality of the OLS and 2SLS estimates is conducted through a paired-bootstrap proce-

dure that samples at the UPZ level to account for correlation of student outcomes within UPZs.[9] The results indicate that OLS and 2SLS estimates of CEC attendance for the math and composite tests are statistically different at the 5% and 10% significance levels, respectively. While the 2SLS estimated effect for the verbal test is 58% higher than the OLS estimate (0.208 vs 0.131) in Column (3), I cannot reject that they are statistically equal.

To assess the magnitude of the estimates, I compare the effect of attending a CEC school with some of the estimates of the socio-economic determinants of test scores, presented in Table 2.10 in Appendix B. For example, the estimates for the math test in Column (1) show that having parents with at most primary education reduce math test results by 0.12 standard deviations relative to college educated parents and living in a stratum 1 neighborhood decreases math test scores by 0.1 standard deviations relative to living in stratum 4. Similarly, coming from a household with a monthly income less than one monthly minimum wage reduces math test scores by 0.2 standard deviations relative to those earning 4 or more times the minimum wage. These effects are significantly lower than the estimated 0.6 standard deviations effect of CEC attendance on the math test.

I also compare these results with respect to the average performance of private school students in Bogotá taking the test in the second semester of 2008.[10]

[9] Given that the standard errors allow for correlation at the UPZ level, the variance covariance matrices under the Hausman null hypothesis are not asymptotically efficient as required. Thus, a 5000-repetition, paired bootstrap strategy that samples at the UPZ level with replacement is conducted in order to construct a consistent difference between the 2SLS and OLS variance-covariance matrices.

[10] The ICFES test is conducted two times a year as there are 2 different school calendars, one

As mentioned earlier, the choice between private and public schools in Bogotá is largely determined by income. On average, private school students score one standard deviation higher than TPS in math and 0.5 standard deviations higher in verbal and the composite test. Altogether, the estimated effects for CEC attendance suggest that attending a CEC school reduce by a half the public-private school achievement gap, a significant effect considering the large differences in socio-economic characteristics between these two population groups.

2.6. Robustness Checks

In this section I explore the robustness of the results in two ways. First, I conduct a placebo test to further check for instrument exogeneity. Second, I also check whether the estimated effects of CEC attendance are driven by some specific population groups.

2.6.1. A Placebo Test

The fundamental claim that justifies using an IV strategy to identify the causal effect of interest is that the only reason why test scores change as the instruments change is through the variation that the instruments have on CEC attendance. That is, there should be no relation between the instrument and test scores in samples where there is no relationship between CEC school attendance and the instruments.

for the period February-December and the other for August-June. While all public and CEC schools operate in the first calendar, private schools operate in both.

In order to further assess the validity of the instrument, I construct a placebo test using ICFES data from the year 2000, one year before CEC schools graduated their first class. The idea is to construct the same categorical relative distance instrument used earlier for estimation on a sample for which the instrument should not be relevant. To do this, I first georeference the residential address of public students who took the ICFES test in the second semester of 2000. Then, I construct a variation of residential relative distance to the closest CEC school as introduced earlier in Equation 3.1. Recall that relative distance is defined as the distance to the closest CEC school minus the distance to the closest TPS. Note, however, that it is not possible to calculate the actual distance to the closest CEC school for high school students taking the ICFES test in 2000 because CEC schools were not available for these students in that year. Instead, I calculate the distance for all TPS students in the sample to the closest *potential* CEC school to construct a measure of relative distance. Then, I define the instrument as an indicator variable that takes the value of 1 if potential relative distance is negative and 0 otherwise.

The placebo test consists of estimating reduced form specifications, that is, estimating the effect of the dummy instrument on the math, verbal, and overall test scores. More specifically, the reduced form specification is given by:

$$
\begin{aligned}
Y_{iu} &= \delta Z_i + \phi_u + X_i\Pi + \xi_{iu}, \quad \text{where} \qquad (2.4)\\
Z_i &= \mathbf{1}\{PRD_i < 0\}\\
PRD_i &= \underset{c\in CEC}{Min}(pd_{ic}) - \underset{p\in TPS}{Min}(d_{ip})
\end{aligned}
$$

That is, PRD_i is the potential relative distance for student i, pd_{ic} is the potential distance of student i to CEC school c, and d_{ip} is the actual distance from student's i residence to TPS p. Note that a positive reduced form effect of the instrument on test scores would question the exogeneity of the instrument for it would imply, for example, that CEC schools were strategically located in areas of the city with a higher probability of academic success.

Reduced form estimates of the instrument on ICFES test scores, δ, are presented in Table 2.6 for both 2000 and 2008 academic years. As before, I focus on the results from Column (3) and (6), which are the specifications with the full set of UPZ fixed effects and exogenous covariates. The reduced form estimates of the effect of living relatively closer to a CEC school on the math and verbal tests in the year 2000 are slightly negative and not statistically different from zero. The estimated effect on the composite test score in both samples is also negative and not different from zero in the UPZ sample. In contrast, all the reduced form effects using 2008 data show a significant positive effect of living relatively closer to a CEC school. These results provide strong evidence that the estimated effects of CEC attendance are not due to schools being strategically located in

areas with a higher probability of academic success. If anything, the negative reduced form estimates for the year 2000 indicate that CEC schools may have been constructed in neighborhoods with lower than average SES even within UPZs. In that case, the 2SLS estimates for CEC attendance would be lower bounds of the true causal estimate. However, most of the 2000 reduced form estimates either in the specification in Column (3) in the full sample or in all the specifications using the UPZ sample show the year 2000 reduced form estimates are insignificant. Thus, I interpret the results from this test as additional evidence on the statistical validity of the instrument. [11]

2.6.2. Characterizing Treatment Effect Heterogeneity

Up to this point, the estimated effects of CEC attendance have been assumed to be the same for all students in the data. However, with treatment effect heterogeneity, IV estimates can be interpreted as a weighted average of causal effects for particular subgroups of the population (i.e., the compliers) for whom the treatment status is changed by the instrument. The estimated effect is known as the local average treatment effect, or LATE (Imbens and Angrist, [1994]). Card (1993), for example, argues that the effect of college proximity on college attendance should be more important for children of less wealthy households. That is, what pushes some low-income students into college is the

[11] One concern with this placebo test, however, is whether students graduating in 2000 actually lived close to where potential CEC schools were later located, that is, whether student are similarly distributed in the city in both years. To evaluate this point, Figure 2.9 shows the empirical distributions of relative distance in meters for both 2000 and 2008 academic years. The large similarities of these distributions suggest that results for year 2000 are not driven because of a disproportionately low amount of public students in future CEC school areas.

reduction in the costs due to college proximity. As a result, Card's IV estimates of the return of college attendance can be interpreted as the return to college only for students from less wealthy households who are credit constrained in financing college.

In order to assess possible treatment heterogeneity by income levels, I first construct a socio-economic index on the sample of students who live closer to a TPS than to a CEC school using all the observable characteristics used earlier in estimation. This index is constructed as the predicted probability of being a very-low income household.[12]

Panel A of Table 2.7 shows descriptive statistics of selected student socio-economic characteristics by quartiles of the constructed SES index. By construction, students from the lowest quartile have larger families, lower parental education and income, and a higher probability of living in low strata neighborhoods. Following Kling (2001), the overall weight received for each group q when using 2SLS is given by

$$\omega_{q|x} = W_q \lambda_{q|x} \Delta D_{q|x} / \sum_q W_q \lambda_{q|x} \Delta D_{q|x} \tag{2.5}$$

That is, conditional on the exogenous covariates X, the weight given by 2SLS to a specific quartile q is formed by three components. The first is the proportion of observations that belong to quartile q, W_q. Second, 2SLS weights

[12] In practice, this is equivalent to being a SISBEN 1 household. SISBEN is a poverty-targeting index used by the Colombian government to determine eligibility for social programs. The index takes on 6 values, where only levels 1 and 2 are eligible for most government subsidies and is constructed from a rich set of variables such as housing materials, access to public utilities, ownership of durable assets, demographic composition, educational attainment, and labor force participation.

the observations by the average conditional variance of the instrument estimated over the empirical distribution of X for each q, that is, $\lambda_{q|x} = E[P[Z|X,q](1 - P[Z|X,q])|q]$. The last term reflects the average impact of the instrument on CEC attendance for quartile q, $\Delta D_{q|x} = E[E[D|Z=1,X,q] - E[D|Z=0,X,q]|q]$.

Estimates of $\omega_{q|x}$ in Equation 2.5 and its components are presented in Panel B of Table 2.7. The results in this table show that the two lowest quartiles receive marginally higher weights than the last two quartiles. That is, they receive just 58% of the total weight. I also estimate the causal effect of CEC attendance on the math, verbal, and composite ICFES scores by income quartiles. Both the weights that each quartile receive as well as the estimated causal effects by income quartiles speak of a rather homogeneous treatment effect of the CEC program. This does not contradict the idea that the way the instrument operates is by lowering the costs of attending a CEC school. In fact, given that all students attending TPS belong to households with low socio-economic characteristics, it is not surprising that they respond similarly to cost reductions in school attendance.

2.7. Mechanisms for Higher Academic Achievement

Understanding the mechanisms that improve a student's academic outcomes is a relevant policy question. This section discusses some possible mechanisms through which CEC schools achieve better academic performance. First, I evaluate whether CEC schools responded strategically to the imposed accountability system in ways similar to the ones referenced in the test-based account-

ability literature. Second, I explore other dimensions in which CEC schools are different from TPS (besides higher flexibility and accountability) to assess whether these differences are the driving force behind the higher academic achievement of CEC students.

2.7.1. Strategic Responses

One potential concern with evaluating schools according to the performance of their students in standardized tests is the possibility that schools would respond by devoting more instruction time to high-stakes subjects at the expense of other critical areas such as the natural sciences. That is, given that most standardized tests only evaluate students' math and reading skills, there are strong incentives to increase test-specific skills in these areas (Johnson, [1984]; Koretz and Barron, [1998]; Jacob, [2005]).

This concern is largely addressed in the present context by virtue of the design of the ICFES exam, which evaluates students on most subjects included in the standard academic curriculum defined by the Colombian Ministry of Education. Moreover, the composite ICFES test score is calculated as a weighted average of ICFES test sections that also penalizes students for specializing in some subjects by using a linear function of the student's standard deviation.[13] As shown in Section 5, CEC students score around 0.3 standard deviations higher than TPS students in the composite test. These results suggest that CEC schools

[13] the overall test score for student i is given by $Score_i = \sum_c \{W_c * Score_{c,i}\} - \frac{\sigma_i}{2}$, where c=[Biology, Chemistry, Physics, Math, Verbal, Social Sciences, Philosophy, English], weights given by $W_c = (1, 1, 1, 3, 3, 2, 1, 1)$ and σ_i equal to student's i standard deviation from all c test components.

are not responding to increased test-based accountability by specializing in some academic subjects. Part of this is explained by students' incentives to perform well in all test sections since ICFES composite test score serves as the main (and sometimes only) criterion for admission to two-year and four-year colleges and universities in Colombia. But also, academic accountability for CEC schools is contractually defined in terms of this composite score.

This is an important finding for policy reasons because it suggests that evaluating students on multiple subjects should make test-based accountability programs less likely to be explained by test specialization as long as incentives are defined in terms of composite scores.

A second potential response to test-based accountability is to prevent low-performing students from taking the test by making them transfer or drop out from a given school. Unfortunately, information on dropout or transfer students is not available at the student level. To account for these possibilities, I use data from the C-600 national school survey in 2008, which collects data on teacher and student characteristics at the school level. In particular, this survey collects information on the number of students per academic grade as well as the number of students per grade either transferring or dropping-out. For a given school and grade, the transfer (dropout) rate is calculated as the number of students who transfer (drop out) over the total number of students in that grade. Then, for each academic grade, I calculate the *average* transfer (dropout) rate among all schools which offer that academic grade[14] weighted by the total number of stu-

[14] Unlike CEC schools, most TPS do not offer all academic levels from primary to high school

dents in that school-grade combination. If CEC schools exhibit higher average transfer or dropout rates, this would suggest that higher academic performance in CEC schools is achieved by dismissing low-performing students.

Results on average rates are presented in Figure 2.3 for three different school samples: all TPS, TPS in the UPZ sample, and CEC schools. Results for TPS in the UPZ sample are included to assess whether TPS in this sample UPZs are more similar to CEC schools than the average TPS in the city. The figure shows that the average dropout rate for primary (1st to 5th), middle (6th to 9th), and high school (10th to 11th) grades in TPS are 3%, 5%, and 4%, respectively. In contrast, CEC schools have average dropout rates slightly above 1% for all academic grades. Interestingly, there are no meaningful differences between the rates for TPS in the full and UPZ samples. Moreover, the results on average transfer rates also indicate that whereas TPS transfer 2.5% of their students in each grade, CEC schools transfer just 1% of their students. Rather than being a concern, these results indicate that CEC schools are actually more successful than TPS at keeping students enrolled in school.

A third potential unintended response is to prevent low-performing students from taking the ICFES test or, equivalently, to have students self-select into taking the test. A low test taking rate by CEC students would suggest that the higher academic achievement of CEC schools is due to differences in the composition of test takers. To evaluate this possibility, I construct a test taking rate for each school in the sample. For a given school, the test taking rate is

but are primary, middle, or high school only.

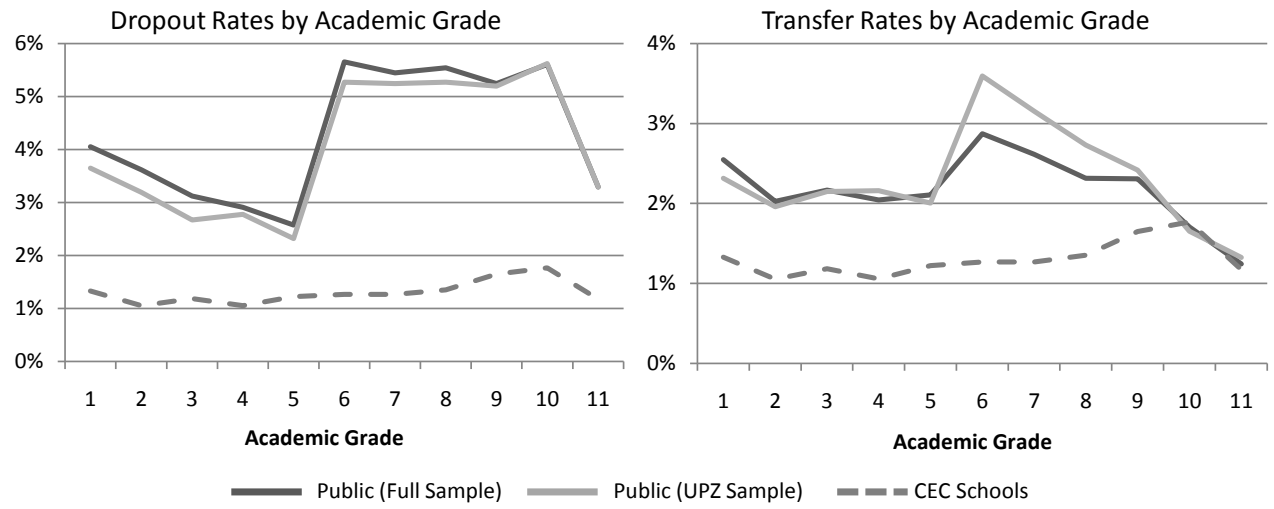


Fig. 2.3. Dropout and Transfer Rates by School Type

Notes: Author's Calculations from 2008 School Survey C-600. This figure shows the average dropout (transfer) rate by grade and school type for both the full regression sample and the UPZ sample. Averages are weighted by the total number of students at each school. Dropout (Transfer) rate is defined as the number of students who dropped out (transfer) from a given school and grade over the total number of students in that grade-school combination.

defined as the total number of students taking the test in the second semester of 2008 over the total number of students in grade 11 as reported in the 2008 C-600 survey. Test taking-rates for TPS is approximately 93% to 96% of CEC schools. Moreover, the high test taking rates exhibited by both school types provides evidence on how serious schools and students are about the ICFES test.

The existing evidence does not indicate that CEC schools are strategically responding to increased accountability by preventing low-performing students from affecting school results —or at least no more than the average TPS. It is possible that students who drop out, transfer, or do not take the test are more likely to come from the bottom part of the potential score distribution. However, given that CEC schools outperform TPS in all these dimensions, then 2SLS estimates of CEC attendance on test scores would be lower bounds of the true

causal effect of interest.

2.7.2. Alternative Mechanisms

Determining the mechanisms that drive the higher academic achievement of CEC schools is relevant for policy reasons. In this section I discuss some potential mechanisms that may explain the higher academic results of CEC students. First, I look at input differences between public and CEC schools that have been associated with education quality in the education literature. In particular, I look at teachers' education, student-teacher ratios and annual expenditure per student. Table 2.8 summarizes the results. Regarding teachers' education, TPS have more highly educated teachers relative to CEC schools at all academic levels. For example, whereas 47% of public middle school teachers have a graduate degree, only 11% of primary CEC school teachers do. This result is not surprising since teachers' salaries in TPS are partly determined by educational attainment. Thus, TPS teachers find it optimal to invest in their own education, regardless of graduate program quality. In contrast, at least 75% of CEC school teachers have at most a college degree in Education.

Second, the data indicates that that both TPS and CEC schools have almost identical student-teacher ratios in primary and middle school grades of 40 and 30 students per teacher, respectively. For high school grades, CEC schools have a ratio of 21 students per teacher compared to 30 students in TPS. Third, the annual cost of a CEC student to the city is lower than the cost of a TPS student. The higher operational costs of TPS are primarily driven by the higher educa-

tional attainment of their teachers relative to CEC schools (Contraloria Distrital, 2003).

In principle, none of these three factors can explain the higher academic achievement by CEC schools. If anything, having more educated teachers and higher spending per student should increase academic performance of TPS. Also, given that the difference in student teacher ratios between CEC and TPS only exists in the last two years of high school, it is unlikely that the estimated results are driven by this factor. In any case, the literature of the effects of school resources on achievement such as teacher's education, student-teacher ratios and student expenditures are far from conclusive, even in studies that exploit exogenous sources of variation [Hanushek, 1986, 1996, 2006].[15]

2.7.3. A Contract for Academic Achievement

The CEC program implemented in Bogotá provides strong empirical support for the case of private provision of public education through service-provision contracts. In particular, the existing institutional design exhibits gains in education quality, while limiting the opportunities for inefficient cost reductions.

The factors that explain the gains in quality are primarily due to private operators being contractually subject to annual performance evaluations, which includes rules for the academic performance of their students in standardized tests. Moreover, in addition to holding CEC schools academically accountable,

[15] For example, in a review of 376 studies on resources and student performance using US data, Hanushek (2006) finds that in 86% of the studies teachers' education does not improve student performance; 72% do not find evidence of a positive effect of lower student-teacher ratios; and, 66% do not find an effect of higher expenditure per student.

schools themselves are able to hold teachers accountable for the academic performance of their students. It is unlikely that academic performance would improve were the schools not allowed to demand results from teachers.

Nevertheless, the arguments against private provision of public services are related to the part of quality that is not contractible in nature. The CEC program addresses potentially harmful cost reductions in a variety of ways. First, students are allowed to choose the schools they want to attend and private operators are paid according to the number of students enrolled up to school capacity. This creates a potential competition effect that softens quality-reducing decisions. Moreover, schools are not able to select their students in any way and were not able to select the school locations in order to prevent CEC schools to systematically select profitable students at the expense of unprofitable ones (e.g., problematic, low-performing students).

Second, to further attenuate incentives for cost reductions, contracts were assigned to not-for-profit, well regarded institutions. The critical characteristic of a non-profit firm is that it is barred from distributing any profits it earns to those who exercise control over it. As a result, profits are usually used to improve the quality of the service (Glaeser and Shleifer, [1998]). This is in fact the case for the CEC program. Although public and CEC schools in Bogotá have similar costs per student, TPS used 30 percent more of their annual budget to pay for teachers wages in 2002 (Cotraloria Distrital, 2003). Additional resources were invested by CEC schools in food provision and school supplies for students. Moreover, by assigning contracts to respected schools and universities, providers should face

large costs from choosing lower non-contractible quality in the form of lower reputation of their own private institutions. Also, given that service provision contracts in Colombia are subject to renewal for at most 50% of the length of the original contract, lower reputation due to reduced quality inflicts large costs on CEC providers interested in contract renewal.

It is also possible that not-for-profit, well regarded organizations have a genuine preference from providing goods of higher quality derived from altruistic behavior (Rose-Ackerman, [1996]; Lakdawalla and Philipson, [1998]). In fact, inspection of CEC school budgets show that they are investing in potential quality-improving activities that are not part of their annual evaluation process such as psychological attention to children, remedial education programs, or sending school social workers to visit the household of students who have recently stopped attending school.

Third, to avoid *ex-post* opportunistic behavior by CEC providers, ownership of school facilities and supplies —the most specific assets of this contractual arrangement— was retained by the state. By doing so, the SED aimed at retaining residual contract rights in uncontracted circumstances (Joskow, 1988).

One final factor that prevents significant reductions in non-contractible quality lies in the nature of education provision along with the wage structure in the education sector in Colombia. Providing education is a labor intensive service with labor costs accounting for an important fraction of total expenditures. This is even more pronounced for CEC schools given that the state is the formal owner of the school facilities and is therefore responsible for major infrastructure

investments. More importantly, wages in Colombia for both private and public teaches are regulated by law. As a result, although CEC schools could find cost reduction opportunities by hiring lower quality workers at lower wages, the legal constraints on teacher wages provide incentives for these schools to hire the best teachers willing to work for them.

2.8. Conclusion

This chapter presents estimates of the causal effects on academic achievement of attending a contracted out public school in Bogotá, Colombia. Instrumental variables estimates constructed by using a distance-based instrument controlling for neighborhood fixed effects and a rich set of exogenous covariates consistently show a large positive association between program participation and academic achievement. These effects are largest and significant for the math test as well as for the composite test, which evaluates students in most middle- and high-school academic subjects included in the Colombian standard curriculum. The results for the verbal test, while positive, are imprecise. I also provide a variety of empirical strategies to argue that, conditional on taking the test, the proposed instrument is indeed exogenous.

Although standardized tests have been used as proxies for school quality, higher academic results in standardized tests do not necessarily translate into longer-run gains in potentially more meaningful outcomes. Evans and Schwab (1995), for example, argue that standardized tests are limited measures of a

student's ability, creativity or deeper problem-solving skills. In Chapter 3, I examine the longer-run effects of CEC school attendance using administrative data on college level enrollment (2- and 4-year programs), major choice, and college academic performance.

This chapter also explores some plausible factors that may have driven the higher academic results of contracted out public schools. Using school-level data, I argue that the higher academic achievement of these schools is unlikely to be explained by unintended strategic responses to increased test accountability. If anything, the lower socio-economic characteristics of student participants and the lower dropout and transfer rates as well as the higher test taking rates of these schools indicate the estimated effects are lower bounds of the true causal effect. Moreover, using school level data on education inputs show that contracted-out schools exhibit higher levels of academic achievement, despite having lower educated teachers and similar student-teacher ratios and expenditures per student.

Tab. 2.1. Sample Exclusion Criteria

	Public (1)	CEC (2)	Total (3)
Initial Sample: Students taking 2008 ICFES Test and Graduating in 2008	48,125	2,074	50,199
Exclusion criteria (total cases)			
Night Schools	4,033	0	4,033
Technical Schools (including Teacher Schools)	3,417	0	3,417
Military Schools	239	0	239
Rural Schools	151	0	151
Observations with missing data (different from address)	2,931	146	3,077
Missing observations / Initial Sample (%)	0.061	0.070	0.061
Subtotal (Initial Sample minus excluded observations)	37,354	1,928	39,282
Minus observations with unmatched address	5,571	298	5,869
Unmatched observations / Total non-excluded observations (%)	0.15	0.15	0.15
Matched observations / Total non-excluded observations (%)	0.85	0.85	0.85
Final Regression Sample	31,783	1,630	33,413

Notes: This table presents the sample construction for regression analyzes. The initial sample of public and CEC students graduating in the second semester of 2008 has 50,199 observations. The sample reduces to 31,783 observations after excluding students who attend night, technical, rural or military public institutions, have missing data for at least one of the variables, or were nor succesfully assigned a valid residential address from the UAECD database.

Tab. 2.2. Descriptive Statistics by School Type

	A. Full Sample		B. UPZ Sample	
	PUBLIC	CEC	PUBLIC	CEC
Male=1	0.46	0.46	0.46	0.46
Age in Years	17.08	16.99 **	17.11	16.97 ***
	(1.30)	(1.75)	(1.40)	(1.79)
Number Household Members	5.16	5.32 ***	5.28	5.40 **
	(2.05)	(2.06)	(2.04)	(2.10)
Number of Rooms	4.24	4.32 *	4.23	4.36 **
	(1.87)	(1.77)	(1.86)	(1.83)
No Younger Siblings=1	0.34	0.27 ***	0.32	0.26 ***
Dad is Literate	0.98	0.98	0.98	0.98
Mom is Literate	0.99	0.99	0.98	0.99
Father Education				
Primary	0.39	0.43 ***	0.48	0.44 ***
Secondary	0.47	0.47	0.44	0.48 ***
Associate	0.08	0.07	0.05	0.06
College or More	0.06	0.04 ***	0.03	0.02
Mother Education				
Primary	0.33	0.38 ***	0.41	0.40
Secondary	0.51	0.49 ***	0.48	0.50
Associate	0.11	0.09 ***	0.08	0.08
College or More	0.05	0.05	0.03	0.03
Household Income				
1 MW or less	0.14	0.13	0.17	0.13 ***
1 < MW < 2	0.53	0.59 ***	0.57	0.60 ***
2 < MW < 3	0.23	0.23	0.20	0.23 **
MW > 4	0.09	0.05 ***	0.05	0.03
Household Stratum				
One	0.15	0.24 ***	0.23	0.26 ***
Two	0.51	0.70 ***	0.66	0.71 ***
Three	0.32	0.05 ***	0.10	0.03 ***
Four+	0.01	0.01	0.00	0.00
Floor Quality of Dwelling				
Low	0.09	0.05 ***	0.08	0.04 ***
Medium	0.34	0.43 ***	0.45	0.43 **
High	0.57	0.53 ***	0.47	0.53 ***
Assets				
Computer at Home	0.49	0.47 ***	0.42	0.45 ***
DVD at Home	0.75	0.75	0.75	0.75
Car Ownership	0.15	0.16	0.12	0.13 *
Motorbike Ownership	0.07	0.10 ***	0.07	0.08
No Cellphone in Household	0.06	0.04 ***	0.06	0.04 ***
One Cellphone in Household	0.22	0.21	0.23	0.19 ***
Internet at Home	0.23	0.19 ***	0.17	0.17
TV Service	0.61	0.56 ***	0.57	0.56
Outcomes				
Math Test Score (SD)	0.00	0.10 ***	-0.05	0.10 ***
	(1.00)	(0.94)	(0.97)	(0.94)
Verbal Test Score (SD)	0.00	0.08 ***	-0.07	0.09 ***
	(1.01)	(0.89)	(0.97)	(0.88)
Overall Test Score (SD)	-0.33	-0.27 ***	-0.39	-0.26 ***
	(0.75)	(0.64)	(0.71)	(0.63)
Distance				
Relative Distance (meters)	1800	468 ***	546	10 ***
	(1774)	(1385)	(564)	(522)
Distance to Actual School (meters)	2856	3244 ***	1803	1883
	(3920)	(5712)	(2662)	(4901)
Number of Schools	410	25	205	25
N	31783	1630	10664	1304

Notes: Panel A includes all observations with valid non-missing data used later in estimation. Panel B includes all students whose residence is within the same UPZ of a CEC school. The stratum variables is an index running from 1 to 6 which summarizes the socio-economic status of the dwelling and its neighborhood, 1 being the lowest. Household income is measured in number of monthly minimum wages (MW). Relative Distance is defined as distance to the closest CEC school minus distance to the closest TPS. Significance levels for the equality of means tests: *** 1%, **5%.

Tab. 2.3. Exogeneity of Relative Distance to Closest CEC

	Full Sample			UPZ Sample		
		Balance Regressions			Balance Regressions	
	RD>0 Means	No Controls	UPZ Fixed Effects	RD>0 Means	No Controls	UPZ Fixed Effects
	(1)	(2)	(3)	(4)	(5)	(6)
Student and Family Characteristics						
Male	0.46	-0.003	0.006	0.47	-0.009	0.004
Age	17.07	0.038	0.023	17.09	0.014	0.014
Number Household Members	5.17	0.012	-0.032	5.31	-0.114	-0.075
Father Education: Primary = 1	0.38	0.107***	0.016	0.47	0.034	0.006
Father Education: Secondary = 1	0.48	-0.048**	-0.009	0.45	-0.019	0.000
Mother Education: Primary = 1	0.32	0.077***	-0.002	0.40	0.020	-0.007
Mother Education: Secondary = 1	0.52	-0.026	0.014	0.48	-0.004	0.019
Dad is Literate	0.98	-0.003	0.004	0.98	0.000	0.004
Mom is Literate	0.99	-0.005	0.002	0.98	-0.002	0.003
No Younger Siblings	0.34	-0.038***	-0.023*	0.32	-0.022	-0.026*
Household Income						
Stratum 1 = 1	0.15	0.050	-0.010	0.24	-0.001	-0.018
Stratum 2 = 1	0.50	0.214**	0.025	0.65	0.061	0.040*
Stratum 3 = 1	0.34	-0.253***	-0.014	0.11	-0.060	-0.021
House Floors - Low Quality	0.09	-0.031**	-0.000	0.08	-0.018	0.006
House Floors - Med Quality	0.34	0.111***	0.005	0.44	0.021	-0.011
Number of Rooms in Household	4.24	0.016	-0.008	4.24	0.011	-0.017
House Income: 1 MW or less	0.14	0.014	0.004	0.16	-0.000	0.006
House Income: 1 < MW < 2	0.53	0.034**	-0.006	0.58	-0.005	-0.015
House Income: 2 < MW < 3	0.23	-0.008	0.003	0.20	0.011	0.008
Household Assets						
Computer at Home	0.50	-0.065**	-0.007	0.43	-0.014	-0.005
DVD at Home	0.75	-0.014	-0.004	0.75	-0.008	0.001
Car Ownership	0.16	-0.031**	-0.003	0.12	-0.000	-0.002
Motorbike Ownership	0.07	0.002	0.001	0.08	-0.003	-0.002
No Cellphone in Household	0.06	-0.001	0.005	0.06	-0.007	0.008
One Cellphone in Household	0.22	0.005	0.007	0.22	0.001	0.002
Internet at Home	0.24	-0.053**	0.011	0.17	0.003	0.020
Cable TV at Home	0.61	-0.058*	-0.018	0.58	-0.043	-0.030
N	29971	33413	33413	9373	11968	11968

Notes: Columns (1) and (4) report means of the variable indicated in each row for students living closer to a TPS than to a CEC school for the full and UPZ samples, respectively. Columns (2), (3), (5), and (6) report coefficients from regressions of the variable indicated in each row on an indicator variable equal to one if the student leaves closer to a CEC school than to a TPS (i.e., the relative distance instrument). Columns (2) and (5) only include the instrument as a regressor. Columns (3) and (6) include also UPZ fixed effects. Significance Levels *** 1%, **5%, *10%. All standard errors account for clustering at the UPZ level.

Tab. 2.4. First Stage Results

Dependent: 1{CEC Student =1}	A. Full Sample			B. UPZ Sample		
	(1)	(2)	(3)	(4)	(5)	(6)
{Relative Distance < 0m} = 1	0.17***	0.10***	0.10***	0.20***	0.14***	0.14***
	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
Exogenous Covariates	No	No	Yes	No	No	Yes
UPZ Fixed Effects	No	Yes	Yes	No	Yes	Yes
Correct Prediction Rate	0.890	0.753	0.717	0.789	0.746	0.759
F-Statistic	42.92	27.64	27.83	52.43	46.81	47.77
N	33413	33413	33413	11968	11968	119968

Notes: Panel A includes observations from the full sample. Panel B includes students only from the UPZ sample; that is, those whose residence is located in UPZ nearby CEC schools. Relative distance is defined as distance to the closest CEC school minus distance to the closest TPS. The excluded instrument for CEC attendance is an indicator variable equal to 1 if relative distance is less than or equal to zero. The exogenous covariates are described in Table 2.2. Significance Levels: *** 1%, **5%, *10%. 5000-repetition, paired bootstrap standard errors sampled at the cluster level in parentheses.

Tab. 2.5. OLS and 2SLS Results of CEC Attendance on ICFES Scores

	Panel A. Full Sample			Panel B. UPZ Sample		
	(1)	(2)	(3)	(4)	(5)	(6)
	Math Test Score in Standard Deviations					
OLS	0.101***	0.136***	0.120***	0.150***	0.159***	0.134***
	(0.032)	(0.030)	(0.030)	(0.035)	(0.035)	(0.035)
2SLS	0.044	0.525***	0.559***	0.309***	0.600***	0.609***
	(0.119)	(0.191)	(0.201)	(0.096)	(0.134)	(0.133)
p-value Hausman	0.63	0.05	0.03	0.11	0.00	0.00
	Verbal Test Score in Standard Deviations					
OLS	0.088**	0.145***	0.131***	0.162***	0.179***	0.159***
	(0.038)	(0.033)	(0.036)	(0.039)	(0.038)	(0.038)
2SLS	-0.089	0.156	0.208	0.195	0.239	0.260
	(0.145)	(0.202)	(0.213)	(0.146)	(0.168)	(0.169)
p-value Hausman	0.22	0.96	0.71	0.82	0.72	0.54
	Overall Test Score in Standard Deviations					
OLS	0.066**	0.113***	0.098***	0.126***	0.137***	0.114***
	(0.029)	(0.026)	(0.028)	(0.031)	(0.029)	(0.029)
2SLS	-0.060	0.307**	0.347**	0.206*	0.333***	0.343***
	(0.122)	(0.151)	(0.162)	(0.107)	(0.110)	(0.109)
p-value Hausman	0.30	0.17	0.10	0.42	0.05	0.03
Covariates	No	No	Yes	No	No	Yes
UPZ FE	No	Yes	Yes	No	Yes	Yes
N	33413			11968		

Notes: See notes to Table 2.4 for details on samples and exogenous covariates. Relative distance is defined as distance to the closest CEC school minus distance to the closest TPS. The excluded instrument for CEC attendance is an indicator variable equal to 1 if relative distance is less than or equal to zero. 5000-repetition, paired bootstrap standard errors sampled at the cluster level in parentheses. Significance Levels: *** 1%, **5%, *10%.

Tab. 2.6. Placebo Test: Reduced Form Effects of Distance

	Panel A. Full Sample			Panel B. UPZ Sample		
	(1)	(2)	(3)	(4)	(5)	(6)
	Math Test Score in Standard Deviations					
ICFES 2000	-0.064***	-0.032*	-0.026	-0.018	-0.017	-0.040
	(0.019)	(0.016)	(0.023)	(0.032)	(0.031)	(0.046)
ICFES 2008	0.007	0.053***	0.057***	0.062***	0.085***	0.086***
	(0.020)	(0.020)	(0.020)	(0.017)	(0.018)	(0.018)
	Verbal Test Score in Standard Deviations					
ICFES 2000	-0.097***	-0.051***	-0.025*	-0.020	-0.034	-0.029
	(0.016)	(0.015)	(0.014)	(0.032)	(0.035)	(0.034)
ICFES 2008	-0.015	0.016	0.021	0.039	0.034	0.037
	(0.026)	(0.020)	(0.021)	(0.028)	(0.023)	(0.024)
	Overall Test Score in Standard Deviations					
ICFES 2000	-0.136***	-0.084***	-0.050**	-0.021	-0.047	-0.049
	(0.025)	(0.024)	(0.022)	(0.050)	(0.054)	(0.048)
ICFES 2008	-0.010	0.031**	0.035**	0.041**	0.047***	0.049***
	(0.021)	(0.015)	(0.016)	(0.020)	(0.014)	(0.014)
Covariates	No	No	Yes	No	No	Yes
UPZ FE	No	Yes	Yes	No	Yes	Yes
N ICFES 2000		20533			3776	
N ICFES 2008		33413			11968	

Notes: This table shows reduced form effects of distance to math, verbal, and composite test scores using 2000 and 2008 ICFES data. The year 2000 is one year before the first CEC schools graduated their first high school class. The instrument for both years is an indicator variable equal to 1 if the student lives relatively closer to a CEC school than to a TPS. For the year 2000, the instrument is constructed as the distance to the closest not-yet-available CEC school minus the distance to the closest TPS.

Tab. 2.7. Treatment Effect Heterogeneity

Panel A. Socio-Economic Characteristics by SES Index

	SES Index Quartiles			
	Lowest	2nd	3rd	Highest
No. Household Members	5.62	5.25	5.03	4.74
Father Education: Primary = 1	0.75	0.50	0.25	0.04
Mother Education: Primary = 1	0.65	0.42	0.19	0.04
Stratum 1 = 1	0.33	0.15	0.08	0.03
House Income: 1 MW or less	0.30	0.16	0.08	0.02
House Income: 2 < MW < 3	0.08	0.17	0.26	0.44
Quality Floor Materials: Medium=1	0.86	0.37	0.10	0.02
Computer at Home = 1	0.19	0.37	0.55	0.87
Car at Home	0.05	0.09	0.16	0.33
Internet at Home = 1	0.03	0.10	0.21	0.61
Rooms in dwelling	3.91	4.12	4.34	4.64
N	8706	8428	8248	8031

Panel B. Decomposition of IV Weighting by SES Index

Quartile	W_q	$\lambda_{q\|x}$	$\Delta D_{q\|x}$	$\omega_{q\|x}$	ρ_q^{math}	ρ_q^{verbal}	$\rho_q^{Composite}$
1	0.260	0.077	0.075	0.247	0.605	0.216	0.398
			(0.020)		(0.299)	(0.270)	(0.218)
2	0.252	0.065	0.124	0.334	0.563	0.170	0.375
			(0.026)		(0.185)	(0.198)	(0.160)
3	0.247	0.055	0.108	0.243	0.396	0.012	0.094
			(0.025)		(0.223)	(0.261)	(0.172)
4	0.240	0.042	0.106	0.176	0.693	0.549	0.557
			(0.022)		(0.267)	(0.272)	(0.235)

Notes: This table decomposes IV CEC school attendance estimates by quartiles of a constructed socio-economic index. Index reflects the predicted probability of being a SISBEN 1 household using demographic characteristics used in estimation for the sample living closer to a TPS than to a CEC school. The SISBEN is a government poverty-targeting index that takes on 6 values, where only levels 1 and 2 are eligible for most government subsidies. $W_q = P(Quartile = q)$ is the proportion of sample observations in quartile $q = \{1,2,3,4\}$. $\lambda_{q|x} = E[P(Z|X,Q)(1-P(Z|X,Q))|Q]$ is the expected conditional variance of Z for each quartile, where Z is the categorical relative distance instrument. $\Delta D_{q|x} = E[E(D|Z=1,X,Q) - E(D|Z=0,X,Q)|Q]$ is the average effect of the instrument on CEC attendance for a given quartile. $\omega_{q|x} = (W_q \lambda_{q|x} \Delta D_{q|x}) / (\sum_q W_q \lambda_{q|x} \Delta D_{q|x})$ is the final weight received by quartile q.

Tab. 2.8. School Inputs

	Primary School		Middle School		High School	
	Public	CEC	Public	CEC	Public	CEC
Teachers' Education						
Less than College	0.07	0.10	0.03	0.11	0.02	0.07
Major in Education	0.48	0.72	0.45	0.76	0.41	0.74
Other Major	0.04	0.01	0.05	0.01	0.06	0.03
Graduate in Education	0.37	0.15	0.43	0.11	0.45	0.15
Other Graduate	0.02	0.00	0.04	0.00	0.04	0.00
Student-Teacher Ratio	40.37	38.09	31.3	31.72	30.26	20.87
	(24.5)	(6.37)	(11.74)	(8.6)	(27.23)	(5.95)
Cost Per Student Ratio	2001		2002		2003	
Public / CEC	1.01		0.99		1.11	

Notes: Author's Calculations from School Survey C-600 for the year 2008 for teachers education and student-teacher ratios. Source for cost per student is Contraloría Distrital, 2003.

Appendix A. Figures

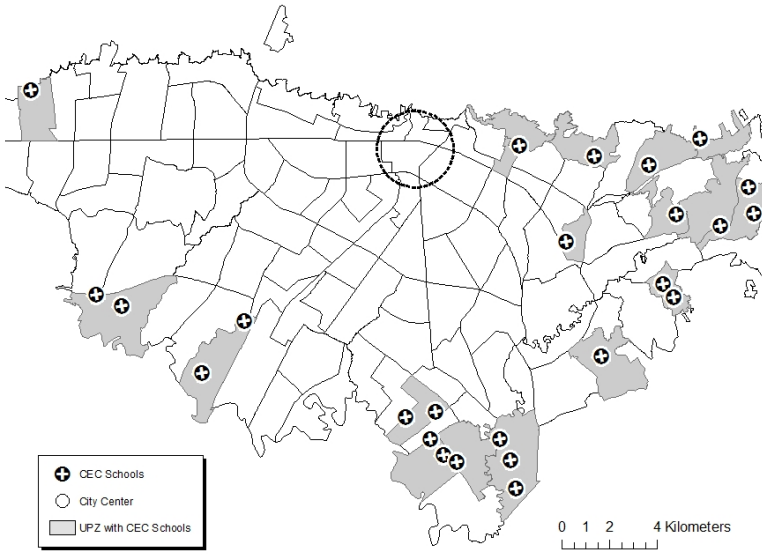


Fig. 2.4. UPZs with CEC Schools

Notes: This figure shows the 120 UPZs in Bogotá. UPZs are administrative subdivisions of the city used for urban planning purposes. The figure also shows UPZs with nearby CEC schools used to define the UPZ sample used in regression analyzes.

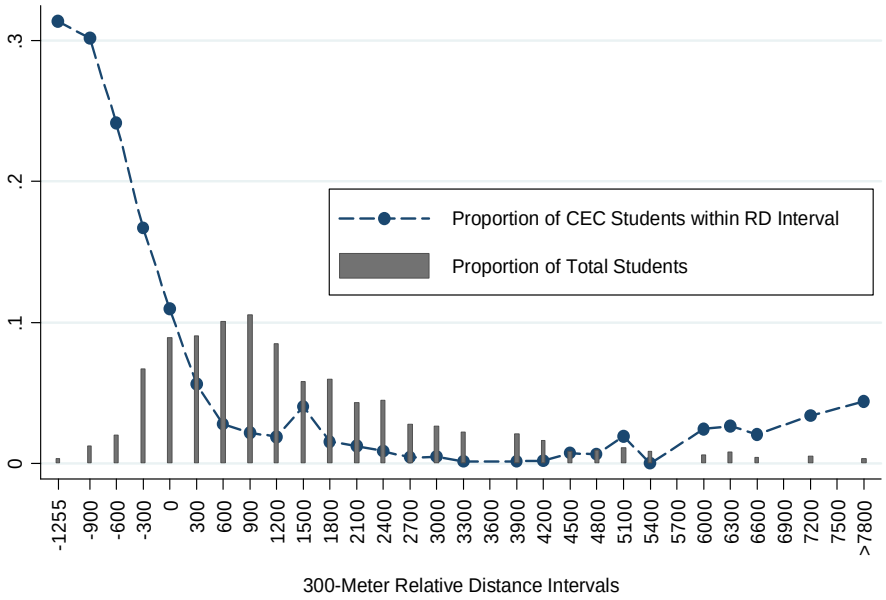


Fig. 2.5. Non-linearity of RD on CEC Attendance Probability

Notes: This figure shows the fraction of total students attending a CEC school who live within a 300-meter interval of relative distance. Relative distance is defined as the distance to the closest CEC school minus the distance to the closest TPS.

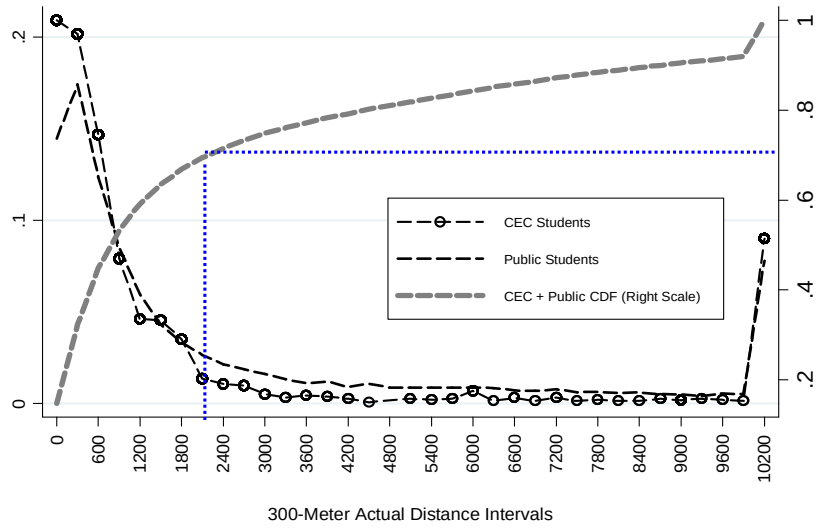


Fig. 2.6. Proportion of Students by Intervals of Actual Distance

Notes: This figure shows empirical distributions of distance in meters to actual school attended for both CEC and TPS students. The gray dashed line depicts the joint empirical cumulative distribution for CEC and TPS students, measured in the right scale. Approximately 15% of all students in the sample live within 300 meters (0.18 miles) from the school they attend. 73% of all students in the sample live 2000 meters (1.24 miles) or less (right scale) from the school they actually attend.

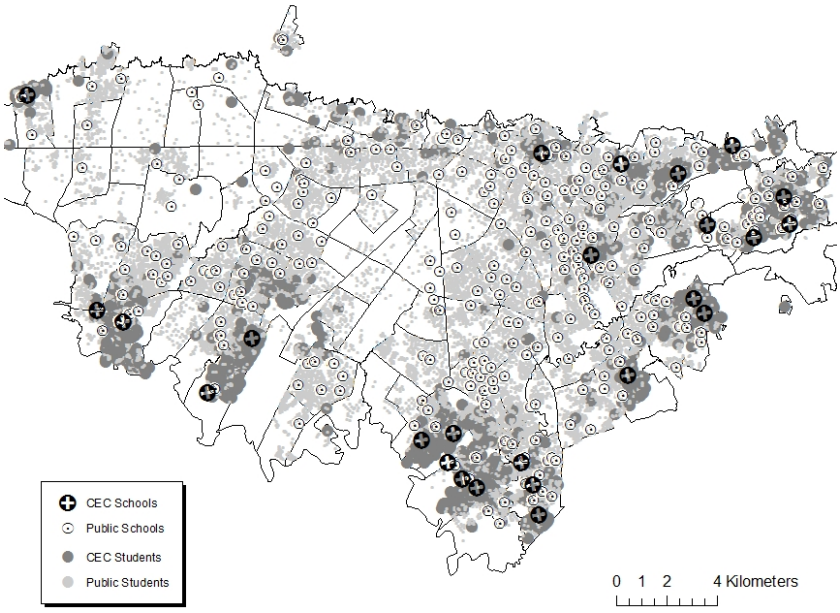


Fig. 2.7. Location of Public and CEC Students' Residence

Notes: This figure shows the location of all public and CEC schools in the city as well as the students residences by type of school attended. CEC and TPS students' residences are depicted with dark and light gray dots, respectively. CEC and TPS locations are represented with crossed black dots and hollow circles, respectively.

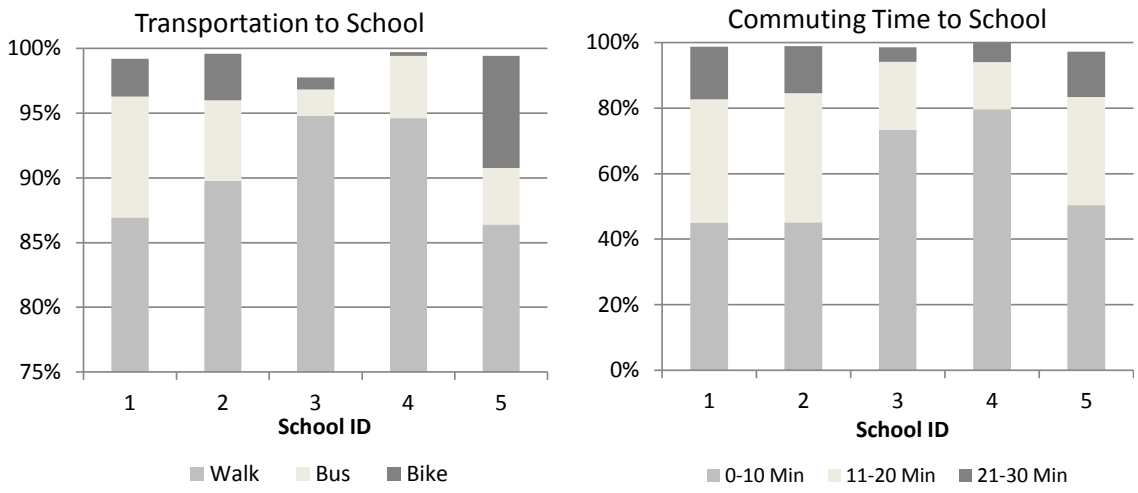


Fig. 2.8. Commuting Patterns of 5 CEC Schools

Notes: This figure describes commuting habits for students from 5 of the 25 CEC schools. Source: Alianza Educativa.

Fig. 2.9. Distribution of Relative Distance in 2000 and 2008

Notes: This figure describes the empirical distributions of relative distance for the years 2000 and 2008. The year 2000 is one year before the first CEC schools graduated their first high school class. For the year 2000, relative distance is constructed as the distance to the closest not-yet-available CEC school minus the distance to the closest TPS.

Appendix B. Full Set of Estimation Results

Tab. 2.9. First Stage Results

Dependent: 1{CEC Student =1}	A. Full Sample			B. UPZ Sample		
	(1)	(2)	(3)	(4)	(5)	(6)
{Relative Distance < 0m} = 1	0.17***	0.10***	0.10***	0.20***	0.14***	0.14***
	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
Male=1			0.00			0.00
Age			-0.00*			-0.01
No. Household Members			0.00			0.00
Father Education: Primary = 1			-0.02**			-0.03*
Father Education: Secondary = 1			-0.00			-0.00
Father Education: Associate = 1			0.00			0.02
Mother Education: Primary = 1			-0.01			-0.01
Mother Education: Secondary = 1			-0.01			-0.01
Mother Education: Associate = 1			-0.01			-0.01
Stratum 1 = 1			0.01			0.09*
Stratum 2 = 1			0.01			0.08*
Stratum 3 = 1			-0.02			0.04
House Income: 1 MW or less			0.01			0.03
House Income: 1 < MW < 2			0.01**			0.05**
House Income: 2 < MW < 3			0.01**			0.04***
Dad is Literate			-0.00			-0.01
Mom is Literate			0.02*			0.03*
House Floors - Low Quality			-0.02***			-0.04***
House Floors - Med Quality			-0.01			-0.02**
Computer at Home			0.00			0.00
DVD at Home			-0.00			-0.01
Car Ownership			0.01			0.01
Motorbike Ownership			0.01			0.01
No Cellphone in Household			-0.01*			-0.02
One Cellphone in Household			-0.00			-0.02
Internet at Home			0.00			0.00
Cable TV at Home			-0.01*			-0.01
Number of Rooms in Household			-0.00			0.00
UPZ Fixed Effects	No	Yes	Yes	No	Yes	Yes
Adj R-Squared	0.06	0.11	0.11	0.07	0.1	0.11
Correct Prediction Rate	0.890	0.753	0.713	0.789	0.746	0.762
F-Statistic	42.92	27.64	27.92	52.43	46.81	47.27
N	33413	33413	33413	11968	11968	119968

Notes: See notes to Table 2.4 for details on samples and exogenous covariates. Significance Levels: *** 1%, **5%, *10%.

Tab. 2.10. Full Set of 2SLS Results

Dependent: Test Score in SD	A. Full Sample			B. UPZ Sample		
	Math	Verbal	Overall	Math	Verbal	Overall
	(1)	(2)	(3)	(4)	(5)	(6)
CEC School = 1	0.553***	0.198	0.338**	0.610***	0.256	0.337***
Male=1	0.296***	-0.007	0.135***	0.293***	-0.028**	0.127***
Age	-0.073***	-0.074***	-0.075***	-0.064***	-0.065***	-0.064***
No. Household Members	-0.013***	-0.016***	-0.015***	-0.012**	-0.018***	-0.016***
Father Education: Primary = 1	-0.124***	-0.205***	-0.175***	-0.103**	-0.139***	-0.144***
Father Education: Secondary = 1	-0.109***	-0.164***	-0.145***	-0.068	-0.081*	-0.096**
Father Education: Associate = 1	0.025	-0.024	-0.003	0.085	0.047	0.037
Mother Education: Primary = 1	-0.124***	-0.125***	-0.123***	-0.088	-0.127**	-0.112**
Mother Education: Secondary = 1	-0.075***	-0.094***	-0.084***	-0.054	-0.110**	-0.083**
Mother Education: Associate = 1	0.023	0.019	0.005	0.013	0.024	0.005
Stratum 1 = 1	-0.107*	-0.104*	-0.122**	0.100	0.110	0.119
Stratum 2 = 1	-0.083	-0.042	-0.065	0.133	0.176	0.187
Stratum 3 = 1	-0.014	0.028	0.001	0.174	0.269	0.251
House Income: 1 MW or less	-0.199***	-0.194***	-0.184***	-0.212***	-0.193***	-0.180***
House Income: 1 < MW < 2	-0.099***	-0.121***	-0.103***	-0.112***	-0.135***	-0.096***
House Income: 2 < MW < 3	-0.061***	-0.051**	-0.047***	-0.083**	-0.081**	-0.047*
Dad is Literate	0.054	0.038	0.041	-0.001	-0.020	-0.027
Mom is Literate	0.083*	0.084*	0.106***	0.013	0.051	0.069*
House Floors - Low Quality	-0.007	-0.047**	-0.012	-0.019	-0.097***	-0.039
House Floors - Med Quality	-0.002	-0.013	-0.004	0.037*	0.008	0.021
Computer at Home	0.073***	0.077***	0.078***	0.097***	0.080***	0.088***
DVD at Home	-0.039***	-0.028*	-0.031***	-0.037**	-0.034	-0.029
Car Ownership	-0.020	-0.032**	-0.029**	0.000	-0.054**	-0.040***
Motorbike Ownership	-0.098***	-0.068***	-0.096***	-0.057**	-0.046	-0.068***
No Cellphone in Household	-0.019	-0.040	-0.032	-0.034	-0.050	-0.045
One Cellphone in Household	-0.047***	-0.023*	-0.031***	-0.045*	-0.030	-0.037**
Internet at Home	0.005	0.011	0.010	-0.017	0.007	0.003
Cable TV at Home	-0.044***	-0.060***	-0.056***	-0.044**	-0.053***	-0.056***
Number of Rooms in Household	0.012***	0.009***	0.011***	0.009*	0.012***	0.010***
UPZ Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N		33413			11968	

Notes: See notes to Table 2.5 for details on samples and exogenous covariates. Significance Levels: *** 1%, **5%, *10%.

Appendix C. Calculating Relative Distance to Closest CEC School

This appendix describes the methodology used to construct the relative distance instrument used in Chapters 2 and 3 of this dissertation. As indicated above, the proposed instrument requires finding the closest CEC and the closest TPS for each student in the sample, regardless of the actual school they attended. For this, two data sources are used. First, I use administrative data on students' residential addresses collected by ICFES at the time of test registration. With these addresses available, the idea is to obtain geographic information —that is, a latitude and a longitude— for each one of these addresses. To do so, I use administrative data from *UACD*, a local government organization in Bogota responsible for keeping a comprehensive register of the metes-and-bounds of all real property of the city. This dataset includes details of ownership, tenure, precise location (GPS coordinates), area, value, and UPZ location.

For these two datasets to be successfully merged by address, both ICFES and UACD addresses may be written in a standardized form. While the addresses in the cadastral dataset are properly written (in fact, UACD is responsible for assigning legal address to properties), students —and city residents in general— usually use several ways of writing them. As a result, approximately 15% of students' addresses can be merged using the data reported by students. Fortunately, addresses in Bogota have a rather specific alpha-numeric structure that can be used to infer the proper address reported to ICFES by students.

The general address structure in Bogota can be best described by a numer-

ical cartesian plane where streets increase in number as they move away from the center. In principle, streets that run from east to west are known as *calles* and streets that run from north to south are known as *carreras*. Nevertheless, as the city is far from being a simple raster, some streets are also referred as *Avenida, Diagonal*, or *Transversal*. A common address in Bogota starts with the name of the street type (i.e., *calle, carrera, avenida, diagonal, transveral*) where the property is located. After the street type, most addresses have next a number with at most 3 digits which may be followed by a single letter in the set [A-D,F-M,O-R,T-Z] as well as by the word BIS, which may also have a letter on its own too. Then, addresses located in the south part of the city have the word *SUR* and addresses un the east part of the city the word *ESTE*. Addresses located in the north or west sections of the city do not have anything. After this part of the address is written, another at-most 3-digit number must follow with the possibility of having another single letter in the set [A-D,F-M,O-R,T-Z] as well as by the word BIS. Then a final at-most 3-digit number follows. At this point there may also be addresses with either the word *SUR* or the word *ESTE*. After this point, properties that are apartments or houses within a residential complex may have additional information such as the apartment number.

To make things clear, an example of an address in Bogota can be: KR 5A SUR 24B 58 . An address like that, for example, is located on *carrera* 5A in the south-west quadrant of the city, 58 meters away from the intersection of the 5A *carrera* and the 24B *calle*. Note that the letters that follow the streets indicate that there are many streets with the same number and the letters are used to

distinguish between them. For example, a property on the *calle* 5B is located in between *calle* 5A and *calle* 5C (or *calle* 6 in case there is no 5C).

Taking advantage of this common structure, I wrote a stata program that makes extensive use of regular expressions in order to rewrite all student addresses in the UACD format to maximize the number of merged addresses. The main reasons why addresses do not exactly match between these two datasets is because students include either more information than needed (e.g., variations of the word *número* to separate numerical parts within the address, or the name if the neighborhood), or because spaces between numbers and letters do not precisely coincide (KR 5 A as opposed to KR 5A). The written program allows me to assign geographic coordinates (e.g., latitude and longitude) to 81% and 85% of the students' residences for the years 2007 and 2008, respectively. As shown in Table 2.11, there are no significant differences in the SES characteristics of the matched and unmatched samples for the year 2008, suggesting, for example, that students with lower SES are not more likely to misreport their home address. Unfortunately, this analysis can only be conducted for a subset of the SES variables in 2007 since most of the SES variables were not collected in this year. Nevertheless, the results for 2007 also show that there are no significant differences in students' age and gender between matched and unmatched samples.

Once I am able to geo-reference student residences, I proceed to calculate the linear (i.e., euclidean) distance from each student's home to all TPS and CEC schools in Bogota. To do this, I use the Hawths tool in ARC-GIS to calculate

the distance between all the points of two datasets, the ICFES and the UACD address files. Then, for each student I find what is the closest CEC school as well as the closest TPS. Finally, I use these two measures to calculate the relative distance to the closest CEC school as the difference between the distance to the closest CEC school minus the distance to the closest TPS.

Tab. 2.11. Matched and Unmatched Samples by School Type

	2007		2008					
	All Sample		*All Sample*		*TPS*		*CEC*	
	Unmatched	Matched	Unmatched	Matched	Unmatched	Matched	Unmatched	Matched
Male	0.46	0.47	0.47	0.46	0.47	0.46	0.43	0.46
Age in Years	16.30	16.30	17.14	17.07	17.15	17.08	16.86	16.99
	(1.46)	(1.54)	(1.49)	(1.32)	(1.51)	(1.30)	(1.05)	(1.75)
No. Household Members			4.94	5.17	4.93	5.16	5.16	5.32
			(1.86)	(2.05)	(1.86)	(2.05)	(1.85)	(2.06)
Father's Education								
Primary			0.40	0.39	0.39	0.39	0.40	0.43
Secondary			0.48	0.47	0.47	0.47	0.51	0.47
Associate			0.08	0.08	0.08	0.08	0.06	0.07
Some College or Higher			0.05	0.05	0.05	0.06	0.03	0.04
Mother's Education								
Primary			0.33	0.33	0.33	0.33	0.39	0.38
Secondary			0.50	0.51	0.50	0.51	0.49	0.49
Associate			0.11	0.10	0.11	0.11	0.08	0.09
Some College or Higher			0.06	0.05	0.06	0.05	0.04	0.05
Stratum								
One			0.17	0.15	0.17	0.15	0.23	0.24
Two			0.55	0.52	0.54	0.51	0.71	0.70
Three			0.27	0.31	0.28	0.32	0.05	0.05
Four+			0.01	0.01	0.01	0.01	0.00	0.01
Household Income								
1 MW or less			0.14	0.14	0.15	0.14	0.13	0.13
1 < MW < 2			0.54	0.53	0.53	0.53	0.60	0.59
2 < MW < 3			0.23	0.23	0.23	0.23	0.22	0.23
MW > 4			0.09	0.09	0.09	0.09	0.04	0.05
N	8228	35236	5869	33413	5571	31783	298	1630

Notes: This table compares socio-economic characteristics between students whose residences were successfully geo-referenced (matched) and those who were not (unmatched). The stratum variables is an index running from 1 to 6 which summarizes the socio-economic status of the dwelling and its neighborhood, 1 being the lowest. Household income is measured in number of monthly minimum wages (MW).

3. LONGER-RUN EFFECTS OF THE CEC PROGRAM

3.1. Introduction

The question of whether private schools provide better education than public schools has been a long and much debated issue. This question, for example, is at the center of the debate over the effects on academic performance of programs such as vouchers, charter schools, or education management organizations. Unlike voucher programs —where the control over the quality of education provided by participating schools is mostly left to private users— other programs have been designed so that the state retains a fair measure of control over service delivery by monitoring performance, imposing penalties or by replacing providers in case of performance failure. To some extent, charter schools in the Unites States and in Alberta (Canada), Academies in England, Free schools in Sweden, and CEC schools in Bogota (Colombia) are good examples of this second provision type. In general, these initiatives aim at broadening the decision-making autonomy of schools and promoting accountability, while remaining under —admittedly varying levels of— public control.

Previous research on the effects of this second provision type focuses mostly on the short-run effects of attending privately run public schools on test scores,

with most of the existing evidence coming from evaluating US charter schools with rather mixed results (Angrist et. al [2010]; Abdulkadiroglu et. al, [2009]; Dobbie and Fryer, [2009]; Hoxby and Murarka, [2009]; Hoxby and Rockoff, [2004]; Saas, [2006]; Bifulco and Ladd, [2004]; Hanushek et. al, [2007]; Booker et. al [2007]). Nevertheless, missing from these studies is an assessment of longer-run outcomes of attending such schools, such as earnings and college enrollment, outcomes that are more clearly tied to economic success.

While generating higher earnings capacity is one of the most important goals of education, using earnings as an outcome to evaluate school quality is empirically difficult for a variety of reasons, including the fact that actual earnings do not show up until many years after individuals have finished their secondary education. As a result, standardized tests have been used as proxies for school quality, even though the existing evidence of the relationship between test scores and earnings is not conclusive. While some have argued in favor of a positive relationship between test scores and individual earnings and productivity (e.g., Hanushek, [2006]; Lazear, [2003]), others have asserted that standardized tests can only partially measure a student's ability and cannot measure students' deeper problem-solving skills (Card and Krueger, [1992]; Evans and Schwab, [1995]). Consequently, these authors have stressed the importance of looking at alternative measures of educational attainment such as completing high school or going on to college to evaluate school performance. Looking at college entrance is an important outcome because of the large pecuniary gains derived from higher education and its potential effects on reducing income inequality.

This chapter examines the longer-run effects of attending contracted-out public schools using data from Bogota's CEC school program, previously discussed in chapters 1 and 2. To the best of my knowledge, this study is the first attempt to look at the causal relationship between contracted out public schools and higher education outcomes.

In chapter 2, I looked at the effects on ICFES test scores, a high-stakes standardized test taken by the vast majority of students in their last year of high school. In 2008, for example, 93% of TPS and 96% of CEC students, respectively, took the test. Taking the test is a compulsory requirement for students intending to enroll in college in Colombia and serves as the primary college admission criterion (ICFES, 1999). Therefore, it seems natural to ask whether CEC students have been able to translate higher ICFES test scores, for example, into higher college enrollment rates relative to Traditional Public School (TPS) students. The latter outcome is a relevant long term measure of school performance given that the returns to college in Colombia have been estimated to be twice as large as the returns to secondary schooling (World Bank, 2003).

In addition to this outcome, I also consider whether students who attended CEC schools are more likely to be admitted at selective universities, as there is causal evidence for Colombia showing that students who attend selective universities are more likely to have formal employment and have higher earnings than students attending non-selective institutions (Saavedra, [2008]). However, low-fee charging, selective, public universities in Colombia have managed to keep the number of admitted students low (World Bank, 2003). As a result, low-

income students who traditionally graduate from TPS and CEC schools may find it difficult to compete with private school students for admission into selective, public institutions. Consequently, some public schools may be aiming to place their students in two-year vocational programs, specifically designed to increase students' odds of getting formal employment. In fact, some CEC schools have developed terminal vocational courses in order to smooth out their students' entrance to vocational programs at higher education institutions. Thus, as a third outcome, I look at the probability of enrolling in 2-year technical and technological programs relative to TPS students.

Finally, I look at the college dropout behavior of CEC students. In Colombia, about 50% of the students that enroll in higher education institutions drop out from their programs (MEN, 2010). While part of this may be due to financial considerations, including inadequate student financial aid for low-income students, it is often argued that the low-quality of secondary education is also an important reason for dropping out of college.

To construct these higher education outcomes, I use administrative data from the Ministry of Education on college enrollment which has student-level information on institution and program enrollment as well as dropout information. Given that students who attend CEC schools may differ in unobservable ways from public school students, I obtain causal estimates of CEC attendance by exploiting variation in distance from a student's residence to the closest CEC institution to construct an instrument for CEC attendance. In chapter 2, I carefully argued that this instrument is conditionally uncorrelated with unobserved

determinants of academic achievement.

OLS and 2SLS estimates indicate that, relative to TPS students, CEC students are substantially more likely to enroll in college in general and to enroll in two-year vocational programs in particular. Moreover, while CEC students score significantly higher in the ICFES test than TPS students, these higher scores do not seem to be sufficiently larger to effectively compete for admission at selective, public institutions in Bogota. I also provide some evidence that CEC students are not more likely to drop out from college relative to TPS students.

The remainder of the chapter proceeds as follows: Section 3.2 provides background information on the CEC program and on the higher education sector in Colombia. Section 3.3 describes the sample and the construction of the higher education outcomes. Section 3.4 presents the empirical strategy. Section 3.5 provides the OLS and IV results and Section 3.6 concludes.

3.2. Background

The demand for secondary education increased dramatically in the last two decades in Colombia. In 2002, there were 1.6 millon 15- and 16-year-olds in the country, of whom 57% were attending a high school institution. By 2010, this gross enrollment rate reached 79%, even though the population in that age bracket also grew by 8 percent during that period (MEN, 2010). As a result, the number of high school graduates increased by 67% between 2002 and 2009. Interestingly, most of the increase in high school enrollment was primarily ab-

sorbed by the public education system, with 81% of the high school students attending public schools, up from 70% a decade earlier.

What these figures suggest is that both local and national education authorities in Colombia have implemented policies to meet the increasing demand for public education. However, local governments have also been exploring policies aimed at improving the quality of public education. Colombia has consistently performed below average in international standardized tests relative to countries with similar levels of income. Indeed, country average results on the 2006 PISA test for reading, mathematics and science are slightly below the Latin American average and much lower relative to other emerging OECD countries. Alternative international evaluations such as TIMSS 1995, TIMSS 2006, and Pisa 2009 show similar results.

Some of the implemented policies to either increase enrollment or improve quality involved the participation of the private sector in the provision of public education. The PACES program, for example, during the 1990s in Colombia is known for being one of the largest voucher school programs to have ever been implemented (Angrist, 2002). That program was an effort to increase secondary enrollment rates among low income families. In addition to PACES, the local government of Bogota implemented in 1999 the *Colegios en Concesión* (CEC) Program, a large-scale initiative, which contracted out the administration of all the new public schools constructed in the city in the period 2000-2003.

As discussed in detail in chapters 1 and 2, the CEC program allowed contracted out schools to operate outside teacher collective bargaining provisions

in return for increased school accountability, including test-based accountability. More specifically, the program made CEC schools subject to an annual evaluation based on a series of factors related to education quality including, for example, teachers' education and experience and student dropout and transfer rates. Also, CEC schools failing to meet academic standards based on the school's average score on the overall ICFES test may be subject to contract rescission.

Instrumental variable results in Chapter 2 show that CEC students' ICFES scores in 2008 are approximately 0.6 and 0.25 standard deviations higher in math and verbal test scores, respectively, relative to TPS students. Moreover, the results on ICFES composite test score[1] indicate that attending a CEC school increases composite test scores by 0.3 standard deviations relative to TPS students. This latter finding is of interest for the present chapter given that the ICFES composite test score is the single most important criterion used by higher education institutions to determine admission (ICFES, 1999). Then, the idea in this chapter is to determine to what extent the higher ICFES test scores exhibited by CEC students have translated into better education outcomes for them relative to TPS students.

3.2.1. Higher Education in Colombia

In Colombia, the proportion of 18- to 24-year-olds enrolled in college in 2010 reached 37%, which represents a 85% increase relative to the rate in 1999

[1] the ICFES test evaluates students on most of the curriculum subjects determined by the Colombian Ministry of Education, namely, Math, Reading, Biology, Chemistry, Physics, History, Geography, Philosophy, and English.

(MEN, 2011) —although, it is still below the Latin American rate which has an average rate of 44%. Despite these gains in college enrollment in the last decade, there remains a significant difference between the gross college enrollment rate of 37% and the high school gross enrollment rate of 79%. However, as is true almost everywhere, college enrollment in Colombia rises dramatically with income. According to Saavedra (2008), 40% of the 18- to 24-year-olds from the wealthiest income quintile are enrolled in college, compared to just 6% from the lowest quintile.

There are 289 colleges and universities in Colombia, 72% of which are privately owned. About 44% of college students attend private institutions indicating that private institutions serve fewer students on average relative to public ones. There are four types of tertiary education institutions: universities (27% of the total number of institutions), university institutions (40%), technological institutions (18%), and technical training institutions (15%). While the first two categories serve as teaching and some as research institutions, technical and technological institutions provide short, non-academic programs that respond flexibly to labor market demands —similar to two-year colleges in the United States. Whereas in 2000, 86% of higher education students were enrolled in either universities or university institutions (World Bank, 2003), by 2010 65% of them are. This suggests that most of the large increase in college enrollment in Colombia in the last decade has been absorbed by technical and technological institutions (MEN, 2011).

There are 59 selective higher education institutions in Colombia, that is,

institutions with more applicants than slots. As expected, the most selective institutions are those with higher expenditures per student and higher fractions of full time and PhD faculty and admit students with higher ICFES test scores (Saavedra, 2008).

As noted above, students intending to enroll in college in Colombia must be high school graduates and must have taken the ICFES test. Moreover, a high ICFES score almost certainly leads to a place in high-return programs at selective universities. In fact, of the 59 selective universities in Colombia, 25 use the ICFES test exclusively to determine admission; the remaining schools use it in combination with other requisites (Saavedra, 2008). The test is conducted twice a year, usually in April and September, given that some high schools in Colombia end their academic year in June while others do so in December. As a result, higher education institutions also have two different entry periods each year.

In Colombia, the private returns to each year of tertiary education reached 22% in 2001. Moreover, workers with tertiary education earn 275% more than average worker and more than 6.5 times the wage of a worker with no education (World Bank, 2003). In comparison, college graduates in the US earned 55% more on average than high school graduates in 2009 (Becker et al, 2010).

The joint existence of high returns to higher education and low enrollment rates suggests there may be some systematic barriers that prevent students from investing in higher education. Although a comprehensive characterization of this phenomenon is outside the scope of the present study, some studies have

argued that the low and unequal access to higher education in Colombia is partly originated in the basic education system (Bloom and Hansen, 2003). That is, the low quality primary and secondary education may prevent students from being admitted at selective, high returns college and majors, leaving low-quality, low-return institutions as their only choice. Indeed, whereas inexpensive, selective, public institutions have been in strong demand in the last two decades, private, non-selective institutions have faced oversupply (World Bank, 2003).

In addition, there is also evidence suggesting that the probability of dropping out of college in Colombia is highly correlated with poor academic background. First, only 14% of college dropouts passed all attempted credits in the period 1998-2005. Second, the largest college dropout rates occur in the first two semesters of college. Indeed, out of 100 students enrolled in higher education, 25 dropped out at the end of the first semester —by far the largest dropout rate for a given semester. This may be a sign that students enrolling in college have not been sufficiently prepared. Third, the highest dropout rates occur among those with the lowest composite ICFES scores as well as those enrolled in majors with higher requirements for high-school background such as engineering (MEN, 2006).

Consequently, improvements in the quality of education received by low-income households at public schools should not only increase their odds of attending more selective institutions, but also the likelihood of staying enrolled while in college.

3.3. *Data and Descriptive Statistics*

The data used for this chapter are derived from three sources. First, I use administrative data from ICFES, which contains student level information on TPS and CEC students who took the test in the second semesters of 2007 and 2008. For both of these years, I have individual scores for each one of the nine sections of the test, the student's high school, age, gender, and residential address. For the year 2008, I also have information on students' parental education, residence stratum,[2] household income, number of household members, and asset ownership (e.g., car, computer, cell phone, TV, etc.).

The second source of data uses Bogota's cadastral database, a comprehensive register of all the real properties in the city. This dataset —which includes details of ownership, tenure, location (GPS coordinates), area, value, and UPZ location of all properties— allows me to assign geographic coordinates (i.e., latitude and longitude) to 81% and 85% of the students' residences for the years 2007 and 2008, respectively. By geo-referencing students residences, I am able to calculate the distance from a student's home to both actual and potential TPS and CEC schools in Bogota. As shown in Table 2.12 in Chapter 2, there are no economically significant differences in the SES characteristics of the matched and unmatched samples for the year 2008, suggesting, for example, that students

[2] The stratum is a six-level classification used by the local government to characterize the socio-economic characteristics of a given dwelling. The higher the stratum is, the better the socioeconomic status of the dwelling. In general, residents of dwellings in the first 2 strata are considered the urban poor and pay, for example, subsidized prices for public utilities such as water and electricity.

with lower SES are not more likely to misreport their home address. Unfortunately, this analysis can only be conducted for a subset of the SES variables in 2007 since most of the SES variables were not collected in this year. Nevertheless, the results for 2007 also show that there are no significant differences in students' age and gender between matched and unmatched samples.

The last data source uses information from SPADIES 2010, an administrative dataset from the Ministry of Education of Colombia that contains individual level information on college enrollment such as institution attended, major, date of first entry into higher education, and date of last semester the student is observed enrolled.

Table 3.1 presents descriptive statistics for CEC and TPS students by year of high school graduation and college enrollment status. Some of these statistics are worth discussing. First, students enrolled in college have higher ICFES test scores than students who did not enroll. For example, for both 2007 and 2008 and both school types (i.e., TPS and CEC), students attending a college institution score 0.3 standard deviations higher in Math relative to students not in college. Second, as shown in columns 7 to 10, relative to non-college students, college students are younger, come from smaller families, have more educated parents, have a higher family income, and live in better neighborhoods as indicated by the stratum of the dwelling. In general, these figures provide evidence that college enrollment in Bogota is positively correlated with family income.

Third, 34% of TPS students and 35% of CEC students are enrolled in higher education in 2007. It is rather surprising, however, that only 18% of TPS and CEC

students were pursuing a college degree in 2008. It is not clear what the reason is for this lower college enrollment rate in 2008. Although the 2007 cohort has had three years to have enrolled in college by 2011 —relative to two years for the 2008 cohort— data on students' college entry dates shows this extra year explains little of the difference in college enrollment rates. That is, the 2007-cohort college enrollment rate is as high as 31% whenever the students who enrolled in college in their third year after high school graduation are considered as not enrolled. A more plausible explanation is that some higher education institutions have not reported their most recent information on enrollment to SPADIES. In any case, the striking difference in enrollment for these two cohorts cast some doubts on the use of the 2008 data on higher education. Consequently, in Section 5, I will be presenting separate results for 2007 cohort as well as joint results for the 2007 and 2008 cohorts.

Finally, I compare test scores and SES characteristics for TPS and CEC students who enrolled in college and whose residences are located in UPZs with nearby CEC schools (henceforth, the UPZ sample). UPZs are subdivisions of the city used by the local government for urban planning purposes and are defined in such a way that the urban and economic characteristics of the real properties within them are similar. The descriptive statistics in column 12 show that CEC and TPS students have very similar SES characteristics, although CEC students are slightly more likely to live in low-strata neighborhoods. Nevertheless, CEC students exhibit higher ICFES scores than TPS students of about 0.15 to 0.2 standard deviations.

In Table 3.2, I also present descriptive statistics on college outcomes by high school graduation cohort and school type. Using observations from the *full sample*, one can see that higher education outcomes between TPS and CEC students in the full sample are fairly similar. First, TPS and CEC students have very similar college enrollment rates. Second, around 30% of both CEC and TPS students are enrolled at a selective institution.[3] Third, they also have very similar major distributions with 2-year vocational programs (i.e., technical and technological) being the program most commonly chosen by students. Fourth, their ICFES composite test scores make them equally eligible for government sponsored ICETEX loans for higher education studies.[4]

Fifth, based on students' ICFES scores and cut-offs used to determine admission into engineering programs at the *Universidad Distrital*, I find that at most 6% of TPS and CEC students are eligible for admission into selective, 5-year engineering programs at this institution. The *Universidad Distrital* is a low-fee, selective, public university in Bogota, although it is not the most selective, public university in the city.[5] This shows that low-income students intending to enroll in selective, public institutions in Bogota face strong competition from private school students. Finally, CEC and TPS students have similar college dropout rates with a quarter or more dropping out at the end of their first semester of

[3] An institution is considered selective if the ratio of slots over applicants is less than one. I construct this ratio based on information from ICFES (2002)

[4] The ICFES score is just one of the criteria used to grant these loans. Students are also required to have guarantors with collateral, which in practice may have resulted in low-income students receiving a relatively low proportion of the granted loans.

[5] I use the *Universidad Distrital* as an example here since —unlike other selective, public institutions in Bogota— its admission process is only determined by ICFES test scores.

enrollment and 40% or higher dropping out during their first college year.

While the higher education statistics for the *UPZ sample* mostly reflect the patterns of the *full sample*, two differences are worth noting. First, CEC students are 9 percentage points more likely to enroll at a college institution in 2007. Second, CEC students are slightly more likely to be enrolled at a selective, public university than TPS students.

3.4. Empirical Strategy

I use the same identification strategy in this chapter as in Chapter 2, that is, an instrumental variables approach that uses distance to closest CEC school to construct an instrument for CEC attendance. As previously discussed, the algorithm used in Bogota to allocate students into public schools gives priority to families with the lowest socioeconomic status (SES) and, as a result, over subscribed schools could systematically get students with lower than average SES. On the other hand, students are allowed to apply to any school in the city, something that can lead to selection of most informed or motivated parents into better public schools. Whatever the case, an identification strategy must account for the potential selection of CEC program participants into CEC schools in order to estimate the causal effect of CEC attendance on higher education outcomes.

A consistent estimate for the effect of CEC attendance on academic performance can be recovered if there is at least one variable Z that, in addition to being uncorrelated with unobserved determinants of college outcomes, is also a

strong predictor of the probability of attending a CEC school. I exploit variation in distance from a student's residence to the closest CEC institution to construct an instrument for CEC attendance. More specifically, I first calculate the distance to the closest CEC school relative to the closest TPS school, mostly to account for the fact that students who live far from a CEC school may still live even further away from a TPS and consequently are more likely to attend a CEC school. Thus, I define the instrument as a categorical variable taking the value of 1 if a student lives closer to a CEC school than to a traditional public school (i.e., for negative relative distances) and 0 otherwise. That is,

$$Z_i = \mathbf{1}\{RD_i < 0\}, \text{ where } RD_i = \underset{c \in CEC}{Min}(d_{ic}) - \underset{p \in TPS}{Min}(d_{ip}) \tag{3.1}$$

where d_{ij} is the distance from student's i residence to school $j \in [c, p]$

The rationale behind the proposed instrument is that differential distances to CEC schools may induce quasi-experimental differences in transportation and opportunity costs of attending a given CEC school to students and their parents. These differences may be especially important for low-income students for whom the decrease in costs due to CEC proximity is what may induce choosing a CEC school. For the proposed instrument to be valid, it can only affect student outcomes through its effect on CEC attendance. Since CEC schools were located in low-income neighborhoods in Bogota, students who live closer to CEC schools are also more likely to have a lower SES relative to TPS students and, as a result, distance to CEC schools would also capture their lower socio-economic back-

ground, violating the exclusion restriction. Indeed, in Table 3.1, columns 8 and 10, the SES characteristics of CEC students who enrolled in college are slightly lower than those of TPS students. That is, CEC students have less educated parents, come from lower income families, and live in low-strata neighborhoods. Note also that CEC students have a lower SES than TPS students among those that did not enroll in college —columns 7 versus 9.

However, the SES characteristics of the 2008 CEC and TPS students who are enrolled in college and belong to the UPZ sample (columns 11 and 12) are remarkably similar. Moreover, correlations between each of the SES variables and the categorical instrument for the 2008 cohort (Table 2.4, chapter 2) suggests that the instrument is not correlated with SES variables in those specifications that control for either student UPZ fixed effects or include observations only from the UPZ sample. I interpret these results as evidence that the proposed relative distance instrument is exogenous conditional on UPZ fixed effects or conditional on residing in UPZs with nearby CEC schools (i.e., the UPZ sample).

3.5. Results

This section estimates 2SLS specifications of CEC attendance on higher education outcomes. To account for the possibility of correlation of student outcomes within a given neighborhood, all regression estimates are clustered at the UPZ level for the 2007 cohort and at the UPZ-year level for specifications with data from both 2007 and 2008 cohorts .

3.5.1. *First Stage Estimates*

Table 3.3 shows the estimates of linear probability models for CEC school attendance on the categorical relative distance instrument and different sets of exogenous regressors. For the 2007 cohort and using all observations in the sample, the probability of attending a CEC school is 16 percentage points higher whenever the closest school available to the student is a CEC school. In turn, using observations from the UPZ sample increases this probability by 26 percentage points.

Notice that whereas the inclusion of UPZ fixed effects slightly reduces the reported point estimates, controlling for SES student characteristics such as age, gender, and student's residential stratum has little effect on the point estimates. That is, that the coefficient estimates and standard errors show little or no change across columns indicates there is little correlation between the instrument and the observable characteristics. This result supports the argument that the proposed instrument may be uncorrelated with unobserved characteristics as well.

First stage estimates obtained from the joint 2007-2008 sample largely replicates the results of the the 2007 cohort. Notice that, whenever this sample is used, I also include a year fixed effect to account for differences in CEC attendance in time. Finally, note that the F-statistic on the excluded instrument in all specifications are well above the conventional levels used to assess finite sample bias from weak instruments and provides evidence on the strong association between the relative-distance based instrument and the probability of CEC

attendance.

3.5.2. 2SLS Estimates

I now proceed to present ordinary least squares (OLS), reduced form (RF), and two-stage least square (2SLS) estimates of CEC attendance on higher education outcomes. In particular, I estimate the effects on ICFES test scores as well as the effects on the probability of college enrollment, the probability of being enrolled at a selective public institution, the probability of enrolling in a 2-year vocational program, and the probability of dropping out during the first year in college. Notice that in Table 3.4, I restrict the analysis to observations from the UPZ sample to better control for unobserved neighborhood characteristics. In addition to this, all specifications include UPZ fixed effects, age, gender, and student residential stratum as controls. For the joint 2007-2008 cohort specifications, I also include a 2008 year fixed effect.

In chapter 2, I provide causal evidence that CEC students graduating from high school in 2008 exhibited large and significant gains in test scores relative to TPS students. In the top panel of Table 3.4, I estimate the effects of CEC attendance for those graduating in 2007 as well as for the joint 2007-2008 cohorts. The point estimates for 2007 indicate that CEC students score 0.13 standard deviations higher on the ICFES test than TPS students. Similar point estimates are found for the math and verbal sections of the test. Note that these results are smaller than the ones found in Chapter 2 for the 2008 cohort and similar in magnitude to OLS estimates. In fact, the results using both 2007 and 2008

cohorts show stronger results of ICFES scores in favor of CEC students mostly because of the large effects of the 2008 cohort. The lower estimates of the 2007 cohort could be a result of a series of factors including CEC schools' learning curve. In addition, as discussed in detail in Chapter 2, it was only after 2007 that a standardized and more comprehensive annual evaluation process of CEC schools' performance was implemented, including more demanding conditions in terms of ICFES test results. These evaluations have been conducted yearly since then to all CEC schools and allow for individual school comparisons over time.[6]

Regarding higher education outcomes, I first report the estimates of CEC attendance on college enrollment. In 2007, CEC students are 12 percentage points more likely to enroll in college. This represents more than a 50% increase over the average college enrollment of 22% for this sample. For the joint 2007-2008 cohorts, the increase in the probability of college enrollment of CEC students relative to TPS students is less pronounced, 4.6 percentage points, and less precisely estimated —although similar in magnitude to the more precise OLS estimate. In any case, as stated before, it remains to be seen to what extent this lower estimated effect has been affected by the suspiciously low proportion of 2008 students found enrolled in higher education as discussed in Section 3.

There is a rather low proportion of students in the sample who are enrolled at the selective public universities in Bogota, namely, the *Universidad Nacional*

[6] In future work, it will be of interest to determine how more recent cohorts of CEC students have performed in the ICFES test to further assess the evidence among these two plausible explanations.

and the *Universidad Distrital*. This is not surprising given that these two universities are the most highly selective, low-fee institutions in the city and, as a result, public high school students face strong competition from private school students. In any case, OLS and 2SLS estimates for the 2007 cohort indicate that CEC students are about 1 percentage point more likely to attend one of these institutions than TPS students —a relatively large effect compare to an unconditional mean of 3%.

The low proportion of public high school students enrolled at selective, public institutions provides suggestive evidence that there is high demand for public, selective institutions in the city and, unless public school students have outstanding high ICFES scores relative to *all* college applicants, the probability of being admitted to programs at these institutions is quite low. Figure 3.1 presents some evidence on this point. In particular, it shows kernel distributions of all ICFES test takers in the second semester of 2008 in Bogota by school type. First, notice that —despite large heterogeneity in test scores among private school students— the test score distribution for private school students is to the right of CEC and TPS distributions. As a result, private school students are more likely to be admitted at selective institutions thanks to having higher ICFES test scores. More importantly, note how similar the unconditional test score distributions for CEC and TPS are. However, in Chapter 2 I provided evidence that —after accounting for negative selection into the CEC program— the average CEC student significantly outperforms the average TPS student on the ICFES test, especially for the 2008 cohort. What these two results indicate

is that, although CEC schools attendance improve average performance on the ICFES test, these higher results are not sufficiently large so as to compensate for the negative selection of CEC participants so that they can compete with private school students for admission at selective institutions.

Nevertheless, what the results on college enrollment indicate is that CEC students are significantly more likely to enroll in a college or university than TPS students, just not at selective institutions. I therefore consider, as a third outcome for higher education, the probability of attending a two-year vocational program by CEC students. The results indicate that CEC students are 8.8 and 6.5 percentage points more likely to attend a vocational program than TPS students in the 2007 and the 2007-2008 samples, respectively. These results represent more than an 85% increase when compared to the unconditional means of 2-year programs. The estimated results for this outcome are of interest because, according to the Ministry of Education, 74% of the graduates from technological programs in Colombia have formal employment —just 3 percentage points less than graduates from 5-year colleges and universities in the 2001-2009 period (MEN, 2011). Also, graduates from technology programs have earnings equal to 75% of the earnings of university graduates. Thus, these results suggest that attending a CEC school has important longer-run effects related to higher education, even though these effects are not so much obtained via higher ICFES test scores. Finally, the evidence on the probability of dropping out in the first two semesters after enrolling in higher education suggests there is no statistically significant difference in this probability between CEC and TPS students.

3.6. Conclusion

In this chapter I estimate the causal effects of attending contracted out public schools on higher education outcomes. The issue of contracting out public schools has gained attention in the education literature as a potential alternative for the provision of public education with schools experiencing higher levels of autonomy while being contractually accountable for their students' performance. Given that the literature has mostly focused on the effects on standardized tests, this study is, to the best of my knowledge, the first attempt to look at the effects of these programs on longer-run outcomes and, in particular, on tertiary education outcomes.

Given that in Bogota CEC students were not randomly allocated into schools and CEC schools were not randomly allocated in the city, I use an instrumental variables strategy that exploits exogenous variation in distance from a student's residence to the nearest CEC school. In Chapter 2 and here, I provide evidence that the location of CEC schools was unrelated to the academic performance of potential students and that the proposed instrument is likely to be uncorrelated with unobserved determinants of academic performance.

OLS and 2SLS estimates indicate that CEC students are substantially more likely to enroll in college in general and to enroll in two-year vocational programs in particular. Moreover, while CEC students score significantly higher in the ICFES test —the main criterion used to determine admission into higher education in Colombia— than TPS students, these higher scores do not seem to be

sufficiently higher to effectively compete for slots at selective, public institutions in Bogota. I also provide some evidence that CEC students are not more likely to drop out from college relative to TPS students.

In this study, I provide some evidence on positive longer-run effects of attending a CEC school, especially the higher college enrollment rate of CEC students. The evidence also indicates that this higher participation is, to a great extent, explained by a higher probability of enrolling in 2-year vocational programs. Estimates by the Ministry of Education suggests that graduates from vocational programs may enjoy better labor market outcomes in terms of the probability of being formally employed and earnings. However, admission into vocational programs imposes lower requirements in terms of ICFES test scores as admission is not as competitive. Therefore, what these results indicate is that, even though CEC students outperform TPS in the ICFES test, their higher college enrollment rates are not explained by their higher ICFES scores. This is consistent with the intention of some CEC schools of providing terminal vocational courses in order to smooth their students' entrance to vocational programs at higher education institutions.

These results also suggest that perhaps there are other labor market outcomes such as wages and employment that will be relevant to evaluate the full impact of this program.

Finally, it bears keeping in mind that the 2008 data on college enrollment seems to be incomplete given the striking difference in enrollment relative to 2007. Thus, some of the results presented here —particularly the ones using 2008

data— are to be considered preliminary as this requires a better understanding of this discrepancy.

Tab. 3.1. Selected Descriptive Statistics by College Attendance

	2007						2008					
	TPS		CEC		In College (UPZ Sample)		TPS		CEC		In College (UPZ Sample)	
	Not (1)	In College (2)	Not (3)	In College (4)	TPS (5)	CEC (6)	Not (7)	In College (8)	Not (9)	In College (10)	TPS (11)	CEC (12)
ICFES Math Score in sd	-0.11 (0.95)	0.24 (1.06)	-0.080 (0.88)	0.22 (1.12)	0.13 (1.02)	0.20 (1.13)	-0.085 (1.00)	0.34 (0.95)	0.028 (0.89)	0.41 (1.07)	0.31 (0.92)	0.45 (1.05)
ICFES Verbal Score in sd	-0.14 (0.97)	0.32 (0.98)	-0.11 (0.96)	0.28 (1.01)	0.17 (0.98)	0.26 (1.00)	-0.087 (1.02)	0.35 (0.88)	0.011 (0.87)	0.41 (0.90)	0.29 (0.88)	0.48 (0.79)
ICFES Composite Score in sd	-0.51 (0.59)	-0.095 (0.69)	-0.47 (0.56)	-0.14 (0.71)	-0.23 (0.65)	-0.16 (0.70)	-0.41 (0.76)	0.013 (0.62)	-0.33 (0.60)	0.047 (0.69)	-0.035 (0.61)	0.092 (0.61)
I(Relative Distance to CEC < 0)	0.094	0.075	0.47	0.44	0.13	0.47	0.090	0.070	0.43	0.41	0.16	0.53
Male = 1	0.46	0.49	0.48	0.49	0.46	0.48	0.46	0.48	0.46	0.49	0.47	0.48
Age	16.4 (1.61)	16.0 (1.38)	16.4 (1.39)	15.8 (1.22)	15.9 (1.81)	15.8 (1.22)	17.2 (1.33)	16.6 (1.02)	17.1 (1.60)	16.6 (2.26)	16.5 (1.09)	16.5 (2.51)
No. Household Members	.	.	.	.	.	.	5.21	4.94	5.35	5.18	5.07	5.29
No. Rooms in House	.	.	.	.	.	.	4.19	4.46	4.28	4.48	4.47	4.52
Father Education Primary = 1	.	.	.	.	.	.	0.42	0.26	0.45	0.31	0.35	0.31
Father Education Secondary = 1	.	.	.	.	.	.	0.47	0.48	0.45	0.52	0.49	0.55
Mother Education Primary = 1	.	.	.	.	.	.	0.36	0.21	0.41	0.24	0.27	0.27
Mother Education Secondary = 1	.	.	.	.	.	.	0.51	0.53	0.47	0.56	0.56	0.56
Stratum 1 = 1	0.13	0.060	0.20	0.16	0.15	0.17	0.16	0.080	0.25	0.18	0.17	0.22
Stratum 2 = 1	0.46	0.39	0.67	0.68	0.65	0.69	0.53	0.47	0.69	0.76	0.69	0.74
Stratum 3 = 1	0.36	0.49	0.11	0.15	0.19	0.13	0.30	0.43	0.052	0.054	0.14	0.035
House Income: 1 MW or less	.	.	.	.	.	.	0.16	0.078	0.15	0.088	0.11	0.092
House Income: 1 < MW < 2	.	.	.	.	.	.	0.55	0.46	0.60	0.53	0.52	0.53
House Income: 2 < MW < 3	.	.	.	.	.	.	0.22	0.30	0.21	0.30	0.28	0.32
Computer at Home = 1	.	.	.	.	.	.	0.45	0.68	0.43	0.65	0.61	0.63
Car Ownership = 1	.	.	.	.	.	.	0.14	0.23	0.15	0.20	0.16	0.20
Internet at Home = 1	.	.	.	.	.	.	0.20	0.38	0.17	0.28	0.28	0.27
Observations	21988	11759	971	518	2196	465	25780	6006	1334	296	1614	229
Proportion	0.66	0.34	0.65	0.35			0.81	0.19	0.82	0.18		

Tab. 3.2. Descriptive Statistics for Higher Education Outcomes

	2007				2008			
	Full Sample		UPZ Sample		Full Sample		UPZ Sample	
	TPS	CEC	TPS	CEC	TPS	CEC	TPS	CEC
Enrollment and Majors								
Enrolled at Selective	0.28	0.28	0.27	0.28	0.31	0.35	0.31	0.36
Enrolled at Selective and Public	0.18	0.22	0.19	0.21	0.22	0.26	0.25	0.27
Two-year Technology Program	0.15	0.18	0.18	0.19	0.13	0.13	0.15	0.14
Two-year Vocational Program	0.19	0.24	0.25	0.24	0.20	0.22	0.24	0.23
Health	0.07	0.07	0.06	0.07	0.07	0.07	0.06	0.07
Social Sciences	0.08	0.06	0.07	0.07	0.09	0.09	0.08	0.09
Economics / Business	0.18	0.10	0.15	0.10	0.15	0.15	0.14	0.16
Engineering / Architecture	0.17	0.13	0.13	0.13	0.18	0.16	0.15	0.16
Education	0.12	0.16	0.13	0.16	0.14	0.15	0.15	0.14
Student Loan and Selective Program Eligibility								
ICETEX Eligible for 5-year Program	0.80	0.77	0.74	0.76	0.83	0.83	0.81	0.83
ICETEX Eligible for 2-year Program	0.96	0.95	0.94	0.95	0.97	0.97	0.97	0.97
UD Eligible for Cadastral Engineering	0.15	0.16	0.10	0.16	0.15	0.17	0.14	0.18
UD Eligible for Mechanical Engineering	0.05	0.05	0.03	0.05	0.05	0.06	0.04	0.06
UD Eligible for Industrial Engineering	0.06	0.05	0.03	0.05	0.05	0.06	0.04	0.06
UD Eligible for Industrial Technology	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Dropout Behavior								
Drop out in 1st Semester	0.24	0.25	0.26	0.26	0.29	0.27	0.30	0.26
Drop out in 1st or 2nd Semester	0.36	0.40	0.37	0.40	0.45	0.41	0.46	0.40
Observations	11759	518	2196	465	6006	296	1614	229
Proportion enrolled in College	0.35	0.35	0.25	0.34	0.19	0.18	0.15	0.18

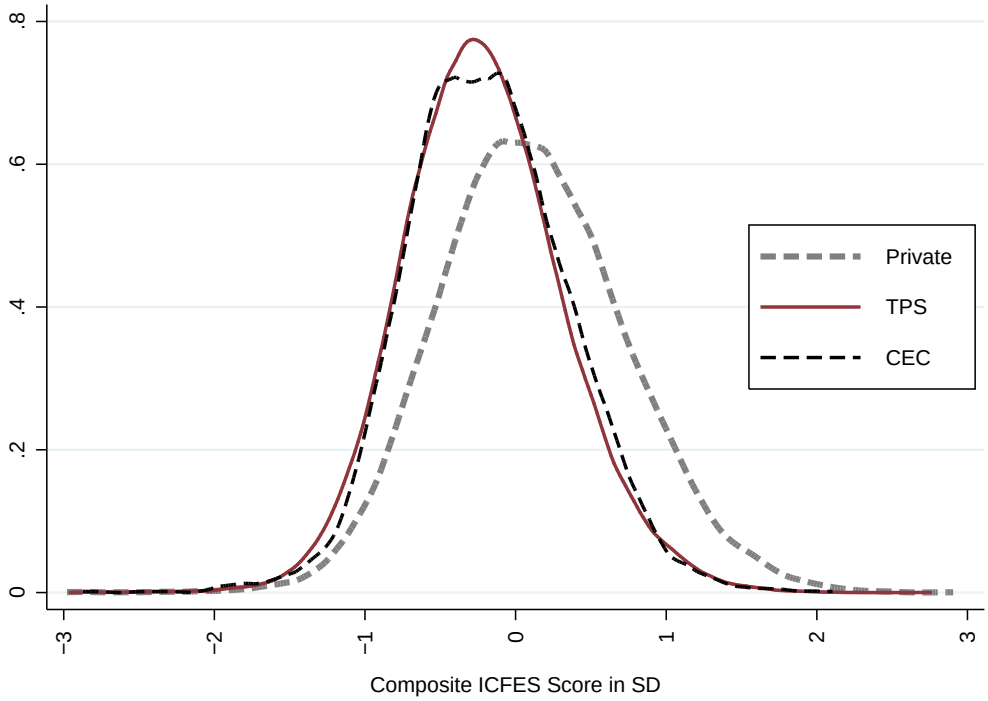
Tab. 3.3. First Stage Results

	2007						2007-2008					
	Full Sample			UPZ Sample			Full Sample			UPZ Sample		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
I(Relative Distance to CEC < 0)	0.16***	0.13***	0.13***	0.26***	0.24***	0.23***	0.17***	0.12***	0.12***	0.23***	0.19***	0.19***
	(0.03)	(0.03)	(0.03)	(0.05)	(0.05)	(0.04)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)
I(Male = 1)			0.00			0.01			0.00			0.00
			(0.00)			(0.01)			(0.00)			(0.00)
I(Stratum 1 = 1)			0.01			-0.01			0.01			0.03
			(0.02)			(0.09)			(0.01)			(0.05)
I(Stratum 2 = 1)			0.00			-0.02			0.01			0.03
			(0.02)			(0.10)			(0.01)			(0.05)
I(Stratum 3 =1)			-0.01			-0.06**			-0.01			-0.03
			(0.01)			(0.02)			(0.01)			(0.03)
I(Year=2008)							0.01	-0.00	-0.00	-0.03*	-0.06***	-0.06***
							(0.01)	(0.00)	(0.00)	(0.02)	(0.02)	(0.02)
UPZ Fixed Effects	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Exogenous Covariates	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
Correct Prediction Rate	0.89	0.71	0.71	0.81	0.74	0.75	0.89	0.72	0.70	0.79	0.71	0.72
F-Statistic of Excluded Instruments	39.72	24.59	24.73	25.33	22.86	31.46	80.55	49.76	49.13	69.99	49.47	57.37
N	34710	34710	34710	9817	9817	9817	67347	67347	67347	21008	21008	21008

Tab. 3.4. OLS, Reduced Form, and 2SLS Estimates of CEC attendance

	2007				2007-2008			
Dependent Variable	Mean	OLS	RF	2SLS	Mean	OLS	RF	2SLS
ICFES Test Scores								
Math Score in sd	-0.071	0.114***	0.021	0.092	-0.051	0.125***	0.054***	0.257***
		(0.040)	(0.021)	(0.090)		(0.026)	(0.015)	(0.084)
Verbal Score in sd	-0.106	0.137***	0.037	0.159	-0.078	0.145***	0.036*	0.158
		(0.035)	(0.027)	(0.105)		(0.026)	(0.019)	(0.102)
Composite Score in sd	-0.472	0.125***	0.031*	0.133**	-0.422	0.120***	0.041***	0.172***
		(0.026)	(0.016)	(0.059)		(0.019)	(0.012)	(0.063)
Higher Education Outcomes								
Enrolled in College	0.228	0.092***	0.028*	0.120**	0.187	0.057***	0.006	0.046
		(0.017)	(0.015)	(0.057)		(0.012)	(0.010)	(0.048)
Enrolled at Selective and Public	0.034	0.013***	0.003	0.011	0.031	0.011***	0.001	0.004
		(0.004)	(0.004)	(0.016)		(0.004)	(0.003)	(0.017)
Two-year Vocational Program	0.097	0.044***	0.020*	0.088**	0.076	0.022***	0.011*	0.065**
		(0.012)	(0.011)	(0.041)		(0.007)	(0.006)	(0.030)
Drop out in 1st or 2nd Semester	0.088	0.047***	0.010	0.044	0.078	0.024***	-0.000	0.000
		(0.013)	(0.012)	(0.046)		(0.009)	(0.006)	(0.033)
UPZ Fixed Effects		Yes	Yes	Yes		Yes	Yes	Yes
Exogenous Covariates		Yes	Yes	Yes		Yes	Yes	Yes
N		9815	9815	9815		21006	21006	21006

Fig. 3.1. ICFES Composite Score Distribution by School Types



Notes: This figure presents kernel distributions of all ICFES test takers in the second semester of 2008 in Bogota.

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