UNOBSERVED HETEROGENEITY, SCHOOL CHOICE AND THE EFFECT OF VOUCHER SCHOOLS: EVIDENCE FROM CHILE *

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Abstract

In this paper we use a two-period panel at the individual level to estimate a sequential schooling choice model for the Chilean education system. Our empirical strategy assumes the existence of a source of unobserved heterogeneity which we interpret as a combination of student's inherent abilities (cognitive and non-cognitive). We use the estimated model to calculate three different treatment parameter to assess the causal effect of attending a private-voucher school: Average Treatment Effect, Treatment on the Treated, and Treatment on the Untreated. We find that private-voucher schools improve academic achievement with the magnitude of the effect varying across schooling decision paths, being low (1%-7% s.d.) yet statistically significant for the majority of students and high (23%-43%) for a small group of them. We also find that in general students in voucher schools are more able than students in public schools. However for a small group of individuals this sorting reverses.

1 Introduction

A very interesting and still open question in the education debate is whether the introduction of a private market and competition incentives can improve the efficiency and quality of public financed education. Proponents of this idea argue that public schools are inefficient local monopolies and that the profit-maximizing structure of privates leads to a more efficient education system, as well as competition incentives guarantee the existent of good providers on the supply side. On the other hand, supporters of the idea of a public education believe that improving the

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availability and quality of educational inputs such as teachers, computers, classrooms, etc., are the right policies to improve educational outcomes, over the introduction of a private market.

In the Chilean school system private providers coexist with the public sector. The actual system was established in early 1980's as one of several liberalizing reforms introduced by the government, and has remained basically the same until these days. It consists of a voucher subsidy perceived by providers, public or private, depending on enrollment. This ties schools' budget to the total number of students. Another characteristic of the Chilean school system is that families freely choose schools, no matter their type or location. The purposes are to increase parental choice, promote competition in the supply side, and allow low income children to attend private schools.

The enrollment composition in Chile has shown to be very dynamic since the establishment of the reforms. Table 1 shows the enrollment by type of schools across years. In 1981, 78% of students attended public schools, 15% attended privately run voucher schools, and the remaining 7% were enrolled in private fee paying and unsubsidized schools[1]. By 1990, students in public schools represented 54% of total enrollment, while the share of private voucher schools increased to 32%; private unsubsidized schools accounted for the remaining 8%. The enrollment in private voucher schools continued to increase at the same time public enrollment decreased. By 2008, public schools' share of enrollment was 44%, smaller than the 48% of private voucher schools, while private-fee-charging accounted for 7% of enrollment, same as in the beginning of the period. Thus, most of the increase of private voucher's enrollment was at the expenses of public schools. Hence, one could think that, if parents choose schools depending on academic achievement and are well informed, this picture of enrollment may suggest that private voucher schools have been constantly outperforming public administered schools through these years.

In this paper we assess the relative performance of private voucher schools compared to public ones. We use a new data set[2] containing detailed information on academic achievement and school decisions at the individual level. This novel data tracks students over time and allows us to construct a panel with individual schooling outcomes at different periods of time. However, we are forced to deal with the potential endogeneity associated with school decisions. We do so by estimating a school choice model with endogenous outcomes and unobserved heterogeneity (Heckman, Urzua and Vytlacil, 2006), which we interpret as a combination of different abilities. We use our estimated model to compute three different treatment effects, Average Treatment

[1]This type of schools serve the elite minority of the country. Fees charged to parents are on average three times the amount of the voucher subsidy.

[2]Contreras and Santos (2008), and Lara, Mizala and Repetto (2009) also made use of this data base in related studies.

Effect (ATE), Treatment on the Treated (TT), and Treatment on the Untreated (TUT), and measure the causal effect of attending a private voucher school. We find a positive and statistically significant effect, ranging from 3%-5% of test scores standard deviations for most of students to 43% s.d. for a small group of them.

The paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the Chilean school system. Section 4 introduces the econometric model and discusses its empirical implementation. Section 5 discusses the main findings. Section 6 concludes.

2 Literature Review

The unique characteristics of the Chilean school system along with the good quality of the available data have motivated several empirical studies since its establishment, and mostly in the last decade.

How parents decide between different schools and what are the school attributes they value the most are some of the questions researchers have already addressed in the literature. Gallego and Hernando (2009) find that there is a lot heterogeneity in preferences, because the valuation of most of school attributes depends on household characteristics, with the two most important dimensions being test scores and distance to school. Makovec, Mizala and Barrera (2010) find that parents valuing academic performance more than other attributes are more likely to enroll their children in public schools for their secondary education, while parents concerning more about peer's socioeconomic background and school values (e.g. religion) are more likely to enroll their children in private voucher schools.

Time series of standard measures of schools' relative performance have also been calculated (Mizala, Romaguera and Urquiola, 2006), suggesting that rankings of schools based on individual test scores are very similar to rankings based purely on students' socioeconomic status, and are very volatile from year to year, making the task of informing parents and policy makers harder than is commonly assumed. Mizala, Romaguera and Ostoic (2005) also study the relationship between socioeconomic status and academic achievement finding a positive relationship in the between-schools analysis and also a positive but not so strong relationship in the within-school one.

Schools' relative performance has also been documented for the Chilean education system. Studies at the school level find that private fee paying schools perform substantially better than private-voucher and public schools (Mizala and Romaguera, 2000), and also find very small

and sometimes not significance difference between the latter two (Mizala and Romaguera, 2000; Tokman, 2002). The evidence with data at the student level is mixed. Sapelli and Vial (2005) estimate large and significant positive treatment effects (ATE and TT ranging from 30% to 60% of standard deviations of test scores) for the treatment of attending a private-voucher school instead of a public one. On the other hand, using propensity score methods and a two-period panel[3], Contreras and Santos (2009), and Lara, Mizala and Repetto (2009) find small and sometimes not statistically significant differences in academic performance, favoring private voucher schools.

Hsieh and Urquiola (2006) test the performance of the entire system since the introduction of the reforms and across years, arguing that the greater degree of competition introduced by the voucher system should lead to an improvement in the aggregate academic outcomes. Their results show no evidence of such improvement, using test scores, failures rates and years of schooling as different measures of academic outcomes.

In this paper we assess the relative performance of private voucher schools and take into account all previous approaches. We postulate a sequential schooling decision model, where families make their decisions based on their observed and unobserved (to the econometrician) characteristics. The analysis of schooling choices using structural models has long been utilized in the literature (e.g. Willis and Rosen, 1979; Cameron and Heckman, 2001). Our empirical strategy is based in the work of Hansen, Heckman and Mullen (2004), and follow the analysis of Heckman, Stixrud and Urzúa (2006), and Urzúa (2008).

3 The Chilean School System: A Brief Overview

In 1981, the Chilean government introduced several reforms in the education system. The administration of public schools (which covered 78% of total enrollment) was transferred from the central government to around 300 local municipalities. It was also established a per-student subsidy (voucher) to be payed to all public schools and to some privates[4]. Three types of schools emerged after these reforms: Public, Private-voucher, and Private-fee-paying schools.

Public schools are financed by the voucher subsidy and administered by the municipalities. They are compelled to accept every child who wishes to enroll, unless it can be shown they are

[3]Based on the same data base we use.

[4]Before the establishment of the reforms, these private institutions were known under the name of *Subsidized-private schools*. They received public subsidies and did not charge tuition. The size of this subsidy depended on the government fiscal condition, but averaged 50% of per-student spending in public schools.

oversubscribed. Teacher's job contracts are governed by the Teacher Statute, wages are based on uniform pay-scales, and schools have dismissal restrictions.

Private-voucher schools are run by private agents and are financed by the per-student subsidy. They weren't allowed to charge additional fees until 1993, when this restriction was eliminated[5]. As opposed to public schools, private-voucher institutions can select their students. They operate as profit-maximizing firms and teacher's job contracts are ruled by the Labor Code, which allows them to hire and dismiss teachers.

Private-fee-paying schools are also run by privates and do not receive any kind of public funds. They are financed by the fees charged to parents and behave as profit-maximizing firms. They can hire and dismiss teachers, as well as carry out selection processes to select their students. They serve to the elite minority of the country and account for 7% percent of the total enrollment.

An important feature of the Chilean school system is that parents have complete freedom to choose the school to where enroll their children, no matter the location or the type of it.

The introduction of this voucher program transformed the Chilean education system in a school choice one, where parents have complete freedom to choose between different schools and types of them.

4 Model for School Choice and Tests Scores under Unobserved Heterogeneity

This section presents the econometric model underlying our empirical analysis discussed in Section 5 below.

We model schooling decisions at two different periods of time and assume them to be taken by parents and determined by family background and environment characteristics, as well as by cognitive and non-cognitive endowments. We also model individual educational outcomes (test scores) at every decision node.

In our model, individuals are heterogenous even after controlling for selection and observed characteristics. Two observationally identical individuals are allowed to respond differently to stimulus. We postulate that this heterogeneity is due to unobserved (to the econometrician) endowments. Hence, in order to compare outcomes between two individuals, we should also

[5] At present, roughly 50% of these schools effectively charge additional fees to supplement the voucher subsidy.

control for this unobserved heterogeneity. We do so by postulating the existence of a source of unobserved heterogeneity that accounts for all the dependence across choices in the model.

Let f denote the unobserved heterogeneity. We interpret this as a combination of different types of abilities (cognitive and non-cognitive) and determining school choices and test scores.

4.1 The System of Test Scores and School Choices in 8th grade

Let $I(s)$ denote the indirect utility associated with school-type s. We assume parents decide s^*, the optimal school-type, according to a utility maximizing argument:

$$s^* = \underset{\{s\}}{\text{argmax}} \{I(s)\}$$

We also observe tests scores given s^*. Let $T(s)$ denote the vector of tests scores given school-type s.

We assume

$$I(s) = \gamma_s Z(s) + \eta(s) \tag{1}$$

$$T(s) = \beta_s X(s) + \varepsilon(s) \qquad \text{for } s = 1, \ldots, \bar{S}, \tag{2}$$

where we allow $\eta(s)$, $\eta(s')$, $\varepsilon(s)$, $\varepsilon(s')$ to be correlated, for any $s \neq s'$. Following Hansen, Heckman and Mullen (2004) we impose a factor structure to our model. Specifically,

$$\eta(s) = \alpha_s f - \nu(s) \tag{3}$$

$$\varepsilon(s) = \lambda_s f + \tau(s) \qquad \text{for } s = 1, \ldots, \bar{S}, \tag{4}$$

where we assume $\nu(s) \perp\!\!\!\perp \tau(s) \perp\!\!\!\perp f$.

4.2 The System of Test Scores and School Choices in 10th grade

Conditional on the school-type in primary school (8th grade), parents decide the type of secondary school to where enroll their child. Specifically, knowing child's ability and given the school-type chosen in 8th grade, s^p, parents decide the school-type s^* such that,

$$s^* = \underset{\{s\}}{\text{argmax}} \{I(s|s^p, f, Z)\},$$

where

$$I(s|s^p, f, Z) \quad = \quad \gamma_{s|s^p} Z(s|s^p) + \alpha_{s|s^p} f - \nu(s|s^p) \qquad \text{for } s = 1, \ldots, \bar{S} \tag{5}$$

Test scores, on the other hand, are modeled as

$$T(s|s^p, f, X) \quad = \quad \beta_{s|s^p,f,X} X(s|s^p) + \lambda_{s|s^p,f,X} f + \tau(s|s^p) \qquad \text{for } s = 1, \ldots, \bar{S} \tag{6}$$

Our discrete-continuous econometric model of school choice and test scores share the structure of the model in Hansen, Heckman and Mullen (2004) and consequently we directly apply their argument to prove its non-parametric identification. Specifically, we can apply Theorem 1 in Hansen, Heckman and Mullen (2004) and Kotlarsky Theorem (Kotlarsky, 1967) to show the identification of the distribution of our latent factor as well as the identification of the parameters in the equations for test scores (given s) and latent utilities.

4.3 Implementing the Model

We are able to observe the optimal schooling decisions (s^*), as well as the associated observable characteristics (X and Z). We also observe test scores (T), which combine counterfactual test scores and optimal decisions in the following fashion:

$$T_i = \sum_{s=1}^{\bar{S}} T_i(s) \times D_i[s = s_i^*]$$

where $D_i[s = s_i^*]$ is an indicator function taking a value of one if the argument is true and zero otherwise.

We allow for the possibility of a causal effect from education on test scores, where different schooling choices imply different educational achievements. Hence, in order to make valid comparisons between individuals' outcomes we must account for the endogenous selection. The key insight is that, conditional on unobserved abilities, all error terms are mutually independent. Thus, the likelihood function can be written as:

$$\begin{aligned}\Gamma(\mathbf{T}_i, \mathbf{D}_i|X_i, Z_i) &= \prod_{i=1}^{N} \int f(\mathbf{T}_i, D_i|X_i, Z_i, f) dF(f) \\ &= \prod_{i=1}^{N} \int \left(\prod_{j=1}^{J} [f(\mathbf{T}_{ij}|D_{ij}=1, X_i, f) \times Pr(D_{ij}=1|Z_{ij}, f)]^{D_{ij}} \right) dF(f)\end{aligned}$$

We also assume that f is distributed according to a three-component mixture of normals. Formally,

$$f \sim p_1 N(\mu_1, \sigma_1^2) + p_2 N(\mu_2, \sigma_2^2) + p_3 N(\mu_3, \sigma_3^2)$$

This assumption provide enough flexibility and doesn't impose normality a priori.

The model is estimated using Markov Chain Monte Carlo methods (MCMC) and we use the sampler proposed by Gibbs.

4.4 Sequential Decision Model

The model is fundamentally sequential. At any given decision node the choice set confronted by the agent is a consequence of choices made in previous periods.

In the Chilean school system parents are not forced to choose schools depending on their location of residence (as it happens in United States, France and many other countries) or any other criterium. So, they can freely choose between schools and move their children from one school to any other one at any time or school grade. Our empirical strategy simplifies this by modeling schooling decisions at two different periods of time: primary and secondary. This is convenient as most of school transitions occur between this two schooling levels[6]. Hence, in the first period parents choose the school-type on two dimensions: public or private-voucher, and only with primary education or with both primary and secondary[7]. This decision node is represented by D_{i1} in Figure 1. In the second period, parents choose again the school-type. This decision depends on the choice made in the previous period and in general is not the same for all individuals. Students in "only primary" schools are forced to switch to another school after 8th grade and choose between public and private-voucher schools. On the other hand, students enrolled in "primary and secondary" schools can decide to stay in the same school or to switch to another one. If they choose to switch, they face the public or private-voucher decision again.

[6] See Section 5.1 below and Lara, Mizala and Repetto (2009).

[7] Again, see Section 5.1 below for a justification of these two different dimensions.

Decision nodes D_{i2}, D_{i3}, D_{i4} and D_{i5} in Figure 1 represent second period choices.

We observe optimal decisions in 8th grade (primary) and 10th grade (secondary). Additionally, we observe tests scores in both schooling grades. Language (Spanish), Mathematics, Social Sciences and Natural Sciences are observed in 8th grade. Language and Mathematics are observed in 10th grade. We normalize each test to have zero mean and unit variance in the overall sample. We also normalize the mean of the factor to zero and the loading to be equal to one for Mathematics test scores in 8th grade in all school-types.

We complete the structure of our empirical strategy approximating every dimension of schooling decisions as a probit model and every test score as a linear-in-the-parameter equation, in both periods (see Table 4).

5 Empirical Analysis

In this section we analyze the implementation of our model. We first describe the data and then discuss the estimation results and the most important findings.

5.1 Data

We constructed a two-period panel using the SIMCE[8] data bases for years 2004 and 2006. SIMCE is a standardized battery of tests administered to students of a specific grade level, which rotates yearly between 8th grade and 10th grade, and is also administered to 4th graders every year since 2005. This rotation pattern doesn't allow to track students across time, except for the years 2004 and 2006, when coincidentally the same group of students took SIMCE's tests in 8th and 10th grades. The aim of SIMCE is to measure students' degree of learning in some subjects of the curriculum[9]. The 2004 version consisted of four tests: Language (Spanish), Mathematics, Social Sciences and Natural Sciences. The 2006 version, in turn, evaluated the subjects of Language (Spanish) and Mathematics for 10th grade.

The number of students taking at least one of four tests in 2004 is 279,866 , enrolled in 5,614 schools. In 2006, 244,594 students from 2,454 schools took any of two tests for 10th grade. When we consider only those students taking all tests in both years, the number of students reduces to 205,427.

We also use information on students' family background and environment. This is collected in the form of a questionnaire answered by the parents at the time children took the tests.

[8] SIMCE stands for *Sistema de Medición de la Calidad de la Educación.*

[9] These subjects are Language, Mathematics, Social Sciences and Natural Sciences.

Although parents are not forced to complete the questionnaire, the majority of them do it. In fact, 92% of parents responded the questionnaire in 2004, and 91% of them did the same in 2006.

When we consider only those individuals whose family background characteristics are available, our balanced panel data base reduces to 178,304 students.

Now, since we are interested in measuring the causal effect of enrolling a voucher school instead of a public school, we ignore the observations for students enrolled in private-fee-paying schools. The number of students then reduces then to 163,313.

Finally, and since we do not use imputation methods for missing values, we consider only those students with no missing data in all the variables, including test scores. This makes the number of students to decrease to 87,862.

Tables 2 and 3 present the summary statistics of our final sample. Each table displays the mean and standard deviation for the variables of interest. Table 2 does it by school type in 8th grade, differentiating between "only primary" and "primary and secondary" schools. In both sub-samples and when comparing students in public schools with those in vouchers, we notice that the latter have on average more educated parents, live in richer environments, spend more money in school related items, and have a higher probability of having a computer available at home, of living in urban areas and of having attended pre-school. We observe also that students in voucher schools outperform their counterparts in public schools in every test taken in 8th grade. On the overall, students in the "only primary" sub-sample have lower test scores relative to students in schools with primary and secondary. In terms of enrollment, in the "only primary" sub-sample, the number of students in public schools is more than three times the number of students in voucher schools. The opposite is observed in "primary and secondary" schools.

Table 3 presents the summary statistics by type of school in 10th grade. This table follows the structure of our schooling choice model depicted in Figure 1. Each column represents a potential decision path. For instance, the first column shows summary statistics for students attending a public school offering only primary in 8th grade, and a public school in 10th grade. Column 5, in turn, shows summary statistics for individuals attending a public school with both primary and secondary schooling levels, deciding to switch to another school at the end of 8th grade, and attending a public school in 10th grade. In the "only primary" sub-sample, we observe that among those first enrolled in a public school, all family background and environment characteristics are more favorable for those choosing a voucher school in 10th grade. The same occurs if we consider only those attending a voucher school in 8th grade.

On the other hand, students in the "primary and secondary" sub-sample are not forced to switch schools, so they face an additional decision at the end of the 8th grade: to stay in the same school or to switch to another one. The last row of columns 5-10 of Table 3 shows us that the majority of these students remain in the same school in 10th grade. Specifically, 67% of those attending a public school and 71% of those attending a voucher school don't decide to attend a different school for their secondary education. We also observe that parents' education and household income is highest for individuals not switching and lowest for those switching, regardless the school-type in 8th grade. This result reverses when we look at the additional education related spending variable. We also observe a greater proportion of males among students not switching schools but only for those enrolled in a public school in 8th grade. For individuals first enrolled in voucher schools, the proportion of males is highest among those deciding to switch. Now, if we only focus on those switching schools, we observe the same pattern than in the "only primary" sub-sample: all variables for those choosing a voucher school in 10th grade are more favorable than those of students choosing public schools, regardless the type of the school attended in 8th grade. For test score variables (Language and Mathematics), we observe basically the same we did in Table 2: students in voucher schools have higher test scores than those in public schools, in 8th and 10th grades, and the same for the "primary and secondary" sub-sample relative to those in "only primary" schools. We also observe that test scores are highest for individuals not switching schools between 8th and 10th grades.

5.2 Estimates

As stated above, we approximate every dimension of schooling decisions as a probit model, for both first and second period. We do so for the ease of the estimation. This implies a slightly more complex picture than the one depicted in Figure 1. For instance, we separate first period decision into two dichotomous ones: a decision between schools only with primary education and schools with both primary and secondary; and another decision between public and voucher schools. Second period decisions are approximated in a similar fashion, with a first decision of whether to switch to another school or not, and a second one between public and voucher schools. Table 4 shows the complete decision scheme.

Estimates of the parameters of the equations of the model are presented in tables 5-9. Table 5 displays the estimates for the probit equations corresponding to schooling decisions. We observe that parents' level of education has a positive effect on the probability of attending a school offering both primary and secondary schooling levels (column 1), of choosing a voucher school in

8th grade (columns 2 and 5), and of choosing a voucher school in 10th grade (columns 3, 4, 8 and 9), whereas it has a negative effect on the probability of switching schools between 8th grade and 10th grade, although this is only statistically different from zero for those attending a voucher school in 8th grade. We observe basically the same pattern for all other family background variables (household total income, father as a household member, additional education related spending and computer availability at home). Females are more likely to attend a school with both primary and secondary schooling levels (column 1), a voucher school in 8th grade (columns 2 and 5), and to switch to another school for those first attending a public school in 2004 (column 6). School fees lowers the probability of switching the school for those first enrolled in a voucher school and raises the probability of choosing a voucher school in 10th grade for those switching schools and attending a voucher school in 8th grade. The proportion of public schools in the municipality has a positive effect in every decision equation. Having attended preschool has a negative effect in the first decision and on the probability of attending a voucher school in 8th grade in the "only primary" sub-sample (column 2).

The unobserved component of our model is a strong predictor of schooling decisions, and we observe some interesting related findings that are worth to mention. First, high ability people are more likely to select "only primary" schools (column 1). Then, we observe a positive sorting[10] in the 8th grade school-type decision in the "only primary" sub-sample[11] (column 2). There is also evidence of positive sorting in 10th grade in this sub-sample (column 3, students attending a public school in 8th grade). We also observe that people with high ability decide not to switch schools between 8th and 10th grades (columns 6 and 7), and for those effectively switching, the sorting is slightly negative.

Tables 6-9 present the estimated coefficients for test equations. We observe that females perform consistently better than men in language tests, but do worse in every other test. Mother and father's education and household income have an expected positive effect on test scores. Father's presence at home doesn't seem to be a strong predictor of academic achievement. Expenditure variables such as school fees and other related spending don't have the same effect on tests scores: fees have in general a positive effect, whereas the effect or other related spending is ambiguous and in most of the cases not statistically significant. Environment characteristics have a positive effect, while preschool has a particular pattern throughout the tables: it is negative for those in public school in 8th grade, and positive for the others. This might suggest that what really determines student's future academic achievement is the quality of the preschool

[10] By positive we mean selecting a voucher in lieu of a public school.

[11] The sorting for the "primary and secondary" sub-sample is negative although not statistically significant.

center rather than the enrollment in preschool in itself, as it may be the case that parents enrolling their children in voucher schools, also enrolled them in better preschools when younger.

The unobserved factor has a positive and significant effect along all test equations both in 8th grade and 10th grade. Student's inherent ability is therefore a strong predictor of academic achievement.

5.3 Goodness of Fit

To better understand our model, we simulated it using the estimated coefficients and the sample data. In this section we study the goodness of fit of the simulated model.

Model predictions in general do well when compared to the sample data. Table 10 presents the goodness of fit for the schooling decisions. The model captures the right pattern every school transitions, even for transitions with relatively few observations such as the switching decision and school-type in 2006 for individuals in public schools with primary and secondary schooling.

Table 11 presents the goodness of fit for the measurement system and outcomes. It displays mean test scores[12] by transitions and compares the actual mean observed in the data with its simulated counterpart. The model fits well the distribution of test scores conditional on transitions, and it is able to capture all facts discussed in Section 5.1 such as the one that students enrolled in voucher schools in 8th grade perform better than those enrolled in public schools. It also captures the heterogeneity of the outcomes across transitions.

5.4 Analysis: Sorting on Ability

In this subsection we present an analysis of the sorting on ability across schooling transitions. Figures 2, 3 and 4 display the factor distributions by different schooling nodes.

Figure 2 presents the unconditional simulated distribution of the unobserved component of the model (ability). We observe that, despite not imposing normality a priori, its shape resembles that of a normal density.

Figure 3 presents the distribution of students' ability by school-type in 8th grade. For the "only primary" sub-sample (left side figure) we observe that on average individuals with relatively higher levels of the unobserved component select to enroll in voucher schools (the density associated with this group is to the right of the density of those in public schools). Then, as we argue that this unobserved component is a combination of different abilities, we can postulate that smarter people attend voucher schools in 8th grade. However, this is only

[12] Test scores are normalized to have zero mean and unit variance in the overall sample.

true for the "only primary" sub-sample[13], and is consistent with the estimation results observed in Table 4.

Figure 4 presents the sorting on ability across schooling decisions in 10th grade. Panel A shows the distribution of ability for students attending "only primary" schools in 8th grade. We observe that individuals selecting voucher schools are slightly more able than those in public schools, but only for those attending public schools in 8th grade (left-hand side figure). Panel B shows the distribution of ability for students attending "primary and secondary" schools in 8th grade. These students are not forced to leave the school at the end of 8th grade and therefore can stay in the same school if they decide to do it. Thus, this group of students face two sequential decisions when finishing 8th grade: first, to stay in the same school or to switch to another one; then, and only if they have chosen to switch, they must select the type (public or voucher) of the new school. The left-hand side figure of Panel B shows no significant sorting between those switching to a public school and those switching to a voucher, but it does show a negative sorting in the switching decision, which means that individuals deciding not to switch have a higher level of abilities relative to those switching.

A more interesting picture is the one we observe on the right-hand side of Panel B in Figure 4. This corresponds to individuals attending voucher schools in 8th grade for the "primary and secondary" group. The observed sorting on ability is as follow: students with the highest abilities are the ones deciding to switch to a public school; students not switching come next; and students switching to a voucher school are those with the lowest abilities. This finding is interesting as this schooling decision node is the only one where we find that individuals switching to public schools are the most able ones. It would be interesting then, to characterize this group of students and thus learn about their decision process and up to what point this is different from students in other groups/decision nodes. One of the first things that comes to mind to everyone familiarized with the Chilean education system is that some these more able students might be deciding to switch to a *Liceos de Excelencia* school instead of a common public one. In Chile, what people call under the name of *Liceos de Excelencia* is a very small group of public secondary schools that are well recognized for being very good providers of education and for performing much better than most other public and voucher schools in national standardized tests, including those needed to apply to the universities[14][15]. Most of these schools are renowned

[13] For the "primary and secondary" group the evidence isn't clear.

[14] Morover, many of these schools perform better than an important number of private-fee-paying schools.

[15] Notwithstanding that people recognize these schools, there isn't a list of them that we can take and work with it. Hence, in order to have a list of all *Liceos de Excelencia* schools, we ranked all 677 secondary public schools following a performance in the 2009 PSU tests (needed to apply to the universities) criterium, and defined as *Liceos de Excelencia* the group of the top 50 schools. Table 12 shows this list.

traditional public institutions such as *Instituto Nacional*, *Liceo Carmela Carvajal* and *Liceo José Victorino Lastarria*. A first and very simple exercise to investigate whether the sorting result found above is driven by a *Liceos de Excelencia* effect, we counted the number of students in this decision node effectively switching from a voucher school to a *Liceos de Excelencia* one. The percentage of those individuals is 24%. On the other hand, the share of total enrollment of these schools in the overall sample is 6%, and is 13% if we consider only public schools[16]. Thus, people in this decision node are more likely to select a *Liceos de Excelencia* school compared to a random individual in the overall sample selecting a public school (24% versus 13%). This simple exercise confirms at a first look the common belief. However, much more work is necessary if we want to have a comprehensive characterization of these students.

5.5 Treatment Effects

In this section we are interested in estimating the causal effects of attending a voucher school in lieu of a public one. To do so, we follow a program evaluation approach and estimate three different treatment parameters: Average Treatment Effect (ATE), Treatment on the Treated (TT), and Treatment on the Untreated (TUT).

Let Y_1 denote the test scores achievement for students attending voucher schools, and Y_0 denote the test scores achievement for students attending public schools. Also, let D denote the observed treatment participation, where $D = 1$ denotes receipt of treatment (attending a voucher school), and $D = 0$ nonreceipt (attending a public school).

ATE is defined as the expected gain from attending a voucher school for a randomly chosen individual. The average treatment effect can therefore be expressed as:

$$ATE = \int\int E(Y_1 - Y_0 \mid X = x, f = \theta) dF_{X,f}(x, \theta) \tag{7}$$

The Treatment on the Treated parameter is the average gain from treatment for those that actually select into treatment. In our case, TT is the average gain from attending a voucher school for those who effectively do it, and is defined as:

$$TT = \int\int E(Y_1 - Y_0 \mid X = x, f = \theta, D = 1) dF_{X,f}(x, \theta) \tag{8}$$

[16] These numbers are taken from our final sample.

Treatment on the Untreated, in turn, is the average gain from attending a voucher school for those attending a public school:

$$TUT = \int\int E(Y_1 - Y_0 \mid X = x, f = \theta, D = 0) dF_{X,f}(x, \theta) \quad (9)$$

We estimate these treatment parameters using simulations of the entire model. Specifically, we simulate all possible schooling decisions paths for every individual, as well as the corresponding test scores. This allows us to observe every potential academic achievement for every individual, and therefore compute the treatment parameters.

We evaluate the return of the specific treatment of attending a voucher school in 10th grade. To do so, we only take individuals that are effectively comparable. Thus, we estimate separately the treatment effects by schooling decisions paths and estimate four different values for each treatment parameter: one for individuals attending an "only primary" public school in 8th grade; another one for those attending an "only primary" voucher school in 8th grade; a third one for students attending a "primary and secondary" public school in 8th grade, and deciding to switch to another school; and a last one for those in "primary and secondary" voucher schools in 8th grade, and switching school.

Table 13 presents the estimated treatment effects for Language and Mathematics tests. All values are in standard deviations[17]. At a first look, we observe that all estimated parameters are positive and statistically significant[18], except for the TT parameter in Mathematics for individuals in a "primary and secondary" public school in 8th grade and deciding to switch schools. The greatest effects are for students in "primary and secondary" voucher schools and deciding to switch (fourth and last rows in Table 12). For a random individual in this group, attending a voucher school increase her test scores in about 38% of a standard deviation in the Language test and by 35% s.d. in Mathematics. Still for this group of students, we observe that TT parameters are slightly greater than ATE (43% s.d. and 41% for Language and Mathematics), and TUT smaller (27% s.d. and 23% s.d., respectively). Sapelli and Vial (2005) estimate treatment parameters of these magnitudes and bigger. The number of students in this group is 6,414 (of a total of 87,862). For the three other schooling paths we observe much smaller treatment parameters. ATE ranges from 3% s.d. to 5% s.d. in Language test, and from 1% s.d. to 6% s.d. in Mathematics. TT ranges from 3% s.d. to 4% s.d. in Language test, and

[17] Tests corresponding mean and standard deviation are 255 and 52 for Language, and 253 and 65 for Mathematics.

[18] To compute significance tests, we performed mean tests on the simulated $Y_1 - Y_0$, $Y_1 - Y_0 | D = 1$ and $Y_1 - Y_0 | D = 0$ expressions for ATE, TT and TUT parameters, respectively. The null hypothesis is the parameter being zero.

from 0.2%[19] s.d. to 5% s.d. in Mathematics. TUT estimated parameters range from 3% s.d. to 4% s.d. in Language, and from 1% s.d. to 7% s.d. in Mathematics. These treatment effects resemble to those reported by Lara, Mizala and Repetto (2009), and Contreras and Santos (2009).

Table 14 presents the proportion of people with positive and negative potential gains ($Y_1 - Y_0 > 0$ and $Y_1 - Y_0 < 0$) in the event of attending a voucher school in 10th grade. We observe in general that the proportion of students whose test scores would increase is much larger than the proportion of students whose test scores would decrease, for both Language and Mathematics tests (first and third columns). We also observe (second and fourth columns) that the average individual potentially benefiting from the treatment is in general an individual with relatively low abilities (negative $\bar{f}$).

Table 15 presents the fraction of individuals for whom we would had observed a better outcome if they hadn't choose their actual school-type, that is, those who have made wrong decisions. It also displays the ability for the average individual in each group. We observe that in general only few students attending a voucher school in 10th grade ($D = 1$) made a "wrong decision" or, in other words, would increase their test scores if they had gone to a public school. These are high-ability students for the two first schooling decision paths and low-ability ones for the remaining paths. On the other hand, people attending a public school in 10th grade and making wrong decisions are the majority in each group. They are low-ability students for almost every schooling path.

Figures 5-8 complement the analysis of Table 14. They display the distribution of treatment effects for those treated (Figures 5 and 6) as well as the distribution of treatment effects for those untreated (Figures 7 and 8).

Figures 9 and 10 present the treatment on the treated (TT) parameter as a function of unobserved ability (f). We observe that high ability people tend to report lower and even negative treatment effects in every schooling path. The figures also display the treatment effects as a function of observed initial test scores (T in 8th grade). We observe that in general the distinction between unobserved and measured ability is important. Treatment effects are moderated by differences in observable characteristics (X, Z).

Figures 11 and 12 carry out the same analysis as above but for the treatment on the untreated (TUT). The results remain the same as in the TT analysis for every schooling decision path, except for individuals in "primary and secondary" and voucher schools in 8th grade (Figure 12, panels A.ii. and B.ii.), where the relationship between ability and the TUT parameter isn't

[19] Although this is the only treatment parameter not statistically significant.

monotonic neither very clear. These figures show also that the distinction between unobserved and measured ability is important.

6 Conclusions

In this paper we address the question of whether private-voucher schools are better than public schools in the Chilean school system. This is challenging task given the non-experimental design of the voucher program established in early 1980's. Our approach involves a structural school choice model and take into account all previous approaches in the related literature.

Using SIMCE 2004 and 2006 data sets, we construct a two-period panel at the individual level with relevant information on schooling outcomes and academic achievement. We allow the existence of a source of individual heterogeneity and use a factor structure to model it. We interpret this unobserved heterogeneity as a combination of different abilities.

We calculate three different treatment parameter to assess the causal effect of attending a private-voucher school: Average Treatment Effect, Treatment on the Treated, and Treatment on the Untreated. We find that private-voucher schools improve academic achievement with the magnitude of the effect varying across schooling decision paths, being low (1%-7% s.d.) yet statistically significant for the majority of students and high (23%-43%) for a small group of them.

Interesting findings are those regarding the sorting on abilities by each sequential schooling decision. The common picture is students in voucher schools being more able than students in public schools. However, for individuals in "primary and secondary" voucher schools in 8th grade, it happens that the most able students are those switching to a public school, followed by those deciding not to switch, and finally those switching to another voucher school in 10th grade. We propose a possible explanation regarding the *Liceos de Excelencia*, which are public schools performing consistently very good in national standardized tests.

From the point of view of public policies, our results would suggest to encourage the attendance to voucher schools.

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A Tables

Table 1: Enrollment by School Type (%)

Year	Public	Private Voucher	Private Fee Paying
1981	78.0	15.1	6.9
1985	65.3	28.1	6.6
1990	58.4	33.7	7.9
1991	58.1	33.6	8.3
1992	58.0	33.5	8.5
1993	57.8	33.5	8.7
1994	57.6	33.5	8.9
1995	57.4	33.5	9.1
1996	56.3	34.2	9.5
1997	56.1	34.4	9.5
1998	55.7	35.0	9.3
1999	54.9	36.1	9.0
2000	54.3	36.8	8.9
2001	53.7	37.6	8.7
2002	52.7	38.9	8.4
2003	51.3	40.9	7.8
2004	49.8	42.6	7.6
2005	48.7	44.6	6.7
2006	46.8	46.5	6.7
2007	45.2	48.0	6.8
2008	43.5	49.6	6.9

Source: Ministry of Education of Chile

Notes:

Table 2: Summary Statistics by School Type in 8th grade

	Only Primary			Primary and Secondary		
School Type 2004	Total	Public	Voucher	Total	Public	Voucher
Male	0.48	0.48	0.48	0.48	0.51	0.47
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
Repeated Grade	0.11	0.11	0.08	0.08	0.10	0.07
	(0.31)	(0.32)	(0.27)	(0.27)	(0.30)	(0.25)
Mother's Years of Education	9.28	8.95	10.32	11.36	9.94	11.82
	(3.31)	(3.23)	(3.34)	(3.52)	(3.63)	(3.35)
Father's Years of Education	9.51	9.18	10.53	11.60	10.13	12.09
	(3.43)	(3.38)	(3.41)	(3.65)	(3.81)	(3.46)
Household's Total Income	197.77	180.77	250.58	352.85	250.25	386.48
	(188.77)	(171.62)	(226.16)	(340.12)	(263.95)	(355.23)
Father as a Household Member	0.76	0.76	0.78	0.79	0.77	0.80
	(0.42)	(0.43)	(0.41)	(0.40)	(0.42)	(0.40)
Household's # of Members	5.05	5.08	4.95	4.83	4.98	4.78
	(1.73)	(1.76)	(1.63)	(1.52)	(1.66)	(1.47)
Additional Education Related Spending (2004)	13.76	13.35	15.05	18.53	15.41	19.55
	(15.92)	(15.79)	(16.23)	(18.57)	(17.03)	(18.93)
School Tuition (2004)	1.71	0.00	7.04	12.01	0.00	15.95
	(5.54)	(0.00)	(9.40)	(16.21)	(0.00)	(16.92)
Household's # of books: 10 or less (2004)	0.39	0.43	0.27	0.20	0.34	0.15
	(0.49)	(0.50)	(0.44)	(0.40)	(0.47)	(0.36)
Household's # of books: 11 to 50 (2004)	0.40	0.39	0.43	0.41	0.37	0.42
	(0.49)	(0.49)	(0.50)	(0.49)	(0.48)	(0.49)
Household's # of books: more than 50 (2004)	0.21	0.18	0.30	0.39	0.29	0.43
	(0.41)	(0.38)	(0.46)	(0.49)	(0.45)	(0.49)
Computer Availability (2004)	0.27	0.22	0.40	0.54	0.36	0.60
	(0.44)	(0.42)	(0.49)	(0.50)	(0.48)	(0.49)
School in Urban Area (2004)	0.84	0.81	0.94	0.95	0.88	0.97
	(0.36)	(0.39)	(0.24)	(0.22)	(0.32)	(0.17)
Public Schools in the municipality (%)	0.39	0.40	0.35	0.35	0.38	0.34
	(0.10)	(0.11)	(0.09)	(0.09)	(0.12)	(0.07)
Geographic Region: North	0.14	0.16	0.07	0.13	0.05	0.15
	(0.35)	(0.37)	(0.25)	(0.33)	(0.23)	(0.36)
Geographic Region: Center	0.51	0.48	0.60	0.67	0.71	0.66
	(0.50)	(0.50)	(0.49)	(0.47)	(0.45)	(0.47)
Geographic Region: South	0.35	0.36	0.33	0.20	0.24	0.19
	(0.48)	(0.48)	(0.47)	(0.40)	(0.42)	(0.39)
Pre-school	0.91	0.90	0.94	0.96	0.92	0.98
	(0.29)	(0.30)	(0.24)	(0.19)	(0.27)	(0.14)
Language (8th grade)	-0.18	-0.24	0.01	0.19	0.00	0.25
	(0.95)	(0.93)	(0.96)	(0.98)	(1.06)	(0.95)
Mathematics (8th grade)	-0.20	-0.27	0.00	0.19	0.02	0.24
	(0.92)	(0.90)	(0.96)	(0.99)	(1.07)	(0.96)
Social Sciences (8th grade)	-0.18	-0.24	0.03	0.20	0.01	0.26
	(0.96)	(0.95)	(0.98)	(1.00)	(1.07)	(0.96)
Natural Sciences (8th grade)	-0.20	-0.26	-0.01	0.20	0.01	0.26
	(0.91)	(0.89)	(0.96)	(1.01)	(1.05)	(0.98)
Number of observations	58122	43970	14152	29740	7341	22399

Notes:

Table 3: Summary Statistics by School Type in 10th grade

School Type 2004	Only Primary				Primary and Secondary					
	Public		Voucher		Public			Voucher		
Switching Decision					Yes		No	Yes		No
School Type 2006	Public	Voucher	Public	Voucher	Public	Voucher		Public	Voucher	
Male	0.46	0.51	0.47	0.49	0.43	0.48	0.53	0.49	0.49	0.46
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
Repeated Grade	0.12	0.10	0.09	0.07	0.09	0.10	0.11	0.09	0.07	0.06
	(0.33)	(0.29)	(0.29)	(0.26)	(0.28)	(0.30)	(0.31)	(0.28)	(0.25)	(0.25)
Mother's Years of Education	8.77	9.26	9.90	10.54	9.51	9.75	10.09	10.87	11.70	11.98
	(3.20)	(3.25)	(3.40)	(3.29)	(3.32)	(3.37)	(3.76)	(3.26)	(3.24)	(3.37)
Father's Years of Education	9.01	9.50	10.10	10.76	9.62	9.84	10.32	11.08	11.95	12.25
	(3.36)	(3.39)	(3.40)	(3.39)	(3.48)	(3.46)	(3.95)	(3.31)	(3.36)	(3.49)
Household's Total Income	170.56	198.94	214.85	269.59	196.43	217.87	271.02	273.01	370.65	405.32
	(163.10)	(184.45)	(192.05)	(240.22)	(193.83)	(191.50)	(290.57)	(240.00)	(334.65)	(369.84)
Father as a Household Member	0.75	0.77	0.77	0.79	0.76	0.76	0.78	0.78	0.81	0.80
	(0.43)	(0.42)	(0.42)	(0.41)	(0.43)	(0.43)	(0.42)	(0.42)	(0.39)	(0.40)
Household's # of Members	5.11	5.04	5.01	4.92	5.00	4.97	4.98	4.90	4.75	4.77
	(1.77)	(1.75)	(1.69)	(1.60)	(1.69)	(1.69)	(1.65)	(1.63)	(1.42)	(1.46)
Additional Education Related Spending (2006)	15.13	20.50	15.29	21.43	16.51	21.97	15.87	17.06	24.96	22.85
	(14.86)	(18.28)	(14.04)	(18.71)	(14.06)	(19.57)	(16.51)	(16.11)	(21.13)	(20.90)
School Tuition (2006)	0.00	20.50	0.00	21.43	0.00	21.97	0.19	0.00	24.96	22.85
	(0.00)	(18.28)	(0.00)	(18.71)	(0.00)	(19.57)	(2.67)	(0.00)	(21.13)	(20.90)
Household's # of books: 10 or less (2006)	0.48	0.40	0.37	0.28	0.37	0.35	0.37	0.28	0.20	0.20
	(0.50)	(0.49)	(0.48)	(0.45)	(0.48)	(0.48)	(0.48)	(0.45)	(0.40)	(0.40)
Household's # of books: 11 to 50 (2006)	0.40	0.44	0.44	0.48	0.46	0.47	0.40	0.47	0.50	0.47
	(0.49)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.49)	(0.50)	(0.50)	(0.50)
Household's # of books: more than 50 (2006)	0.12	0.16	0.19	0.24	0.18	0.18	0.23	0.25	0.29	0.33
	(0.32)	(0.36)	(0.39)	(0.42)	(0.38)	(0.38)	(0.42)	(0.43)	(0.46)	(0.47)
Computer Availability (2006)	0.35	0.45	0.48	0.61	0.45	0.52	0.51	0.62	0.73	0.74
	(0.48)	(0.50)	(0.50)	(0.49)	(0.50)	(0.50)	(0.50)	(0.49)	(0.44)	(0.44)
School in Urban Area (2006)	0.97	0.94	0.98	0.96	0.97	0.95	0.89	0.98	0.97	0.97
	(0.16)	(0.24)	(0.13)	(0.19)	(0.18)	(0.21)	(0.31)	(0.12)	(0.17)	(0.17)
Primary and Secondary (2006)	0.16	0.34	0.24	0.36	0.23	0.36	1.00	0.22	0.51	1.00
	(0.36)	(0.47)	(0.42)	(0.48)	(0.42)	(0.48)	(0.00)	(0.41)	(0.50)	(0.00)
Public Schools in the municipality (%)	0.42	0.36	0.37	0.34	0.42	0.37	0.38	0.36	0.32	0.34
	(0.11)	(0.09)	(0.09)	(0.08)	(0.12)	(0.10)	(0.12)	(0.08)	(0.07)	(0.08)
Geographic Region: North	0.19	0.11	0.08	0.06	0.08	0.04	0.05	0.17	0.13	0.15
	(0.40)	(0.31)	(0.27)	(0.25)	(0.27)	(0.19)	(0.22)	(0.38)	(0.34)	(0.36)
Geographic Region: Center	0.42	0.60	0.51	0.65	0.69	0.76	0.70	0.60	0.72	0.65
	(0.49)	(0.49)	(0.50)	(0.48)	(0.46)	(0.43)	(0.46)	(0.49)	(0.45)	(0.48)
Geographic Region: South	0.39	0.30	0.41	0.28	0.23	0.20	0.25	0.23	0.15	0.20
	(0.49)	(0.46)	(0.49)	(0.45)	(0.42)	(0.40)	(0.43)	(0.42)	(0.36)	(0.40)
Pre-school	0.89	0.92	0.91	0.95	0.92	0.95	0.91	0.97	0.98	0.98
	(0.32)	(0.27)	(0.28)	(0.21)	(0.27)	(0.21)	(0.28)	(0.17)	(0.13)	(0.15)
Language (10th grade)	-0.30	-0.18	-0.06	0.01	-0.05	-0.11	0.02	0.11	0.17	0.31
	(0.93)	(0.91)	(0.98)	(0.93)	(0.95)	(0.93)	(1.09)	(0.99)	(0.94)	(0.96)
Mathematics (10th grade)	-0.32	-0.17	-0.12	0.01	-0.06	-0.11	0.05	0.10	0.18	0.35
	(0.91)	(0.90)	(0.99)	(0.93)	(0.93)	(0.93)	(1.11)	(0.99)	(0.92)	(0.95)
Number of observations	28159	15811	4915	9237	1093	1335	4913	2045	4369	15985

Notes: *Additional Education Related Spending* refers to all expenses concerning the child's education other than tuition fees. *School Tuition*, *Additional Education Related Spending* and *Household's Total Income* are measured in thousands of Chilean pesos.

Table 4: Summary of Decisions

	Decision = 1	Decision = 0	Conditional on
D_{i1}	Primary and Secondary	Only Primary	none
D_{i2}	Voucher 8th grade	Public 8th grade	$D_{i1=0}$
D_{i3}	Voucher 10th grade	Public 10th grade	$D_{i2=0}$
D_{i4}	Voucher 10th grade	Public 10th grade	$D_{i2=1}$
D_{i5}	Voucher 8th grade	Public 8th grade	$D_{i1=1}$
D_{i6}	Switching	Not Switching	$D_{i5=0}$
D_{i7}	Switching	Not Switching	$D_{i5=1}$
D_{i8}	Voucher 10th grade	Public 10th grade	$D_{i6=0}$
D_{i9}	Voucher 10th grade	Public 10th grade	$D_{i7=0}$

Notes:

Table 5: Estimated Coefficients for Schooling Decisions

Variable	D_{i1}	D_{i2}	D_{i3}	D_{i4}	D_{i5}	D_{i6}	D_{i7}	D_{i8}	D_{i9}
Intercept	-1.348	-0.682	-2.409	-1.799	0.056	-0.069	-0.863	-1.612	-2.748
	(0.048)	(0.049)	(0.061)	(0.128)	(0.084)	(0.127)	(0.131)	(0.209)	(0.245)
Male	-0.052	-0.012	0.130	0.044	-0.145	-0.134	0.058	0.101	-0.002
	(0.010)	(0.012)	(0.014)	(0.023)	(0.018)	(0.033)	(0.019)	(0.054)	(0.033)
Grade Repetition	0.047	-0.077	-0.158	-0.062	0.016	-0.120	0.042	0.126	-0.045
	(0.019)	(0.021)	(0.022)	(0.041)	(0.031)	(0.051)	(0.036)	(0.091)	(0.062)
Mother's Years of Education	0.041	0.031	0.010	0.006	0.032	0.001	-0.008	0.002	0.013
	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.006)	(0.003)	(0.010)	(0.006)
Father's Years of Education	0.028	0.017	0.007	0.002	0.027	-0.005	-0.007	-0.007	0.007
	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.005)	(0.003)	(0.009)	(0.006)
Household's Total Income	0.001	0.0003	0.0003	0.0004	-	-0.0005	-0.0001	0.0002	0.0005
	(0.00003)	(0.00004)	(0.00004)	(0.0001)	-	(0.0001)	(0.00003)	(0.0002)	(0.0001)
Father as a Household Member	0.041	0.044	0.023	0.050	0.087	-0.049	-0.001	-0.034	0.051
	(0.013)	(0.014)	(0.015)	(0.028)	(0.020)	(0.037)	(0.022)	(0.059)	(0.043)
Number of Household Members	-0.047	-0.018	-0.016	-0.023	-0.036	-0.001	0.001	-0.016	-0.033
	(0.003)	(0.003)	(0.004)	(0.007)	(0.005)	(0.009)	(0.006)	(0.016)	(0.011)
Additional Education Related Spending (2004)	-	0.003	0.001	0.001	0.003	-0.003	-0.0003	0.003	0.002
	-	(0.0004)	(0.0004)	(0.001)	(0.0005)	(0.001)	(0.0005)	(0.002)	(0.001)
School Fees (2004)	-	-	-	0.001	-	-	-0.007	-	0.003
	-	-	-	(0.001)	-	-	(0.001)	-	(0.001)
Household's # of books: 11 to 50 (2004)	0.185	0.117	0.034	0.088	0.274	0.130	0.032	-0.072	0.060
	(0.015)	(0.016)	(0.014)	(0.028)	(0.024)	(0.038)	(0.028)	(0.064)	(0.046)
Household's # of books: more than 50 (2004)	0.362	0.161	0.024	0.034	0.238	0.067	0.015	-0.090	0.025
	(0.021)	(0.022)	(0.021)	(0.031)	(0.026)	(0.048)	(0.031)	(0.079)	(0.053)
Computer Availability (2004)	0.316	0.185	0.082	0.153	0.171	-0.102	-0.026	0.101	0.078
	(0.014)	(0.015)	(0.017)	(0.025)	(0.020)	(0.040)	(0.022)	(0.067)	(0.037)
School in an Urban Area (2004)	0.382	0.467	-0.053	0.115	0.531	-0.070	0.018	0.108	-0.148
	(0.019)	(0.021)	(0.018)	(0.050)	(0.036)	(0.049)	(0.050)	(0.075)	(0.097)
Public Schools in the municipality (%)	-0.612	-2.549	3.169	2.722	-3.178	-0.496	0.611	2.462	4.189
	(0.056)	(0.076)	(0.075)	(0.147)	(0.105)	(0.145)	(0.133)	(0.271)	(0.262)
Geographic Region: North	-0.317	-0.524	-0.440	-0.098	0.697	-0.012	-0.020	-0.425	-0.137
	(0.017)	(0.022)	(0.021)	(0.047)	(0.031)	(0.072)	,02631	(0.122)	(0.051)
Geographic Region: South	-0.427	0.076	-0.147	-0.096	0.259	-0.156	-0.072	0.024	-0.016
	(0.015)	(0.015)	(0.015)	(0.027)	(0.023)	(0.040)	(0.027)	(0.071)	(0.048)
Pre-school	-0.045	-0.125	0.033	0.114	0.304	0.324	0.139	0.183	0.185
	(0.024)	(0.024)	(0.023)	(0.049)	(0.045)	(0.062)	(0.063)	(0.106)	(0.117)
Factor	-0.694	0.211	0.056	-0.016	-0.043	-0.093	-0.121	-0.064	-0.061
	(0.054)	(0.052)	(0.010)	(0.017)	(0.040)	(0.024)	(0.014)	(0.041)	(0.025)

Notes: *Additional Education Related Spending* refers to all expenses concerning the child's education other than tuition fees. *School Tuition*, *Additional Education Related Spending* and *Household's Total Income* are measured in thousands of Chilean pesos.

Table 6: Estimated Coefficients for Tests Scores 2004 Linear Models (Only Primary Schools)

School Type 2004	Public				Voucher			
Variable	Language	Mathematics	Social Sc.	Natural Sc.	Language	Mathematics	Social Sc.	Natural Sc.
Intercept	-0.527	-0.750	-0.683	-0.683	-0.826	-1.168	-1.016	-1.025
	(0.027)	(0.025)	(0.027)	(0.025)	(0.073)	(0.073)	(0.075)	(0.075)
Male	-0.144	0.222	0.215	0.211	-0.157	0.222	0.214	0.208
	(0.009)	(0.009)	(0.009)	(0.009)	(0.015)	(0.015)	(0.015)	(0.015)
Grade Repetition	-0.539	-0.513	-0.449	-0.398	-0.638	-0.607	-0.553	-0.505
	(0.014)	(0.014)	(0.015)	(0.014)	(0.028)	(0.028)	(0.030)	(0.028)
Mother's Years of Education	0.024	0.021	0.025	0.024	0.031	0.028	0.031	0.028
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Father's Years of Education	0.018	0.016	0.019	0.018	0.025	0.024	0.031	0.028
	(0.002)	(0.002)	(0.002)	(0.001)	(0.003)	(0.003)	(0.003)	(0.003)
Household's Total Income	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00004)	(0.00004)	(0.00004)	(0.00004)
Father as a Household Member	-0.006	0.007	0.017	-0.004	-0.012	-0.002	0.031	0.007
	(0.010)	(0.010)	(0.010)	(0.010)	(0.018)	(0.018)	(0.018)	(0.018)
Number of Household Members	-0.021	-0.009	-0.025	-0.020	-0.019	-0.003	-0.026	-0.022
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)	(0.005)
Additional Education Related Spending (2004)	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0004)	(0.0004)	(0.0003)
School Fees (2004)	-	-	-	-	0.002	0.002	0.002	0.002
	-	-	-	-	(0.001)	(0.001)	(0.001)	(0.001)
Household's # of books: 11 to 50 (2004)	0.057	0.054	0.061	0.053	0.044	0.075	0.053	0.045
	(0.007)	(0.007)	(0.007)	(0.007)	(0.014)	(0.014)	(0.015)	(0.015)
Household's # of books: more than 50 (2004)	0.098	0.084	0.117	0.104	0.105	0.135	0.130	0.103
	(0.010)	(0.010)	(0.010)	(0.009)	(0.017)	(0.016)	(0.018)	(0.017)
Computer Availability (2004)	-0.003	0.008	-0.010	0.004	0.001	0.040	-0.001	0.021
	(0.008)	(0.008)	(0.009)	(0.008)	(0.013)	(0.012)	(0.014)	(0.013)
School in Urban Area (2004)	-0.022	-0.058	-0.061	-0.065	-0.023	0.012	-0.041	-0.079
	(0.008)	(0.008)	(0.009)	(0.008)	(0.024)	(0.023)	(0.025)	(0.024)
Geographic Region: North	-0.035	-0.013	-0.042	-0.016	0.019	-0.031	-0.048	0.023
	(0.014)	(0.013)	(0.013)	(0.013)	(0.033)	(0.031)	(0.032)	(0.032)
Geographic Region: South	0.165	0.130	0.162	0.161	0.125	0.118	0.099	0.141
	(0.011)	(0.011)	(0.011)	(0.010)	(0.018)	(0.017)	(0.018)	(0.018)
Pre-school	-0.058	-0.020	-0.072	-0.068	0.058	0.109	0.053	0.076
	(0.015)	(0.015)	(0.016)	(0.014)	(0.035)	(0.034)	(0.034)	(0.036)
Factor	1.056	1.000	1.024	0.972	1.050	1.000	1.034	1.049
	(0.005)	(0.000)	(0.005)	(0.005)	(0.009)	(0.000)	(0.009)	(0.009)

Notes: *Additional Education Related Spending* refers to all expenses concerning the child's education other than tuition fees. *School Tuition*, *Additional Education Related Spending* and *Household's Total Income* are measured in thousands of Chilean pesos.

Table 7: Estimated Coefficients for Tests Scores 2004 Linear Models (Primary and Secondary Schools)

School Type 2004	Public				Voucher			
Variable	Language	Mathematics	Social Sc.	Natural Sc.	Language	Mathematics	Social Sc.	Natural Sc.
Intercept	-0.231	-0.422	-0.400	-0.391	0.031	-0.238	-0.237	-0.202
	(0.085)	(0.082)	(0.086)	(0.084)	(0.070)	(0.073)	(0.073)	(0.075)
Male	-0.089	0.273	0.304	0.272	-0.166	0.221	0.227	0.235
	(0.021)	(0.021)	(0.021)	(0.021)	(0.012)	(0.012)	(0.012)	(0.013)
Grade Repetition	-0.581	-0.574	-0.503	-0.464	-0.612	-0.596	-0.544	-0.516
	(0.034)	(0.033)	(0.035)	(0.035)	(0.023)	(0.024)	(0.023)	(0.025)
Mother's Years of Education	0.030	0.029	0.034	0.036	0.023	0.022	0.028	0.028
	(0.004)	(0.004)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)
Father's Years of Education	0.031	0.026	0.024	0.029	0.020	0.020	0.021	0.024
	(0.004)	(0.004)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)
Household's Total Income	0.0003	0.0004	0.0004	0.0003	0.0001	0.0002	0.0001	0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.00002)	(0.00002)	(0.00002)	(0.00002)
Father as a Household Member	-0.015	0.018	0.001	0.014	-0.028	-0.007	0.014	-0.002
	(0.026)	(0.025)	(0.027)	(0.025)	(0.015)	(0.015)	(0.015)	(0.015)
Number of Household Members	-0.024	-0.023	-0.033	-0.036	-0.020	-0.012	-0.029	-0.024
	(0.006)	(0.006)	(0.006)	(0.006)	(0.004)	(0.004)	(0.004)	(0.004)
Additional Education Related Spending (2004)	-0.0003	0.0004	0.00003	0.0001	-0.001	-0.001	-0.001	-0.001
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
School Fees (2004)	-	-	-	-	0.001	0.0004	0.0003	0.0001
	-	-	-	-	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Household's # of books: 11 to 50 (2004)	0.042	0.038	0.064	0.022	0.042	0.069	0.081	0.047
	(0.018)	(0.018)	(0.019)	(0.018)	(0.013)	(0.014)	(0.014)	(0.013)
Household's # of books: more than 50 (2004)	0.109	0.140	0.131	0.120	0.095	0.135	0.142	0.103
	(0.023)	(0.022)	(0.025)	(0.022)	(0.014)	(0.015)	(0.015)	(0.015)
Computer Availability (2004)	-0.001	0.039	-0.006	0.012	-0.019	0.004	-0.014	-0.021
	(0.020)	(0.019)	(0.019)	(0.019)	(0.010)	(0.010)	(0.011)	(0.010)
School in Urban Area (2004)	0.081	0.092	0.084	0.070	0.049	-0.008	0.025	-0.010
	(0.027)	(0.027)	(0.028)	(0.027)	(0.029)	(0.030)	(0.031)	(0.032)
Geographic Region: North	-0.123	-0.173	-0.136	-0.094	0.022	0.053	-0.020	0.081
	(0.050)	(0.048)	(0.050)	(0.050)	(0.019)	(0.019)	(0.019)	(0.020)
Geographic Region: South	0.096	0.057	0.111	0.095	0.209	0.229	0.217	0.273
	(0.028)	(0.026)	(0.027)	(0.026)	(0.017)	(0.017)	(0.017)	(0.018)
Pre-school	0.014	-0.006	0.009	-0.013	0.080	0.108	0.098	0.055
	(0.041)	(0.039)	(0.041)	(0.041)	(0.041)	(0.040)	(0.041)	(0.043)
Factor	1.073	1.000	1.054	1.049	1.015	1.000	1.001	1.063
	(0.011)	(0.000)	(0.012)	(0.012)	(0.008)	(0.000)	(0.007)	(0.007)

Notes: *Additional Education Related Spending* refers to all expenses concerning the child's education other than tuition fees. *School Tuition*, *Additional Education Related Spending* and *Household's Total Income* are measured in thousands of Chilean pesos.

Table 8: Estimated Coefficients for Tests Scores 2006 Linear Models (Only Primary Schools)

School Type 2004	Public				Voucher			
School Type 2006	Public		Voucher		Public		Voucher	
Variable	Language	Mathematics	Language	Mathematics	Language	Mathematics	Language	Mathematics
Intercept	-0.584	-0.808	-0.616	-0.824	-0.868	-1.111	-0.921	-1.279
	(0.034)	(0.036)	(0.038)	(0.039)	(0.104)	(0.102)	(0.081)	(0.082)
Male	-0.112	0.179	-0.118	0.193	-0.120	0.177	-0.167	0.160
	(0.010)	(0.010)	(0.012)	(0.012)	(0.020)	(0.021)	(0.017)	(0.016)
Grade Repetition	-0.557	-0.601	-0.538	-0.581	-0.656	-0.709	-0.641	-0.622
	(0.015)	(0.015)	(0.020)	(0.020)	(0.036)	(0.035)	(0.031)	(0.031)
Mother's Years of Education	0.022	0.023	0.025	0.023	0.028	0.026	0.033	0.032
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.003)	(0.003)
Father's Years of Education	0.020	0.015	0.017	0.014	0.027	0.026	0.026	0.026
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.003)	(0.003)
Household's Total Income	0.0002	0.0002	0.0001	0.0001	0.0003	0.0002	0.0001	0.0001
	(0.00003)	(0.00003)	(0.00004)	(0.00004)	(0.0001)	(0.0001)	(0.00004)	(0.00004)
Father as a Household Member	-0.002	0.019	0.022	0.035	-0.021	0.025	0.007	0.043
	(0.011)	(0.011)	(0.013)	(0.013)	(0.023)	(0.024)	(0.021)	(0.020)
Number of Household Members	-0.022	-0.014	-0.023	-0.014	-0.019	-0.019	-0.023	-0.012
	(0.003)	(0.003)	(0.003)	(0.003)	(0.006)	(0.006)	(0.005)	(0.005)
Additional Education Related Spending (2006)	0.0001	0.001	0.00003	0.001	-0.002	0.0003	-0.0005	-0.0001
	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.001)	(0.001)	(0.0004)	(0.0003)
Household's # of books: 11 to 50 (2006)	0.052	0.030	0.040	0.038	0.089	0.070	0.042	0.050
	(0.008)	(0.008)	(0.011)	(0.012)	(0.019)	(0.021)	(0.016)	(0.017)
Household's # of books: more than 50 (2006)	0.112	0.102	0.078	0.081	0.138	0.122	0.093	0.094
	(0.012)	(0.013)	(0.015)	(0.017)	(0.027)	(0.028)	(0.020)	(0.019)
Computer Availability (2006)	0.011	0.043	0.028	0.019	0.006	0.047	0.004	0.030
	(0.008)	(0.009)	(0.011)	(0.011)	(0.020)	(0.020)	(0.014)	(0.015)
School in Urban Area (2006)	-0.003	0.046	0.045	0.074	0.045	0.104	0.038	0.102
	(0.023)	(0.024)	(0.019)	(0.020)	(0.066)	(0.071)	(0.034)	(0.034)
Primary and Secondary (2006)	-0.044	-0.016	-0.007	-0.027	-0.056	-0.030	0.030	0.008
	(0.010)	(0.010)	(0.010)	(0.011)	(0.020)	(0.021)	(0.014)	(0.014)
Geographic Region: North	-0.053	-0.003	0.032	0.048	-0.065	-0.005	0.092	0.085
	(0.014)	(0.014)	(0.019)	(0.020)	(0.041)	(0.042)	(0.035)	(0.035)
Geographic Region: South	0.146	0.115	0.202	0.167	0.101	0.029	0.219	0.199
	(0.012)	(0.011)	(0.014)	(0.015)	(0.022)	(0.022)	(0.020)	(0.020)
Pre-school	-0.065	-0.071	-0.067	-0.013	0.025	0.012	0.070	0.106
	(0.016)	(0.016)	(0.021)	(0.022)	(0.040)	(0.043)	(0.040)	(0.040)
Factor	0.998	0.914	0.964	0.890	0.996	0.966	0.935	0.908
	(0.006)	(0.006)	(0.008)	(0.008)	(0.013)	(0.014)	(0.011)	(0.011)

Notes: *Additional Education Related Spending* refers to all expenses concerning the child's education other than tuition fees. *School Tuition*, *Additional Education Related Spending* and *Household's Total Income* are measured in thousands of Chilean pesos.

Table 9: Estimated Coefficients for Tests Scores 2006 Linear Models (Primary and Secondary Schools)

School Type 2004	Public						Voucher					
Switching Decision	Yes				No		Yes				No	
School Type 2006	Public		Voucher				Public		Voucher			
Variable	Lang	Math	Lang	Math	Lang	Math	Lang	Math	Lang	Math	Lang	Math
Intercept	-0.251	-0.512	-0.091	-0.102	-0.243	-0.430	-0.080	-0.254	-0.028	-0.399	-0.016	-0.262
	(0.170)	(0.166)	(0.145)	(0.160)	(0.091)	(0.088)	(0.167)	(0.158)	(0.123)	(0.119)	(0.075)	(0.074)
Male	-0.044	0.231	-0.009	0.248	-0.028	0.282	-0.076	0.188	-0.153	0.197	-0.162	0.181
	(0.041)	(0.040)	(0.035)	(0.038)	(0.024)	(0.024)	(0.028)	(0.028)	(0.022)	(0.021)	(0.013)	(0.013)
Grade Repetition	-0.733	-0.779	-0.630	-0.690	-0.607	-0.618	-0.653	-0.727	-0.606	-0.686	-0.626	-0.692
	(0.073)	(0.072)	(0.059)	(0.064)	(0.039)	(0.038)	(0.049)	(0.052)	(0.042)	(0.040)	(0.026)	(0.026)
Mother's Years of Education	0.039	0.026	0.026	0.027	0.025	0.029	0.027	0.022	0.023	0.024	0.026	0.027
	(0.008)	(0.008)	(0.006)	(0.007)	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)	(0.003)	(0.002)
Father's Years of Education	0.031	0.016	0.016	0.017	0.032	0.032	0.020	0.018	0.022	0.020	0.018	0.020
	(0.007)	(0.007)	(0.007)	(0.006)	(0.004)	(0.004)	(0.006)	(0.005)	(0.004)	(0.004)	(0.003)	(0.002)
Household's Total Income	0.0004	0.0005	0.0005	0.0004	0.0003	0.0004	0.0002	0.0003	0.0001	0.0002	0.0001	0.0002
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.00004)	(0.00004)	(0.00002)	(0.00002)
Father as a Household Member	0.081	0.038	-0.102	0.019	-0.015	0.054	0.048	0.121	0.013	0.036	-0.007	0.021
	(0.048)	(0.047)	(0.042)	(0.045)	(0.028)	(0.028)	(0.034)	(0.034)	(0.027)	(0.027)	(0.016)	(0.016)
Number of Household Members	-0.025	-0.030	-0.021	-0.023	-0.022	-0.023	-0.026	-0.018	-0.023	-0.022	-0.019	-0.011
	(0.012)	(0.012)	(0.011)	(0.012)	(0.007)	(0.007)	(0.009)	(0.009)	(0.008)	(0.007)	(0.005)	(0.004)
Additional Education Spending (2006)	0.001	0.003	0.001	0.001	-0.0001	0.001	0.001	0.001	-0.001	0.001	0.0001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.0005)	(0.0005)	(0.0002)	(0.0002)
HH's # of books: 11 to 50 (2006)	0.075	0.094	0.100	0.044	0.027	-0.016	0.042	0.039	0.002	0.027	0.041	0.029
	(0.042)	(0.044)	(0.039)	(0.039)	(0.021)	(0.021)	(0.033)	(0.033)	(0.027)	(0.027)	(0.013)	(0.013)
HH's # of books: more than 50 (2006)	0.157	0.168	0.160	0.064	0.102	0.073	0.075	0.044	0.071	0.057	0.088	0.066
	(0.058)	(0.059)	(0.054)	(0.056)	(0.026)	(0.028)	(0.038)	(0.038)	(0.031)	(0.031)	(0.014)	(0.014)
Computer Availability (2006)	-0.047	0.013	-0.012	0.025	0.041	0.076	0.003	0.055	0.039	0.057	0.013	0.032
	(0.042)	(0.043)	(0.036)	(0.040)	(0.021)	(0.021)	(0.030)	(0.029)	(0.023)	(0.023)	(0.012)	(0.013)
School in Urban Area (2006)	-0.077	0.279	0.095	0.046	0.045	0.048	0.063	0.012	0.006	0.115	0.032	-0.006
	(0.104)	(0.106)	(0.080)	(0.088)	(0.036)	(0.034)	(0.109)	(0.112)	(0.060)	(0.061)	(0.035)	(0.035)
Primary and Secondary (2006)	-0.135	-0.054	0.023	0.022	-	-	-0.009	0.013	0.022	0.032	-	-
	(0.047)	(0.047)	(0.035)	(0.039)	-	-	(0.035)	(0.034)	(0.021)	(0.020)	-	-
Geographic Region: North	-0.212	-0.096	0.052	-0.034	-0.123	-0.106	-0.097	-0.013	0.056	0.058	0.046	0.085
	(0.085)	(0.080)	(0.101)	(0.103)	(0.052)	(0.054)	(0.039)	(0.039)	(0.034)	(0.034)	(0.021)	(0.020)
Geographic Region: South	0.166	0.116	0.174	0.147	0.072	0.067	0.165	0.159	0.247	0.230	0.263	0.229
	(0.053)	(0.051)	(0.049)	(0.050)	(0.029)	(0.029)	(0.036)	(0.036)	(0.030)	(0.032)	(0.018)	(0.018)
Pre-school	0.023	0.023	-0.077	-0.202	0.013	-0.049	0.041	0.056	0.118	0.106	0.076	0.100
	(0.077)	(0.074)	(0.083)	(0.091)	(0.045)	(0.044)	(0.085)	(0.086)	(0.082)	(0.082)	(0.044)	(0.045)
Factor	1.039	0.967	0.954	0.911	1.015	1.004	0.987	0.978	0.952	0.872	0.981	0.952
	(0.031)	(0.031)	(0.028)	(0.027)	(0.014)	(0.014)	(0.021)	(0.019)	(0.015)	(0.015)	(0.008)	(0.008)

Notes: *Additional Education Related Spending* refers to all expenses concerning the child's education other than tuition fees. *School Tuition*, *Additional Education Related Spending* and *Household's Total Income* are measured in thousands of Chilean pesos.

Table 10: Model and Data Comparison on Schooling Decisions

Total	Only Primary				Primary and Secondary			
Actual	0.66				0.34			
Model	0.66				0.34			
School Type 2004	Public		Voucher		Public		Voucher	
Actual	0.50		0.16		0.08		0.25	
Model	0.50		0.16		0.08		0.25	
Switching Decision					Yes	No	Yes	No
Actual					0.03	0.06	0.07	0.18
Model					0.03	0.06	0.08	0.18
School Type 2006	Public	Voucher	Public	Voucher	Public	Voucher	Public	Voucher
Actual	0.32	0.18	0.06	0.11	0.01	0.02	0.02	0.05
Model	0.32	0.18	0.06	0.11	0.01	0.02	0.03	0.05

Notes:

Table 11: Model and Data Comparison on Tests Scores

Language

Total	Only Primary				Primary and Secondary					
School Type 2004	Public		Voucher		Public			Voucher		
Actual	-0.24		0.01		0.00			0.25		
Model	-0.24		0.01		0.03			0.23		
Switching Decision					Yes		No	Yes		No
School Type 2006	Public	Voucher	Public	Voucher	Public	Voucher		Public	Voucher	
Actual	-0.30	-0.18	-0.06	0.01	-0.05	-0.11	0.02	0.11	0.17	0.31
Model	-0.31	-0.17	-0.07	-0.01	-0.05	-0.06	0.05	0.20	0.11	0.29

Mathematics

Total	Only Primary				Primary and Secondary					
School Type 2004	Public		Voucher		Public			Voucher		
Actual	-0.27		0.00		0.02			0.24		
Model	-0.27		0.00		-0.05			0.22		
Switching Decision					Yes		No	Yes		No
School Type 2006	Public	Voucher	Public	Voucher	Public	Voucher		Public	Voucher	
Actual	-0.32	-0.17	-0.12	0.01	-0.06	-0.11	0.05	0.10	0.18	0.35
Model	-0.32	-0.16	-0.11	-0.03	-0.06	-0.05	0.09	0.20	0.11	0.33

Social Sciences

Total	Only Primary		Primary and Secondary	
School Type 2004	Public	Voucher	Public	Voucher
Actual	-0.24	0.03	0.01	0.26
Model	-.024	0.03	-0.05	0.24

Natural Sciences

Total	Only Primary		Primary and Secondary	
School Type 2004	Public	Voucher	Public	Voucher
Actual	-0.26	-0.01	0.01	0.26
Model	-0.26	-0.01	0.04	0.24

Notes:

Table 12: Public Schools of Excellence

Ranking	School Name	Municipality	Ranking	School Name	Municipality
1	Instituto Nacional	Santiago	26	Liceo Eduardo de la Barra	Valparaíso
2	Liceo Carmela Carvajal	Providencia	27	Colegio Antártica Chilena	Vitacura
3	Liceo República de Siria	Ñuñoa	28	Liceo Luis Cruz Martńez	Calama
4	José Victorino Lastarria	Providencia	29	Liceo Manuel Montt	Pto. Montt
5	Liceo Augusto D'Halmar	Ñuñoa	30	Cultura y Difusión Artística	Talca
6	Liceo No. 1 Javiera Carrera	Santiago	31	Teresa Prats de Sarratea	Santiago
7	Liceo 7 de Niñas	Providencia	32	Rector Abdón Andrade C.	La Unión
8	Inter. Fem. Carmela Silva	Ñuñoa	33	Liceo José Toribio Medina	Ñuñoa
9	Liceo Zapallar	Curicó	34	Liceo de Música	Copiapó
10	Liceo de Aplicación A-9	Santiago	35	Liceo Pablo Neruda	Temuco
11	Liceo Nacional	Maipú	36	Galvarino Riveros C.	Castro
12	Juan Bautista Contardi G.	Pta. Arenas	37	Liceo Mary Graham	V. Alemana
13	Poliv. A. Alessandri Palma	Providencia	38	Liceo J. Mackenna O'Reilly	Puente Alto
14	Manuel Barros Borgono	Santiago	39	Liceo Carmela Carvajal	Osorno
15	Inter. Nac. Barros Arana	Santiago	40	Colegio Cordillera	San Felipe
16	Liceo Abate Molina	Talca	41	Poliv. Abdón Cifuentes	Conachalí
17	República de Brasil	Concepción	42	Instituto Chacabuco	Colina
18	Amanda Labarca	Vitacura	43	Isidora Zegers de Huneeus	Pto. Montt
19	San Francisco del Alba	Las Condes	44	Liceo María Elena	María Elena
20	Rector Armando Robles	Valdivia	45	Liceo B. Vicuña Mackenna	La Florida
21	San Miguel	Liceo Andrés Bello	46	Liceo San Nicolás	San Nicolás
22	Liceo Tajamar	Providencia	47	Enrique Molina Garmendia	Concepción
23	Liceo Lenka Framulic	Ñuñoa	48	Liceo Octavio Palma Pérez	Arica
24	Liceo Óscar Castro Zúniga	Rancagua	49	Liceo Federico Varela	Chañaral
25	Liceo Los Ángeles	Los Ángeles	50	Liceo de Niñas	Concepción

Notes:

Table 13: Estimated Treatment Effects

Language			
School Decision Path	**ATE**	**TT**	**TUT**
Only Primary, Public 8th grade	0.05***	0.04***	0.06***
Only Primary, Voucher 8th grade	0.04***	0.03***	0.04***
Primary and Secondary, Public 8th grade, Switching	0.03***	0.03***	0.03***
Primary and Secondary, Voucher 8th grade, Switching	0.38***	0.43***	0.27***
Mathematics			
School Decision Path	**ATE**	**TT**	**TUT**
Only Primary, Public 8th grade	0.06***	0.05***	0.07***
Only Primary, Voucher 8th grade	0.06***	0.05***	0.07***
Primary and Secondary, Public 8th grade, Switching	0.01***	0.002	0.01***
Primary and Secondary, Voucher 8th grade, Switching	0.35***	0.41***	0.23***

Notes:

Table 14: Proportion of people with positive potential gains if treated

		Language		**Mathematics**	
School Decision Path		%	f	%	f
Only Primary, Public 8th grade	$Y_1 - Y_0 > 0$	0.83	-0.03	0.87	0.02
	$Y_1 - Y_0 < 0$	0.17	0.55	0.13	0.46
Only Primary, Voucher 8th grade	$Y_1 - Y_0 > 0$	0.62	0.00	0.67	0.01
	$Y_1 - Y_0 < 0$	0.38	0.47	0.33	0.51
Primary and Secondary, Public 8th grade, Switching	$Y_1 - Y_0 > 0$	0.54	-0.39	0.48	-0.41
	$Y_1 - Y_0 < 0$	0.46	-0.08	0.52	-0.10
Primary and Secondary, Voucher 8th grade, Switching	$Y_1 - Y_0 > 0$	0.64	-0.30	0.61	-0.42
	$Y_1 - Y_0 < 0$	0.36	-0.20	0.39	-0.02

Notes:

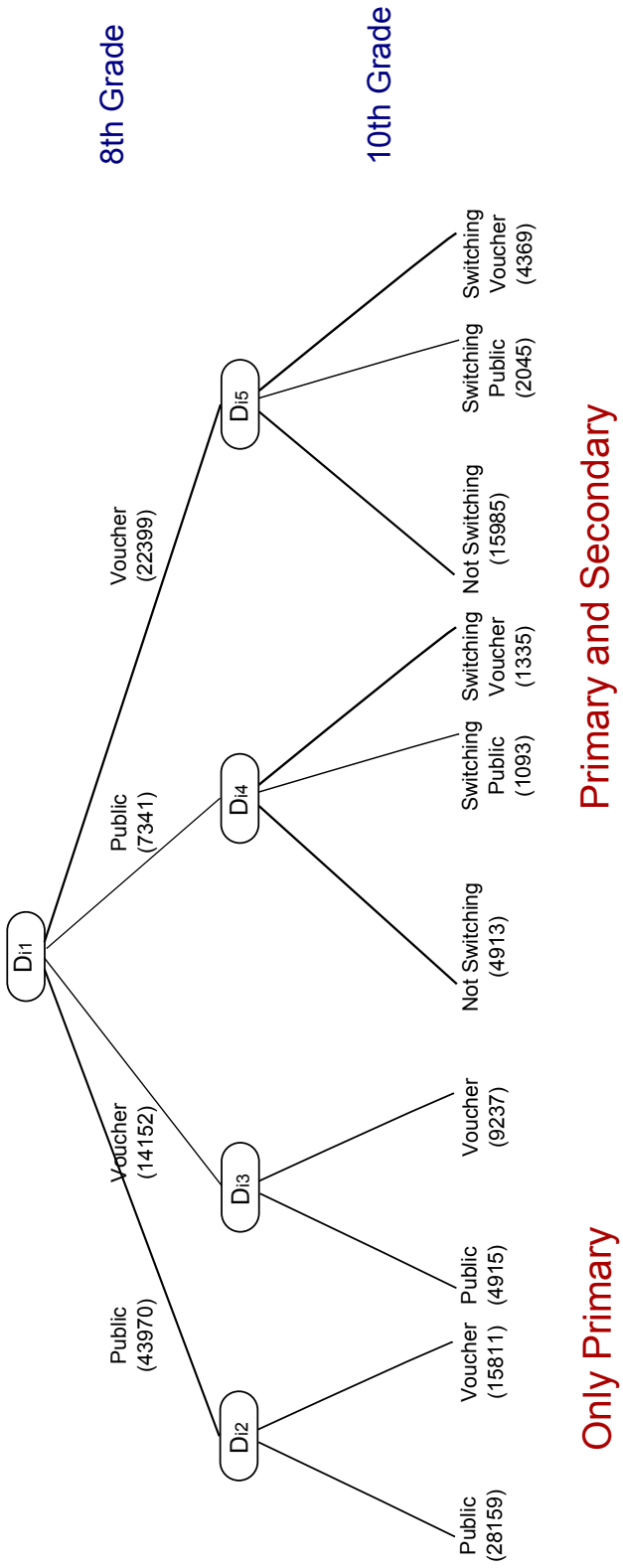
Table 15: Proportion of individuals making wrong decisions

		Language		**Mathematics**	
School Decision Path		%	f	%	f
Only Primary, Public 8th grade	$Y_1 - Y_0 \mid D = 1 < 0$	0.21	0.56	0.16	0.47
	$Y_0 - Y_1 \mid D = 0 < 0$	0.85	-0.04	0.89	0.00
Only Primary, Voucher 8th grade	$Y_1 - Y_0 \mid D = 1 < 0$	0.40	0.46	0.35	0.51
	$Y_0 - Y_1 \mid D = 0 < 0$	0.65	0.01	0.71	0.03
Primary and Secondary, Public 8th grade, Switching	$Y_1 - Y_0 \mid D = 1 < 0$	0.46	-0.09	0.53	-0.12
	$Y_0 - Y_1 \mid D = 0 < 0$	0.54	-0.38	0.49	-0.39
Primary and Secondary, Voucher 8th grade, Switching	$Y_1 - Y_0 \mid D = 1 < 0$	0.39	-0.21	0.40	-0.03
	$Y_0 - Y_1 \mid D = 0 < 0$	0.68	-0.01	0.64	-0.11

Notes:

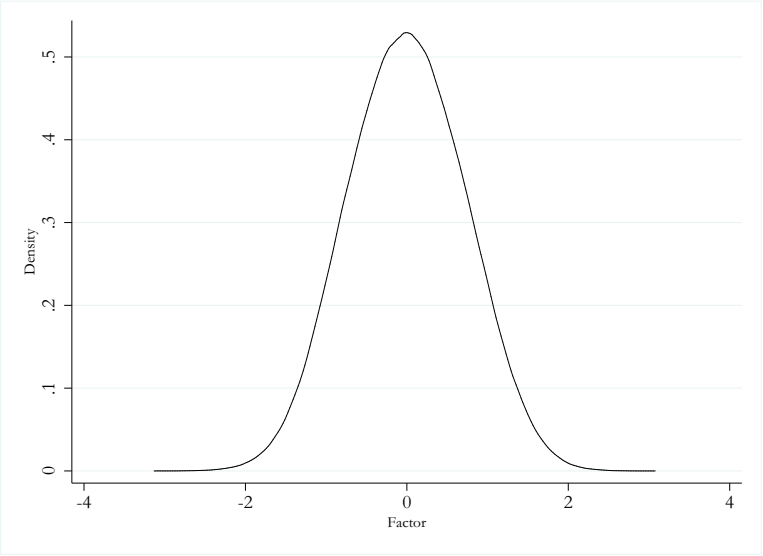
B Figures

Figure 1: Scheme of Decisions



Notes:

Figure 2: Distribution of Factor



$$f \sim p_1 N(\mu_1, \sigma_1^2) + p_2 N(\mu_2, \sigma_2^2) + p_3 N(\mu_3, \sigma_3^2)$$

where

$$\mu = (0.12, \quad -0.37, \quad 0.75)$$

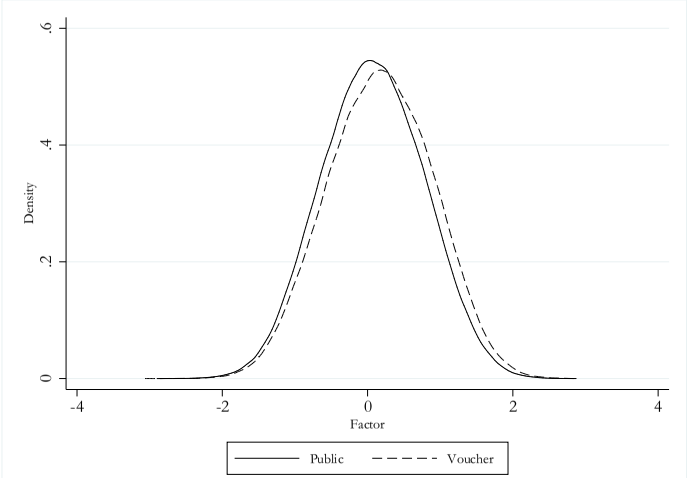
$$\sigma = (4.39, \quad 2.54, \quad 3.91)$$

$$\mathbf{p} = (0.18, \quad 0.57, \quad 0.25)$$

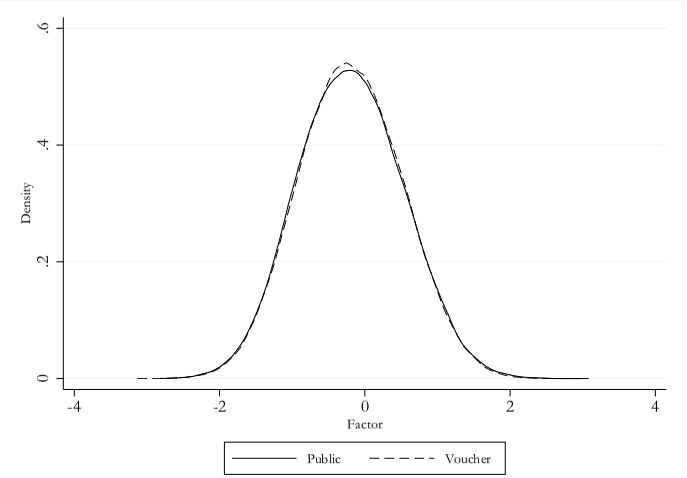
Notes:

Figure 3: Distribution of Factor by School Type in 8th grade

Only Primary



Primary and Secondary

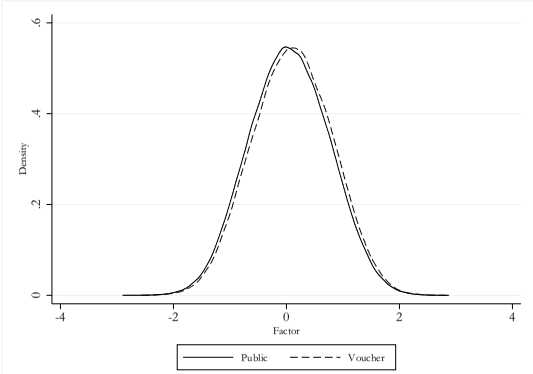


Notes:

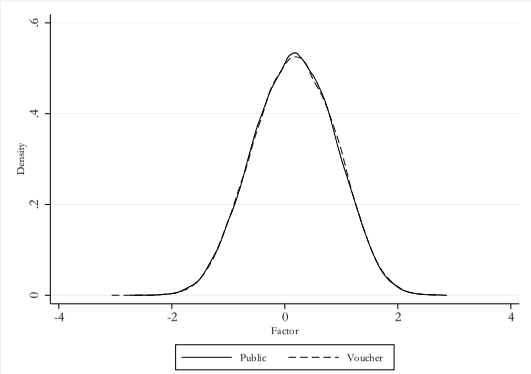
Figure 4: Distribution of Factor by School Type in 10th grade

(A) Only Primary

i. Public 8th grade

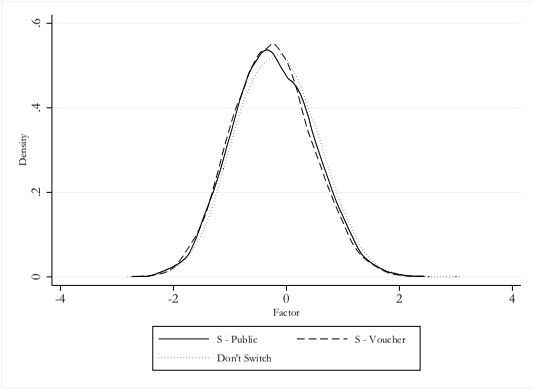


ii. Voucher 8th grade

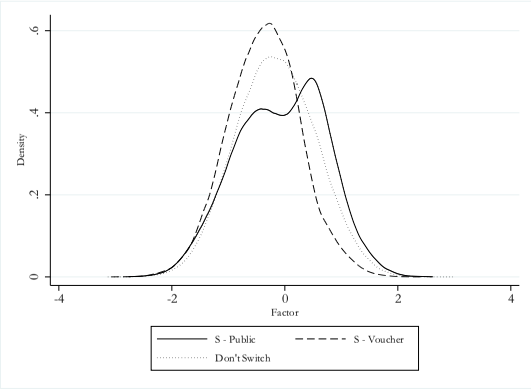


(B) Primary and Secondary

i. Public 8th grade



ii. Voucher 8th grade

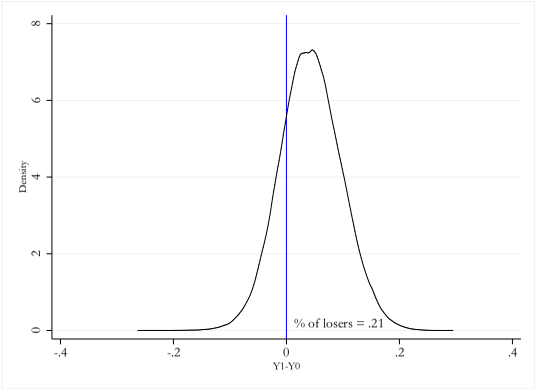


Notes:

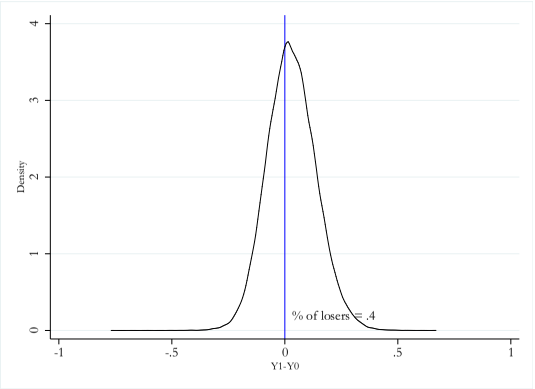
Figure 5: Distribution of TT Parameter (Only Primary)

(A) Language

i. Public 8th grade

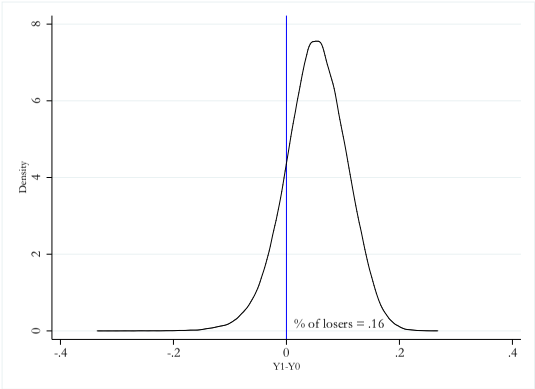


ii. Voucher 8th grade

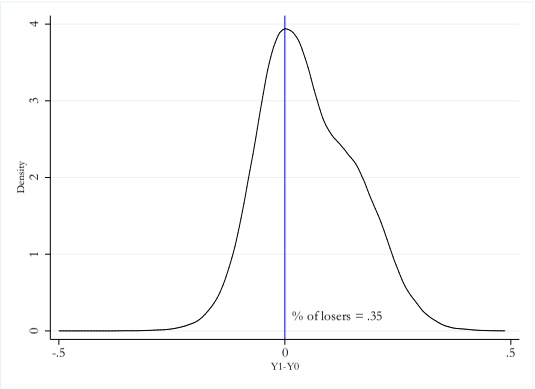


(B) Mathematics

i. Public 8th grade



ii. Voucher 8th grade

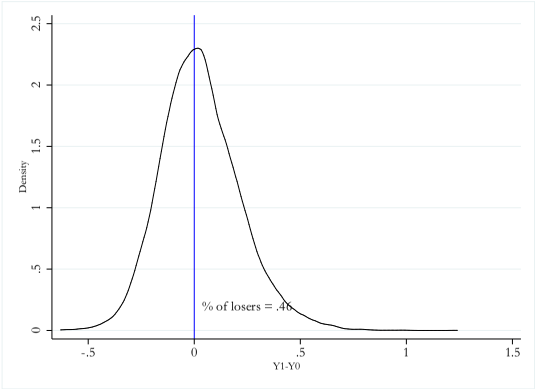


Notes: Treatment is attending to a Voucher school in 10th grade.

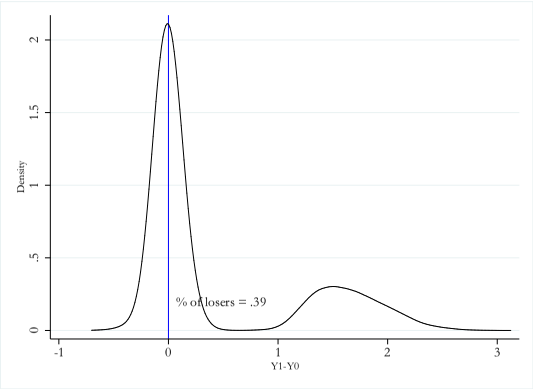
Figure 6: Distribution of TT Parameter (Primary and Secondary, Switched School)

(A) Language

i. Public 8th grade

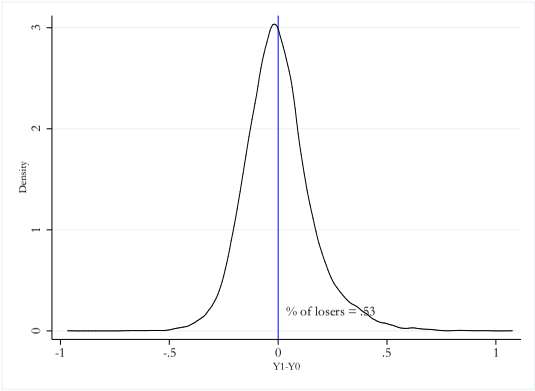


ii. Voucher 8th grade

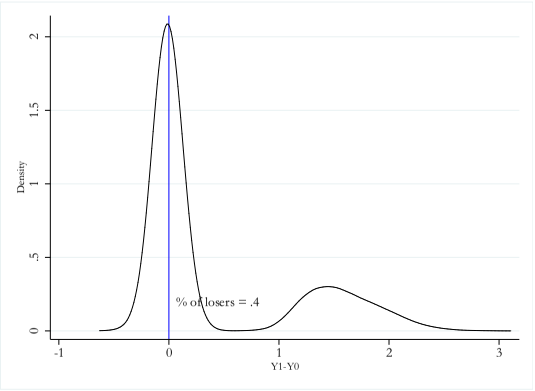


(B) Mathematics

i. Public 8th grade



ii. Voucher 8th grade

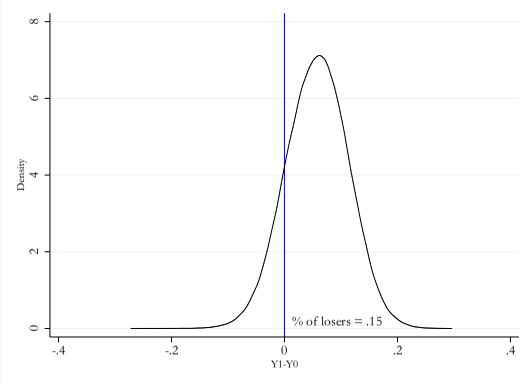


Notes: Treatment is attending to a Voucher school in 10th grade.

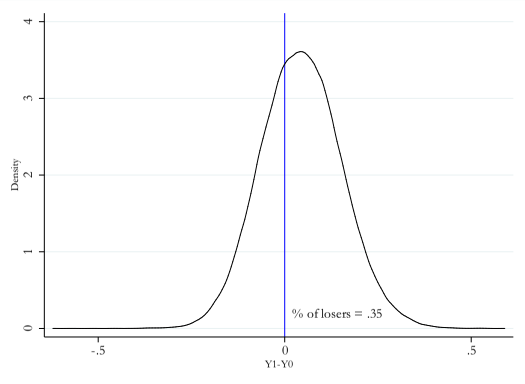
Figure 7: Distribution of TUT Parameter (Only Primary)

(A) Language

i. Public 8th grade

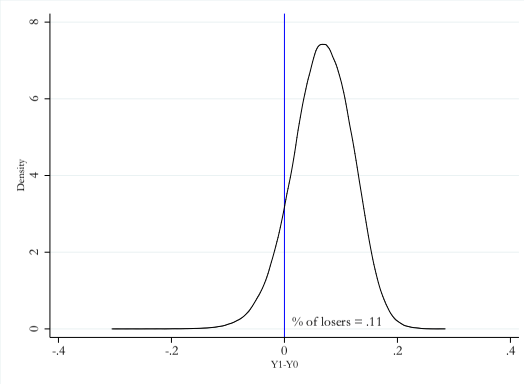


ii. Voucher 8th grade

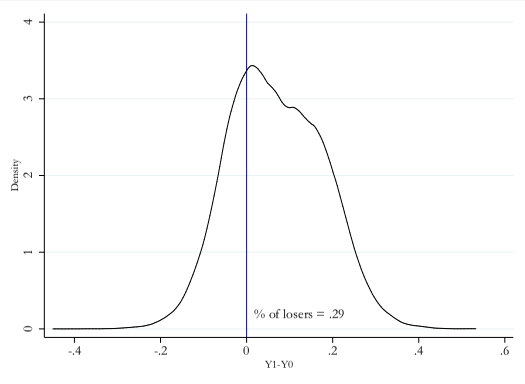


(B) Mathematics

i. Public 8th grade



ii. Voucher 8th grade

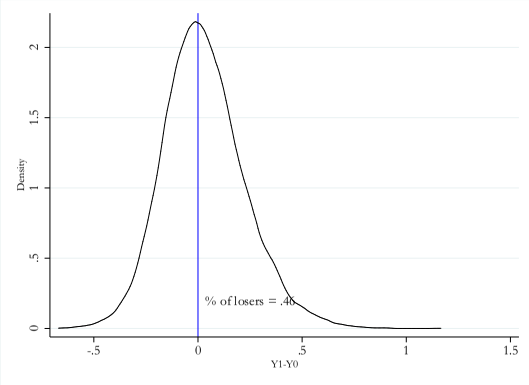


Notes: Treatment is attending to a Voucher school in 10th grade.

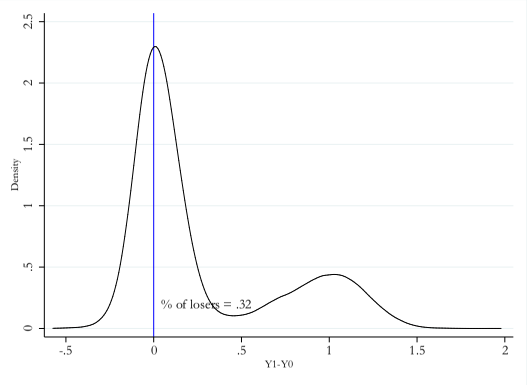
Figure 8: Distribution of TUT Parameter (Primary and Secondary, Switched School)

(A) Language

i. Public 8th grade

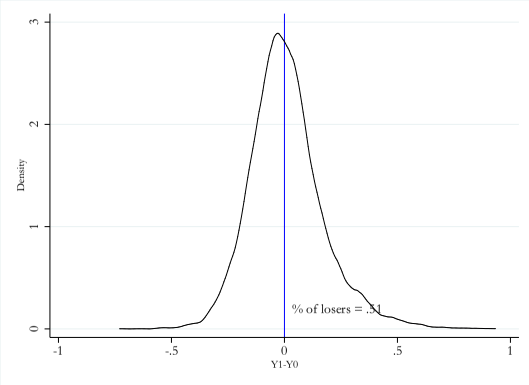


ii. Voucher 8th grade

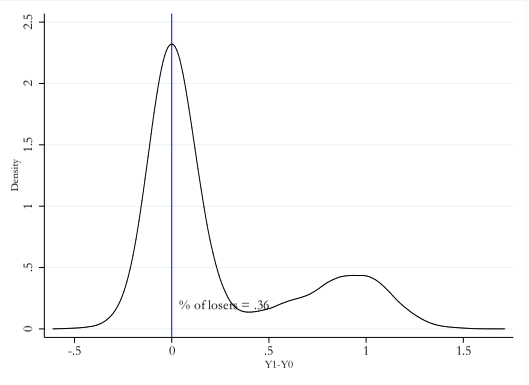


(B) Mathematics

i. Public 8th grade



ii. Voucher 8th grade

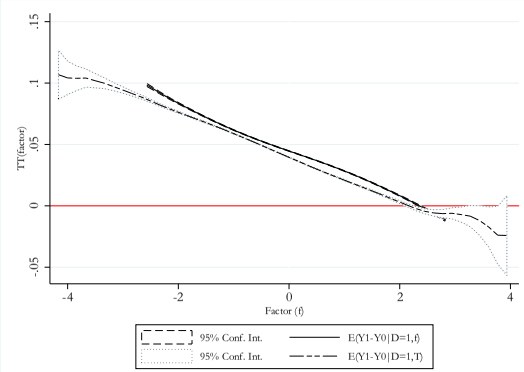


Notes: Treatment is attending to a Voucher school in 10th grade.

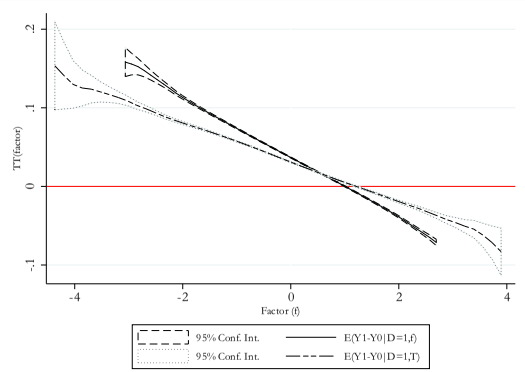
Figure 9: TT Parameter as a function of Unobserved Ability and Initial Test Scores (Only Primary)

(A) Language

i. Public 8th grade

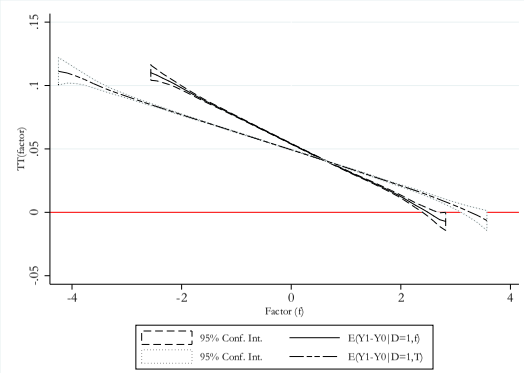


ii. Voucher 8th grade

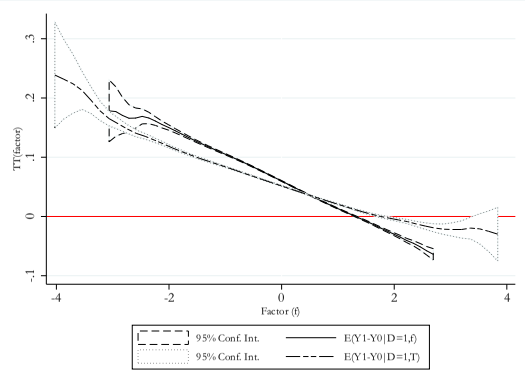


(B) Mathematics

i. Public 8th grade



ii. Voucher 8th grade

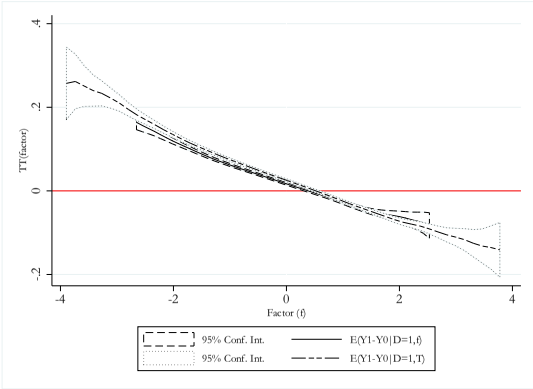


Notes: Treatment is attending to a Voucher school in 10th grade.

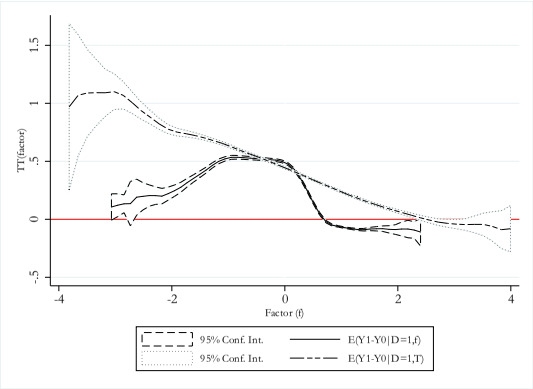
Figure 10: TT Parameter as a function of Unobserved Ability and Initial Test Scores (Primary and Secondary, Switched School)

(A) Language

i. Public 8th grade

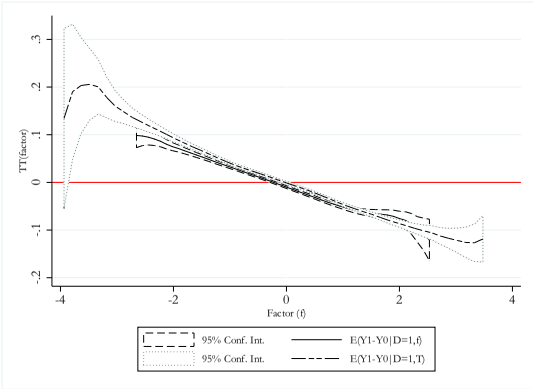


ii. Voucher 8th grade

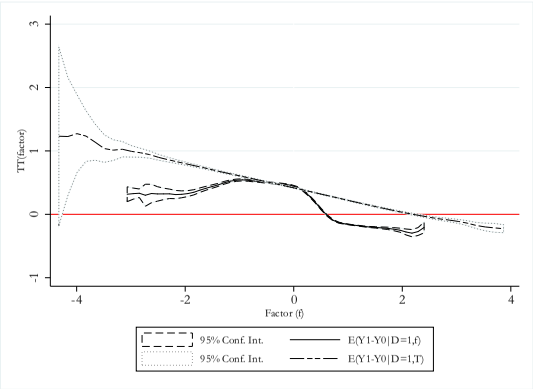


(B) Mathematics

i. Public 8th grade



ii. Voucher 8th grade

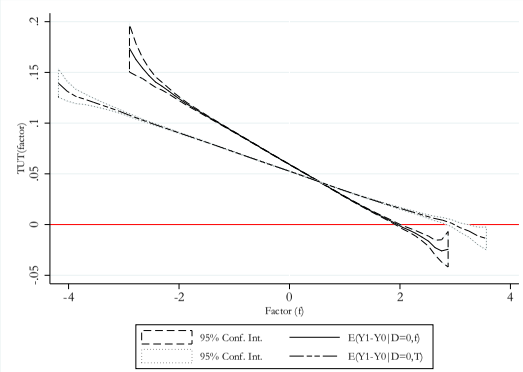


Notes: Treatment is attending to a Voucher school in 10th grade.

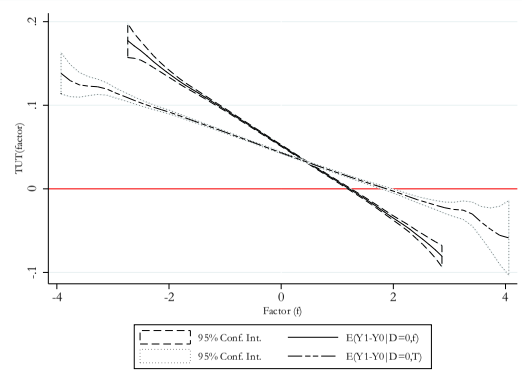
Figure 11: TUT Parameter as a function of Unobserved Ability and Initial Test Scores (Only Primary)

(A) Language

i. Public 8th grade

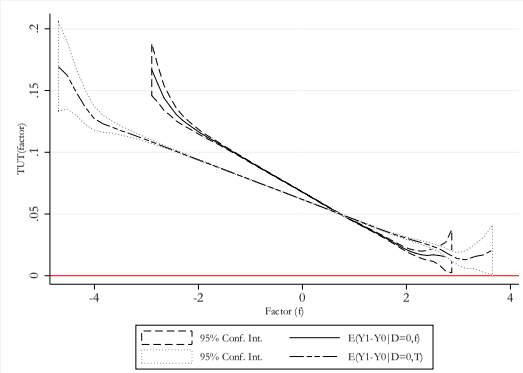


ii. Voucher 8th grade

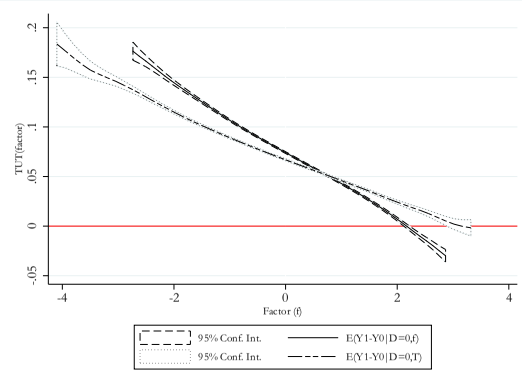


(B) Mathematics

i. Public 8th grade



ii. Voucher 8th grade

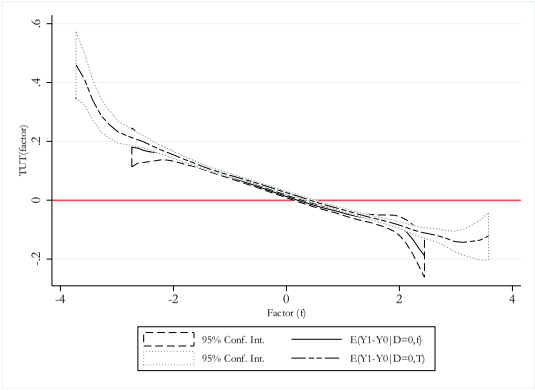


Notes: Treatment is attending to a Voucher school in 10th grade.

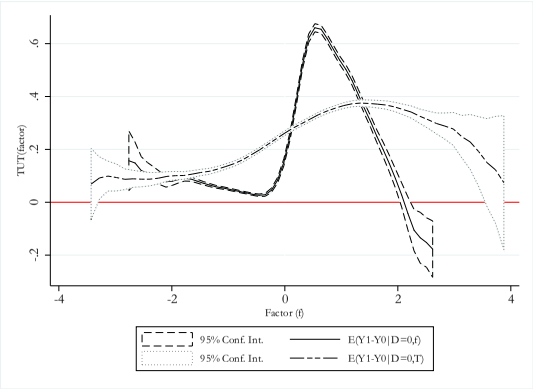
Figure 12: TUT Parameter as a function of Unobserved Ability and Initial Test Scores (Primary and Secondary, Switched School)

(A) Language

i. Public 8th grade

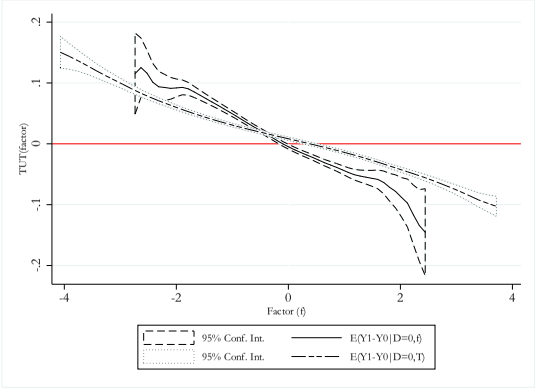


ii. Voucher 8th grade

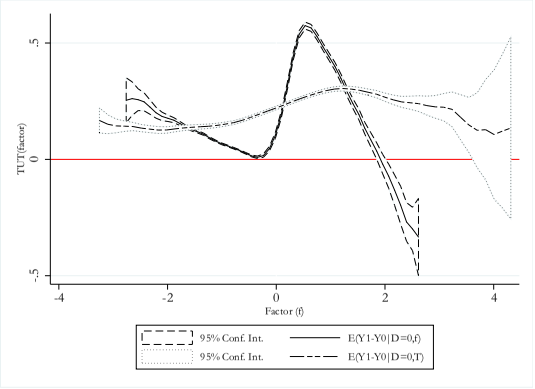


(B) Mathematics

i. Public 8th grade



ii. Voucher 8th grade



Notes: Treatment is attending to a Voucher school in 10th grade.