

NBER WORKING PAPER SERIES

WHEN SCHOOLS COMPETE, HOW DO THEY COMPETE?  
AN ASSESSMENT OF CHILE'S NATIONWIDE  
SCHOOL VOUCHER PROGRAM

Chang-Tai Hsieh  
Miguel Urquiola

Working Paper 10008  
<http://www.nber.org/papers/w10008>

NATIONAL BUREAU OF ECONOMIC RESEARCH  
1050 Massachusetts Avenue  
Cambridge, MA 02138  
September 2003

For useful comments, we thank Harold Alderman, Roland Benabou, Julian Betts, Eric Bettinger, Stephen Coate, Angus Deaton, Milton Friedman, Varun Gauri, Roger Gordon, James Heckman, Patrick McEwan, Derek Neal, Lant Pritchett, Pilar Romaguera, Richard Romano, Cecilia Rouse, Norbert Schady, Ernesto Schiefelbein, and particularly David Card, Ken Chay, Darren Lubotsky, and Enrico Moretti. Marco Galván and Lottos Gutierrez provided outstanding research assistance. We thank Dante Contreras, Patrick McEwan, the Chilean Ministries of Education and Planning, and the National Statistics Institute for providing data. We worked on this project while at the World Bank's Development Research Group (Hsieh as a visitor and Urquiola as staff), and are grateful for its hospitality. The Smith-Richardson Foundation provided generous financial support. The views expressed herein are those of the authors and are not necessarily those of the National Bureau of Economic Research.

©2003 by Chang-Tai Hsieh and Miguel Urquiola. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

When Schools Compete, How Do They Compete? An Assessment of Chile's Nationwide School Voucher Program

Chang-Tai Hsieh and Miguel Urquiola

NBER Working Paper No. 10008

September 2003

JEL No. I2, L3, O1

**ABSTRACT**

In 1981, Chile introduced nationwide school choice by providing vouchers to any student wishing to attend private school. As a result, more than 1,000 private schools entered the market, and the private enrollment rate increased by 20 percentage points, with greater impacts in larger, more urban, and wealthier communities. We use this differential impact to measure the effects of unrestricted choice on educational outcomes. Using panel data for about 150 municipalities, we find no evidence that choice improved average educational outcomes as measured by test scores, repetition rates, and years of schooling. However, we find evidence that the voucher program led to increased sorting, as the "best" public school students left for the private sector.

Chang-Tai Hsieh

Department of Economics

549 Evans Hall, #3880

University of California, Berkeley

Berkeley, CA 94720-3880

and NBER

chsieh@econ.berkeley.edu

Miguel Urquiola

SIPA and Department of Economics

Columbia University

1022 International Affairs Building

420 West 118<sup>th</sup> Street

New York, NY 10027

msu2101@columbia.edu

# 1 Introduction

A central argument in the school choice debate is that public schools are inefficient local monopolies, and that educational quality would improve dramatically if only parents were allowed to freely choose between schools. For example, Hoxby (2003) asks “what is the range of productivity over which choice could cause productivity to vary? Recent history suggests that school productivity could be much higher than it is now - 60 to 70 percent higher.” Two arguments underlie this view. First, there is a widely-held belief that private schools are more effective than public schools. Although the evidence from quasi-experiments with vouchers is mixed, if private schools are in fact more efficient, then school choice could raise students’ achievement merely by facilitating their transfer to the private sector.<sup>1</sup> A second, perhaps even more compelling argument for choice comes from the notion that organizations respond to incentives. Therefore, by correctly aligning the incentives public schools face, choice would force their seemingly ossified bureaucracies to improve.

This paper assesses these arguments by examining the impact of a comprehensive school voucher program introduced in Chile. Specifically, in 1981 Chile’s government began to provide vouchers to any student wishing to attend private school, and to tie the budget of public schools to their enrollment. We show that this program, whose essential features remain unchanged 20 years later, created a dynamic educational market: more than a thousand private schools entered the market, and the private enrollment rate increased from 20 to 40 percent by 1988, surpassing the 50 percent mark in many urban areas. The Chilean case thus provides a unique opportunity to analyze the transition from a centrally controlled public school system, to one in which *all* families can freely choose between public and private schools.

To measure the effects of the competitive forces unleashed by the voucher program, we exploit the fact that it had a greater impact in communities with larger markets, and in those where the demand for private schooling appears to have been greater. For example, from 1981 to 1988, the private enrollment rate grew by 11 percentage points more in urban than in rural communities.

---

<sup>1</sup> See Ladd (2002) and Neal (2002) for recent surveys of the large literature on school vouchers.

As long as this differential impact is driven by community characteristics that are fixed over time, we can measure the impact of the voucher program by comparing the *change* in educational outcomes in urban and wealthier communities, to that in communities where private schooling increased by less. Using this approach with panel data for roughly 150 communities in Chile, we consistently fail to find evidence that school choice improved average academic outcomes.<sup>2</sup> Specifically, we find that average test scores did *not* rise any faster in communities where the private sector made greater inroads, and that average repetition and grade-for-age measures *worsened* in such areas (relative to other communities).

This evidence thus suggests that school choice did not improve average schooling outcomes in Chile. However, a natural alternative explanation is that the reallocation of students *did* raise achievement, but that these gains were masked by pre-existing negative trends in communities where the private sector grew by more. We cannot rule out this possibility, but we provide two pieces of evidence that are inconsistent with it. First, we show that our estimates do not change when we introduce a battery of controls for pre-existing and concurrent trends, nor when we use a number of pre-program community characteristics—such as the initial population, urbanization rate, and degree of inequality—as instruments for the differential impact of the voucher program. Admittedly, the controls we use may not capture unobservable trends in school quality, and the instruments may not be ideal, but it is still puzzling that we continue to find no evidence that choice improved schooling quality.

Second, we explore another way to measure whether school quality has improved in Chile, one that does not rely on the differential impact of the voucher program across markets. Namely, we compare the performance of Chilean students in international tests in science and mathematics (widely known as the TIMSS), in which Chile participated in 1970 and 1999. This comparison indicates that despite nearly two decades under an unrestricted school choice regime, the performance of the median Chilean student has not improved relative to that of the median student in other countries.<sup>3</sup>

---

<sup>2</sup> As described later in the paper, we define a community (or school “market”) as a Chilean municipality.

<sup>3</sup> In addition to Chile, twelve other countries participated in the TIMSS in 1970 and 1999. As we document below, after controlling for variables such as per capita GDP growth, changes in enrollment rates, and educational spending per student, the performance of the median Chilean students appears to have

This collective body of evidence presents an enormous puzzle. How can we reconcile it with our instinct that when parents are able to choose between schools, they will select the most effective ones, and that schools should respond to this pressure? Again, it is possible that our estimates are biased by unobserved trends in schooling outcomes. However, an alternative explanation is that when parents are allowed to freely choose between schools, they select those that provide “good” peer groups for their children, which might not necessarily be the most productive. In turn, schools might respond by competing to attract better students, rather than by raising their productivity. Both forces are obviously complementary, and although they will not necessarily improve average school quality, they will tend to result in more stratification between schools.

We provide suggestive evidence that this appears to have happened in Chile – that the main effect of unrestricted school choice was an exodus of “middle-class” students from the public sector. Specifically, we find that in communities where private schools grew by more, there is a greater decline in the socioeconomic status (measured by parental schooling and income) of public school students relative to the community average. In addition, we show that the loss of these students had a major effect on academic outcomes in the public sector. Namely, the performance of public schools (measured by test scores and repetition rates relative to the community average) worsened by more in markets where the voucher program had a larger effect.

The rest of the paper proceeds as follows. We begin by reviewing the institutional details of Chile’s voucher program. We then sketch a simple model of vouchers, and discuss how the usual empirical approaches fit into this framework. Finally, we assess how choice affected achievement and sorting across communities in Chile.

## **2 Chile’s school voucher program: A brief overview**

In 1981, as part of the Pinochet government’s sweeping market-oriented reforms, Chile introduced a nationwide school voucher program. The easiest way to explain this reform is

---

slightly worsened between 1970 and 1999.

to discuss how it modified the manner in which schools were governed and funded. Before the reforms, there were three types of schools in Chile:

- 1) *Fiscal schools*. These public schools were controlled by the national Ministry of Education, which was responsible for all aspects of their operation. It hired and paid teachers, maintained facilities, and designed the curriculum. In 1981, 80 percent of all students were in such institutions.
- 2) *Unsubsidized private schools*. These private institutions did not receive public funding. They charged relatively high tuition and catered primarily to upper income households. Prior to the reforms, they accounted for about 6-7 percent of enrollment.
- 3) *Subsidized private schools*. These institutions did *not* charge tuition, received public subsidies, and were generally religious.<sup>4</sup> The size of the subsidy they received depended on the government's fiscal condition, but averaged 50 percent of nominal per-student spending in the fiscal schools. This aid was supposed to be disbursed at the end of the school year, but was typically delayed by several months, and was therefore eroded by inflation.<sup>5</sup> Prior to the reform, these schools accounted for 15 percent of enrollment.

The 1981 reforms sought to create a nationwide voucher program with financial incentives for both public and private institutions. This initiative had three main components:

- 1) *Decentralization of public schools*. Fiscal schools were transferred from the Ministry of Education to roughly 300 municipalities or "communes", such that they became known as *municipal* schools. The contract between the Ministry and the national teachers' union was abrogated, and public school teachers had to either transfer to municipal schools as common public employees, or resign and reapply for teaching jobs as regular private sector workers. To encourage the latter, the Ministry offered substantial severance payments.
- 2) *Public school funding*. Municipal schools continued to be funded centrally, but municipalities started to receive a *per-student* payment for every child attending their schools.

---

<sup>4</sup> Espínola (1993) states that in 1970, 53 percent of private schools were Catholic and the remaining were Protestant or run by private foundations.

<sup>5</sup> See Schiefelbein (1971). Inflation averaged 5.2 percent per month in the 1970's. Assuming that public school teachers are paid every month, the real value of the stipend would be only 35 percent of real per-student expenditures in the public sector if the stipends were paid on time (at the end of the school year), and 26 percent if the payments were delayed by 6 months.

As a result, enrollment losses came to have a direct effect on their education budgets.

3) *Public funding for private schools.* Most importantly, (non tuition-charging) subsidized private schools began to receive exactly the same per-student payment as the municipal schools.<sup>6</sup> These payments were distributed on a monthly basis, and their initial level was set 30 percent higher than the pre-1981 average spending per student in the public sector. To distinguish these institutions from the subsidized private schools that existed before the reforms, we will call them *voucher* private schools.<sup>7</sup>

Tuition-charging private schools mostly continued to operate without public funding. While they could have stopped charging tuition and started to accept vouchers, these elite institutions in general chose not to do so.

Finally, because voucher programs are often short-lived, it is worth mentioning that the essential features of this system have remained in place over the last 20 years. The center-left coalitions in power since 1990 have chosen to focus their efforts on channeling additional resources to “vulnerable” schools, increasing real educational spending and teacher salaries, and financially rewarding schools with high test scores.<sup>8</sup> Nevertheless, the core of the system – the per-student voucher payments and the freedom to attend any school, religious or not – has been left intact.

### 3 The industrial organization effects of school choice

These reforms led to significant changes in the Chilean educational market. Figure 1 shows that the public sector’s enrollment share hovered around 80 percent throughout the

---

<sup>6</sup> The size of the voucher payment each school receives varies according to: 1) the educational level at which it operates, 2) whether it offers special programs, and 3) its distance from urban centers. Importantly, a given private school receives the same payment as a municipal school with similar characteristics.

<sup>7</sup> In Chile, they continue to be known as subsidized private schools.

<sup>8</sup> These are mainly policies aimed at: i) the worst performing schools – the P900 (*Programa de las 900 Escuelas*) program, ii) the entire K-12 system – the MECE (*Programa de Mejoramiento de la Calidad y Equidad de la Educación Preescolar y Básica*) initiative, iii) rural schools – the MECE-Rural, and iv) rewarding teachers in schools that perform well – the SNED (*Sistema Nacional de Evaluación del Desempeño de los Establecimientos Educativos Subvencionados*). Here we focus on the 1980’s because it is the period in which the voucher program had its largest effects and was the key educational intervention, with the government refraining from compensatory initiatives.

1970's, but fell rapidly after 1981, dipping below the 60 percent level by 1990. The figure also describes the evolution of private schools' participation, which beginning in 1981, can be decomposed into that of voucher and tuition-charging schools. This makes clear that the rise of private enrollment in the 1980's is almost entirely due to the growth of voucher private institutions. By 1986, only five years after the per-student payments were introduced, these schools' market share crossed the 30 percent level, doubling relative to that of the pre-1981 subsidized private sector. In contrast, the participation of the "elite" private schools remained roughly constant over the 1980's, and experienced a gradual but sustained increase during the 1990's.

This transfer of students was accompanied by a large reallocation of resources towards private schools. First, because of voucher financing, the 20 percentage point enrollment shift means that a corresponding percentage of the Ministry of Education's school-related operational expenditures were reallocated to private schools. Second, although the transfer of teachers was more gradual than the shift in enrollment, by 1990 the fraction of teachers working in public schools had also fallen by 20 percentage points.

The aggregate trends in Figure 1 conceal considerable variation in the growth of the private sector across different educational markets. Using Chile's approximately 300 communes as proxies for such markets, Figure 2 (panel A) presents kernel densities of the *change* in private enrollment ratios from 1982 to 1996 for all communes in Chile, and for a subset of urban communes.<sup>9</sup> As can be seen, there was substantial heterogeneity in the impact of the school voucher program across communes. In addition, the impact of the voucher program was generally greater in urban communities.

Table 2 provides further information on the characteristics of the communities that were more affected by the availability of vouchers.<sup>10</sup> The first four columns indicate that the voucher program had a larger effect in urban and populated communes. For example, our point estimates indicate that the private enrollment rate grew by 11 percentage points more in a fully urban than in a wholly rural community. The next two columns suggest that

---

<sup>9</sup> Defined as those with urbanization rates above 80 percent and populations above ten thousand.

<sup>10</sup> We defer a discussion of the data sources until section 5.1. Descriptive statistics are in Table 1.



the voucher program also had a larger effect in more unequal communities, where we proxy inequality by the inter-quartile range in years of schooling among working age adults.

Over time, such differences have produced substantial cross sectional variation in private enrollment, as described in Figure 2 (panel B), which presents density estimates of private participation in 1996.<sup>11</sup> In roughly 40 percent of the urban communes the public sector has become a minority player, and in extreme cases, it accounts for only 20 to 25 percent of all enrollments. Further, this supply response was not limited to growth in pre-existing schools. Figure 3 shows that more than 1,000 private schools were created from 1982 to 1985, increasing their number by almost 30 percent. While the voucher schools that existed prior to 1982 were largely religious institutions, the subsequent entrants are often for-profit enterprises.<sup>12</sup>

A notable fact is that despite extensive private entry and sustained declines in public enrollments, the aggregate number of municipal schools has barely fallen. Municipal officials seem to have been unable or unwilling to close public schools. This leaves open the possibility that public schools did not face strong incentives to compete. This is reinforced by the fact that for these schools, revenue losses are mediated by municipal educational budgets, which makes it possible for them to lose students without automatic consequences on their resources. If indeed incentives were completely blunted for this sector, the gains from school choice would be entirely due to the reallocation of students to the (presumably) more productive private sector.

## 4 Measuring the effects of school choice

There are two issues one has to address to credibly measure the effects of school choice on educational outcomes. The first is how to separate those effects that operate through enhanced school *productivity*, from those that operate through *sorting*. The second concerns

---

<sup>11</sup> As all other data presented henceforth, this figure refers only to the primary school sector (grades 1-8).

<sup>12</sup> Using a sample of urban communes for which we are able to construct a 1982-88 panel of schools (these communes account for about 70 percent of total enrollment in the country), we find that 84 percent of the new private schools in 1988 were private non-religious institutions.

the need for an adequate control group or counterfactual. This section addresses these issues in turn.

## 4.1 Disentangling sorting from productivity

To illustrate how sorting complicates an assessment of the effects of choice, we present a model in which aside from leading to sorting, choice enhances achievement via two channels: public schools improve in response to competition, and private schools are more effective.<sup>13</sup> The model makes two points. First, as long as choice results in sorting, it will be virtually impossible to disentangle how it affects achievement through sorting itself, and how it affects it through enhanced school productivity. Second, faced with this difficulty, the best way to measure the gains from choice is to study how it affects achievement at the market level.

### 4.1.1 A model of choice, sorting, and productivity

Consider a community in which students differ only according to their socioeconomic status (henceforth SES), which is indexed by  $i$  and distributed uniformly between 0 and 1. We assume higher SES students have higher  $i$ 's, and denote this as  $SES_i = \alpha \cdot i$ . Suppose further that educational outcomes (“test scores”) are a function of a student’s SES and the average SES of children in the school she attends – a peer group effect. Furthermore, before the introduction of vouchers in a community  $j$ , all students are enrolled in homogeneous public schools. The test score of student  $i$  in community  $j$  is thus initially given by:

$$T_{ij} = \gamma SES_{ij} + \lambda \overline{SES}_j + \phi \overline{SES}_j \cdot SES_{ij} + \beta_{0j} \quad (1)$$

where  $\overline{SES}_j$  is the average SES of students in the school, and  $\beta_{0j}$  allows for achievement differences across communities. There are two things to note about this expression. First, as long as  $\lambda + \phi \cdot \alpha > 0$  (which we will assume), every student benefits from interacting with

---

<sup>13</sup> The mechanisms in this model are closest to those in Manski (1992), who also allows for both productivity and sorting effects. Epple and Romano (1998) also allow for sorting between private schools, as well as between the public and private sectors, but they do not allow for productivity improvements due to choice.

better peers, but  $\phi$  allows this benefit to differ according to an individual's SES.<sup>14</sup> Second, since we assume that public schools are homogeneous, the average SES of the peer group in each school is simply that of the entire community.

Now, suppose that community  $j$  was chosen to participate in a school voucher program. After the program is introduced, private entry leads to productivity improvements through two channels. First, students who switch to private schools benefit to the extent that these are more effective than (the pre-voucher) public schools. We denote the private productivity advantage as  $\beta_{priv_j}$ . Second, students remaining in public schools may also gain if these improve in response to competitive pressures. We denote this response by  $\beta_{pub_j}$ . In summary, if she switches to the private sector, a student's score is given by:

$$T_{ij,priv} = \beta_{priv_j} + \gamma SES_{ij} + \lambda \overline{SES}_{priv_j} + \phi \overline{SES}_{priv_j} \cdot SES_{ij} + \beta_{0_j}$$

and if she remains in the public sector, her score is:

$$T_{ij,pub} = \beta_{pub_j} + \gamma SES_{ij} + \lambda \overline{SES}_{pub_j}^v + \phi \overline{SES}_{pub_j}^v \cdot SES_{ij} + \beta_{0_j}$$

Note that in both cases students no longer experience the peer group quality of the entire community. The relevant peer group quality is now either  $\overline{SES}_{pub_j}^v$ , or  $\overline{SES}_{priv_j}$ .

A key question, then, is how private schools select students and thereby affect the public school peer group. In the case of Chile, there are at least two reasons to expect that private schools would “skim” the highest SES children. First, unlike public schools, they are allowed to freely choose their student body. Second, since pre-voucher public schools in Chile were centrally funded and administered, it is likely that higher SES students (at least those who could not afford tuition-charging private schools) were not able to sort into good public schools as effectively as they could have under an unrestricted voucher program. Below we will provide evidence that Chile's voucher program did indeed lead to an exodus of higher SES students from the public sector.

Nevertheless, one should not assume that school choice will *always* result in “cream-skimming.” The type of sorting that takes place will depend on the rules of the program

---

<sup>14</sup> If  $\phi > 0$ , students with higher SES benefit more from interacting with better peers. If  $\phi < 0$ , lower SES children derive the greater benefit.

and the institutional setup of the school system. For instance, Bettinger (1999) shows that the test scores of students in charter schools in Michigan are *lower* than those of students in neighboring public schools. One reason for this might be that in a decentralized and locally financed public school system, like the one in the U.S., high SES households are more able to sort into “good” public schools. Therefore, a school choice program might largely attract lower SES households that have been unable to sort into “good” districts or enrollment areas.

#### 4.1.2 Vouchers and academic achievement: public schools

Regardless of its precise nature, as long as sorting takes place, it will have an important effect on public school outcomes. For example, assume for now that choice leads to cream-skimming. Specifically, once vouchers are introduced, we assume that all students  $i \in [b_j, 1]$  enroll in the private school, and lower SES students,  $i \in [0, b_j]$ , remain in the public sector. Consequently, the average “quality” of public school students falls from  $\overline{SES}_{pub_j} = \frac{\alpha}{2}$  to  $\overline{SES}_{pub_j}^v = \frac{\alpha b_j}{2}$ .

In this scenario, vouchers induce the following change in the average test score of public school students

$$\Delta \overline{T}_{pub_j} = \beta_{pub_j} + (b_j - 1) \frac{\gamma \alpha}{2} + (b_j - 1) \frac{\lambda \alpha}{2} + (b_j^2 - 1) \frac{\phi \alpha^2}{4}. \quad (2)$$

There are three different effects in this expression:

- 1) The *productivity effect* of competition,  $\beta_{pub_j}$ , which measures the extent to which competitive pressures prompt public schools to improve. In the spirit of Dee (1998) and Hoxby (1994), we will assume that the magnitude of the public response is increasing in the private sector’s market penetration:  $\beta_{pub_j} = \eta(1 - b_j)$ .
- 2) The *direct effect of student composition*, which we call sorting and is measured by the second right hand side term. This expression reflects that since the average SES in public schools has fallen, all else equal, their average test score will fall as well.
- 3) The *peer group effect*, measured by the last two terms. If peer effects exist, this will adversely affect the performance of students who remain in public schools.

The last two effects capture how sorting can directly and indirectly hurt the public school’s performance. If the effect of sorting is strong enough, it may outweigh the positive productivity effect of competition. Regardless of what the net effect is, equation (2) makes clear that in the presence of sorting, it will be essentially impossible to measure,  $\eta$ . On the one hand, if choice results in cream-skimming, public schools’ average score might fall even if they become more effective, simply because they have lost their best students. On the other hand, if low SES students leave the public sector, then it might improve even if  $\eta$  is zero.

One could potentially narrow the bias due to sorting with detailed data on the background of students in each sector. However, even then, there might be unobservable characteristics that influence both academic outcomes and the probability of switching sectors. Further, even with perfect SES measures, one would need the correct functional form relating peer quality to educational outcomes.

To conclude this section, we underline the importance of sorting for the recent empirical work that studies whether public schools respond to competition, where the degree of competition is measured by the extent of private enrollment or the extent of charter school entry. The main methodological issue addressed in this literature is that private enrollment shares are potentially endogenous to the initial quality of public schools.<sup>15</sup> While this is an important issue—which we take up in the next section—equation (2) tells us that even if we put it aside and imagine an ideal experiment in which the private share is randomly assigned, the presence of sorting will make it impossible to isolate the public sector’s response. Put differently, since the students that respond to choice programs are almost surely different from the average student, there is simply no instrument that would allow one to isolate the effect of choice on public sector productivity.

### 4.1.3 Vouchers and academic achievement: private school students

We now turn to the gain in achievement for students who switch to the private sector. Maintaining the assumption that students  $i \in [b_j, 1]$  transfer to the private school, their

---

<sup>15</sup> See Couch, Shughardt, and Williams (1993), Dee (1998), Hoxby (1994), Jepsen (1999), McMillan (2001), and Newmark (1995). See McEwan and Carnoy (1999) for similar empirical work on Chile.

change in test score is

$$\Delta \bar{T}_{priv_j} = \beta_{priv_j} + \frac{\lambda \alpha b_j}{2} + \frac{\phi \alpha^2 (1 + b_j)}{4}.$$

Thus, there are two potential sources of improvement for these students:

- 1) A *productivity* gain, assuming  $\beta_{priv_j} > 0$ . In words, if private schools are more effective, these students gain simply from transferring to the private sector.
- 2) A *peer group effect*. As long as the marginal effect of the peer group is positive, they also gain from having sorted themselves into a better peer group.

This last effect is important because it suggests that one has to be cautious making inferences from small-scale school voucher experiments. While such experiments potentially provide an unbiased answer to the question “would a randomly selected student perform better in a private than in a public school,” one still cannot interpret the resulting estimates as evidence that private schools are more productive, since the student in the private school also enjoys a better peer group.<sup>16</sup> Randomization can ensure that the children in treatment and control groups are identical along all (their own) characteristics but private enrollment status, but it does not imply that their classmates’ will be similar.

This matters because the overall peer quality in a given community is fixed, so if there is no true private productivity advantage, switching children between sectors could end up having no effect, or even reducing aggregate achievement. Put differently, a small-scale school voucher experiment cannot answer the question “what would happen to achievement if we shifted a substantial proportion of children to the private sector?”<sup>17</sup>

---

<sup>16</sup> See Rouse (1998), Howell and Peterson (2002), Krueger and Zhu (2002), and Angrist et al. (2002) for evaluations of voucher experiments in Milwaukee, Dayton, New York City, Washington D.C., and Colombia. For recent examples of comparisons between public and private schools in Chile, see Mizala and Romaguera (1998), Bravo, Contreras and Sanhueza (2000), McEwan (2000), and Tokman (2001).

<sup>17</sup> Peer group quality offers a convenient illustration of this point, but the issue arises whenever the private sector is better endowed with some input (like effective teachers) the aggregate supply of which is at least temporarily fixed.

#### 4.1.4 Vouchers and academic achievement: all students

To recapitulate, sorting makes it almost impossible to separately measure the two sources of productivity gains from choice (the private advantage and the public response). Nonetheless, we can approximate the sum of these two effects by measuring the average change in academic outcomes of *all* students in the community. Specifically, this is a weighted average of the change in scores among students who remain in public schools, and among those who switch to the private sector:

$$\Delta\bar{T}_j = b_j\Delta\bar{T}_{pub_j} + (1 - b_j)\Delta\bar{T}_{priv_j} = b_j\eta(1 - b_j) + (1 - b_j)\beta_{priv_j} + \frac{\phi\alpha^2 b_j(1 - b_j)}{4} \quad (3)$$

This is in turn a weighted average of the two productivity effects (the first two terms on the right hand side), where the weights are the shares of students in each sector, plus the net effect of sorting induced by choice.<sup>18</sup>

The key advantage of measure (3) is that it nets out the direct effect of sorting. It is still not ideal because it confounds the impact of productivity improvements and the net effect of peer group composition. Again, this is a problem that cannot be solved unless one has knowledge of the precise functional form for peer effects, along with all the information necessary to control for it.

In sum, we will measure the productivity effects of choice using aggregate outcomes. Specifically, we will regress the change in average school outcomes (e.g., test scores) in a community on the change in the private school share

$$\Delta T_j = \nu(1 - b_j) + \epsilon_j. \quad (4)$$

Here,  $\nu$  answers the question: “what is the marginal change in achievement for a marginal increase in the private share?” Additionally, because sorting is a central part of our argument, we will also test whether the relative SES of students in public schools (compared to that of the whole community) declines with private enrollment.

---

<sup>18</sup> The sign of the latter depends on whether the peer group-related gains to the highest SES students outweigh the losses of those students who remain in the public sector.

## 4.2 Empirical implementation and endogenous private entry

Thus far, our discussion suggests that to adequately study the productivity effects of choice, one has to look at its effects at the aggregate market level, and preferably in situations in which it has produced substantial and sustained changes in the educational market. From this point of view, the Chilean experience is very valuable. On the other hand, we have focused on measuring the effects of choice in situations in which the private enrollment share is as good as randomly assigned. Such an experiment would be very difficult to implement, and was not carried out in Chile, where the voucher program was introduced across the entire country at once. The Chilean case still offers empirical leverage, however, since in response to this program, the private sector grew substantially more in some markets.

This differential response is endogenous to the characteristics of a community, but as long as these characteristics do not change over time, one can difference them away by comparing the *change* in outcomes in a given community with the *change* in its private share. That is, we can estimate equations like (4), and this is the base specification we use below. The identifying assumption is that the rate of improvement in educational outcomes (or the rate of change in sorting measures) that would have been observed without vouchers is not systematically related to characteristics that affected the extent of private entry.

There are, however, three reasons why this may not be the case. First, there could be differences in *pre-existing* trends that are correlated with the growth of the private sector. For example, if performance had been falling over time in markets where private enrollment grew rapidly after 1982, our estimates could understate the improvement due to choice.

Second, differential *concurrent* trends also pose potential problems. For example, it could be that the areas where private schools entered more were also ones that subsequently experienced rapid income growth, and that it was this growth, rather than any productivity effects stemming from vouchers, that improved outcomes. In this case, our estimates would overstate the gains from choice.

Third, the existence of heterogeneous treatment effects would also affect both private entry and subsequent achievement growth. For example, it could be that the voucher pro-



gram resulted in greater entry in communities in which the private productivity advantage was greater. In this case, comparing the change in achievement in communities with more private growth (and a greater private advantage) with communities with less entry (and a smaller private advantage) would *overstate* the impact of choice in an average community.<sup>19</sup> Put differently, what we would be doing is to estimate the average *marginal* impact of choice, which would be larger than the average effect.

There are two ways in which we address these concerns. First, we introduce a number of controls for pre-existing and concurrent trends in regressions like (4). Second, we look for instrumental variables that affect the extent of private entry, but are ideally uncorrelated with trends in academic outcomes, or with the productivity advantage of the private sector. While the controls and instruments we use may not be ideal, by comparing how the estimate of  $\nu$  changes with these modifications, we can obtain some sense of the magnitude and the direction of bias in our base estimates.

## 5 Results

Based on the framework presented, we now measure the impact of the voucher program. We first briefly describe our data, and then present results on academic outcomes. Finally, we turn to the program’s impact on sorting.

### 5.1 Data and coverage

Our simple model suggests that the proper way to assess the impact of vouchers is to measure changes in educational outcomes at the *aggregate* market level. To implement this,

---

<sup>19</sup> Specifically, suppose that  $\beta_{priv_j} = \bar{\beta}_{priv} + e_j$  where  $e$  has mean zero and variance  $var(e)$ . As a benchmark, consider the case where  $(1 - b_j)$  is uncorrelated with  $e_j$ . For simplicity, assume that there are no peer effects and that public schools do not respond to competition. With these assumptions,  $\nu_{ols} = \bar{\beta}_{priv}$ , which is the private productivity advantage in an *average* community. Now, suppose that  $(1 - b_j) = \rho_0 + \rho_1 e_j$ , where we assume that  $\rho_1 > 0$  (the private sector grows by more in markets in which the private advantage is larger). In this case,  $\nu_{ols} = \bar{\beta}_{priv} + (1 - b)\rho_1 \frac{var(e)}{\sigma^2}$ , where  $\sigma^2$  is the variance of the change in the private enrollment rate across communities. Thus, an OLS regression of the change in average test scores on the change in the private enrollment rate will *overstate* the impact of choice in an average community.

we make use of Chile’s (approximately) 300 communes as proxies for educational markets. Communes have a median area of about 55 square kilometers and an average population of 39 thousand. In 1988, the average commune had 27 schools, 18 of which were public, 7 private voucher, and 2 tuition-charging. Each commune has an autonomous government that manages schools and other public services.<sup>20</sup>

We use three types of outcomes measures. The first consists of the average mathematics and language test score in each commune, which the PER testing program provides for 1982, and the SIMCE for later years.<sup>21</sup> This information is provided at the school level, which we aggregate to create weighted averages for each commune. A potential problem with this data is that several rural communes were not covered in the initial year (1982). However, it still reached 90 percent of all students, and if the test was administered in a given commune, all the schools in the commune participated.<sup>22</sup>

Our second outcome measure is the average repetition rate, which is defined as the fraction of students who have repeated the same grade at least twice, the official measure of repetition in Chile. We compiled this data from school-level administrative records collected by the Ministry of Education for 1982 and 1988. It covers *all* schools in the country, so it allows us to check that our results with test scores are not driven by the choice of communes.

Our third outcome variable is the average years of schooling among 10-15 year old children. This measure captures several dimensions of the educational system’s performance, since it reflects factors like age at entry, repetition, and dropout patterns. We compiled this variable from the population census and CASEN household survey micro data.

Finally, we use two sources of data to measure students’ socioeconomic status. First, the Ministry of Education classifies each school into three to four categories, based on the educational background of the parents. We use this classification, but it is obviously rather

---

<sup>20</sup> With the exception of those 50 communes in the Santiago metropolitan area, virtually all students attend school in the same commune in which they live. Because we want to use these as markets, we aggregate the 50 Santiago communes and consider them as a single school market.

<sup>21</sup> PER stands for *Programa de Evaluación del Rendimiento Escolar*, and SIMCE for *Sistema de Evaluación de Calidad de la Educación*. These tests have been conducted every year (with the 4<sup>th</sup> grade in even and the 8<sup>th</sup> in odd years) since 1982, with a suspension during 1985-87.

<sup>22</sup> See Espínola (1993).

coarse. To complement it, our second measure is based on household survey data. The Chilean National Household Survey (CASEN) is unusual in that it identifies the precise school attended by the children surveyed. With this school identifier, we can link its information to administrative records and obtain detailed information on the SES profile of individual schools. The summary statistics for the data are in Table 1, and Table A.1 in the appendix contains further detail on the precise data sources used.

## 5.2 Measuring the effects of choice on achievement

We begin by measuring the impact of the voucher program on four measures of academic achievement: 1) language test scores, 2) math test scores, 3) repetition rates, and 4) average years of schooling among 10-15 year old children. The key independent variable is the change in the private enrollment rate. These estimates are shown in Table 3. We focus on the 1982-88 period (panel A) since this is the period where we see the largest changes in private enrollment.

Columns 1 and 4 present the basic bivariate OLS regression for language and math, respectively. Although statistically insignificant, the point estimates suggest that, if anything, test scores experienced a relative *decline* in communities where the private sector made greater inroads. Columns 7 and 10 turn to repetition rates and years of schooling (among 10-15 year old children). Once again, the simplest bivariate OLS estimates provide no evidence of a relative improvement in communes where the private sector grew by more. In fact, column 7 indicates that repetition rates experienced a relative *increase* in communes where private schooling grew by more. The coefficient is statistically significant and large – a one standard deviation increase in the 1982-88 private enrollment growth increases the observed change in repetition by a quarter of a standard deviation.

As previously discussed, these estimates are robust to the endogeneity of the growth in private enrollment to the extent that it is driven by community characteristics that are fixed over time. However, there could be differential trends in academic outcomes that are correlated with the differential increase in private enrollment. For example, it might be

the case that the private sector grew by more in areas where schooling outcomes had been worsening over time. To address this concern, columns 2, 5, 8, and 11 add three controls for pre-existing trends.

First, we include the 1970-82 change in average years of schooling, which summarizes several aspects of the educational system's performance up to the introduction of vouchers.<sup>23</sup> It is an ideal control for our age for grade measure, and also indirectly captures previous performance on repetition. A second control is the 1980-82 change in private enrollment. While this is not a direct outcome measure, the logic is that as a reaction to declining public performance prior to 1982, households may have started moving to the private sector even before the introduction of vouchers.<sup>24</sup> We would have liked to include data on private enrollment from years prior to 1980, but unfortunately this is not available at the commune level. Using information from maps,<sup>25</sup> however, we were able to also include the 1978-82 change in the proportion of *schools* private in each commune. When we add these variables, the point estimates are essentially unchanged, and in the case of repetition rates, they continue to be significant at the 5 percent level.

The differential impact of the voucher program might also be correlated with *concurrent* trends. For example, if areas with greater private entry also experienced greater income growth which independently raised achievement, then our results might overestimate the effect of choice. Columns 3, 6, 9 and 12 add further controls to address this possibility. Specifically, they include 1982-88 changes in population, labor income, and average years of schooling among adults.<sup>26</sup> Again, the point estimates are essentially unchanged, and continue to suggest that greater private growth might have even lowered average achievement.

We have so far focused on the 1982-88 period, since these were the years in which the voucher program had the greatest effect. However, because it is possible that six years is not enough time for the productivity effects of choice to be observed, panel B (Table 3) presents estimates for the impact of the voucher program from 1982 to 1996. Measured by language

---

<sup>23</sup> We compiled this data from the 5 percent sample of the 1970 and 1982 population censuses.

<sup>24</sup> We obtained this information from administrative data provided by the Ministry of Education.

<sup>25</sup> Data source 19 in Table A.1

<sup>26</sup> This information is compiled from the 1982 population census and the CASEN; see Table A.1.

scores, math scores, and years of schooling (among 10-15 year old children), the impact of the voucher program appears to have been even more negative over this longer time period.<sup>27</sup>

### 5.3 Robustness check: Instrumental variables

An alternative strategy to check for biases is to identify pre-existing commune characteristics that explain the differential impact of vouchers. These can then be used as instruments for the private enrollment growth after 1982, under the assumption that they are uncorrelated with subsequent achievement changes. We use three instruments below. Our first two variables are the urbanization rate and the population of a commune in 1982. These capture the effect of market size on the extent of private entry. A third instrument is the inter-quartile range in years of schooling observed among adults (also in 1982). We use this as a measure of heterogeneity. The idea is that if parents consider peer group quality when choosing schools, then the demand for private schools that are able to admit “good” peer groups will be larger in less homogeneous communities.

Table 2 presents the first stage estimates from OLS regressions of the 1982-88 change in private enrollment shares on the three candidate instruments. As can be seen, all three are highly correlated with the growth in private enrollment after 1982.<sup>28</sup>

As with any instruments, the estimates these variables yield have to be interpreted with caution, if only because there is ultimately no way of guaranteeing the instruments’ validity. We will present standard over-identification tests, but we cannot rule out the possibility that these instruments are correlated with trends in unobserved determinants of academic outcomes, or that our controls for trends do not capture such determinants. Nonetheless, a comparison of the IV and the OLS estimates can provide us with a further sense of the direction of biases in our base specifications.

With this in mind, Table 4 presents the IV results (Table A.2 in the appendix contains the corresponding reduced form estimates). The instrumental variables are ordered across

---

<sup>27</sup> We do not have repetition data for 1996.

<sup>28</sup> We also considered population density as a candidate for an instrumental variable. The results are qualitatively similar, so we omit these estimates for reasons of space. Estimates with population density as an instrument are available upon request from the authors.

columns, with the last ones presenting the combination of the three variables.<sup>29</sup> In each case we present two specifications, one without and one with the controls for the pre-existing and concurrent trends introduced above. As the table shows, these estimates continue to suggest that greater private growth resulted in lower achievement. In fact, the IV estimates suggest that, if anything, the OLS estimates *overstate* the impact of the voucher program. Further, the negative effects for years of schooling also become statistically significant. The only exception arises when we use population as an instrument and the change in average language scores as the outcome of interest. Further, our estimates are not affected when we introduce controls for trends (with the same exception). Finally, we should mention that all the estimates comfortably pass a standard over-identification test, with the usual caveat about the power of such tests.

## 5.4 Robustness check: International and sectoral comparisons

An alternative manner to determine whether school choice has improved schooling quality in Chile is to measure the country’s performance in international tests in math and science, widely known as the TIMSS. This is possible because Chile participated in the TIMSS in 1999, and in its precursor, the IEA, in 1970. While international comparisons should always be interpreted with caution, in this case they have the advantage of not relying on the differential impact of vouchers across different markets. We summarize the results graphically in Figure 4. Panel A shows that during the last three decades, the score of the median Chilean student did not change relative to that of the median student in the other 12 countries that also participated in both years.<sup>30</sup> This is all the more surprising since Chile’s economy has performed quite well over the last two decades.<sup>31</sup> In fact, when one introduces

---

<sup>29</sup> The samples vary according to the outcome measure because of the interaction of two factors: i) in the case of test scores, the 1982 PER system did not cover all communes and, ii) in some of the household surveys, there are not enough observations in some communes to estimate a reliable measure of several of the variables we use as proxies for pre-existing and concurrent trends. We checked that our results are robust to changes in the sample of communes.

<sup>30</sup> The unit is the standard deviation of U.S. students taking the TIMSS in 1970 and 1999.

<sup>31</sup> From 1970 to 1999, per capita GDP grew at an annual rate of 4.3 percent in Chile and at average annual rate of 2.8 percent in the other 12 countries (authors’ calculations using the International Financial Statistics).

controls for per capita income growth, and changes in enrollment rates and school spending, the performance of the median Chilean student appears to have slightly *worsened* over the last 30 years (panel B).<sup>32</sup>

A final way to measure whether average school quality has improved is to use the average test scores from the PER and SIMCE. Clearly, it would not make much sense to compare the change in average test scores, since we have no way of knowing that the tests are comparable over time. However, since the tuition-charging private schools were plausibly unaffected by the voucher program, we can use these schools as a control and measure the gap between the test scores of the elite private schools and those of publicly funded (voucher and public) institutions. This evidence, presented in Figure 5, similarly provides no indication that vouchers improved outcomes in the schools they affected. Here the data show a well-known feature of the Chilean education system, namely the large gap in test scores between the subsidized (voucher and municipal) sector and the tuition-charging private schools. In 1982 the average score of the publicly funded schools is about 1.3 standard deviations below the elite private schools. By 1996, this gap had actually become larger.<sup>33</sup>

## 5.5 Sorting

We now turn to the effect of the voucher program on sorting. We begin by describing the relation between a commune’s private enrollment rate, on the one hand, and the ratio between the average “quality” of its public school students and the commune-wide average, on the other. Note that the latter variable is a within-commune observation—it does not compare public school students in one commune with those in a different market. The idea

---

<sup>32</sup> The cross-sectional evidence provides a similar story. For example, the math score of the median Chilean student on the 1999 TIMSS was 1.08 standard deviations below that of the average student in the other 38 countries, while the science score was 0.7 standard deviations lower (again, the unit is the standard deviation of the US in 1999). After controlling for GDP per worker, school spending (per student relative to per capita GDP), and enrollment rates, the “residual” score of the median Chilean student was 0.78 standard deviations below that of 38 other countries in math and 0.33 standard deviations lower in science. We took the figures on GDP per worker from the Penn World Tables and those on school spending and enrollment rates from UNESCO’s yearbook.

<sup>33</sup> In part, this in itself may be capturing some sorting, since the tuition-charging private sector did grow significantly (although from a small base) during this period, presumably “cream skimming” some students from voucher and even municipal schools.

is that if private schools cream skim, then this measure should fall with private enrollment.

Panel A in Table 5 first looks at purely cross sectional evidence. The dependent variable in columns 1 and 2 is the ratio of the educational background of public school students to the average in the community (for 1996). This data is based on an index of the educational background of each school, provided by the Ministry of Education. This measure is crude, but the estimates are nonetheless precisely estimated, and suggest that the relative educational attainment of parents in public schools is lower in communes with higher private enrollment.<sup>34</sup> Using more detailed household survey data on parental income for 1990/92, columns 3 and 4 suggest a similar conclusion. The point estimates are again precisely estimated and quite large: they suggest that a one standard deviation increase in the private enrollment rate is associated with 38-43 percent of a standard deviation decline in the relative income of public school parents.

Building on this evidence, columns 5-10 turn to indirect measures of sorting, namely the ratios of the average performance (on test scores and repetition) of public school students and the average in the entire commune. These are indirect measures, because they are a function of two effects: sorting and the public productivity response. If private schools take the best students from the public sector, the sorting effect suggests that the relative test scores (or relative repetition rates) of public schools should be lower (higher) in communes with greater private sector penetration. As for the public response, there are effects going in opposite directions. On the one hand, if public schools improve by more in communes with more competition from the private sector, then the relative grades of public schools should be higher in communes with greater private enrollment. On the other hand there is the possibility of endogenous entry: if the private sector grew by more in communes where public schools were under-performing (prior to the voucher program), then this would suggest that the relative grades of public schools should be lower in communes with a larger private

---

<sup>34</sup> For each variable featured in Panel A, we present results using the most recent cross-section in our data. However, we obtain very similar estimates using the cross-sections from other years. For instance, for the 1988 and 1990 cross-sections, the point estimates in columns 1 and 2 are -0.15 and -0.15, and -0.16 and -0.14, respectively. In every case these are significant at the 5 or 1 percent level (these results are available upon request). Similar robust findings emerge for the math and language results we discuss below. For income, 1990/92 is the only cross-section for which we matched household survey and school level data.



enrollment rate.

In the event, the estimates in columns 5-10 uniformly indicate that, when measured by math scores, language scores, and repetition rates, public schools do worse in communes with a higher private enrollment rate. All the estimates are precisely estimated and suggest that the private enrollment rate has a first order effect on the relative performance of public schools. For example, a simple bivariate OLS regression suggests that a one-standard deviation increase in the private enrollment rate lowers the relative math score of public schools by about 40 percent of a standard deviation.

Nonetheless, we cannot rule out that these results may be influenced by the endogenous entry of private schools in communes where public schools are weakest. One way to deal with this is to again difference out fixed commune characteristics by looking at changes over time. We do this in panel B with regressions of the 1982-88 change in the relative “quality” of public schools (again, measured by language and math scores, and by the repetition rate) and the change in the private enrollment rate. These estimates indicate that the composition effect of choice seems to dominate any effect of competition on the public schools’ productivity. Although not as precisely estimated as the cross-sectional estimates, they are generally statistically significant, and indicate that the relative “quality” of public schools has worsened in communes where private enrollment grew by more.<sup>35</sup>

For completeness, we again use the urbanization rate, population, and the interquartile range in years of schooling (of working age adults) as instruments for the differential impact of the voucher program. Table 6 presents these results (the reduced form estimates are in Table A.3 in the appendix). These estimates provide further evidence that the main effect of school choice in Chile has been to facilitate greater sorting. In fact, the IV estimates generally indicate that choice led to *more* sorting than that suggested by the OLS estimates.

There are two points we take away from this evidence. First, private schools attracted students from families with higher levels of income and schooling. Second, because these

---

<sup>35</sup> We do not have data on sorting over time based on income measures, since the 1982 population census does not identify whether a child is enrolled in a public or a private school (this information is only contained in the CASEN household survey, which is available starting in 1987). We also do not use the SES index, since the way in which it is calculated has changed over the years.

characteristics are important determinants of educational outcomes, it will be virtually impossible to isolate whether public schools improved in response to the competitive forces unleashed by the private sector. As our estimates show, the relative grades of public school students fell by more in communes with a larger increase in private enrollment. This does not necessarily imply that public schools did not improve – it simply indicates that if this productivity effect is present, it is overwhelmed by the sorting effect. However, as we discussed, when choice also results in sorting, then the proper way to measure whether this productivity effect is present is to look at aggregate measures, and the evidence we presented in the previous section suggests that these productivity effects are not there.

Finally, we note that our findings are consistent with the only two studies that we are aware of that measure the consequences of comprehensive school choice on sorting. Although they do not have the data to assess the effect on educational productivity, Fiske and Ladd's (2000) analysis of the open-enrollment program among public schools in New Zealand suggests that a major effect of choice has been to induce greater segregation. A second study, by Berry, Jacob, and Levitt (2001), on Chicago's open-enrollment program, also suggests that the main effect has been to induce segregation, without any evidence of increased academic outcomes (except for career academies).

## **6 When schools compete, how do they compete?**

In sum, the central effect of the school voucher program in Chile appears to have been to facilitate the exodus of the Chilean middle class from public schools, without much evidence that it has improved aggregate academic outcomes. While it is not surprising that choice could result in sorting, what accounts for the surprising lack of improvement on achievement? One possibility, often raised by Chilean observers, is that public schools may in fact not have experienced significant incentives to compete. We presented evidence consistent with this view in Figure 3, which suggested that few public schools have been forced to close. However, even if the public schools were not forced to compete and thus did not improve, as long as private schools have a productivity advantage, we should still see better aggregate

performance given the large number of students that transferred to the private sector, and we simply find no evidence of this.

So what can account for the lack of a private productivity advantage? One possibility is that private schools responded to the competitive pressures unleashed by the voucher program, not by raising their productivity, but rather by choosing better students. School administrators in Chile, as in the rest of the world, can raise their schools' outcomes by doing things such as identifying and hiring effective teachers, and then supporting and monitoring their work; but they also realize that this is costly and may not always work. In contrast, it is easier to improve outcomes simply by picking the best students. Parents can also be willing participants in this, and their demand for good peer groups obviously reinforces the desire of school administrators to "cream skim".<sup>36</sup>

In fact, there is abundant institutional evidence that in Chile, private schools do compete by attempting to select better students. As previously mentioned, private schools are allowed to reject students, and Gauri (1998) presents evidence that the majority of them do exercise this ability, and that they screen children either by requiring a parental interview, or by using admissions tests. Chilean observers have also pointed out that new voucher schools have sought to attract students by endowing themselves with "symbols" previously associated only with elite, tuition-charging institutions, such as uniforms, and the use of foreign and particularly English names.<sup>37</sup>

## 7 Conclusion

This paper makes two contributions to the school choice debate. First, we make the methodological point that if choice leads to greater segregation, we will not be able to isolate the extent to which public schools improve their productivity in response to the competitive threat induced by choice, from the effect of sorting on the public sector's performance. On the one hand, if choice results in cream-skimming (as we suggest happened in Chile), the

---

<sup>36</sup> For suggestive evidence of this in the U.S., see Rothstein (2003).

<sup>37</sup> See Espínola (1993).

average performance of public schools might fall even if they become more effective, simply because they have lost their best students. On the other hand, if low SES students leave the public sector, as Bettinger (1999) suggests happened in Michigan with charter school entry, then the average performance of public schools might improve even if they do not raise their productivity. We argue that the best that one can do is to measure changes in outcomes at the aggregate level.

Second, we focus on a country that implemented an unrestricted nationwide school choice program. We show that the first order consequence of the voucher program in Chile was middle-class flight into private schools, and that this shift does not seem to have resulted in achievement gains, certainly not of the magnitude claimed by some choice advocates. Again, we cannot rule out the possibility that our estimates are biased by unobserved trends in schooling outcomes, but we show that our results do not change when we introduce a number of controls for such trends.

We want to make two points clear. First, we are not claiming that vouchers have not produced any gains at all. It might be the case, for instance, that after twenty years of choice, Chilean schools are spending their money in ways that parents value more. For instance, they may now be emphasizing freshly-painted walls more than reduced teaching loads. Additionally, many families surely value the availability of subsidized religious instruction. In short, school choice might improve parents' utility even if it does not improve academic achievement.

Second, our claim is not that incentives do not matter in the educational industry. On the contrary, we interpret the Chilean experience as providing strong support for the notion that schools do respond to incentives. The key question is incentives for what? It seems that if schools are provided with incentives to improve their absolute outcomes, and are also allowed to choose their student body, they are likely to respond by attempting to select better students. This should not be surprising to those familiar with elite universities, since an integral part of the perceived quality of these institutions is their ability to "skim" the very best students. While there are enormous rewards for the institutions that are

successful in this endeavor, from a societal perspective it may be a zero-sum game, since one school's selectivity gain is another's loss. Therefore, an important topic for further research is the design of mechanisms that would preserve the competitive effects of vouchers, but force schools to improve by raising their value added, and not by engaging in rent-seeking behavior.<sup>38</sup>

---

<sup>38</sup> See for instance Epple and Romano (2002).

## References

- Angrist, J., E. Bettinger, E. Bloom, E. King, and M. Kremer (2002) *Vouchers for private schooling in Colombia: evidence from a randomized natural experiment*, **American Economic Review** 92(5), 1535-1558.
- Bettinger, E. (1999) *The effect of charter schools on charter students and public schools*. National Center for the Study of Privatization in Education, Teachers College, Columbia University, Occasional Paper No. 4.
- Berry, J., B. Jacob, and S. Levitt (2000) *The impact of school choice on student outcomes: An analysis of the Chicago public schools*. NBER Working Paper No. 7888.
- Bravo, D. D. Contreras, and C. Sanhueza (2000) *Educational achievement, inequality, and the public/private gap: Chile 1982-1997*. Universidad de Chile, mimeo.
- Comber, L. and J. Keeves (1973) **Science education in nineteen countries: International studies in evaluation I**. New York: John Wiley for the International Association for the Evaluation of Educational Achievement.
- Couch, J., W. Shughart II, and A. Williams (1993) *Private school enrollment and public school performance*, **Public Choice**, 76, 301-312.
- Dee, T. (1998) *Competition and the quality of public schools*. **Economics of Education Review**, 17(4), 419-427.
- Epple, D. and R. Romano (1998) *Competition between private and public schools, vouchers, and peer group effects*, **American Economic Review**, 88(1), 33-62.
- Epple, D. and R. Romano (2002) *Educational vouchers and cream skimming*, NBER Working Paper No. 9354.
- Espínola, V. (1993) *The educational reform of the military regime in Chile: The school system's response to competition, choice, and market relations*. Ph.D. dissertation, University of Wales College Cardiff.
- Fiske, E. and H. Ladd (2000) **When schools compete: A cautionary tale**. Washington, D.C.: Brookings Institution.
- Gauri, V. (1998) **School choice in Chile: two decades of educational reform**. Pittsburgh: University of Pittsburgh Press.
- Howell, W. and P. Peterson (2002) **The education gap: Vouchers and urban schools**. Washington, D.C.: Brookings Institution.

- Hoxby, C. (1994) *Do private schools provide competition for public schools?*, National Bureau of Economic Research Working Paper No. 4978 (Revised Version).
- Hoxby, C. (2003) *School choice and school productivity: could school choice be a tide that lifts all boats?* in Hoxby, C., editor, **The economics of school choice**. Chicago, IL: University of Chicago Press for the NBER.
- Instituto Geografico Militar (1993) **Atlas de la república de Chile**. Santiago: Instituto Geografico Militar.
- Jepsen, C. (1999) *The effects of private school competition on student achievement*, Northwestern University, mimeo 1999.
- Krueger, A. and P. Zhu (2002) *Another look at the New York City school voucher experiment*. Princeton University IR Section Working Paper No. 470.
- Ladd, H. (2002) *School vouchers: a critical view*, **Journal of Economic Perspectives**, 16(4), 3-24.
- Manski, C. (1992) *Educational choice (vouchers) and social mobility*, **Economics of Education Review**, 11(4), 351-369.
- McEwan, P. (2000) *The effectiveness of public, catholic, and non-religious private schools in Chile's voucher system*, **Education Economics**, 9(2), 103-128.
- McEwan, P. and M. Carnoy (1999) *The impact of competition on public school quality: Longitudinal evidence from Chile's voucher system*, Stanford University, mimeo.
- McMillan, R. (2001) *The identification of competitive effects using cross-sectional data: An empirical analysis of public school performance*. Mimeo, The University of Toronto.
- Mizala, A. and P. Romaguera (1999) *School performance and choice: the Chilean experience*, **Journal of Human Resources**, XXXV(2), 392-417.
- Neal, D. (2002) *How vouchers could change the market for education*, **Journal of Economic Perspectives**, 16(4), 25-44.
- Newmark, C. (1995) *Another look at whether private schools influence public school quality*, **Public Choice**, 1995, 82 (3), 365-373.
- Programa Interdisciplinario de Investigaciones en Educación (1984) *Las transformaciones educacionales bajo el regimen militar*, Mimeo.
- Rothstein, J. (2002) *Good principals or good peers? Parental valuation of school characteristics, Tiebout equilibrium, and the incentive effects of competition among jurisdictions*. Mimeo, Univer-

sity of California at Berkeley.

Rouse, C. (1998) *Private school vouchers and student achievement: an evaluation of the Milwaukee parental choice program*, **The Quarterly Journal of Economics**, 113, 553-602.

Schiefelbein, E. (1971) *El financiamiento de la educacion particular en Chile: Problemas y alternativas de solución*, Mimeo, CIDE.

Tokman, A. (2001) *Is private education better? Evidence from Chile*, University of California at Berkeley, mimeo.



Table 1: Descriptive statistics at the commune level

	1982			1988			1996		
	N	Mean	Std. dev.	N	Mean	Std. dev.	N	Mean	Std. dev.
<b>Outcomes:</b>									
Language score <sup>1</sup>	97	56.0	6.3	293	50.2	6.9	298	68.3	5.8
Math score <sup>1</sup>	97	50.7	6.4	293	48.3	5.9	298	68.0	5.7
Repetition rate <sup>2</sup>	299	0.12	0.05	304	0.08	0.04			
Years of schooling, 10-15 year olds <sup>3</sup>	170	5.2	0.6	125	6.3	0.4	170	6.2	0.4
<b>Sorting measures:</b>									
<i>Average among public schools</i> for:									
<i>Average among all schools</i>									
Language score <sup>1</sup>	101	0.97	0.04	292	0.98	0.05	298	0.98	0.04
Math score <sup>1</sup>	101	0.97	0.04	292	0.98	0.04	298	0.99	0.04
Repetition rate <sup>2</sup>	299	1.06	0.13	300	1.07	0.17			
Socioeconomic status (SES) index <sup>1</sup>	101	0.96	0.06	292	0.97	0.08	298	0.96	0.07
Household income <sup>4</sup>							185	0.87	0.16
<b>Private enrollment rate<sup>5</sup></b>	299	0.12	0.14	304	0.17	0.17	304	0.18	0.18
<b>Controls:</b>									
Population (hundreds of thousands) <sup>6</sup>	303	0.37	2.1	310	0.43	2.48			
Years of schooling, household heads <sup>7</sup>	303	6.2	1.5				177	8.5	1.5
Log of average imputed labor income <sup>7</sup>	303	10.4	0.3				177	12.2	0.3
Poverty rate <sup>8</sup>							164	0.19	0.07
Household income <sup>8</sup>							164	0.33	0.13
Literacy rate <sup>8</sup>							303	0.90	0.05

<sup>1</sup> Calculated using test system information, data sources (1), (2), and (4), as described in Table A.1.

<sup>2</sup> Variable comes from administrative information, data sources (8) and (9). It is not available for subsequent years.

<sup>3</sup> Based on micro census information for 1982 (data source 16), and household survey information for 1990 and 1996 (sources 11 and 13).

<sup>4</sup> Variable based on household survey information, pooled data sources (11) and (12).

<sup>5</sup> Variable comes from administrative information, data sources (8), (9), and (10).

<sup>6</sup> Calculated using census summary information, data sources (17) and (18).

<sup>7</sup> For household heads at least 18 years of age. Calculated using census micro data (source 16), and household survey (data source 13).

<sup>8</sup> Variable based on household survey information, data source (14).

**Table 2: Explaining the private sector's growth, 1982-88**

Independent variable – 1982 observation of:	Dependent variable – 1982-88 change in private enrollment <sup>1</sup>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Urbanization rate <sup>2</sup>	0.11*** (0.01) [0.45]	0.08*** (0.02) [0.33]					0.09*** (0.01) [0.37]	0.04* (0.02) [0.16]
Population <sup>2</sup>			0.67*** (0.19) [0.21]	0.54*** (0.11) [0.17]			0.40*** (0.07) [0.13]	0.40*** (0.06) [0.13]
Inter-quartile range in years of schooling <sup>2</sup>					0.16*** (0.02) [0.34]	0.18*** (0.04) [0.39]	0.06** (0.03) [0.13]	0.13*** (0.04) [0.28]
Controls: 1982-88 changes in population, years of schooling among adults, and income <sup>3</sup>	No 297	Yes 171	No 297	Yes 171	No 297	Yes 171	No 297	Yes 171
$R^2$	0.204	0.242	0.046	0.205	0.121	0.263	0.232	0.310

Notes: \*, \*\*, and \*\*\* indicate significance at the 10, 5, and 1 percent level, respectively. Huber-White standard errors are in parenthesis. Brackets contain the proportion of a std. dev. change in the dependent variable brought about by a one std. dev. increase in the independent variable. Sample sizes vary due to the addition of controls with missing observations.

<sup>1</sup> Based on administrative information, data sources (8) and (9), as described in Table A.1.

<sup>2</sup> Calculated using census micro and summary information, data sources (16) and (17). Urbanization is expressed as a proportion; population is in units of 10 million; and the inter-quartile range is in units of 10 years of schooling.

<sup>3</sup> Controls for concurrent trends are the 1982-92 change in population (from data sources 17 and 18), and the 1982-96 change in mean years of schooling and imputed labor income among adults (from census and household survey information, sources 13 and 16).

Table 3: OLS regressions for achievement, 1982-1988 and 1982-1996

		Dependent variable – change in average:													
		Language score <sup>1</sup>				Math score <sup>1</sup>				Repetition rate <sup>2</sup>				Years of schooling <sup>3</sup>	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)		
<b>Panel A — 1982-1988</b>															
Change in priv. enrollment <sup>2</sup>		-5.5 (7.5)	-6.7 (7.7)	-3.4 (8.7)	-7.2 (7.6)	-9.4 (7.5)	-9.2 (8.9)	0.10*** (0.03)	0.09** (0.03)	0.07* (0.04)	-0.84 (0.70)	-0.72 (0.67)	-0.84 (0.68)		
		[-0.08]	[-0.10]	[-0.05]	[-0.10]	[-0.13]	[-0.12]	[0.24]	[0.21]	[0.17]	[-0.11]	[-0.10]	[-0.11]		
Controls: previous trends <sup>4</sup>		No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes		
Controls: concurrent trends <sup>5</sup>		No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes		
N		84	84	84	84	84	84	145	145	145	85	85	85		
R <sup>2</sup>		0.006	0.073	0.105	0.010	0.087	0.156	0.057	0.078	0.095	0.013	0.203	0.239		
<b>Panel B — 1982-1996</b>															
Change in priv. enrollment <sup>2</sup>		-13.8* (7.9)	-12.3 (7.7)	-8.9 (9.9)	-15.8** (6.5)	-15.0** (6.7)	-12.8 (8.0)				-2.2*** (0.4)	-2.1*** (0.4)	-2.1*** (0.4)		
		[-0.24]	[-0.21]	[-0.15]	[-0.27]	[-0.25]	[-0.22]				[-0.42]	[-0.40]	[-0.40]		
Controls: previous trends <sup>4</sup>		No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes		
Controls: concurrent trends <sup>5</sup>		No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes		
N		84	84	84	84	84	84	145	145	145	145	145	145		
R <sup>2</sup>		0.056	0.106	0.145	0.072	0.117	0.171				0.179	0.229	0.250		

Notes: \*, \*\*, and \*\*\* indicate significance at the 10, 5, and 1 percent level, respectively. Huber-White standard errors are in parenthesis. Brackets contain the prop. of a std. dev. change in the dependent variable brought about by a one std. dev. increase in private enrollment.

<sup>1</sup> Calculated using test system information, data sources (1), (2), and (4), as described in Table A.1.

<sup>2</sup> Variable comes from administrative information, data sources (8) and (9), and (10). Repetition is available only up to 1988.

<sup>3</sup> Based on micro census data for 1982 (data source 16), and household survey data for 1990 and 1996 (sources 11 and 13).

<sup>4</sup> Controls for previous trends are: the 1970-1982 change in average years of schooling (from census micro data, sources 15 and 16), the 1980-82 change in private enrollment (sources 7 and 8), and the 1978-82 change in the proportion of schools private (sources 19 and 8).

<sup>5</sup> Controls for concurrent trends are the 1982-92 change in population (from data sources 17 and 18), and the 1982-96 change in mean years of schooling and imputed labor income among adults (from census and household survey information, sources 13 and 16).

**Table 4: IV regressions for achievement, 1982-1988**

	IV: Urbanization rate <sup>4</sup>		IV: Population <sup>4</sup>		IV: Inter-quartile range in years of schooling <sup>4</sup>		IV: All three variables	
<b>Dependent variable</b> — 1982-1988 change in average:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Panel A — Language score<sup>1</sup></b>								
Change in private enrollment <sup>2</sup>	-38.7 (30.9)	-27.2 (35.2)	4.3 (5.2)	11.7** (5.2)	-19.9 (18.7)	-10.1 (20.3)	-15.8 (14.7)	-4.5 (14.9)
Controls for trends <sup>5</sup>	No	Yes	No	Yes	No	Yes	No	Yes
<i>N</i>	84	84	84	84	84	84	84	84
Overid. test, p-value <sup>6</sup>	0.99	0.99	0.99	0.99	0.99	0.99	0.97	0.97
<b>Panel B — Mathematics score<sup>1</sup></b>								
Change in private enrollment <sup>2</sup>	-99.0** (45.7)	-103.5** (46.7)	-8.0 (6.2)	-1.0 (7.2)	-57.5** (23.7)	-46.4* (25.6)	-49.6** (21.9)	-37.6* (22.4)
Controls for trends <sup>5</sup>	No	Yes	No	Yes	No	Yes	No	Yes
<i>N</i>	84	84	84	84	84	84	84	84
Overid. test, p-value <sup>6</sup>	0.99	0.99	0.99	0.99	0.99	0.99	0.92	0.92
<b>Panel C — Repetition rate<sup>2</sup></b>								
Change in private enrollment <sup>2</sup>	0.33*** (0.08)	0.37*** (0.11)	0.17*** (0.04)	0.15*** (0.04)	0.28*** (0.08)	0.28*** (0.10)	0.29*** (0.07)	0.28*** (0.08)
Controls for trends <sup>5</sup>	No	Yes	No	Yes	No	Yes	No	Yes
<i>N</i>	145	145	145	145	145	145	145	145
Overid. test, p-value <sup>6</sup>	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
<b>Panel D — Years of schooling<sup>3</sup></b>								
Change in private enrollment <sup>2</sup>	-4.0*** (1.4)	-5.1*** (1.6)	-2.0*** (0.7)	-2.5*** (0.8)	-2.9* (1.6)	-2.7** (1.2)	-3.2*** (1.1)	-3.5*** (1.1)
Controls for trends <sup>5</sup>	No	Yes	No	Yes	No	Yes	No	Yes
<i>N</i>	85	85	85	85	85	85	85	85
Overid. test, p-value <sup>6</sup>	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.90

Notes: \*, \*\*, and \*\*\* indicate significance at the 10, 5, and 1 percent level, respectively. Huber-White standard errors are in parenthesis. <sup>1, 2, 3</sup>, and <sup>4</sup> as in Table 3.

<sup>4</sup> Variables calculated using census information, data sources (16) and (17), as described in Table A.1.

<sup>5</sup> Controls for pre-existing and concurrent trends, as described in Table 3, notes 4 and 5.

<sup>6</sup> The overidentification test is based on Sargan (1958). We report the p-value for the statistic constructed by multiplying the number of observations and the  $R^2$  from a regression of the residuals from the second stage regression on the instrument(s).

Table 5: Sorting among communes, 1990's cross-section and 1982-1988 changes

Dependent variable – within commune observations of															
<i>Average characteristic in public schools</i>															
<i>Average characteristic in all schools</i>															
	SES index <sup>1</sup>	Income <sup>2</sup>	Language <sup>1</sup>	Mathematics <sup>1</sup>	Repetition <sup>3</sup>	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<b>Panel A - 1990's Cross sections<sup>4</sup></b>															
Private enrollment <sup>3</sup>	-0.20***	-0.16***	-0.37***	-0.33***	-0.08***	-0.08***	-0.09***	-0.09***	-0.09***	-0.09***	-0.09***	-0.09***	-0.09***	0.42***	0.28***
	(0.02)	(0.03)	(0.07)	(0.09)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.07)	(0.07)
	[-0.58]	[-0.46]	[-0.43]	[-0.38]	[-0.39]	[-0.39]	[-0.39]	[-0.39]	[-0.39]	[-0.39]	[-0.39]	[-0.42]	[-0.42]	[0.44]	[0.29]
Commune controls <sup>5</sup>	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Yes	No	Yes
Thirteen regional dummies	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Yes	No	Yes
N	296	296	184	184	296	296	184	184	296	296	184	184	296	299	299
R <sup>2</sup>	0.313	0.493	0.171	0.285	0.188	0.396	0.188	0.285	0.188	0.396	0.188	0.285	0.346	0.193	0.447
<b>Panel B - 1982-1988 changes</b>															
Change in private enrollment <sup>3</sup>	-0.21**	-0.22**	-0.21**	-0.22**	-0.14*	-0.19**	-0.14*	-0.19**	-0.14*	-0.19**	-0.14*	-0.19**	-0.19**	0.51**	0.38*
	(0.10)	(0.10)	(0.10)	(0.10)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.24)	(0.24)
	[-0.24]	[-0.26]	[-0.24]	[-0.26]	[-0.17]	[-0.23]	[-0.17]	[-0.23]	[-0.17]	[-0.23]	[-0.17]	[-0.23]	[-0.23]	[0.24]	[0.18]
Controls: concurrent trends <sup>6</sup>	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Yes	No	Yes
N	84	84	84	84	84	84	84	84	84	84	84	84	84	163	163
R <sup>2</sup>	0.060	0.065	0.060	0.065	0.027	0.097	0.027	0.097	0.027	0.097	0.027	0.097	0.054	0.100	0.100

Notes: \*, \*\*, and \*\*\* indicate significance at the 10, 5, and 1 percent level, respectively. Huber-White standard errors are in parenthesis.

<sup>1</sup> Calculated using test system information, data sources (1) and (2), as described in Table A.1.

<sup>2</sup> Based on household survey information, pooled from data sources (11) and (12).

<sup>3</sup> Based on administrative information, data sources (8), (9), and (10). Repetition data is available only up to 1988.

<sup>4</sup> In the cross-section, the data for test scores and the SES index are for 1996, for income they are for 1990/92 (pooled data) and for repetition they are for 1988. For each variable, these are the latest cross-sections available in our data.

<sup>5</sup> Cross-sectional controls include: literacy rate, mean years of schooling, poverty rate, average household income (all from household survey information, data source 14), population and population squared (from census summary information, data source 18).

<sup>6</sup> Controls for concurrent trends are the 1982-92 change in population (from data sources 17 and 18), and the 1982-96 change in mean years of schooling and imputed labor income among adults (from census and household survey information, sources 13 and 16).

**Table 6: IV regressions for sorting, 1982-1988**

	IV: Urbanization rate <sup>1</sup>	IV: Population <sup>1</sup>	IV: Inter-quartile range in years of schooling <sup>1</sup>	IV: All three variables				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Dependent variable</b> – change in <i>Average characteristic in public schools</i> <sup>2</sup> :								
<i>Average characteristic in all schools</i> <sup>2</sup> :								
<b>Panel A: Language score</b> <sup>2</sup>								
Change in private enrollment <sup>3</sup>	-1.04** (0.51)	-1.54* (0.91)	-0.16*** (0.06)	-0.16*** (0.06)	-0.58** (0.29)	-0.78* (0.40)	-0.50** (0.23)	-0.57* (0.30)
Controls: concurrent trends <sup>4</sup>	No	Yes	No	Yes	No	Yes	No	No
<i>N</i>	84	84	84	84	84	84	84	84
Overidentification test, p-value <sup>5</sup>	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
<b>Panel B: Math score</b> <sup>2</sup>								
Change in private enrollment <sup>3</sup>	-0.69** (0.31)	-1.01* (0.59)	-0.07 (0.06)	-0.08* (0.05)	-0.61** (0.24)	-0.73* (0.38)	-0.42** (0.18)	-0.45* (0.26)
Controls: concurrent trends <sup>4</sup>	No	Yes	No	Yes	No	Yes	No	No
<i>N</i>	84	84	84	84	84	84	84	84
Overidentification test, p-value <sup>5</sup>	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
<b>Panel C: Repetition rate</b> <sup>3</sup>								
Change in private enrollment <sup>3</sup>	1.62*** (0.46)	1.71** (0.66)	0.50*** (0.14)	0.47*** (0.15)	0.63 (0.39)	0.54 (0.44)	1.03** (0.33)	0.88** (0.34)
Controls: concurrent trends <sup>4</sup>	No	Yes	No	Yes	No	Yes	No	No
<i>N</i>	163	163	163	163	163	163	163	163
Overidentification test, p-value <sup>5</sup>	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99

Notes: \*, \*\*, and \*\*\* indicate significance at the 10, 5, and 1 percent level, respectively. Huber-White standard errors are in parenthesis.

<sup>1</sup> Based on census summary and micro information, data sources (16) and (17), as described in Table A.1.

<sup>2</sup> Calculated using test score information, data sources (1) and (2).

<sup>3</sup> Variable based on administrative information, data sources (8) and (9).

<sup>4</sup> Controls for concurrent trends are the 1982-92 change in population (from data sources 17 and 18), and the 1982-96 change in mean years of schooling and imputed labor income among adults (from census and household survey information, sources 13 and 16).

<sup>5</sup> The overidentification test is based on Sargan (1958). We report the p-value for the statistic constructed by multiplying the number of observations and the  $R^2$  from a regression of the residuals from the second stage regression on the instrument(s).

Table A.1: Data sources

Data type and source	Original unit of observation	Year									
		1970	1978	1980	1982	1988	1990	1992	1996	1998	1999
<b>Test scores</b>											
PER <sup>1</sup>	School				(1)	(2)	(3)	(4)			
SIMCE <sup>2</sup>	School										
TIMSS <sup>3</sup>	Country										(5)
International science exams <sup>4</sup>	Country			(6)							
<b>Administrative information</b>											
Enrollment files	School			(7)	(8)	(9)					(10)
<b>Household surveys</b>											
CASEN <sup>5</sup>	Individual						(11)	(12)	(13)	(14)	
<b>Census</b>											
Micro data	Individual						(16)				
Summary files	Commune			(15)			(17)				(18)
<b>Other</b>											
School maps <sup>6</sup>	Commune										(19)

<sup>1</sup> Programa de Evaluación del Rendimiento Escolar.

<sup>2</sup> Sistema de Evaluación de Calidad de la Educación.

<sup>3</sup> Third International Mathematics and Science Study, see <http://timss.bc.edu>

<sup>4</sup> International Science Exams, International Education Association, see Comber and Keeves (1973).

<sup>5</sup> Encuesta de Caracterización Socioeconómica Nacional.

<sup>6</sup> See Instituto Geográfico Militar (1983).

**Table A.2: Reduced form regressions for achievement, 1982-1988**

Independent variable – 1982 observation of:						
	Urbanization rate <sup>1</sup>		Population <sup>1</sup>		Inter-quartile range in years of schooling <sup>1</sup>	
Dependent variable – 1982-88 change in:	(1)	(2)	(3)	(4)	(5)	(6)
<b>Private enrollment</b> <sup>2</sup>	0.09*** (0.03) [0.32]	0.08*** (0.03) [0.28]	0.44*** (0.07) [0.31]	0.42*** (0.07) [0.30]	0.19*** (0.04) [0.38]	0.19*** (0.05) [0.38]
Controls for trends <sup>3</sup>	No	Yes	No	Yes	No	Yes
N	84	84	84	84	84	84
R <sup>2</sup>	0.101	0.222	0.091	0.238	0.150	0.281
Average <b>Language</b> score <sup>4</sup>	-3.5 (2.4) [-0.18]	-2.2 (2.8) [-0.11]	1.9 (2.2) [0.02]	5.0** (2.2) [0.05]	-3.8 (3.5) [-0.11]	-1.9 (3.8) [-0.06]
Controls for trends <sup>3</sup>	No	Yes	No	Yes	No	Yes
N	84	84	84	84	84	84
R <sup>2</sup>	0.031	0.113	0.000	0.105	0.012	0.106
Average <b>Math</b> score <sup>4</sup>	-9.0*** (2.2) [-0.43]	-8.2*** (2.4) [-0.39]	-3.5 (3.0) [-0.03]	-0.4 (3.1) [-0.00]	-11.0**** (3.6) [-0.30]	-8.8** (4.0) [-0.24]
Controls for trends <sup>3</sup>	No	Yes	No	Yes	No	Yes
N	84	84	84	84	84	84
R <sup>2</sup>	0.182	0.277	0.001	0.144	0.091	0.194
Average <b>Repetition rate</b> <sup>2</sup>	0.04*** (0.01) [0.34]	0.04*** (0.01) [0.34]	0.09** (0.04) [0.09]	0.08** (0.04) [0.08]	0.06*** (0.02) [0.26]	0.06*** (0.02) [0.26]
Controls for trends <sup>3</sup>	No	Yes	No	Yes	No	Yes
N	145	145	145	145	145	145
R <sup>2</sup>	0.119	0.151	0.009	0.078	0.085	0.122
Mean <b>years of schooling</b> <sup>5</sup>	-0.5*** (0.2) [-0.26]	-0.7*** (0.2) [-0.37]	-1.0** (0.5) [-0.09]	-1.2** (0.5) [-0.11]	-0.8** (0.3) [-0.22]	-0.7** (0.3) [-0.19]
Controls for trends <sup>3</sup>	No	Yes	No	Yes	No	Yes
N	85	85	85	85	85	85
R <sup>2</sup>	0.077	0.326	0.007	0.239	0.043	0.261

Notes: \*, \*\*, and \*\*\* indicate significance at the 10, 5, and 1 percent level, respectively. Huber-White standard errors are in parenthesis. Brackets contain the proportion of a std. dev. change in the dependent variable brought about by a one std. dev. increase in the private enrollment rate.

<sup>1</sup> Based on census summary and micro information, data sources (16) and (17), as described in Table A.1.

<sup>2</sup> Calculated using administrative information, data sources (8) and (9)

<sup>3</sup> Controls for pre-existing and concurrent trends, as described in Table 3, notes 4 and 5.

<sup>4</sup> Based on test score information, data sources (1) and (2).

<sup>5</sup> Calculated using census and household survey information, data sources (16) and (11).



Table A.3: Reduced form regressions for sorting, 1982-1988

Dependent variable – 1982-88 change in:	Independent variable:					
	Urbanization rate <sup>1</sup>		Population <sup>1</sup>		Inter-quartile range in years of schooling <sup>1</sup>	
	(1)	(2)	(3)	(4)	(5)	(6)
<b>Private enrollment</b> <sup>2</sup>	0.08**	0.06**	0.44***	0.41***	0.16***	0.15***
	(0.03)	(0.03)	(0.05)	(0.05)	(0.04)	(0.04)
	[0.31]	[0.23]	[0.33]	[0.31]	[0.36]	[0.34]
Controls: concurrent trends <sup>3</sup>	No	Yes	No	Yes	No	Yes
N	84	84	84	84	84	84
R <sup>2</sup>	0.104	0.183	0.110	0.228	0.138	0.220
Sorting measure for <b>Language</b> <sup>4,5</sup>	-0.09***	-0.10***	-0.07**	-0.06**	-0.09**	-0.11**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.05)
	[-0.40]	[-0.45]	[-0.06]	[-0.05]	[-0.24]	[-0.29]
Controls: concurrent trends <sup>3</sup>	No	Yes	No	Yes	No	Yes
N	84	84	84	84	84	84
R <sup>2</sup>	0.151	0.171	0.004	0.011	0.062	0.080
Sorting measure for <b>Math</b> <sup>4,5</sup>	-0.06***	-0.06**	-0.03	-0.03	-0.10***	-0.11**
	(0.02)	(0.03)	(0.02)	(0.02)	(0.04)	(0.05)
	[-0.28]	[-0.28]	[-0.02]	[-0.03]	[-0.28]	[-0.30]
Controls: concurrent trends <sup>3</sup>	No	Yes	No	Yes	No	Yes
N	84	84	84	84	84	84
R <sup>2</sup>	0.073	0.128	0.001	0.052	0.076	0.120
Sorting measure for <b>Repetition</b> <sup>2,4</sup>	0.17***	0.14***	0.28**	0.07	0.25**	0.09
	(0.04)	(0.05)	(0.11)	(0.10)	(0.08)	(0.07)
	[0.31]	[0.26]	[0.03]	[0.02]	[0.11]	[0.09]
Controls	No	Yes	No	Yes	No	Yes
N	163	163	163	163	163	163
R <sup>2</sup>	0.100	0.130	0.003	0.076	0.014	0.080

Notes: \*, \*\*, and \*\*\* indicate significance at the 10, 5, and 1 percent level, respectively. Huber-White standard errors are in parenthesis. Brackets contain the proportion of a std. dev. change in the dependent variable brought about by a one std. dev. increase in the private enrollment rate.

<sup>1</sup> Based on census summary and micro information, data sources (16) and (17), as described in Table A.1.

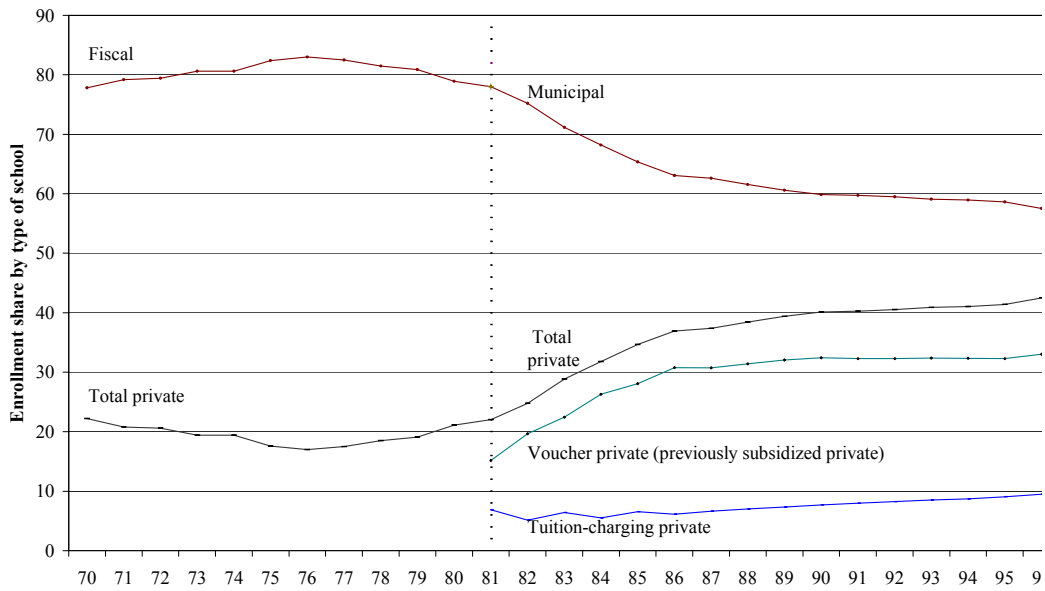
<sup>2</sup> Based on administrative information, data sources (8) and (9)

<sup>3</sup> Controls for concurrent trends are the 1982-92 change in population (data sources 17 and 18), and the 1982-96 change in mean years of schooling among adults, and imputed labor income (from census and household survey information, sources 13 and 16).

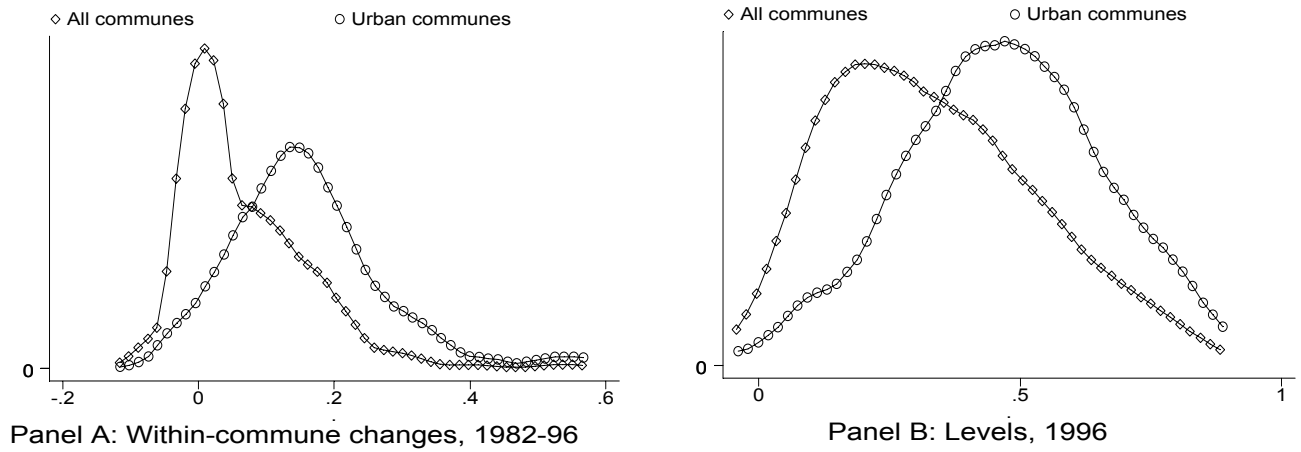
<sup>4</sup> The sorting measure is  $\frac{\text{Average characteristic in public schools}}{\text{Average characteristic in all schools}}$ .

<sup>5</sup> Based on test score information, data sources (1) and (2).

**Figure 1: National enrollment shares by sector, 1970-1995<sup>1</sup>**



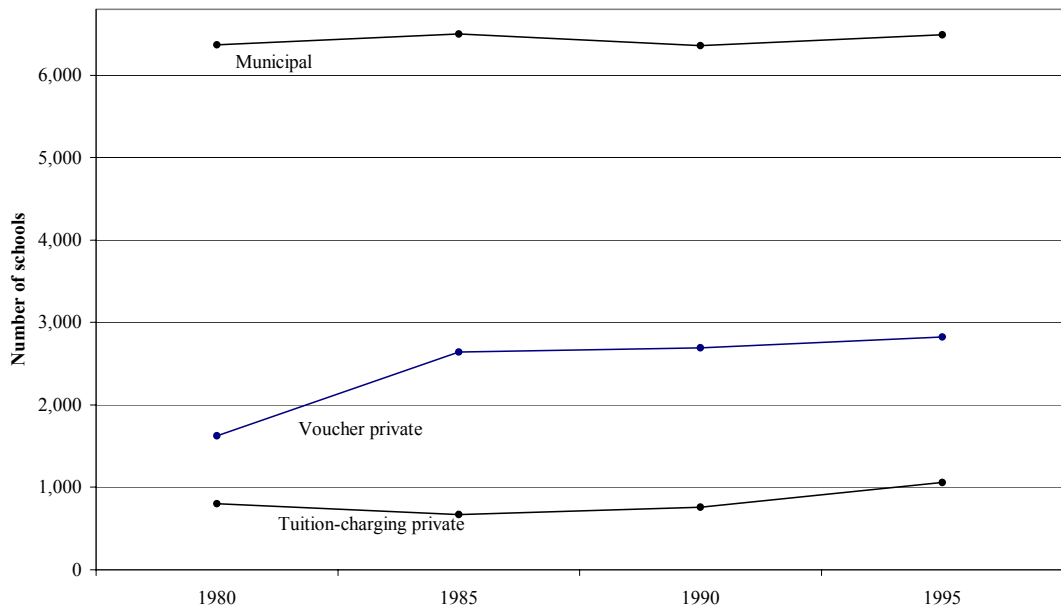
**Figure 2: Private enrollment among communes<sup>2</sup>**



<sup>1</sup> Data assembled from several issues of the Ministry of Education's *Compendio Estadístico*.

<sup>2</sup> Panel A is based on administrative information, data sources (8) and (10) in Table A.1. It covers all communes in Chile. Panel B refers to communes with positive private enrollment.

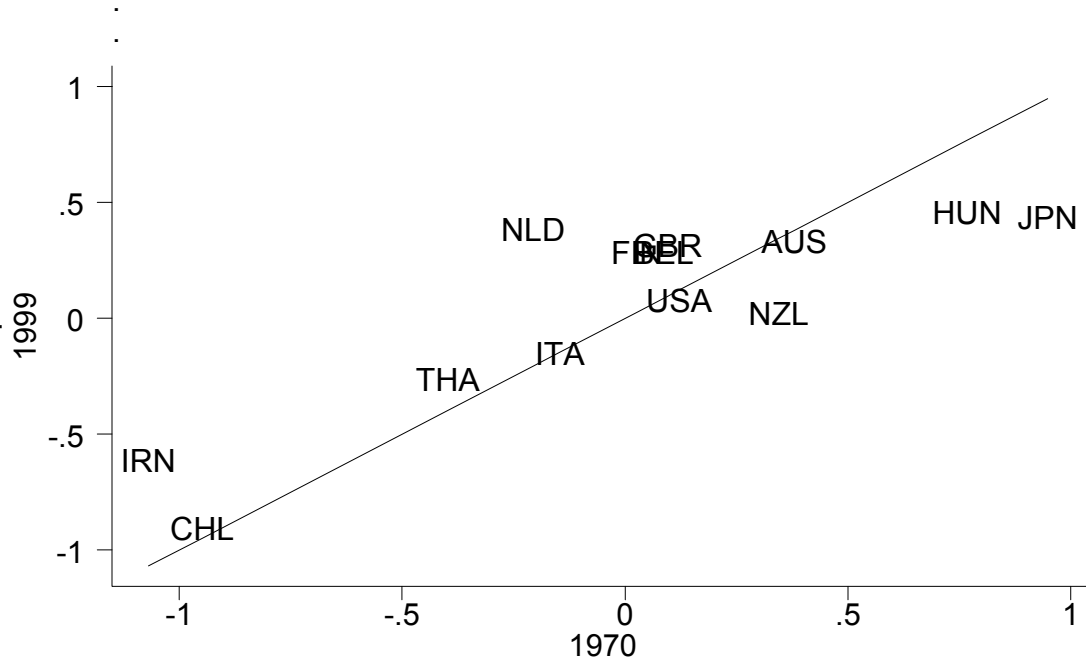
**Figure 3: Number of schools by sector, 1980-1995<sup>1</sup>**



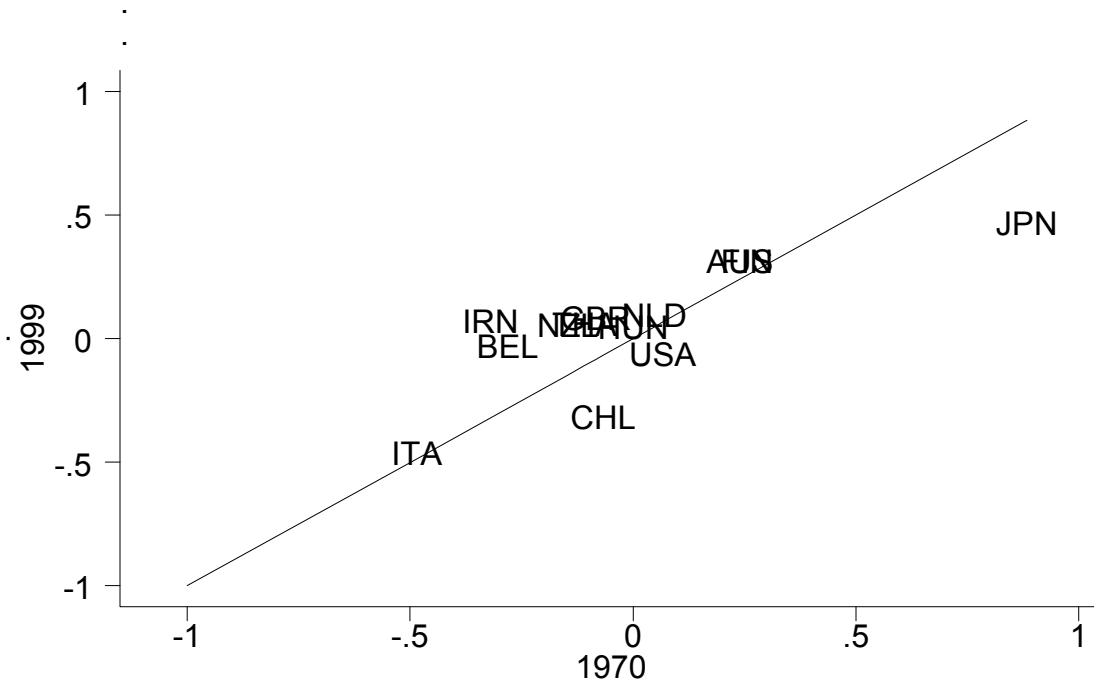
<sup>1</sup> Data assembled from several issues of the Ministry of Education's *Compendio Estadístico*.

**Figure 4: Chile's Performance in International Tests, 1970 and 1999**

A. Median Test Scores (standard deviation from 13-country average).



B. Residual Median Test Scores (standard deviation from 13-country average)



Note: The scores for each country subtract the mean score for the 13 countries and are divided by the standard deviation of U.S. scores in the given year. Residual test scores are residuals from regression of median test score on GDP/worker, enrollment rate, and ratio of spending per student to GDP per capita.

**Figure 5**  
**Average test score among municipal and voucher schools, relative to tuition-charging private schools, 1982 and 1996 (Std. Deviations below tuition charging)**

