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Vouchers, School Choice and the Access to Higher Education

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Abstract

For over twenty years, a voucher system has been used in Chile to promote competition in the educational system between public and private schools. Attending a private subsidized school is associated with increased standardized test scores, but the apparent impact is relatively small. Controlling for school choice using a supply-side instrument (school availability at community level) implies substantially larger impacts of the voucher system. The effect of parents' education on academic performance is smaller than that implied by simple OLS estimates that do not control for school choice. Finally, the results also show that family school choice is gender biased, females are sent more often to voucher schools while males are sent more often to private (non voucher) schools. In addition, the TSLS estimates show that females gain less than males from going to voucher schools.

Key words: education, vouchers, gender, Chile

JEL classification: I21, I22, I28

1. Introduction

Many studies have shown the importance of education as a source of increased earnings. In addition, in many developing countries equalizing education and opportunities is also advocated as means to reduce income inequality. In the past decades, debates on how to improve the access and quality of education have been intense and controversial. On the one hand, this goal may be achieved by adding more resources to the educational system. However, there is yet no clear evidence on when such policies are successful (Hanushek 1986, 1996). Alternatively, Friedman (1955) proposed the introduction of a voucher system, arguing that the ensuing competition generated among schools would improve the quality of education. Parents would prefer to send their children to good schools and as a consequence bad schools would loose enrollment and eventually disappear from the market.

Although the theoretical arguments in favor of a voucher system as a means to improve the quality of education are clear, there has not been sufficient empirical evidence to know whether or when this type of system might work. In this paper we use Chilean data to analyze this issue. Free choice of schools together with a voucher system providing public funding to both private and public schools was introduced in Chile over twenty years ago. Thus, Chilean data offers the opportunity to examine educational performance in a country where vouchers have been implemented on a large scale (national level) and where many new schools have been created. Therefore, it is a promising case study of the potential merits of this market based educational system.

In this study we examine the impact of different types of school on performance, as measured by a standardized performance test, the Academic Aptitude Test (PAA), a college entrance examination analogous to the SAT in the United States. Previous studies using Chilean data using Ordinary Least Squares (OLS) analysis show that voucher schools perform more akin to public rather than private schools when test results are analyzed (Rodriguez, 1988; Mizala and Romaguera, 2000). This result of the existing literature has cast some doubt regarding the merits of the voucher scheme. However, I find that traditional OLS estimates are significantly biased because they do not control for the endogeneity of school choice. Using the availability (supply) of schools at the community level as an instrument for school choice, Two-Stage Least Square (TSLS) estimates are obtained. The results show that the impact of attending a private subsidized voucher school versus a public non-subsidized school more than doubles with respect to OLS estimates. At the same time, we observe a drop in the importance of parental education on children's academic performance. Therefore, the previous literature has overestimated the impact of parental education and underestimated the impact of the voucher system in providing better education.

In this paper I also analyze the determinants of access to higher education, and the impacts that school choice and other variables such as gender may have in this respect. We find that while female students are more likely to obtain better grades than males during high school, their PAA test scores are significantly lower. The selection of students going to private schools favors males. Thus the family choice of sending children to private non-subsidized schools is gender biased, and girls go more often to the voucher schools. However, the TSLS estimates show that girls gain less than boys from going to these schools. These outcomes imply that the educational gender gap may be widening.

The evidence presented in this paper gives strong empirical support to the ascribed theoretical benefits of a voucher system in education. The voucher system in Chile seems to provide students with the opportunity to increase their test scores and improve their chances of access to higher education, and thus higher future earnings. We do find, however, that there is a case to introduce special policies aimed at improving female performance.

The paper is organized as follows. The second section of the paper briefly describes the Chilean voucher system. In addition, this section presents a description of the Chilean educational system and how the PAA test works in the selection of students for higher education. This section also outlines the methodological issues and reviews the empirical evidence. The third section describes the data. Section four presents the results. Conclusions are found at the end of the paper.

2. The Chilean Voucher System

The Chilean voucher system has been working since 1980. This long period of functioning provides with a strong ground to evaluate how well the system is actually working. Prior to 1980, the administration of the Chilean school system was fully centralized in the Ministry of Education. The Ministry was not only responsible for the curriculum of the whole education system, but also for the administration of the public schools, which accounted for 80 percent of all schools in the country. The ministry also appointed public school teachers and principals, as well as approving and paying expenses and salaries.

The decentralization process initiated in the early 1980s transferred the administration of public-sector schools to the municipalities.[1] In addition, the reform opened the way for the private sector to participate as a provider of publicly financed education, by establishing a voucher-type per-

student subsidy. Three types of schools were established: Municipal schools- financed by the per student subsidy granted by the state and run by municipalities; Private subsidized schools- financed by the per-student subsidy and run by the private sector (from now on referred to as voucher schools); and private fee-paying schools- financed by fees paid by parents and managed by the private sector.[2] The voucher system gives families complete freedom to choose schools for their children: they can choose a free subsidized school, either municipal or private. Alternatively, they can choose a fee-paying private school if they can afford the tuition fees. In 1998, the monthly voucher per student was about forty five dollars.

In a traditional voucher system the government makes payments directly to families to enable them to choose which public or private schools their children attend. In the Chilean system, the government subsidizes the school chosen by parents in direct proportion to the size of enrollment. Specifically, the government pays each school one school subsidy unit (SSU) for every child attending classes there. In other words, the size of the subsidy paid per student is the same for both the municipal and subsidized private schools.[3]

Thus the school dependency (privately paid, voucher or public) is a choice variable, which may be correlated with resources at home, location, poverty at community level, community size, etc. In addition, many private schools perform admission tests, where only the best students are accepted. These schools also select students on the basis of family characteristics, including parent's education, religion, and family income. However, voucher schools cannot select students in that way. The only constraint for voucher schools is the number of students per class, which may not exceed 45.

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[1] The total number of municipalities in Chile is 326. The number of community encompassed in this data set is 298.
[2] Between 1981 and 1996, enrollment in private voucher schools expanded from 15% to around 33% of the total; most of these gains at the expense of public schools enrollments.

2.1 The Chilean Educational System and Access to Higher Education

The Chilean educational system is divided into three levels. Primary education is mandatory and consists of eight years of schooling. Secondary education covers four or five years of schooling for humanistic and technical (vocational) schools respectively. The technical schools are designed for students who want to achieve a technical diploma in accounting, secretarial work, mechanics, etc. The curriculum for the first two years of a technical school is equivalent to that of the humanistic schools, but for the last three years mostly covers a technical curriculum. Tertiary education is composed of education in Technical Formation Centers (TFC), Professional Institutes (PI) and both public and private universities.[4] Upon finishing secondary education students decide to continue studying or enter the labor force. However, most job offers and educational institutions require the PAA score.

The Academic Aptitude Test is divided into two groups of tests: aptitude (PAA) and knowledge (PCE). The aptitude test (PAA) is primarily oriented towards identifying innate skills of students. Therefore, they are assumed to be relatively stable over time. This test follows the structure of the Scholastic Aptitude Test (SAT). On the other hand, the Knowledge test identifies the knowledge acquired by students in secondary schools. The results in both examinations are presented in standardized terms, with a score fluctuating between 0-850 points. The PAA is divided into two tests: mathematics and reading. These tests are mandatory for any application to higher education. The Knowledge tests are divided into Biology, Physics, Mathematics, Social Sciences, and Chemistry.

[4] Public universities are not free in Chile. The annual tuition varies depending on the major in which the students are enrolled. For example, Economics costs about 3,000 dollars per year. However, low-income students may apply for public loans, which cover the tuition as a function of the family income. This loan has to be repaid to the university after graduation.

Students pursuing a university career need to undergo this examination process. The number of tests they need to take is a function of the field of study to which they want to apply.[5] For example, aspiring Economics students must take the PAA in mathematics and reading. In addition, they also need to take the PCE in mathematics. The PAA system provides a ranking of students, which affects their access to higher education. In the test a correct answer is assigned one point towards the final score, while a wrong answer subtracts 0.25 from the score. This procedure generates a "corrected score". By using the corrected score, the average and standard deviation is calculated for each test. The average of the corrected score is set at 500 points, then the scores are adjusted to a normal distribution with a standard deviation equal to 100 points.

In Chile, only 15 percent of university students come from the poorest 40 percent of families. The selective university entrance process can largely explain this situation. Of the students taking the examination, only 40 percent end up being admitted, only 25 percent are accepted in "traditional" universities, and just 5 percent are accepted by the country's two most prestigious universities: Universidad de Chile and Universidad Católica. Finally, this percentage is reduced significantly if we consider access to the majors having the highest demand, such as Medicine, Economics, Engineering, Law, Psychology and Architecture. [6] In 1998, 178,526 students were in the fourth year of secondary education, and as such were eligible to take the exam. From this group about 80% actually did so.

Access to higher education has a significant effect on earnings. Bravo et. al. (1999) using data for the last 40 years in Chile shows that the return to schooling varying significantly by educational level. In particular, the evidence indicates that the return to schooling in Chile not only follows a convex pattern, but also the convexity has been increasing over time. In 1960 the return for an additional year in primary education was equivalent to 7%, the return to secondary and tertiary

[5] For some majors additional tests are required.

education were 10 and 13 percent respectively. In 1998, these returns are 7%, 10% and 21% for primary, secondary and tertiary education respectively. Therefore, by accessing higher education, in which a good performance in the PAA test is required, individuals will enjoy significantly higher earnings. For individuals from poor families, access to higher education means greater earnings and upward social mobility.

2.2 Empirical Evidence and Methodological Issues

2.2.1 Empirical Evidence

A study of the voucher system and the educational achievement on the PAA could be undertaken from several perspectives. The traditional "production function" approach is to analyze the relationship between inputs and outputs of the educational process. Most production function studies explain test scores as the output of school inputs, home and individual inputs. Within this context, controlling for other characteristics, a dummy variable identifying private establishments would measure the gap between private and public education.

Previous studies using OLS evidence indicate attending a voucher school in primary education does increase educational achievement, but that the impact is relatively small. This type of evidence has been used to argue that parental schooling and attendance in a private school are the most important factors in accessing better education. Others have used this evidence against the voucher system arguing no impact of private provider on school performance. This argument is questionable for at least two reasons. First, the actual evidence is not robust in the sense that only OLS estimates have been provided, which are biased due to endogeneity of school choice. Second, even though the outcomes associated with private and public school providers were similar, they could be explained by the competitive pressure of the private schools forcing the public schools to be equally efficient.

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[6] See Table 2. Admission figure were obtained from Ministry of Education

The literature on educational production functions contains a number of controversial results, and at the present time there is a continuing debate on this topic fueled by new studies. The controversial aspects of these results are reviewed in Hanushek (1986, 1996). Hanushek concludes that available studies, which estimate production functions, do not find inputs such as the teacher/student ratio, teacher's education, experience and salary, and expenditure per student on education have a significant effect on test scores.

Additional discussion on these results can be found in Hedges, Laine and Greenwald (1994) and Hedges and Greenwald (1996), where the previous conclusions are questioned. Card and Krueger (1992, 1996) evaluate the effect of the available resources in schools on student performance in the labor market. This study finds a significant effect between the cost and quality of the inputs on earnings in the labor market. This study has been scrutinized by other authors (mainly Heckman, Layne-Farrar and Todd (1996)). For this reason, it is still premature to suggest a general conclusion on this topic.

The traditional estimates of the private/public school gap in test scores (for example, Chubb and Moe (1990)) have the additional problem of selection bias, besides the bias of omitted input variables. The school type (private, public or voucher) is a choice variable, which may depend on family resources and the availability of such schools (restrictions). Therefore, estimating a model without considering the endogeneity of school choice would bias the estimates.

There are various econometric studies on Chile that summarize evidence on the public-private educational gap in primary education (Rodriguez, 1988; Aedo and Larranaga, 1994; Bravo, Contreras and Sanhueza, 1999). These studies rely on the average standardized test scores as the dependent variable. Among many independent variables, a dummy variable is included, which indicates the school category: privately paid, voucher, or public. All the studies mentioned earlier are based on

data on primary education at school level. In other words, there is no information available at the individual level, but only school averages. Based on OLS estimates these studies do not find significant differences in achievement between public and voucher schools.

The most recent evidence on this topic is in Mizala and Romaguera (JHR, 2000). This paper follows the empirical strategy outlined above. The school average test score in primary education is correlated with a vector of average family, school and individual characteristics. They use all the information at the school level in the 1996 SIMCE (more than five thousand schools). They add information on the health status of children from JUNAEB (the institution in charge of administering governmental school-food programs). The group of control variables includes a measure of the socioeconomic level, a vulnerability index of the school, a geographical index, experience of the teacher, the student/ teacher ratio, etc. The dependent variable is defined as the average test score in the Mathematics and Reading tests. The main conclusion of this study is that the initial difference in the average scores between schools of different types, of almost 5 points in favor of the private subsidized schools, disappears when socioeconomic characteristics are added into the regression. In addition, the sign is reversed, indicating a difference in favor of the municipal schools after controls are included.

This paper and the others mentioned above have serious limitations. First, the reports are based on school averages; therefore there is a significant fraction of variation, which is missing from the analysis. In addition, the results are presented for the average score in mathematics and reading; no gender-stratified analysis is performed. Second, many of the explanatory variables are jointly determined choices at the family or school levels, and no attempt is made to examine and solve these problems. Finally, the main result is based on an estimated parameter of the school type, which is a choice variable and therefore OLS estimates are not appropriate.

2.2.2 Methodological Issues

This paper determines the impact on students' scores in the PAA of having attended different types of schools (privately paid, voucher or public). It draws on data at the level of the individual, available for students graduating from secondary education and applying for entrance to higher education (a point of inflexion for future earnings). Before proceeding, however, it is important to notice two potential sources of bias on student scores. First, the type of school (privately paid, voucher, or public) is an endogenous choice variable, which may be correlated with resources at home, location, restrictions, etc. The methodology used in this paper compares OLS and Two Stage Least Squares (TSLS) results, which account endogenously for the school type parents choose to send their children.

Another selection problem arises from the fact that not all graduated students take the PAA test, and not all members of a birth cohort complete secondary school to qualify for the test. In order to solve these problems, different models and samples would be required.

The TSLS model is implemented as follows. In the first stage a Multinomial Logit (ML) is estimated to predict the probability of choosing a private or a voucher school (public schools are used as the reference case). The model hypothesizes that the school choice is a function of resources at home and the actual availability of alternative types of schools in the area. Household resources are assumed to be a function of parental educational attainment. School availability is defined as two dummy variables, which identify whether at community level a private or a voucher school is operating. These last variables allow us to identify the school choice model given that availability is correlated with school choice, but not correlated with students' ability or family unobserved variables. Thus, school choice is influenced by local school supply (proxied by school availability), but that school availability at the community level does not influence individual achievement.

Nevertheless, the proposed instruments are not wholly free of problems. Migration makes the instruments correlated with parent preferences for quality schools and thus makes them correlated with the error in the test achievement equation which could invalidate the instruments, making the school choice estimates biased. Similarly, private or voucher schools may be inclined to locate in larger or richer communities. Then, availability may partially reflect unobserved characteristics of families or communities. Thus availability cannot properly be excluded from the achievement regressions. The impact of this potential problem is examined below.

Thus the TSLS estimates are based on school supply-side innovations. In the first stage, the school choice variable (dependent variable) is defined for student attending private, voucher and public schools. The public school is taken as a reference. The explanatory variables are age, parental education and the supply instruments, mainly availability. In the second stage two specifications are estimated. In specification A, the individual achievement is explained by age, age squared, parental education and the predicted probabilities obtained from the ML model (first stage). This specification uses the availability of the private and voucher school to provide identification for the predicted attending school variables. This is then the identification which we are confident of if the location of those private and voucher schools across regions were uncorrelated with unobserved characteristics of the communities and hence students which would influence their test scores, or in the extreme case a random treatment of a program design.[7] In sum, the A estimates would be fine if private and voucher schools were randomly allocated across regions. However, it is expected that private schools would establish themselves first in larger population communities, and probably in higher density ones to reduce commuting costs, and of course in communities with higher income which are more likely to be willing to pay the private tuitions for possibly better schools. But these same variables are also

likely to influence student scores due to unobserved characteristics of the communities and families and children. Therefore, specification B recognizes these three characteristics (density, total population and average income) of the communities might influence scores and school locations.

The ML is estimated separately for males and females. From this estimation fitted valued are obtained for the probability of attending private and voucher schools.

Thus, the ML model is defined as:

[1] $$\Pr ob(Y = j) = \frac{e^{b_j' x_i}}{1 + \sum_{k=1}^{j} e^{b_k' x_i}}$$ for j = 1 (private) and 2 (voucher)

for j = 3 (public)

$$\Pr ob(Y = 3) = \frac{1}{1 + \sum_{k=1}^{j} e^{b_k' x_i}}$$

Then, fitted probabilities are obtained: $\hat{P}_p$, $\hat{P}_v$

In the second stage, the dependent variable is the performance in the PAA test of individual i in community j. The right-hand side endogenous variables are replaced by their fitted probabilities. In addition, individual age, parental education (S_f , Sm represent schooling of father and mother respectively) and community characteristics are included as others explanatory variables. The TSLS model is run for males and females[8]:

[2A] Specification A:

$$PAA_i^j = a_0 + a_1 Age + a_2 Age^2 + a_3 S_f + a_4 S_m + a_5 \hat{P}p + a_6 \hat{P}v + m_i$$

[7] For a discussion on the impact of a voucher system using experimental data see Angrist et.al. (2000).

[8] For a detailed discussion on the properties of the TSLS estimator see Hamilton (1994). Chapter 9, Section 9.2 Instrumental

[2B] Specification B:

$$PAA_i^j = a_0 + a_1 Age + a_2 Age^2 + a_3 S_f + a_4 S_m + a_5 \hat{P}p + a_6 \hat{P}v + a_7 D + a_8 CTP + a_9 CAPI + m_i$$

where:

D: Density in community j, defined as total population divided by kilometers square.

CTP: Community total population

CAPI: Community average per capita income

3. Data

The study uses the Academic Aptitude Test (PAA) database for 1998. Table 1 presents the number of students taking the exams between 1994-1998. In 1994 136,712 students were enrolled to take the PAA exam, this figure increased to 142,382 in 1998. On average these numbers represent about 78% of the students who graduated from secondary education. Although this percentage is relatively representative of the total population, it varies significantly across regions, fluctuating between 58-85%.

Table 1A presents the coverage of population in primary and secondary education from a long-term perspective. In 1970 nearly 50% of the population eligible to attend secondary education was actually attending. In contrast, this percentage is about 90% for primary education. These figures reach 96% and 82% in 1998, for primary and secondary education, respectively.

Table 2 presents the population distribution for 1998. The first column describes the region from north to south, the second column presents the total population in each region. Regions 5, 8 and the Metropolitan region (MR) are the ones with higher concentration of population. The third

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variables and Two-Stage Least Squares.

column describes the population in the age range, which is equivalent to attending secondary education (potential population attending secondary education). Column 4 presents the actual enrollment in the fourth year of secondary education. The next columns describe the number of people eligible to take the PAA test. Finally, columns 6 and 7 present the students enrolled in the PAA test and its percentage with respect to those eligible.

Table 3 gives some basic descriptive information on the sample. The students come from families where parents have mostly secondary education. About 23 percent of the applicants reported that their father has completed at least primary education, while over 40 percent indicated that their father has completed at least secondary education. Finally, students whose fathers have some degree of university education represent about 34%. A similar pattern is shown for students" mothers.

In 1998, from the students enrolled in the PAA test 21% come from private schools, 45% from public and 35% from voucher schools. However, family school choice is gender bias: while a 22% of males attend private schools, only a 19% of females attend this type of schools. Seventy six percent of the students attend co-educational secondary schools. In contrast, only 10% attended male schools and 15% only females' schools. Finally, 75% of the applicants choose a humanistic school and 90% of these individuals reported a daily class schedule.

Tables 4 and 5 present statistics on the average score by gender and school types, respectively. In Table 4, males systematically score higher on the test than females, but they obtain lower grades during secondary school. This pattern is consistent for the whole set of characteristics. Table 5 presents the average scores by type of schools and for the PAA in mathematics and reading. Private school performs better than voucher and public schools. A positive correlation is also observed between average test score and parent's education. This effect is even greater when both

parents have higher education. For each PAA test and type of school, males obtain better scores than females.

Figure 1 presents the score distribution by school type. Private schools show a better performance in both mathematics and reading, while voucher and public schools exhibit a similar distribution. Without further analysis this data would suggest that voucher schools perform more akin to public than to private schools.

4. Results

Table 6 shows the ML estimates for school choice for males and females.[9] The dependent variable is defined as a dummy for the choice of a private school and a voucher school. Public schools are taken as a reference. Individual age and its square are included as explanatory variables. In addition, a proxy for family resources is included in the form of parental education and access to various types of schools is instrumentalized using a dummy variable, which indicates whether the school type is available at the community level. For each choice variable, i.e., attending a private or a voucher school, two dummy variables are used indicating whether in such community a private and a voucher school is available. These last variables are the key to identifying the econometric model in the first stage. In addition, the TSLS estimates are jointly estimated with the first stage. Then, recognizing that the endogenous explanatory variables for school choice are not actual variables but the predicted values with less variability, the standard errors were corrected for clustering at the community level.[10] The table presents marginal effects, rather than coefficients. Therefore, I assume

[9] For both, PAA mathematics and reading under different specifications, the evidence suggests males and females perform differently in the PAA tests. Consequently, the econometric specifications will be presented separately by gender.

[10] Essentially the degrees of freedom are given by the number of school districts. The same cluster adjustment is performed in the second stage.

that school choice is influenced by local school supply (proxied by school availability), but that school availability does not influence achievement.

The positive coefficient on availability accords with expectation – that increasing availability of a given school type in a municipality increases the probability that it is chosen, all else equal. The results in Table 6 indicate a positive correlation between the parental education and choosing a private school. The cross effects of the supply of private schools on voucher school choice and the cross effect of the voucher school supply effect on private school choice have the expected negative sign (which may be interpreted as effect of competition in the educational system), though not generally statistically significant. As expected, the availability of a private (voucher) school increases the probability of attending a private (voucher) institution.

The evidence also shows a positive correlation between parental education and choosing a voucher school, however, in comparison to private schools, these effects are smaller. On the other hand, the effect of this availability of voucher schools exhibits a positive and significant impact on the probability of attending a voucher school.

The Multinomial Logit estimates provide the expected probabilities of attending private and voucher schools, which are used as explanatory variables in the second stage.

As noted before, the instruments are expected to be correlated with school choice, but be uncorrelated with the error term in the equation for test score. Table 7 presents an auxiliary regression at the community level, which sheds light on this hypothesis. The dependent variables are the school supply instruments (i.e. availability of a private and voucher school) and the explanatory variables are the child's age, parental education, and other individual and family characteristics. The estimated model is Probit, and the marginal effects are reported in table 7. The community income, density, and size variables are also included in alternative specifications. The only variable in the test

equation that is correlated with the school supply instruments, is the mother's secondary and tertiary schooling in the full sample of 287 communities. However, when community characteristics are included, the sample is reduced to 181 communities. These characteristics are obtained from a different data set (CASEN, 1998) where information was available only for this reduced sample.

Table 8 presents the OLS and TSLS for the performance in the PAA test score. The dependent variable is defined as the score in Mathematics and Reading. Among the explanatory variables I included age of the student, parental education and the school choice. This table summarizes the estimates divided by gender and type of test. For each test (mathematics and reading) the first model presents the OLS estimates for males and females including only individual and family characteristics. The second specification shows the OLS model when school choice variables are included. Then, the TSLS model is presented. In specification A, school availability, individual age and parental education are included, and in specification B density, average per capita income and total population in the community are added to the regression.[11]

The OLS estimates indicate that after controlling for individual, family and school characteristics, attending a private school increases the PAA score in mathematics by 54 for males and 66 points for females. The impact of attending a voucher school is about 12 and 13 additional points for males and females. Moreover, the PAA reading results are similar. By attending a private school, males obtain 49 additional points, while females obtain 60 more points. The magnitude is reduced for voucher schools. Indeed, males and females obtain an additional 12 and 18 more points than students attending public schools. However, for males these effects are not statistically significant from public schools. These results are similar to the ones reported in the existing literature.

However, a direct interpretation of the OLS results may be misleading because the type of school is a choice variable, in which case they are biased. The sign of the bias depends on the selection process operating through the educational system. If we believe that more educated and/or richer parents select the best schools for their children, then after controlling for the endogeneity of the school choice the TSLS estimates should be lower. In other words, the OLS estimates are biased upwards.

On the contrary, as it was suggested by Card (2001), Kling (2000) and Carneiro, Heckman and Vytlacil (2001), the institutional features of the educational system such as the availability of different types of school as the instrument to identify the school choice decision would have a different effect on specific population groups.[12] In that case, the TSLS estimator based on school availability as an instrument is more likely to affect the schooling choices of poorer individuals, who would otherwise choose only public schools. In other words, in the hypothetical case where all the children in public schools were moved to private and voucher schools, then we would expect that these children would score relatively higher than the children already enrolled in private and voucher institutions (diminishing return to score). Thus, after correcting for endogeneity the estimated impact of private and voucher schools should increase. By using supply-side features to instrument schooling choices the TSLS estimates should be larger than the corresponding OLS estimates.[13] In other words, if the marginal benefit of attending a private or a voucher school were higher for the lowest

[11] The previous results remain when we add regional dummies to control for geographical heterogeneity, suggesting that effects between and within regions are similar in their effect on test scores.

[12] For instance Card (1995b) speculates that the effect of college proximity is more important for children of less wealthy households.

[13] As mentioned in Kling (2000), these estimates represent the average marginal benefit from an additional student enrolled in a private/voucher school for the subgroup affected by school availability instrument. For additional discussion see Imbens and Angrist (1994) and Angrist and Imbens (1995)

background fraction of the population (students previously attending public schools) this second hypothesis would be consistent with the finding of larger TSLS than OLS estimates.[14]

The policy conclusions are different. In the first hypothesis, a matching between good schools and good students occurs, which operates through the parental decision. In that case, the voucher system would not be a valid explanation for the improvement in the quality of the student achievement. In the second hypothesis, the voucher schools would be making a significant contribution to increase the access of poorer students (a fraction in the population) who without this type of schools would have a lower score and less opportunities to enter tertiary schooling.

The TSLS results presented in Table 8 are striking. While the OLS estimates predict that voucher schools contribute to an increase in the PAA score of 12-18 points, these figures increase significantly when TSLS is used. The TSLS column A estimates use the availability of the private and voucher school to provide identification for the predicted attending school variables. This is then the identification which assumes the location of those private and voucher schools across regions is uncorrelated with unobserved characteristics of the communities and hence unobserved students' abilities which would influence their test scores. In other words, the results in column A represent the extreme case of where the schools were randomly assigned to regions. However, private schools are likely to establish themselves first in larger population communities, and probably in higher density ones to reduce commuting costs, and of course in communities with higher income which are more likely to be willing to pay the private tuitions for possibly better schools. But these same variables are also likely to influence student scores due to unobserved characteristics of the communities and families and children. Hence, specification B recognizes these three characteristics of the communities might influence scores and school locations. Specification B leads to a substantial

[14] See Card (2001) for a summary in the literature supporting such findings.

reduction in the magnitude of the estimated school type effects in comparison to specification A. In addition, the Durbin-Wu-Hausman test – at the bottom of specification B – supports the assumption that the school attending variables are not exogenous in model B.[15] Therefore the TSLS specification B presents the preferred estimates of the school treatment effects.

The impact of the TSLS estimates decreases – especially for females – when the community characteristics are included in specification B, but they are still substantially larger than the OLS and statistically significant. In mathematics while males attending voucher schools would obtain 49 additional points than in public schools, females in voucher school would obtain 32 additional points than in public schools. On the other hand, in reading we still observe a significant positive impact of voucher schools, males score 63 additional points, while females obtain 55 more points than in public schools. Therefore, using different specifications we find that students enrolled in voucher schools perform substantially better than in public ones. The evidence also indicates that such effects are lower for females.

At the same time, parental contribution to PAA score is reduced significantly when instruments are used. In particular, the most important contribution to the OLS estimates is given by parental higher education. For example, for males taking the mathematics test, such a contribution is reduced from 55 and 39 for father and from 50 to 34 for mother. Therefore, parents' contribution is reduced significantly with respect to the OLS estimates. A similar pattern is observed for females and for the PAA reading test. Thus, while previous OLS estimates of the impact of parental education were overestimated, the impact of school choice variables was underestimated. Finally, when

[15] This test involves adding to model B the residuals from the estimated model predicting attending by school types to the score second stage equations. When the estimated coefficient on these residuals are statistically significantly different from zero, it implies that the OLS and IV estimates differ and therefore attending school is not exogenous but endogenous. For details, see Davidson, R. and J. G. MacKinnon (1993).

different samples are used (regions with higher enrollment, students attending humanistic and daily schools) the TSLS estimates do not change substantially.

5. Summary and Conclusions

The voucher system assumes that competition generated between schools will improve the quality of education. The evidence obtained by using OLS estimates indicates that attending a voucher school is associated with higher standardized scores, but the impact is relatively small. This finding has been reported on several occasions, but using only school level information and averages of family characteristics.

This paper uses a supply-side instrument to model school choice. In particular, the instrument is defined as the availability of different types of schools in a locality. The paper presents evidence on the impact of individual, family and school characteristics on test scores in nationwide university entrance examinations in Chile. Different specifications and empirical strategies are employed to determine the robustness of the results.

Traditional analyses based on OLS find that voucher schools are only somewhat better than public schools, well below the performance of private schools. However, when TSLS models are estimated in order to control for school choice, the impact of attending a voucher school versus public increases substantially (at least doubling the OLS estimated impact). The evidence suggests that voucher schools have their biggest impact on males. Corresponding to the increased impact of voucher schools on students' achievement scores, our results suggest that previous estimates of the impact of parents' education on test scores have been considerably overestimated.

Thus, by using school availability to instrument schooling choices, TSLS estimates of voucher school effects on test scores exceed the corresponding OLS estimates. These TSLS estimates

represent the average marginal benefit from an additional student enrolled in a private/voucher school for the subgroup affected by school availability instrument. In other words, if the marginal benefit of attending a private or a voucher school were higher for the lowest background fraction of the population (student currently attending public schools) this would be consistent with the larger estimates (with respect to the OLS estimates) using supply availability as an instrument.

My results suggest that policy makers should support a voucher system and increase its availability. The voucher system is a mechanism that increases scholastic achievement, as measured by the university entrance examinations. Increases in these test scores will thus provide students with greater access to higher education, and thus future social mobility.

Finally, while female students are more likely to obtain better grades than males during high school, their PAA test scores are significantly lower. The selection of students going to private schools favors males. Thus the family choice of sending children to private schools is gender biased, but girls go more often to the voucher schools. However, the TSLS estimates show that girls gain less than boys from going to these schools. These outcomes suggest that the educational gender gap may be widening as a consequence in Chile.

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Table 1: Number of students enrolled in the PAA and Percentage from graduated from secondary education

Year	Enrolled PAA 1	Graduated High School 2	Graduated and Enrolled same Year 3	Percent (4) = (3
1994	136,712	115,943	89,411	
1995	131,297	111,567	85,483	
1996	125,995	104,676	83,749	
1997	140,020	119,844	97,387	
1998	142,382	128,243	97,935	

Table 1A: Population in Primary and Secondary Education
(percentages)

Year	Primary %	Secondary %
1970	93.30	49.73
1982	95.27	65.01
1992	98.18	79.94
1993	94.45	75.06
1994	93.29	79.72
1995	95.71	79.26
1996	96.05	82.34
1997	96.26	82.45
1998	96.06	81.77

Notes:
For years 1970, 1982 and 1992 census population
For 1993-1998 the figures are calculated in basis on projected population prepared by INE, in basis of Census of 1992.

Table 2: Population and enrrollement by regions, 1998.

Region	Total population (1) (1)	Population 14-17 Sec. Education (1) (2)	Enrolled in fourth year High School (2) (3)	Eligible to take PAA (2) (4)	Enrolled in PAA graduated 1997 (3) (5)	% Enrolled in PAA graduated 1997 (6) = (4 / 3)
1	375,705	25,371	4,268	3,970	2,376	59.8
2	441,821	21,863	4,702	4,365		79.9
3	255,934	11,748	2,471	2,281	1,898	83.2
4	549,337	27,622	5,549	5,199	3,693	71.0
5	1,506,257	77,539	15,062	14,128	11,406	80.7
6	757,687	34,196	7,064	6,666	4,846	72.7
7	884,028	40,650	8,130	7,573	4,367	57.7
8	1,880,469	92,831	16,982	15,822	11,038	69.8
9	832,348	39,271	7,563	7,061	4,597	65.1
10	1,019,490	41,404	8,080	7,501	4,741	63.2
11	85,573	4,836	774	724	535	73.9
12	145,978	7,581	1,536	1,493	992	66.4
MR	5,888,642	289,577	54,436	51,458	43,958	85.4
Country	14,623,269	714,489	136,617	128,241	97,937	76.4

Notes:

(1) National Characterization Survey, CASEN 1998

(2) Ministry of Education.

(3) Developed by the author in basis of information DEMRE.

(4) Defined as (4)/(3)

Table 3: Descriptive Statistics, 1998						
	Total		Males		Females	
Variables	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
a. Individual Characteristics						
Age	19.04	3.10	19.07	2.94	18.88	3.08
Grades (1)	501	136.3	494	121.5	524	121.6
b. Family Characteristics (2)						
Father Primary Education=1	0.23	0.42	0.20	0.40	0.24	0.43
Father Secondary Education=1	0.43	0.50	0.44	0.50	0.43	0.50
Father Superior Education=1	0.34	0.47	0.35	0.48	0.33	0.47
Mother Primary Education=1	0.25	0.43	0.23	0.42	0.26	0.44
Mother Secondary Education=1	0.48	0.50	0.50	0.50	0.48	0.50
Mother Superior Education=1	0.26	0.44	0.27	0.45	0.26	0.44
c. School Characteristics						
Private=1	0.21	0.40	0.22	0.42	0.19	0.39
Municipal=1	0.45	0.50	0.44	0.50	0.45	0.50
Voucher=1	0.35	0.48	0.34	0.47	0.36	0.48
Male School=1	0.09	0.29	0.20	0.40	0.00	0.00
Female School=1	0.15	0.36	0.00	0.00	0.28	0.45
Both Sexes=1	0.76	0.43	0.80	0.40	0.72	0.45
Humanistic=1	0.75	0.43	0.73	0.44	0.78	0.41
Daily Schedule=1	0.90	0.30	0.89	0.31	0.92	0.28
Region=1	0.03	0.16	0.03	0.17	0.03	0.16
Region=2	0.04	0.19	0.04	0.19	0.04	0.19
Region=3	0.02	0.13	0.02	0.14	0.02	0.13
Region=4	0.04	0.19	0.04	0.19	0.04	0.19
Region=5	0.12	0.32	0.12	0.32	0.12	0.32
Region=6	0.05	0.21	0.05	0.21	0.05	0.21
Region=7	0.05	0.21	0.05	0.21	0.05	0.22
Region=8	0.12	0.33	0.12	0.32	0.13	0.33
Region=9	0.04	0.21	0.04	0.20	0.05	0.21
Region=10	0.05	0.21	0.05	0.21	0.05	0.21
Region=11	0.01	0.07	0.01	0.07	0.01	0.07
Region=12	0.01	0.11	0.01	0.11	0.01	0.10
Region=13	0.44	0.50	0.44	0.50	0.43	0.50
N° of Observations	**142,382**		**66,910**		**75,472**	

Notes:

(1) Standardized grades from secondary education

(2) In each parents educational category incomplete level is included

Table 4: Descriptive Statistics - Averages Scores by Gender (1998)

	PAA Mathematics		PAA Reading	
Variables	**Male**	**Female**	**Male**	**Female**
Father primary Education=1	470	439	465	442
Father sec. Education=1	501	472	500	484
Father sup. Education=1	573	543	570	557
Mother primary Education=1	472	439	467	442
Mother sec. Education=1	507	478	506	490
Mother sup. Education=1	578	549	576	564
Father/Mother Sup. Education	596	565	591	579
Private=1	584	564	579	573
Municipal=1	492	458	490	467
Voucher=1	509	478	508	492
Male school=1	571	480	566	496
Female school=1	544	510	560	521
Both sexes=1	505	476	504	486
Region 1=1	497	469	501	485
Region 2=1	505	475	493	476
Region 3=1	495	469	479	470
Region 4=1	500	468	496	472
Region 5=1	512	479	514	491
Region 6=1	508	476	500	481
Region 7=1	519	489	503	491
Region 8=1	520	487	507	489
Region 9=1	501	465	499	476
Region 10=1	506	475	505	483
Region 11=1	502	471	504	490
Region 12=1	530	497	527	505
Region 13=1	528	495	532	511
TOTAL	518	486	516	496

Table 5: Descriptive Statistics - Averages Scores by type of Schools (1998)

	PAA Mathematics			PAA Reading		
Variables	**Municipal**	**Private**	**Voucher**	**Municipal**	**Private**	**Voucher**
Male	492	584	509	490	579	508
Female	458	564	478	467	573	492
Father primary Education=1	445	492	460	441	503	464
Father sec. Education=1	475	529	486	480	533	493
Father sup. Education=1	516	600	535	526	600	544
Mother primary Education=1	446	483	461	443	493	465
Mother sec. Education=1	478	542	489	484	544	497
Mother sup. Education=1	519	604	539	532	605	549
Father/Mother Sup. Education	534	612	552	547	611	561
Male school=1	560	623	535	558	617	529
Female school=1	497	606	488	509	609	501
Both sexes=1	458	562	487	461	565	495
Region 1=1	456	517	502	466	533	508
Region 2=1	458	543	525	450	539	525
Region 3=1	442	598	525	439	583	513
Region 4=1	451	600	513	451	582	517
Region 5=1	454	560	495	461	566	502
Region 6=1	456	584	490	457	576	488
Region 7=1	481	565	513	473	554	511
Region 8=1	475	582	512	471	568	511
Region 9=1	457	582	492	463	587	496
Region 10=1	465	565	505	470	566	505
Region 11=1	442	509	532	455	518	540
Region 12=1	491	561	521	492	561	527
Region 13=1	494	582	479	505	587	492
TOTAL	474	574	492	478	576	499

Table 6: First Stage, Multinomial Logit

	Marginal Effects	
	Males	**Females**
Probability of Attending a Private School		
Age	0.0005	0.0004
	0.38	0.49
Age square	-0.0003	-0.0004
	-0.17	-0.42
Father secondary education=1	0.0068	0.0051
	5.29	5.85
Father superior education=1	0.0288	0.0239
	5.41	5.13
Mother secondary education=1	0.0099	0.0071
	5.63	5.80
Mother superior education=1	0.0361	0.0287
	5.32	5.46
Dummy Private School available	**0.2508**	**0.2062**
	12.69	10.38
Dummy Voucher School available	**-0.0111**	**-0.0141**
	-0.76	-0.95
Probability of Attending a Voucher School		
Age	-0.3285	-0.0283
	-3.78	-4.55
Age square	0.0404	0.0329
	3.46	3.40
Father secondary education=1	0.0019	0.0153
	0.15	1.49
Father superior education=1	0.0200	0.0366
	0.88	1.43
Mother secondary education=1	0.0259	0.0415
	2.63	3.90
Mother superior education=1	0.0411	0.0676
	1.77	2.72
Dummy Private School available	**-0.0648**	**-0.0142**
	-1.79	-1.18
Dummy Voucher School available	**0.4651**	**0.4782**
	19.38	16.13
Observations	56,395	63,055
Robust z-statistics below marginal effects		
Public schools is the comparison group		

Table 7: Availability of schools type by community. Marginal effects.

	Dependent variable: availabilty of private school at community						Dependent variable: availabilty of voucher school at community					
Individual characteristics												
Age	0.216	1.322	1.316	2.46	2.167	2.171	0.887	1.123	1.108	0.036	0.043	0.042
	[1.1]	[1.7]	[1.7]	[2.2]	[1.9]	[2.0]	[2.1]	[2.1]	[2.2]	[1.6]	[1.6]	[1.7]
Age square	-0.628	-2.911	-2.902	-5.738	-5.136	-5.097	-1.929	-2.285	-2.255	-0.075	-0.091	-0.09
	[1.6]	[1.8]	[1.8]	[2.4]	[2.1]	[2.2]	[2.2]	[2.1]	[2.2]	[1.7]	[1.7]	[1.8]
Paretal education												
Father sec. Education=1	0.41	-0.031	-0.016	-1.433	-1.158	-1.161	0.501	0.874	0.902	0.028	0.034	0.032
	[2.2]	[0.0]	[0.0]	[1.6]	[1.2]	[1.2]	[1.2]	[1.9]	[1.8]	[1.2]	[1.2]	[1.2]
Father sup. Education=1	-0.038	-0.5	-0.448	-0.812	-0.72	-0.998	-0.245	-0.422	-0.414	-0.012	-0.015	-0.015
	[0.1]	[0.4]	[0.4]	[0.7]	[0.6]	[0.9]	[0.5]	[0.6]	[0.6]	[0.5]	[0.5]	[0.5]
Mother sec. Education=1	0.482	1.452	1.381	1.521	1.456	1.729	1.354	0.571	0.561	0.024	0.03	0.029
	[2.2]	[1.6]	[1.7]	[1.7]	[1.6]	[1.7]	[3.2]	[1.1]	[1.1]	[1.0]	[1.0]	[1.1]
Mother sup. Education=1	1.013	4.363	4.322	5.107	4.717	4.969	1.271	1.201	1.109	-0.003	-0.004	0.001
	[3.2]	[3.0]	[3.2]	[3.8]	[3.3]	[3.7]	[2.3]	[1.6]	[1.5]	[0.1]	[0.1]	[0.0]
Average Community characteristics												
Community total population				0.718	0.845	0.789				0.061	0.075	0.073
				[3.2]	[3.0]	[3.0]				[3.4]	[3.3]	[3.2]
Density					-2.696	-2.295					-0.103	-0.074
					[1.1]	[1.0]					[0.5]	[0.3]
Community average per capita income			0.034	0.077	0.124				0.016	0.001	0.001	
			[0.2]	[0.4]	[0.6]				[0.2]	[0.2]	[0.2]	
Observations	297	181	181	181	181	181	297	181	181	181	181	181
Robust z-statistics in brackets												

Table 8: Second Stage, OLS and TSLS estimates

	Mathematics								Reading							
	OLS				TSLS				OLS				TSLS			
	Male	Female	Male	Female	Male A	Male B	Female A	Female B	Male	Female	Male	Female	Male A	Male B	Female A	Female B
Individual characteristics																
Age	-0.80	-1.64	-0.94	-1.81	0.06	-0.44	-1.10	-1.56	6.81	4.85	6.74	4.88	8.40	7.57	6.24	5.33
	[0.5]	[1.7]	[0.4]	[1.4]	[0.0]	[0.2]	[1.1]	[1.5]	[4.9]	[5.2]	[4.1]	[4.2]	[5.8]	[4.7]	[6.4]	[5.2]
Age square	1.52	0.86	1.64	1.09	0.30	0.93	0.29	0.68	-6.50	-6.65	-6.46	-6.65	-8.61	-7.64	-8.20	-7.37
	[0.7]	[0.5]	[0.6]	[0.6]	[0.1]	[0.4]	[0.2]	[0.4]	[2.8]	[4.1]	[2.7]	[3.8]	[3.7]	[3.1]	[5.2]	[4.4]
Parental education																
Father sec. Education=1	18.17	18.64	15.84	16.05	11.17	10.52	12.44	12.18	21.98	25.32	19.84	22.77	14.62	12.86	17.49	16.27
	[11.5]	[12.6]	[8.3]	[8.4]	[7.3]	[7.1]	[9.5]	[9.6]	[13.1]	[14.8]	[11.5]	[11.2]	[8.3]	[7.0]	[11.4]	[11.7]
Father sup. Education=1	67.44	64.80	54.83	49.36	34.05	38.55	35.50	39.04	67.66	72.20	56.31	58.53	34.93	38.91	40.73	44.14
	[18.3]	[16.3]	[14.8]	[13.6]	[7.0]	[8.6]	[10.3]	[12.0]	[17.3]	[18.5]	[17.9]	[15.5]	[6.5]	[8.4]	[11.1]	[13.5]
Mother sec. Education=1	16.62	20.69	13.06	16.86	5.57	6.81	11.60	13.03	23.0	27.1	19.7	23.4	11.2	11.6	15.7	17.2
	[11.9]	[13.2]	[7.8]	[10.7]	[3.0]	[3.9]	[7.1]	[8.5]	[15.4]	[14.4]	[10.2]	[12.5]	[6.2]	[7.1]	[7.5]	[8.8]
Mother sup. Education=1	63.38	67.02	49.87	50.68	27.03	33.48	35.40	41.04	70.80	76.47	58.61	61.88	34.83	41.24	41.93	48.90
	[17.1]	[17.3]	[18.0]	[18.4]	[4.7]	[7.1]	[8.8]	[10.9]	[20.9]	[19.8]	[21.8]	[20.2]	[6.1]	[9.4]	[9.6]	[13.2]
School choice																
Attending a Private School=1			**54.10**	**65.64**							**49.28**	**59.58**				
			[3.2]	[5.7]							[3.2]	[5.2]				
Attending a Voucher School=1			**11.46**	**12.93**							**12.41**	**18.39**				
			[1.2]	[1.9]							[1.3]	[2.6]				
Predicted probabilities from first stage																
Probability of attending a private school					**155.62**	**91.18**	**131.75**	**66.65**					**159.85**	**88.80**	**148.20**	**76.19**
					[9.6]	[5.6]	[8.0]	[4.7]					[9.3]	[5.6]	[9.2]	[5.3]
Probability of attending a voucher school					**75.09**	**48.59**	**58.53**	**32.10**					**100.16**	**63.22**	**94.37**	**55.22**
					[6.7]	[3.3]	[6.8]	[2.9]					[7.3]	[3.6]	[7.9]	[3.5]
Community characteristics																
Density (total population /kms square)						-40.57		-126.68						71.89		-23.76
						[0.6]		[4.2]						[1.0]		[0.8]
Community total population						4.51		2.79						5.51		5.05
						[1.8]		[2.0]						[2.4]		[4.6]
Community average per capita income						12.16		14.35						12.07		13.19
						[14.6]		[18.0]						[14.7]		[18.2]
Constant	472.12	458.67	469.33	455.85	429.94	429.97	428.66	429.50	347.85	363.27	343.71	355.74	285.84	291.84	308.17	317.19
	[18.5]	[32.5]	[13.1]	[21.6]	[18.1]	[15.4]	[30.4]	[27.9]	[16.5]	[27.6]	[12.0]	[18.3]	[13.6]	[11.5]	[21.6]	[19.0]
Durbin-Wu-Hausman test																
F (2,180)						6.27		2.88						7.23		4.61
Prob > F						0.0023		0.0585						0.001		0.0103
Observations	56,395	63,055	56,395	63,055	56,395	54,267	63,055	60,328	56,395	63,055	56,395	63,055	56,395	54,267	63,055	60,328
R-squared	0.15	0.19	0.18	0.23	0.17	0.18	0.20	0.22	0.15	0.18	0.17	0.21	0.16	0.17	0.19	0.20
Robust t-statistics in brackets																
Public schools is the comparison group																

Figure 1: PAA Distribution, by type of test and school