Unobserved Heterogeneity, School Choice and The Effect of Voucher School: Evidence from Chile

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Introduction

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- We assess the relative performance of private-voucher schools
- We use panel data of 8th and 10th graders
- We model a structural model of sequential schooling decisions with endogenous outcomes and unobserved heterogeneity
- We calculate Treatment Effects of attending a private-voucher school (ATE, TT, TUT)

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- We use panel data of 8th and 10th graders
- We model a structural model of sequential schooling decisions with endogenous outcomes and unobserved heterogeneity
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We find a positive effect of private-voucher education, and an important role of unobserved ability in decisions and outcomes

The Chilean School System

After 1981, three types of schools were established:

- **Public schools**. Financed by the per-student voucher subsidy and administered by local municipalities. They are not allowed to select students, and have dismissal restrictions.
- **Private-voucher schools**. Financed by the per-student voucher subsidy and run by privates. Selection processes are allowed, and they can freely hire and dismiss teachers.
- **Private-fee-paying schools**. Financed by the fees charged to parents and run by privates. They behave as profit-maximizing firms.

Literature Review

- Factors underlying school choice: Gallego and Hernando (2009); and Makovec, Mizala and Barrera (2010)
- Link between socioeconomic status and academic achievement: Mizala, Romaguera and Ostoic (2005); and Mizala, Romaguera and Urquiola (2006)
- Private-voucher schools' relative performance: Mizala and Romaguera (2000); Tokman (2002); Sapelli and Vial (2005); Contreras and Santos (2009); and Lara, Mizala and Repetto (2009)

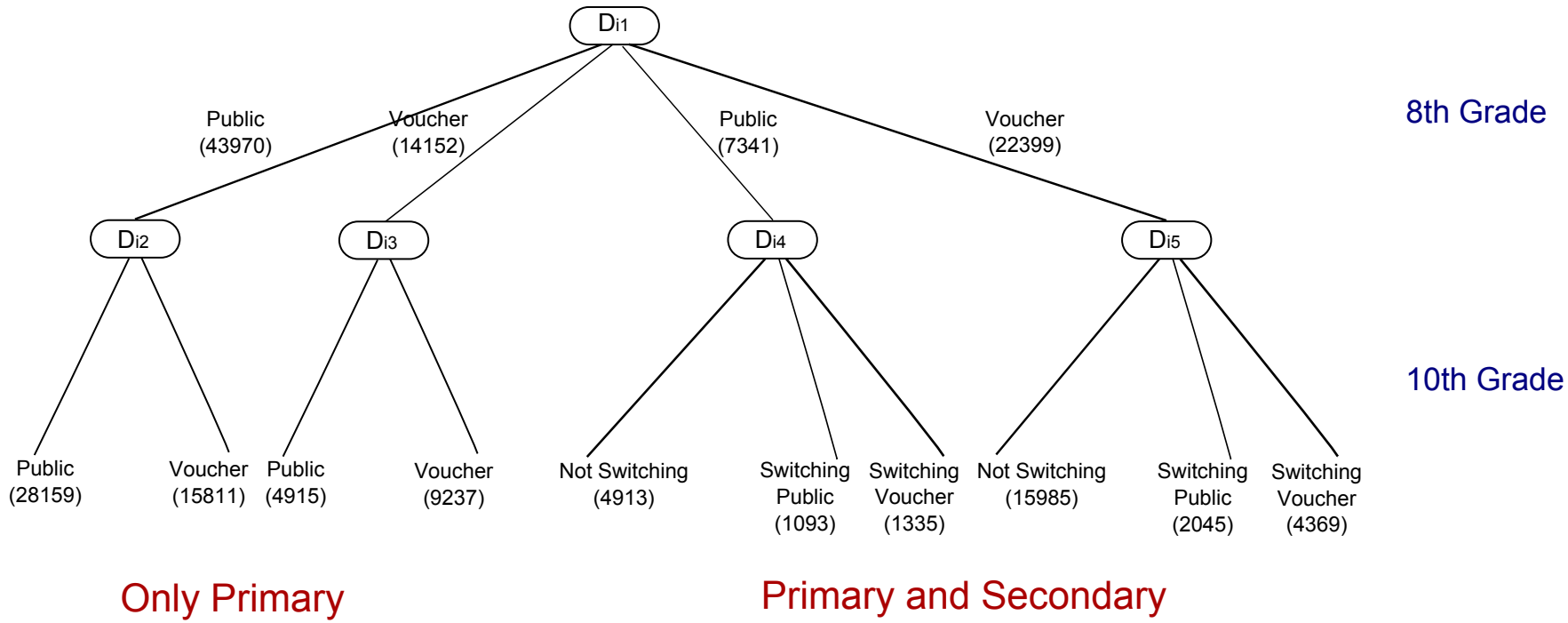
Model for School Choice and Test Scores under Unobserved Heterogeneity

1. Schooling decisions are modeled in two periods of time: 8th and 10th grades
2. Two dimensions of decisions are taken into account: voucher vs. public; **and** whether or not students are forced to switch schools
3. The decision process depends on observed and unobserved characteristics
4. Test scores are observed conditional on the optimal decision, and are also determined by observed and unobserved characteristics
5. The unobserved heterogeneity is interpreted as a combination of different inherent abilities (cognitive and non-cognitive)

Scheme of Decisions

Back to Estimates | Back to Analysis | Back to TE 1 | Back to TE 2

Figure 1: Scheme of Decisions



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

- Parents decide s^*, the optimal school-type:

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

where

$$I(s) \quad = \quad \gamma_s Z(s) + \eta(s) \qquad \text{for } s = 1, \ldots, \bar{S}.$$

- We also observe tests scores given s^*:

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

- 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

$$\begin{aligned} \eta(s) &= \alpha_s f + \nu(s) \\ \varepsilon(s) &= \lambda_s f + \tau(s) \qquad \text{for } s = 1, \ldots, \bar{S}, \end{aligned}$$

  where we assume $\nu(s) \perp\!\!\!\perp \tau(s) \perp\!\!\!\perp f$
- This model is non-parametrically identified

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

- Conditional on the school-type in primary school (s^p), parents decide the type of secondary school, s^*:

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

where

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

- Test scores are modeled as

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

- And, as before, we assume $\nu(s|s^p) \perp\!\!\!\perp \tau(s|s^p) \perp\!\!\!\perp f$

Empirical Implementation

The key insight is that, conditional on unobserved abilities, all error terms are mutually independent. Thus, likelihood function can be written as:

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

- We also assume:

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

- The model is estimated using Markov Chain Monte Carlo (MCMC) methods

Data

- We construct a two-period panel using SIMCE 2004 and 2006
- We examine test scores in Language, Mathematics, Social Sciences and Natural Sciences
- We control for family background and environment characteristics (gender, grade repetition, parents' education, attendance to preschool, HH income, HH members, geographic location, access to computer, books, fees, etc.)
- The number of students of our final sample is 87,862

Estimates

Go to Scheme of Decisions

Findings:

- Females perform better on Language tests, but do worse on every other subject
- Particular pattern for the attendance to preschool variable: positive for private-vouchers and negative for public
- The unobserved component of our model is a strong predictor of schooling decisions and test scores:
  - Sorting on school-type in 8th grade
  - Sorting on switching school decisions for secondary education
  - Positive effect on test scores, at all schooling levels

Simulations and Goodness of Fit

- We simulate our model using the estimated coefficients and the sample data
- We draw samples of the unobserved factor and make predictions of schooling choices and outcomes

Table 1: Goodness of Fit - Schooling Decisions

Total	Only Primary				Primary and Secondary			
Actual	0.66				0.34			
Model	0.66				0.34			
p-value[a]	0.78				0.78			
School Type 2004	Public		Voucher		Public		Voucher	
Actual	0.76		0.24		0.25		0.75	
Model	0.75		0.25		0.25		0.75	
p-value[a]	0.66		0.66		0.65		0.65	
Switching Decision					No	Yes	No	Yes
Actual					0.67	0.33	0.71	0.29
Model					0.67	0.33	0.70	0.30
p-value[a]					0.94	0.94	0.03	0.03
School Type 2006	Public	Voucher	Public	Voucher	Public	Voucher	Public	Voucher
Actual	0.64	0.36	0.35	0.65	0.45	0.55	0.32	0.68
Model	0.64	0.36	0.35	0.65	0.45	0.55	0.33	0.67
p-value[a]	0.84	0.84	0.87	0.87	0.92	0.92	0.28	0.28

Table 2: Goodness of Fit - Test Scores

Language

Total	Only Primary			
School Type 2004	Public		Voucher	
Actual	-0.24 (0.93)		0.01 (0.96)	
Model	-0.24 (0.94)		0.01 (0.95)	
p-value[a]	0.04		0.00	
School Type 2006	Public	Voucher	Public	Voucher
Actual	-0.30 (0.93)	-0.18 (0.91)	-0.06 (0.98)	0.01 (0.93)
Model	-0.31 (0.93)	-0.17 (0.90)	-0.07 (0.99)	-0.01 (0.93)
p-value[a]	0.00	0.00	0.00	0.00

Mathematics

Total	Only Primary			
School Type 2004	Public		Voucher	
Actual	-0.27 (0.90)		0.00 (0.96)	
Model	-0.27 (0.92)		0.00 (0.93)	
p-value[a]	0.00		0.00	
School Type 2006	Public	Voucher	Public	Voucher
Actual	-0.32 (0.91)	-0.17 (0.91)	-0.12 (0.94)	0.01 (0.93)
Model	-0.32 (0.91)	-0.16 (0.90)	-0.11 (0.95)	-0.03 (0.93)
p-value[a]	0.00	0.00	0.00	0.00

Table 3: Goodness of Fit - Test Scores

Language

Total	Primary and Secondary					
School Type 2004	Public			Voucher		
Actual	0.00 (1.06)			0.25 (0.95)		
Model	0.03 (1.00)			0.23 (0.94)		
p-value[a]	0.00			0.00		
Switching Decision	No	Yes		No	Yes	
School Type 2006		Public	Voucher		Public	Voucher
Actual	0.02 (1.09)	-0.05 (0.95)	-0.11 (0.93)	0.31 (0.96)	0.11 (0.99)	0.17 (0.94)
Model	0.05 (0.99)	-0.05 (1.02)	-0.06 (0.95)	0.29 (0.94)	0.20 (1.00)	0.11 (0.95)
p-value[a]	0.00	0.00	0.00	0.00	0.00	0.00

Mathematics

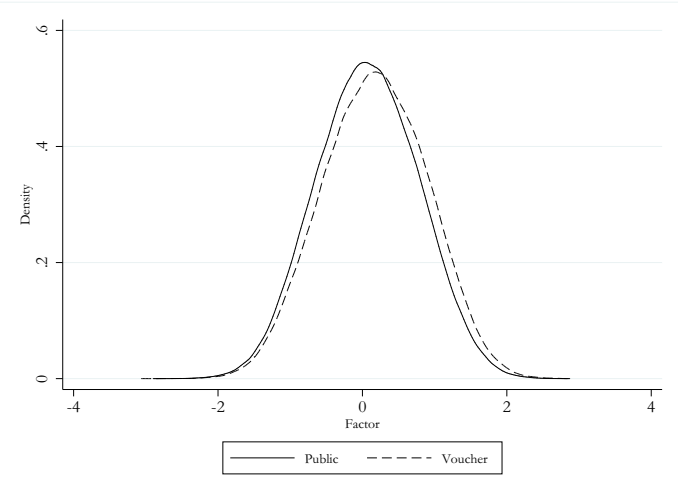
Total	Primary and Secondary					
School Type 2004	Public			Voucher		
Actual	0.02 (1.07)			0.24 (0.96)		
Model	-0.05 (0.98)			0.22 (0.95)		
p-value[a]	0.00			0.00		
Switching Decision	No	Yes		No	Yes	
School Type 2006		Public	Voucher		Public	Voucher
Actual	0.05 (1.11)	-0.06 (0.93)	-0.11 (0.93)	0.35 (0.95)	0.10 (0.99)	0.18 (0.92)
Model	0.09 (1.01)	-0.06 (0.98)	-0.05 (0.94)	0.33 (0.93)	0.20 (1.99)	0.11 (0.93)
p-value[a]	0.00	0.00	0.00	0.00	0.00	0.00

Sorting on Ability

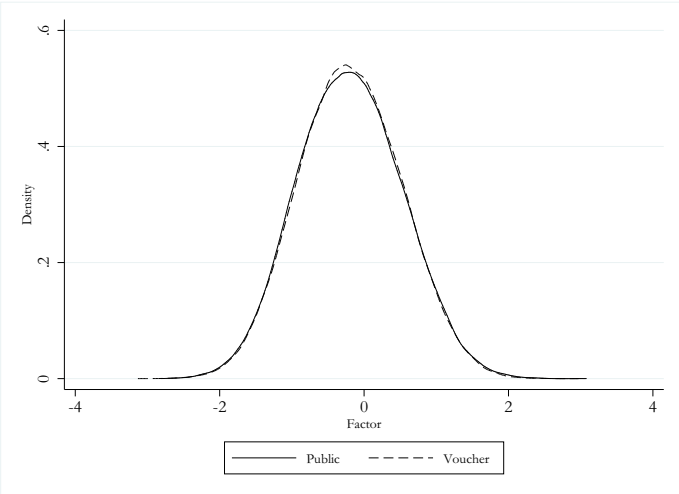
Go to Scheme of Decisions

Figure 2: Distribution of Factor by School Type in 8th grade

Only Primary



Primary and Secondary

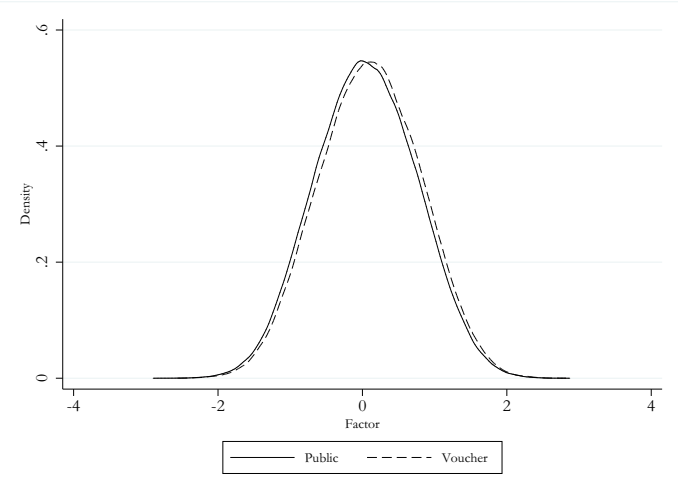


Go to Scheme of Decisions

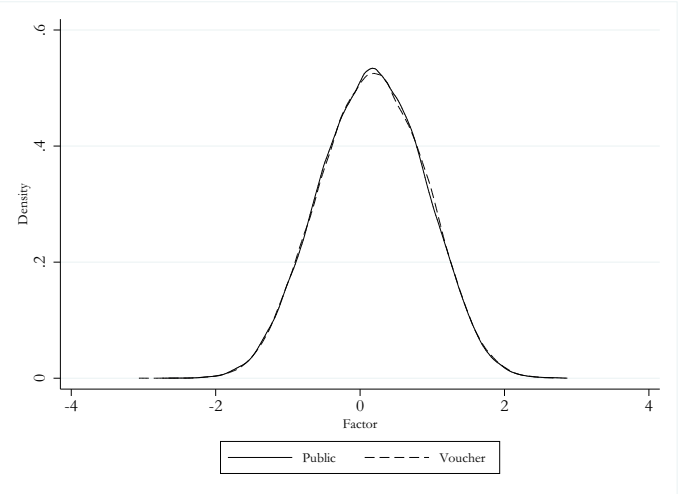
Figure 3: Distribution of Factor by School Type in 10th grade

(A) Only Primary

i. Public 8th grade



ii. Voucher 8th grade

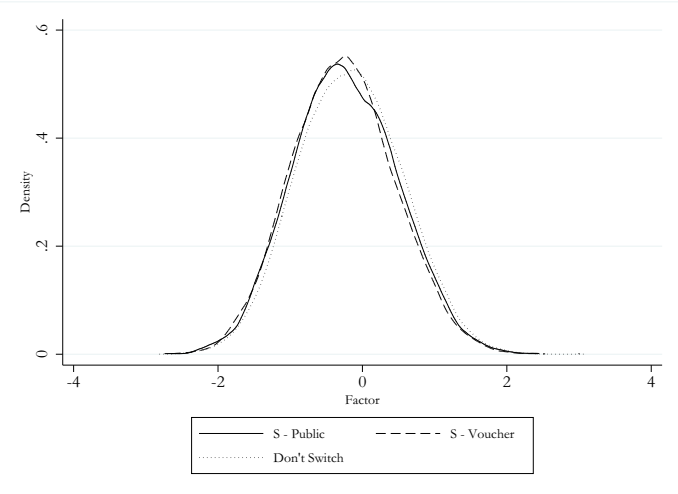


Go to Scheme of Decisions

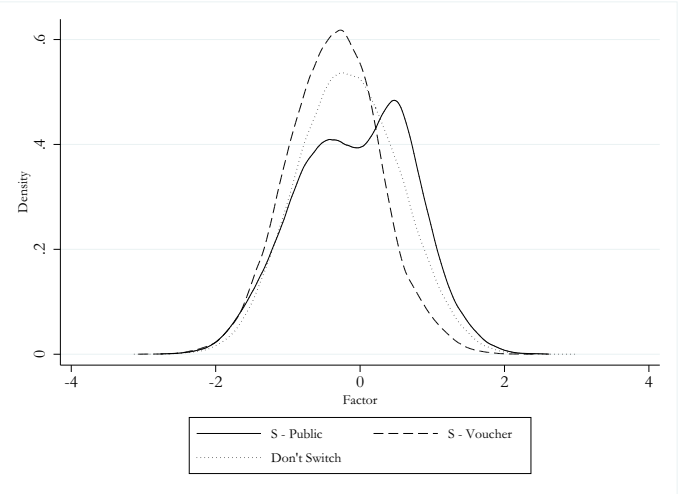
Figure 4: Distribution of Factor by School Type in 10th grade

(B) Primary and Secondary

i. Public 8th grade



ii. Voucher 8th grade



Treatment Effects

- We assess the return of attending a voucher school in 10th grade using ATE, TT, TUT treatment parameters
- Binary set-up: Let Y_1 denote test scores for students in voucher schools, and Y_0 denote test scores for students in public schools. Let also D denote the observed treatment participation. We define

$$
\begin{aligned}
ATE &= \int\int E(Y_1 - Y_0 \mid X = x, f = \theta) dF_{X,f}(x, \theta) \\
TT &= \int\int E(Y_1 - Y_0 \mid X = x, f = \theta, D = 1) dF_{X,f}(x, \theta) \\
TUT &= \int\int E(Y_1 - Y_0 \mid X = x, f = \theta, D = 0) dF_{X,f}(x, \theta)
\end{aligned}
$$

Go to Scheme of Decisions

Table 4: Estimated Treatment Effects

Language			
Schooling 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			
Schooling 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^{***}

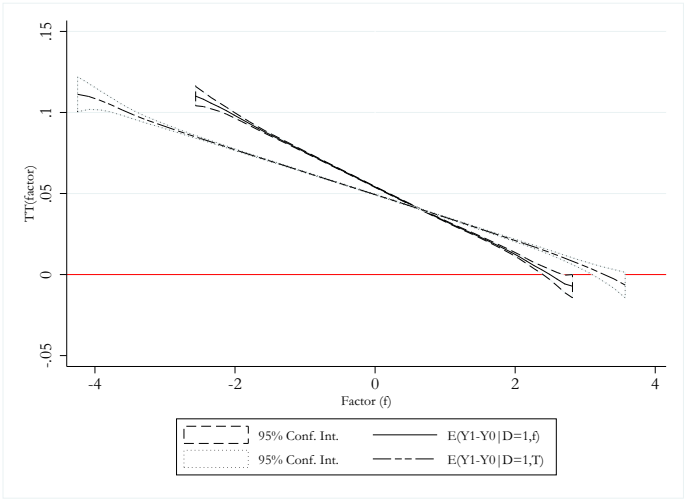
Go to Scheme of Decisions

Table 5: People with positive potential gains if treated

		Language		Mathematics	
School Decision Path		**%**	$\bar{f}$	**%**	$\bar{f}$
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

Figure 5: TT Parameter as a Function of Unobserved Ability and Initial Test Scores (Only Primary)

i. Public 8th grade



ii. Voucher 8th grade

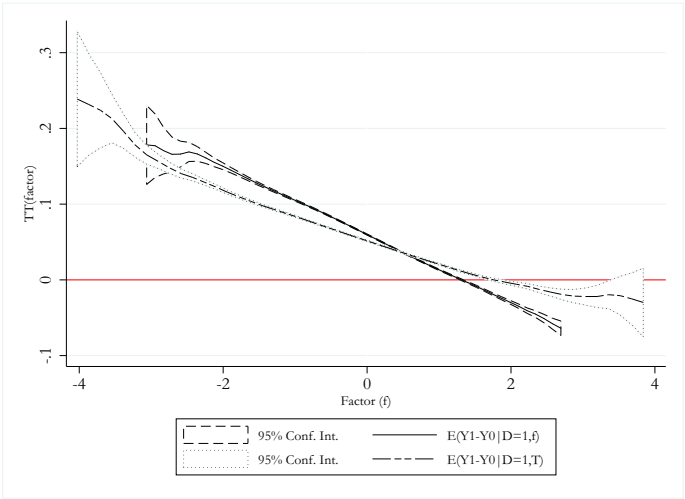
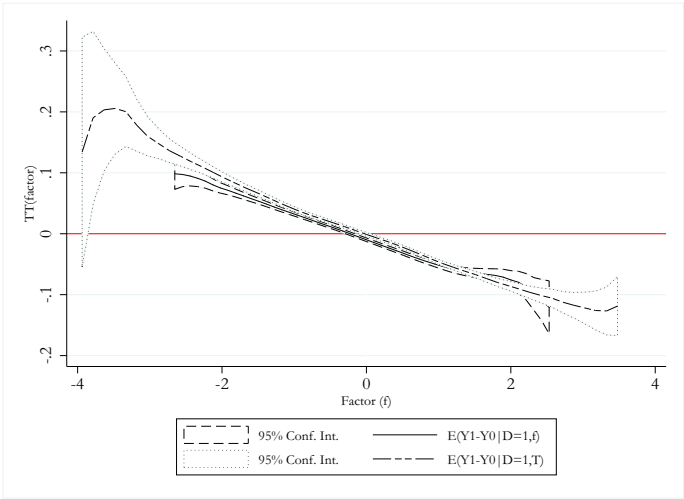
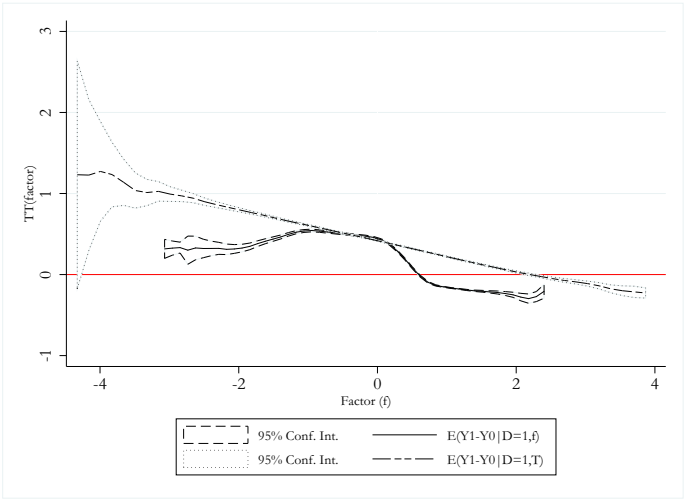


Figure 6: TT Parameter as a Function of Unobserved Ability and Initial Test Scores (Primary and Secondary, Switched School)

i. Public 8th grade



ii. Voucher 8th grade



Final Comments

- Our results suggest that the effect of attending a private-voucher school is positive and statistically significant
- The unobserved component of our model is a strong predictor of the model, and some interesting patterns are found on the sorting on ability:
  - Students in private-voucher schools are on average more able than students in public schools, in 8th grade
  - When facing the switching decision at the end of 8th grade, students switching from a voucher school to a public one are the most able ones
- The benefits of attending a private-voucher school are larger for students with low ability
- From the point of view of public policies, our results suggest to encourage the attendance to private-voucher schools