



Using school scholarships to estimate the effect of private education on the academic achievement of low-income students in Chile

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ABSTRACT

This paper estimates the impact of private education on the academic achievement of low-income students in Chile. To deal with selection bias, we use propensity score matching to compare the test scores of reduced-fee paying, low-income students in fee-charging private voucher schools to those of similar students in public schools and free private voucher schools. Our results reveal that students in fee-charging private voucher schools score slightly higher than students in public schools. The difference in standardized test scores is approximately 10 points, a test score gain of 0.2 standard deviations. We find no difference in the academic achievement of students in the fee-charging private voucher treatment group relative to their counterparts in free private voucher schools.

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1. Introduction

School choice is a topic of vigorous debate among academics and policy makers worldwide. The fundamental theory behind school choice is that private schools are more efficient than public schools; therefore, giving parents the option of sending their children to private schools creates a competitive market that improves the quality of both private and public schools. There have been many evaluations of experimental school choice programs.¹ The findings of these studies suggest that students who used vouchers to attend private schools perform better on standardized tests

than students attending public schools who would have used vouchers had one been offered to them. The test score improvements tend to be small, and the effects depend on gender and race and are sensitive to important sample decisions.²

Of all of the school voucher experiments that have been conducted, Chile stands out because it is one of the few countries that has had a universal system intact for over 25 years. In contrast to programs that are limited to a certain number of students who are selected to participate, Chile's school choice program gives all students the option of attending public schools or private schools that are subsidized by the government with a per-student voucher.

This paper uses the Chilean educational system to estimate the effect on academic achievement that results from moving a low-income student from one type of school to

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¹ Examples are the Milwaukee Parental Choice Program (Greene, Peterson, & Du, 1998; Rouse, 1998), the New York City school voucher experiment (Howell & Peterson, 2002; Krueger & Zhu, 2004), and the PACES program in Colombia (Angrist, Bettinger, Bloom, King, & Kremer, 2002).

² A review of the literature on the impact of private school vouchers can be found in McEwan (2004).

another. Since 1993, private voucher schools have been allowed to charge a fee on top of the voucher; however, schools that charge fees must allocate a percentage of the funds to scholarships to students based on their economic need.³ This paper uses these scholarships to identify the effect on tests scores of moving children of low-income families from a public or a free private voucher school to a fee-charging private voucher school.

There are several important challenges that must be addressed when estimating the academic effects of private education (Goldhaber & Eide, 2003). The first is a missing counterfactual problem: it is impossible to simultaneously observe the outcome of a student that attends a private voucher school as well as the outcome of that same student attending public school. A second challenge is selection bias. Although all students in Chile have the option of attending private voucher schools, those that choose to take advantage of the vouchers may have unobserved characteristics that are correlated with academic achievement. Furthermore, past research indicates that an additional bias may arise from the manner in which schools select the students (Gauri, 1998; Hsieh & Urquiola, 2006; McEwan, 2001).

Lacking panel data or an experimental design, we have taken a two-step approach to deal with the econometric issues discussed above. The first is to use the provision of scholarships for low-income students to attend private voucher schools that charge fees as a method of controlling for the selection bias. That is, we use scholarships to identify a treatment group.

The second step is to use propensity score matching as a non-parametric estimator of the impact of fee-charging private voucher school education on academic achievement. Matching allows us to infer the public school and free private voucher school outcomes for scholarship students in fee-charging private voucher schools, and then use this information to estimate the average treatment effect on the treated students. Dehejia and Wahba (2002) show that this method yields accurate estimates of the treatment effect in non-experimental settings where corrections for sample selection bias due to observable differences are needed.

At the heart of our identification strategy is whether scholarships are awarded in a random fashion. According to information gathered in a number of interviews we conducted, in choosing low-income students to award scholarships, schools tend to give preference to the children of families going through a period of economic difficulty and to the sons and daughters of school employees (such as the school administrators, janitors, etc.). Since these children might be different in several ways, we correct our propensity score – the probability of attending fee-charging private voucher schools – for the probability of a student getting a scholarship, which is a function of multiple student, family and school characteristics.

The main drawback of our identification strategy is the possibility that the children who receive the schol-

arships may be different from otherwise similar students in other schools in unobservable ways, a possibility we discuss in detail in Section 3. With this caveat in mind, our results reveal that students in fee-charging private voucher schools score slightly higher than students in public schools, a result that is robust to various sample and data definitions. The difference in test scores is approximately 10 points, a gain of 0.2 standard deviations. A similar result was obtained by Angrist et al. (2002) when comparing test scores of lottery winners and losers in the PACES program in Colombia. Moreover, in an analysis of 10 Latin American countries, Somers, McEwan, and Willms (2004) find an average private school effect of 0.3 standard deviations after controlling for individual characteristics such as socioeconomic status. They find that this average effect drops to 0.04 standard deviations after controlling for the mean socioeconomic status of peer groups. Our findings are nevertheless larger than the effect of Catholic schooling on educational achievement in the US and Chile, an estimated effect smaller than 0.1 standard deviations.⁴

We also compare the performance of students in fee-charging private voucher schools to students in free private voucher schools. Although students in fee-charging private voucher schools appear in most cases to very slightly outperform students in free private voucher schools, the differences in test scores are not statistically significant.

Our results imply that private education, both free and fee-charging, has a small positive impact on the performance of low income students. In other words, our findings suggest that low-income students who typically attend public schools can benefit from attending private voucher schools. Our methodology, however, does not allow us to determine what causes the differences in test scores. Better peers, superior teachers, more involved parents, and a more effective management, can all explain our findings. Alternatively, it is possible that public schools do not compete on an even playing field with private voucher schools due to public school regulations.

The paper is organized as follows: Section 2 provides an overview of the Chilean educational system and reviews the literature on school choice in Chile. Section 3 explains our identification strategy and its main limitations. Section 4 describes the data sources used in this study. Section 5 discusses the methodology and presents our results. Section 6 concludes.

2. The Chilean educational system

In the early 1980s, sweeping reforms to Chile's educational system paved the way for the private sector to enter the market as a provider of education by introducing a voucher-type demand subsidy to finance public and private voucher schools. The voucher, which is paid directly to schools on a per-student basis, is intended to cover running costs and generate competition to attract and retain students, promoting more efficient and better

³ Florida's McKay Scholarship Program also allows schools to charge fees on top of the voucher.

⁴ See Neal (1997) and McEwan (2001).

quality education services. The monthly voucher for primary schools amounted to nearly \$51 in 2002.⁵

Since 1993, private voucher schools have been permitted to charge a fee on top of the voucher. The conditions under which a school may charge fees are that the voucher is reduced according to the fee charged and the schools allocate a percentage of the fee, in addition to a fraction of the voucher money that is given by the state, to a scholarship fund for students. Two-thirds of the scholarships must be given based on economic need, while the remaining third may be distributed at the discretion of the school. Schools are allowed to define the criteria used to classify students according to economic need, but must use objective information and procedures, and must report to the parents and the government about their scholarship policies.

As a result of these reforms, the number of new schools in the private sector has increased rapidly over the past 20 years. In 1985, there were 2643 private voucher schools in Chile; this number grew to 3640 in 2002 and to 4084 in 2003. The resulting four-legged school system comprises of⁶:

1. Private non-voucher schools, which are financed by fees paid by parents and run by the private sector. These schools accounted for 8.5% of all students in Chile and 12.7% of all students in the Metropolitan Region of Santiago in 2002.
2. Fee-charging private voucher schools, which are co-financed by the per-student voucher provided by the government and the monthly fees paid by the parents. These accounted for 25.3% of total enrollment in Chile and for 41.2% of students in Santiago in 2002.
3. Free private voucher schools, which are financed by the per-student voucher, but are owned and run by the private sector. These accounted for 12.5% of total enrollment in Chile and for 6.4% of students in Santiago in 2002.
4. Public schools, which are financed by the voucher but are owned and managed by municipal authorities. They represented 52.1% of the enrollment in Chile and 37.6% of students in Santiago in 2002.

Other than the permission to charge fees on top of the voucher, the most important differences between public and private voucher schools relate to the students' admission process and the teachers' job contracts and pay. While public schools must admit all their applicants as long as there are vacancies, and have serious constraints on expelling students, private voucher schools are free to establish their own admission and expulsion policies. In fact, they intensively use selection mechanisms such as entrance exams and parental interviews to screen-out students. Only oversubscribed public schools are allowed to administer admission tests.

⁵ As a reference, the 2002 average monthly wage in Chile was about \$550 according to the CASEN Household Survey.

⁶ The remaining of the school population attends schools run by educational corporations linked to business organizations or professional-technical secondary schools.

Another difference is that teachers' job contracts in public schools are regulated by a special legislation, the Teachers' Statute, which involves a centralized collective-bargaining process with wages based on uniform pay-scales and bonuses for training and experience. In contrast, private voucher schools hire and fire teachers according to the more flexible Labor Code. As a result, private voucher schools can select, hire and dismiss teachers, while municipal authorities find it a lot more difficult to fire teachers due to the Teachers' Statute. Nonetheless, some legal changes since 1995 have brought more flexibility into the public school sector.

A number of papers have examined the Chilean educational system. Most of these have studied the relative effectiveness of private versus public schools, while others have investigated the effect of school competition on student academic outcomes. In general, all of the studies conclude that the socioeconomic characteristics of families are statistically significant in order to explain student performance in the different types of school. Nonetheless, when the performance of public and private schools is compared, the studies arrive at different conclusions, depending on the aggregation level of the data (i.e., student vs. school level data).

Until 1998, data on socioeconomic characteristics was only available at the school level; as a result, all research conducted used the school as the unit of analysis. Using school-level data, [McEwan and Carnoy \(2000\)](#) concluded that, on average, non-religious private voucher schools produce lower academic achievement than public schools, while Catholic private voucher schools produce higher outcomes. [Mizala and Romaguera \(2000\)](#) argued that when sufficient control variables and the whole universe of schools are taken into account, there are no consistent differences between public and private voucher schools. [Tokman \(2002\)](#) found that public schools are not consistently better or worse than private voucher schools, although public schools are more effective for students from disadvantaged family backgrounds.

Student level analysis became possible when the Ministry of Education began to administer a questionnaire to all parents of students who participated in the country's standardized test, known as SIMCE. [McEwan \(2001\)](#), using student level data, found that there is no consistent difference between student achievement in public and non-religious private voucher schools, although fee-paying private schools and Catholic private voucher schools have higher achievement levels than public schools. Moreover, [Mizala and Romaguera \(2001\)](#) and [Sapelli and Vial \(2002, 2005\)](#) found that students attending private voucher schools have higher educational outcomes than those from public schools.

This study is innovative in a number of important respects. First of all, given the absence of panel data or an experimental design, it uses a novel identification strategy to address the selection bias that has posed a significant challenge to studies that estimate the effect of private education. Moreover, it uses propensity score matching to identify comparable treatment and control groups. As stated earlier, this method alleviates the bias due to systematic, observable differences between the treated

and comparison groups. Finally, this paper differentiates between fee-charging and free private voucher schools and compares their academic performance.

3. Identification strategy

The goal of this paper is to estimate the average effect on academic achievement that results from moving a student from a public to a fee-charging private voucher school.⁷ We consider fee-charging private voucher school education to be the treatment, and the evaluation parameter is the average treatment effect on the treated. Since it is impossible to observe the same student in two different school types, we use matching to infer the academic achievement that would be produced if a fee-charging private voucher school student had instead attended a public or a free private voucher school. We also attempt to account for selection bias by focusing on students who receive scholarships to attend fee-charging private voucher schools. Scholarships give students that would normally attend free schools the opportunity to attend fee-charging private voucher schools. If these scholarships are uncorrelated with the prior academic achievement, then they can be used to perform a quasi-experimental research design that compares the educational outcomes of scholarship and non-scholarship students.

In order to gain a better understanding of the scholarship system, we conducted interviews with school directors, social workers, and other important participants in the Chilean education system.⁸ The interviews revealed that the two primary reasons for which schools award scholarships to students are either that the family is going through a period of financial difficulty or that they are the son or daughter of a school employee. Scholarships based on short-term financial difficulties are unlikely to appear in our data since they are typically awarded to students in ninth grade or higher, and our analysis focuses on the fourth grade. However, the children of school employees (such as the administrators, janitors, etc.) are of interest because (1) they should display characteristics typical of students in public schools; (2) it is likely that had these children not been given scholarships, their families would have sent them to a public or free private voucher school and (3) they are usually given a preference during the student selection process or in many cases, are automatically admitted into the school. This preference may eliminate the selection bias observed by Gauri (1998), McEwan (2001) and Hsieh and Urquiola (2006), who all suggested that private schools admit students with unobserved characteristics that are correlated with high academic achievement. Unfortunately, the sons and daughters of school employees cannot be directly identified in our database.

A number of caveats have the potential to limit the validity of scholarships in our identification strategy, as

the children of school employees – and all other scholarship students – may be different in unobservable ways. First, it is possible that the most motivated parents look for jobs at schools that award scholarships to offer their children the education that fee-charging private voucher schools provide. High unemployment rates in Chile over the past few years may have reduced the ability of parents to choose the job they like, as it limited the bargaining power the typical school worker had. For instance, according to the *University of Chile Employment Survey (2003)*, the aggregate unemployment rate in Santiago reached 12.7% in years 2000–2001 and the unemployment rate of workers in service sectors was 10.8%. Still, it is possible that parents consider the reduced fee as a non-wage benefit when they search for a job.

An additional concern refers to whether parental motivation is affected by the scholarship. For instance, the possibility of losing the scholarship gives parents an incentive to focus more on school. Similarly, school employees might care more about their children's performance due to reputation concerns. In our estimation procedure below, we add parental input variables (such as the frequency that parents study with their children) in our model for the probability of attending each school type as an effort to account for this potential problem.

Our logit results discussed in Section 5 show that the number of years the student has attended a school is a statistically significant determinant of a scholarship. This result might suggest that schools may use the scholarships to retain good employees from switching jobs. A subsequent concern is the possibility that the characteristics of these employees may be correlated with the educational outcomes of their children. Similarly, the finding might suggest that schools award scholarships to students with low turnover, which in some cases may perform better than their peers who move more often (Hanushek, Kain, & Rivkin, 2004).

Although short-term need based scholarships tend to be awarded to older students, there may still be some scholarship students in the sample that are suffering short-term financial problems, such as an illness in the family or temporary unemployment. Ideally, these students would not be included in the treatment group since we are interested in students whose decision to attend the school was largely influenced by the scholarships, but unfortunately, it is impossible to distinguish the longevity of the financial problems. To partially account for this problem, in our matching procedure we control for the level of education of the parents by only including students whose parents have less than a university degree in both the treatment and control groups. Since parents with low income and high education are most likely to suffer a transitory income drop, this exclusion removes observations that may not represent valid treatment cases.

The exclusion of students with parents with high levels of education also solves a second concern: it allows us to eliminate scholarship students whose parents are teachers at the school. There are several reasons why these students should not remain in the treatment group. First of all, while it is unlikely that a teacher's salary is high enough to pay private non-voucher school fees, teachers are well educated

⁷ We also estimate the effect of moving a student from a free private voucher school to a fee-charging private voucher school.

⁸ The interviews included visits to 11 private voucher schools and to an association of private voucher schools that represents over 800 private voucher schools.

and have often exceptionally invested in the education of their children. These characteristics of the children of teachers distinguish them from most children who attend public schools and make them unsuitable to be considered in the treatment group.

With these caveats in mind, this paper uses the provision of scholarships for low-income students to attend fee-charging private voucher schools to identify the effect of private voucher education on student outcomes. This strategy is valid as long as scholarships are distributed independently of academic ability and also influence the decision to attend a fee-charging private voucher school. This phenomenon creates a treatment group because most of these students would have been likely to attend a public or a free private voucher school had they not been allowed to pay a reduced fee. In the following section, we will describe the data used in this study followed by an empirical analysis of school scholarships.

4. Data

The empirical data used in this study come primarily from two sources. The first source is a standardized test called the SIMCE, which is administered annually throughout Chile to a specified grade level that rotates every year between the fourth, eighth, and tenth grades.⁹ This paper uses the 2002 SIMCE data, which was administered to fourth graders. The young age of the students in the database implies that schools have less evidence of the student's academic abilities to consider when awarding scholarships, relative to older students who have much longer academic records that schools may use as criteria for receiving a scholarship.¹⁰

The second data source is the questionnaire that is answered by the parents of students that participated in the SIMCE in 2002. This questionnaire provides information on the socioeconomic characteristics of each student, such as their family income and the education of the parents. Although it is not mandatory for parents to complete the questionnaire, there is an extremely high response rate for most of the key variables used in this analysis.¹¹

We also used data from the Ministry of Education and the Under-Secretary of Regional Development to calculate the per pupil resources that were available to each school, a principal survey from 1999 to determine the religious affiliation of schools, a list of the schools that were registered in 2000 by the Ministry of Education to determine which schools were new in 2002, and the 2000 SIMCE data to build a ranking of schools.

Once these data sources were combined, several modifications were made to target the population that we are

interested in. First of all, students younger than 6 years old or older than 14 years old were removed.¹² Second, we only analyze students that reside in the Metropolitan Region of Santiago because this is the region where students have the greatest opportunity to attend private voucher schools. In other areas students have limited school choice as a result of geographic and other constraints. Third, we included students whose parents have a university degree in the first stages of our analysis, but excluded them in the final propensity score matching stage, in order to eliminate scholarship students whose parents are teachers at the school and those who received the scholarship because of a transitory income drop.¹³

Finally, we chose to exclude students in private non-voucher schools from the analysis because these schools typically only serve the most elite families in Chile. Private non-voucher schools are not a realistic educational option for the average student in Chile because the typical fee charged at private non-voucher schools is over five times the per-student voucher and much higher than the cost of attending a fee-charging private voucher school.

Table 1 summarizes the basic statistics for the variables used in the analysis,¹⁴ and Table 2 presents some basic statistics by school type in order to characterize the students attending different types of schools in our database. On average, students in fee-charging private voucher schools pay over 13,000 pesos per month (about 24 dollars), roughly 6% of their mean family income. Fees vary widely, from 0 to 110,000 pesos per month (0–196 dollars). Table 2 shows that on average, scholarship students tend to score better than the students in the free private voucher and public schools, but worse than students in the fee-charging private voucher schools. The parents of scholarship students have similar education levels than those at the free private voucher and public schools. Finally, the families of scholarship students earn less income on average than the families of the rest of the students.

5. Empirical strategy and results

We estimate the effect of fee-charging private voucher education on student performance in a three step strategy. First, we estimate a model for the probability of receiving a scholarship. Then, we estimate a school choice model that controls for the likelihood of being awarded a fee reduction. Finally, we match propensity scores to compare the outcomes of students in the treatment and control groups.

5.1. Who receives a scholarship?

According to the law, schools must use objective information and procedures when awarding scholarships. In practice, these are awarded on the basis of a number of

⁹ This rotation implies that the SIMCE tests do not track students over time.

¹⁰ Ability based selection is easier among students in higher grades. However, the use of data on fourth graders does not guarantee that scholarship awards are not based on merit. Schools may be able to predict the students' long-term performance observing their early achievement. They may also gather information by meeting the parents.

¹¹ The response rate for the key student-level variables used in this analysis ranges from 81 to 93%. We only used the observations that had complete information; no data was imputed for missing observations.

¹² These exclusions involved 145 students older than 14 and 29 students younger than 6. We believe these observations may represent typographical errors. Our results are robust to this sample decision.

¹³ Our results are robust to excluding these observations from the first stage. The robustness checks can be found in Anand, Mizala, and Repetto (2008).

¹⁴ A detailed description of these variables can be found in Anand et al. (2008).

Table 1
Summary statistics for the database^a.

Variable	N	Mean	S.D.	Min	Max
Student characteristics					
SIMCE math	77,921	244.9	52.3	94	379
SIMCE language	77,880	249.1	53.4	101	376
SIMCE science	77,976	248.5	52.5	94	386
# of schools in neighborhood of residence	78,184	53.3	32.6	4	125
# of private voucher schools in neighborhood of residence	78,184	36.6	28.1	0	99
Male	83,540	0.5	0.5	0	1
Mother's education (years)	78,868	10.6	3.2	1	22
Father's education (years)	76,490	11.2	3.1	1	22
Mother's education if single (years)	17,039	10.9	3.2	1	22
Siblings	81,606	0.6	0.5	0	1
Single mother	81,606	0.2	0.4	0	1
Parents' educational expectations: university	81,147	0.4	0.5	0	1
Parents' educational expectations: technical or professional school	81,147	0.2	0.4	0	1
Income (divided by 100,000)	81,326	2.1	2.1	0.5	20
Distance from school's income	81,326	0.000	1.8	-18.9	9.7
Fee paid by students in fee-charging private voucher schools (pesos)	38,509	13,346.3	13,124.1	0	110,000 ^b
Scholarship (defined as 50% of fee)	82,777	0.054	0.2	0	1
Repeated grade	81,899	0.1	0.3	0	1
Age if repeated a grade	6,624	10.7	0.8	8	14
Difference from average age (10 years old)	82,427	-0.4	0.7	-4	4
Preschool	81,557	0.5	0.5	0	1
# years attended school	79,419	3.9	1.5	1	6
Reason for school choice: proximity	71,814	0.4	0.5	0	1
Reason for school choice: family members	71,814	0.1	0.3	0	1
Reason for school choice: academic prestige	71,814	0.1	0.4	0	1
Reason for school choice: socio-cultural	71,814	0.03	0.2	0	1
Reason for school choice: teacher quality	71,814	0.1	0.3	0	1
Reason for school choice: values	71,814	0.1	0.3	0	1
Reason for school choice: full day schedule	71,814	0.02	0.1	0	1
Reason for school choice: low cost	71,814	0.05	0.2	0	1
Reason for school choice: only option	71,814	0.02	0.1	0	1
Parent studies with their child	78,731	2.6	0.6	1	3
Parent reads with their child	79,028	2.0	0.8	1	3
School characteristics					
# of schools in school's neighborhood	1,415	49.9	32.2	4	125
# of private voucher schools in school's neighborhood	1,415	34.0	27.4	0	99
Monthly fee of school	1,414	6,373.8	10,826	0	110,000 ^b
Per pupil resources	1,271	27,181	10,559	5260	274,497
Average mothers' education in the school	1,414	10.5	1.7	5	15.7
SD of school's income (heterogeneity)	1,411	165,121	94,723	0	700,476
Religious	1,256	0.1	0.3	0	1
New school	1,415	0.1	0.2	0	1
School's rank in 2000 SIMCE	1,415	755.9	480.9	0	1,551
School ranked in top 10% of private voucher schools in 2000	617	0.1	0.3	0	1

^a Summary statistics are for students in the Metropolitan Region of Santiago who are between the ages of 6 and 14 and attend public schools, free private voucher schools or fee-charging private voucher schools.

^b This maximum amount corresponds to a middle-income private voucher school that has differentiated fees depending on the students' family income.

Table 2
Basic statistics by school type for 4th graders in 2002^a.

Variable	Public	Private voucher		Scholarship students ^b
		No fee	Fee-charging	
SIMCE math	233	237	258	252
SIMCE science	235	242	263	256
SIMCE language	236	241	263	256
Father's education (years)	10.5	10.6	11.9	10.5
Mother's education (years)	9.7	10.0	11.6	9.9
Family income (Ch pesos)	164,090	176,400	267,701	147,754
Fee by student (Ch pesos)	0	0	13,346	2,182

Source: SIMCE Parental Questionnaire, Ministry of Education.

^a Metropolitan Region of Santiago only.

^b Students in the treatment group; i.e., students in fee-charging private voucher schools, that report paying 50% or less of the fee in their school. It excludes the children of highly educated parents.

Table 3

Estimation of the probability of receiving a scholarship to a fee-charging private voucher school.

Variable	Coefficient
# schools in school's neighborhood	-0.005 (0.004)
# private voucher schools in school's neighborhood	0.008 (0.005)
Male	-0.008 (0.041)
Father's education	0.005 (0.008)
Mother's education	-0.018 (0.009)
Single mother	-0.089 (0.200)
Single mother's education	0.020 (0.017)
Siblings	0.218 (0.042)***
Expectations – university	-0.020 (0.053)
Expectations – technical or professional institute	-0.132 (0.065)*
Income	-0.728 (0.060)***
Income squared	0.093 (0.007)***
Income cubed	-0.003 (0.0003)***
Per pupil resources of the school	2.39×10^{-7} (3.63×10^{-6})
S.D. income	0.066 (0.049)
Distance from average income	0.182 (0.044)***
Repeated grade	2.428 (1.307)
Age if repeated	-0.219 (0.125)
Difference from average age	0.109 (0.039)**
Preschool	-0.086 (0.042)*
School's ranking in 2000	0.0003 (7×10^{-5})***
New school	0.742 (0.440)
Religion	0.318 (0.055)***
# years attended school	0.079 (0.015)***
Constant	-1.756 (0.177)***
Pseudo R ²	0.058
Number of observations	26,062

Standard errors are in parentheses.

* Significant at 10%.

** Significant at 5%.

*** Significant at 1%.

family and student characteristics. According to the results of school interviews, schools tend to offer fee reductions to the children of employees and students who suffer from financial difficulties. For the main analysis, a school scholarship is defined as a 50% or more reduction in the fee.

We first conduct a logit model to identify the characteristics of students that are likely to receive a scholarship. The results in Table 3 are consistent with the information gathered in the school interviews we performed: students from lower income families and those that have been in the school for longer periods of time are more likely to have a scholarship. Furthermore, students whose parents have lower educational expectations, who have not attended preschool and who attend religious schools are more likely to be awarded scholarships.

Our model for the probability of a scholarship can only account for observable characteristics of the students and their families, and of the schools. Nevertheless, at the heart of our estimation strategy is whether scholarships are awarded in a manner that is not related to student achievement through unobserved variables. Unfortunately, we do not have panel data to control for unobservable characteristics nor information on the students' prior academic records to test this hypothesis. Instead, as a simple correlation test, we re-estimated our logit models including the student's SIMCE scores as an explanatory variable. Two

separate logits were estimated: one for fee-charging private voucher schools and another for fee-charging private voucher schools that were ranked in the top 10% of schools in Santiago in 2000. This second logit was conducted based on the observation that there is more demand for higher ranked schools and therefore scholarships may be more selectively distributed to students.

However, it should be kept in mind that a number of biases may come from using the SIMCE scores from the same year that the scholarship was awarded in determining whether achievement is a significant predictor of being awarded a scholarship. For instance, if scholarships actually improve the academic achievement of students that lag behind, we may find no statistically significant relationship between SIMCE scores and the likelihood of having a scholarship. Similarly, the regressions may uncover a negative correlation with tests scores if scholarships are awarded based on need and not on merit.

Table 4 shows the results adding math, language and science (which includes the natural and social sciences) SIMCE scores to the logits. We find that there is no statistically significant correlation between language or science scores and the probability of obtaining a scholarship in all schools or in schools that rank in the top 10% of all private voucher schools in Santiago. However, the analyses using math scores do show a significant, positive relationship between test scores and the probability of receiving a scholarship when the data on all schools is used, although this relationship is not significant in the top 10% of private voucher schools in Santiago. This correlation is consistent with a positive effect of scholarships on students' outcomes, but is also consistent with scholarships being awarded to the best students. Moreover, these results are unusual because one would expect the top 10% of private voucher schools to be more selective with their scholarships than all the private schools together. Given that this correlation may invalidate the use of scholarships to identify treatment and control groups, in what follows we focus the analysis on language and science SIMCE scores.

5.2. School choice

Having predicted the likelihood that any given student will receive a scholarship, we next estimate a multinomial logit model for school choice to calculate a propensity score for each student. Each student has three choices for school type: public school, free private voucher school and fee-charging private voucher school. The model includes a number of school- and student-level characteristics as controls, as well as the predicted probability of a scholarship in order to control for the characteristics that make students likely to have a scholarship. We did not include the same variables in the multinomial logit as we did in the logit for the probability of a scholarship. Additional variables used in the multinomial logit are the total number of schools and private schools in the student's neighborhood of residence, a second degree polynomial in the average education of mothers in the school to account for peer effects, the reasons the parents listed for choosing the school, and the frequency that the parents read or study with their child. We use school level peer effects rather than classroom level

Table 4

Estimation of the probability of receiving a scholarship to each school type, including SIMCE scores as control variables.

Variable	Language SIMCE		Science (natural and social) SIMCE		Math SIMCE	
	Fee-charging private voucher	Fee-charging private voucher in top 10%	Fee-charging private voucher	Fee-charging private voucher in top 10%	Fee-charging private voucher	Fee-charging private voucher in top 10%
SIMCE	0.001 (0.0005)	0.002 (0.002)	0.001 (0.0005)	−0.001 (0.002)	0.001 (0.0005)**	−0.002 (0.002)
N	24457	3062	24486	3060	24473	3062
Pseudo R ²	0.058	0.115	0.058	0.121	0.059	0.118

Standard errors are in parentheses.

The regression includes all control variables in Table 3. Detailed results are available upon request.

** Significant at 1%.

Table 5

Estimation of the probability of attending each school type compared to public school.

Variable	Free private voucher	Fee-charging private voucher
# schools in student's neighborhood	−0.040 (0.004)***	−0.004 (0.003)
# private voucher schools in student's neighborhood	0.050 (0.004)***	0.014 (0.003)***
Probability of scholarship to a fee-charging private voucher	−6.387 (0.729)***	−6.555 (0.542)***
Father's education	0.0001 (0.007)	0.004 (0.006)
Mother's education	−0.012 (0.008)	−0.025 (0.006)***
Expectations – university	−0.003 (0.049)	0.107 (0.035)**
Expectations – technical or professional institute	−0.096 (0.056)	−0.061 (0.042)
Income	−0.546 (0.088)***	−0.574 (0.061)***
Income squared	0.057 (0.012)***	0.063 (0.008)***
Income cubed	−0.002 (0.0005)***	−0.002 (0.0003)***
School per pupil resources	1.51×10^{-6} (4.51×10^{-6})	0.0002 (3.12×10^{-6})***
Mothers' education in the school	3.007 (0.189)***	5.763 (0.162)***
Mothers' education in the school squared	−0.145 (0.009)***	−0.227 (0.007)***
Difference from average age	0.107 (0.037)**	−0.015 (0.027)
Preschool	−0.033 (0.040)	−0.095 (0.029)***
Religion	7.500 (0.363)***	5.281 (0.359)***
Reason for choosing school: proximity	−0.009 (0.146)	−0.079 (0.096)
Reason for choosing school: family	0.443 (0.152)**	0.062 (0.102)
Reason for choosing school: academic prestige	0.645 (0.151)***	0.012 (0.100)
Reason for choosing school: socio-cultural	0.534 (0.192)**	0.532 (0.129)***
Reason for choosing school: teacher quality	0.566 (0.151)***	0.207 (0.101)**
Reason for choosing school: values	1.476 (0.162)***	0.948 (0.114)***
Reason for choosing school: full day option	0.003 (0.200)	−0.640 (0.133)***
Reason for choosing school: low cost	0.202 (0.161)	−0.749 (0.111)***
Parent studies with their child	0.008 (0.032)	0.081 (0.023)***
Constant	−15.443 (1.043)***	−38.527 (0.919)***
Pseudo R ²	0.362	0.362
Number of observations	44932	44932

The following variables were not statistically significant and have been excluded from the output: single mother, single mother's education, repeated grade, age if repeated, male, and parent reads with their child.

* Significant at 10%.

** Significant at 5%.

*** Significant at 1%.

because parents can anticipate school and not classroom level characteristics when choosing school type.¹⁵ In addition, the last two variables are included to control for the motivation and involvement of the parents in the education of their children. Variables that affect the probability of a scholarship but do not influence the school choice decision are not included in the multinomial logit.

The results of this model, displayed in Table 5, show some interesting characteristics of students in each school

type. The negative coefficient for the probability of a scholarship to a private voucher school for both types of private voucher schools indicates that students that have a high probability of a scholarship have characteristics that are more typical of public school students, as already suggested by the statistics presented in Table 2. Having controlled for the probability of a scholarship to a fee-charging private voucher school, we find that students with a high income are less likely to attend private voucher schools than public schools, whereas those who pick their school due to socio-cultural reasons, teacher quality, or values are more likely to go to private voucher schools. Also, students are more likely to attend private voucher schools when there are more private schools in their neighborhood. Students are also more likely to attend private voucher schools that

¹⁵ There is evidence that little tracking is used in the Chilean educational system in order to assign students to different classrooms; see Mullis et al. (2000). The results using classroom level peer effects are available upon request.

Table 6
Matching results for scholarship students in fee-charging private voucher schools.

Sample	Matching estimator	Number of observations	Mean propensity score	Language SIMCE score	Science SIMCE score	
Panel A. Comparison: students in public schools						
Treatment	Scholarship students in fee-charging private voucher schools	1,384	0.625	259.6	259.5	
Matched comparison	Students in public schools	One-to-one replacement	1,384	0.625	Language SIMCE ATT	Science SIMCE ATT
		Nearest neighbor (5)	3,064	0.625	11.520 (3.098) ^{***}	9.215 (2.944) ^{***}
		Kernel	14,036	0.621	11.083 (2.442) ^{***}	10.916 (2.405) ^{***}
	Local linear regression	14,036	0.625	10.703 (2.156) ^{***}	9.668 (2.120) ^{***}	
Panel B. Comparison: students in free private voucher schools						
Treatment	Scholarship students in fee-charging private voucher schools	1,353	0.617	259.1	259.1	
Matched comparison	Students in free private voucher schools	One-to-one replacement	1,353	0.617	Language SIMCE ATT	Science SIMCE ATT
		Nearest neighbor (5)	1,983	0.616	3.022 (3.861)	3.143 (3.764)
		Kernel	3,028	0.610	0.882 (3.350)	1.793 (3.224)
		Local linear regression	3,028	0.617	1.182 (2.621)	2.826 (2.509)
				3.422 (3.599)	3.278 (3.428)	

Standard errors in parentheses.

^{***} Significant at 1%.

are religious and where the mothers of the students in the school have more years of education, which may reflect a desire for anticipated peer effects.

5.3. Propensity score matching and the average treatment effect on the treated

The coefficients that are produced in the multinomial logit model are used to calculate a propensity score for each student, which reflects each student's probability of attending fee-charging private voucher schools, conditional on the likelihood of being awarded a scholarship. We then use propensity score matching to estimate the average treatment on the treated (ATT).

Propensity score matching is a technique used for non-experimental data to identify a control group that exhibits the same distribution of covariates as the treatment group. In this paper, we use this method to identify a group of students in public schools and free private voucher schools that display the same observable characteristics as the treatment group. The treatment group used in the benchmark case is students in fee-charging private voucher schools who receive scholarships that are between 50 and 100% of the fee. As discussed earlier, we also control for the level of education of the parents by only including students whose parents have less than a university education in both the treatment and control groups.

We implement a range of estimators (one-to-one with replacement, five-nearest neighbor with replacement, kernel, and local linear regression) in order to gauge the effect of using different matching estimators on the outcome. All matching estimators were conducted using common support. After the matches are made, we use a difference in means test to estimate whether there exists a statistically significant difference in the academic achievement of the control groups compared to their match in the treatment group.

The results of the four matching estimators can be found in Table 6. All estimators reveal statistically significant differences in the language and science SIMCE scores of students in public schools compared to scholarship students in fee-charging private voucher schools. The scores of scholarship students in fee-charging private voucher schools are higher than those of students in public schools, with the estimated differences ranging from 8.96 to 11.52 points. These estimated differences are not large considering the average score on the language and science SIMCE is 249 points with a standard deviation of 53 points (Table 2). The estimated effect of 17–22% of one standard deviation is similar to the order of magnitude as the estimated effect of vouchers in Colombia (Angrist et al., 2002). The performance gap between scholarship students compared to students in free private voucher schools is positive and small, but not significant.

We also conducted a series of robustness checks to see the effect that changing our assumptions and models has on the results. Detailed results can be found in Anand et al. (2008). The first robustness check was to match the scholarship students to non-scholarship students in fee-charging private voucher schools (both with limited parental education) in order to check differences in their test scores. We

found that scholarship and non-scholarship students do not perform differently. This finding suggests support for the assumption that schools do not award scholarships based on academic achievement. However, it may also suggest that scholarships do improve test scores, allowing scholarship students to catch up with classmates that perform better.

The second robustness check repeats the main exercise, but limits the parental education of the students included in the analysis from the first stage. The third and fourth checks redefine a scholarship, first as a reduction in the fee that is equivalent to 5% or more of the student's family income, and second as a 75% or more reduction in the fee. Our final check includes students attending private non-voucher schools in the multinomial logit for school choice. The findings of all these checks show that our results are robust to the relevant assumptions: scholarship students attending private voucher schools score about 10 points more in the tests than students in the public school control group. Similarly, we find no statistical difference between scholarship students and free private-voucher schools' students.

In summary, we have found that students that move from public schools to fee-charging private voucher schools due to a scholarship perform better in language and science tests. The differences are statistically significant, ranging from 17 to 22% of one standard deviation. The difference between private schools with and without fees is not statistically significant.

These results suggest that low-income students who typically attend public schools can benefit from attending fee-charging and free private voucher schools. There are a number of potential sources for the differential outcomes. A more effective and more flexible management, better peers, superior teachers, and more involved parents can all explain these findings. It is interesting to note, though, that the similarity of results among children in private voucher schools with and without fees suggests that differences in the availability of resources do not account for the superior performance of students in fee-charging private voucher schools. An alternative explanation is that scholarship students have unobservable characteristics that allow them to perform better in standardized tests. Unfortunately, given the available data, we cannot rule out this possibility, as the controls we use may not fully capture unobserved student ability.

6. Conclusions

This paper uses scholarships to identify the effect on tests scores that results from moving children of low-income families from a public or a free private voucher school to a fee-charging private voucher school. This identification strategy is limited as it can only account for observable characteristics of students, their families and the schools they attend. Unfortunately, we cannot completely rule out the possibility that the controls we use may not capture unobserved student characteristics that might be correlated with both fee reductions and test scores. For example, the results of the paper may overestimate the effect of private voucher education if the most motivated parents look for jobs at schools that grant scholarships,

parental motivation can be affected by scholarships, or fee reduction offers alter student school turnover and parental job turnover. Ideally, experimental or panel data will become available in the future, allowing researchers to control for unobserved student characteristics.

With these caveats in mind, the results of our paper have shown that low-income students who attend fee-charging private voucher schools attain higher test scores than similar students that attend public schools. All the robustness checks we performed show that their scores are higher by approximately 10 points (0.2 standard deviations). The difference in performance of low-income students in fee-charging private voucher schools compared to similar students in free private voucher schools is not statistically significant.

These results imply that low-income students who typically attend public schools can benefit from attending fee-charging or free private voucher schools. The difference in test scores between private voucher schools and public schools could potentially be attributed to a variety of reasons. The first may be that private voucher schools provide a better quality of education than public school, perhaps because they run the schools under better and more flexible management or because market competition has forced fee-charging private voucher schools to improve their quality of education in order to attract students (Gallego, 2006). Another possible explanation is that there are positive peer effects that occur in private voucher schools captured partially in our models by the mothers' average education in the school. Although the students in our analysis are typically from low-income families with low parental education, it is likely that their classmates come from families with higher incomes and more parental education, which could have an impact on the education of the scholarship students.

Alternatively, the differences in test scores could be partially caused by the higher motivation of parents who send their children to private voucher schools. We have attempted to control for the involvement of parents by including variables that measure the frequency that parents study and read with their children; however, it is possible that we have not entirely captured the parental involvement and motivation that may influence academic achievement.

It is interesting to note that the similarity of results among children in private voucher schools with and without fees suggests that differences in the availability of resources do not account for the superior performance of students in fee-charging private voucher schools.

Regardless of what specific factors cause the difference in test scores, the findings of this paper confirm that it is possible to create an environment in which the academic achievement of low-income students can be improved. Disentangling exactly which factors contribute to a better education for low-income students is an important issue that should be examined in future work.

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