

**Distribution of Student Achievement in Chile  
Baseline Analysis for the Evaluation of the Subvención Escolar  
Preferencial, SEP (Preferential School Subsidy)**

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## **I. Introduction**

In January 2008, the Chilean legislature passed landmark legislation that changed the rules under which the country's educational voucher system operated. The new legislation created the Subvención Escolar Preferencial (SEP) program, or Preferential School Subsidy, the goal of which is to improve the quality of education provided by subsidized schools, especially those that serve vulnerable children (referred to as "Priority students" in the SEP Law). This paper has two primary objectives, both of which concern the "counterfactual" outcomes, defined as the set of educational experiences and educational outcomes that Priority students in grade 4 would have had in 2008 if SEP had not been introduced.<sup>1</sup> The first objective is to describe our method for predicting the counterfactual outcomes, and explain the reasons for this choice. The second is to present our estimates of the counterfactual outcomes. The importance of this paper lies in the role that estimates of the "counterfactual" will play in future papers. In particular, our estimates of the impact of SEP on the education and achievement of Priority students will come from comparisons of actual outcomes for Priority students at the end of 2008 (and later years) with our estimates of the "counterfactual."

In addition to these primary objectives, we have two subsidiary goals. The first is to describe trends over the period 2005-2007 in the gaps between the average achievement of Priority students and that of non-Priority students in Spanish, mathematics, and science. The second subsidiary goal is to decompose the achievement gaps in two ways. One decomposition focuses on the extent to which the gaps consist of differences between the geographic distribution of Priority students and non-Priority students and to what extent they consist of differences in the

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<sup>1</sup> One reason that we focus on outcomes for students in grade 4 is that this is the first grade level at which students take the national (SIMCE) examinations. A second reason is that, in 2008, SEP only applied to students in grades pre-kindergarten through grade 4. In the near future, SEP will apply to students from pre-kindergarten through eighth grade.

achievement of Priority students and non-Priority students living in the same region. The second decomposition focuses on the extent to which the gaps consist of differences between the distribution of schools attended by Priority students and non-Priority students and the extent to which they consist of differences in the achievement of Priority students and non-Priority students attending the same school. The value of understanding trends in the gaps and their components is that they provide another set of counterfactual outcomes against which to compare outcomes under SEP.

The paper contains the following sections. Section II provides a description of the voucher system before the introduction of SEP, an explanation of the main components of SEP, and a summary of other educational reforms currently undergoing Parliamentary review, for which SEP may serve as a valuable pilot. In Section III, we present the methodological approach employed in this paper to predict the counterfactual outcomes to which actual outcomes under SEP will be compared. Section IV describes the data on students and schools used in this paper. This section also provides information on the distributions of grade 4 Priority students and non-Priority students among the nation's three types of elementary schools in the years 2005-2007 and our predictions of what these distributions would have been in 2008 in the absence of SEP. Section V describes the distributions of achievement of Priority students and non-Priority students on SIMCE tests of Spanish, mathematics, and natural and social sciences administered at the end of the 2005, 2006, and 2007 school years, and our predictions of what the average achievement scores for each group would have been in 2008 had SEP not been introduced. Section VI describes trends in achievement gaps between Priority and non-Priority students and trends in the decomposition of these gaps into within- and between-school differences. Section VII summarizes the key findings from the baseline data analysis. It also describes our proposed

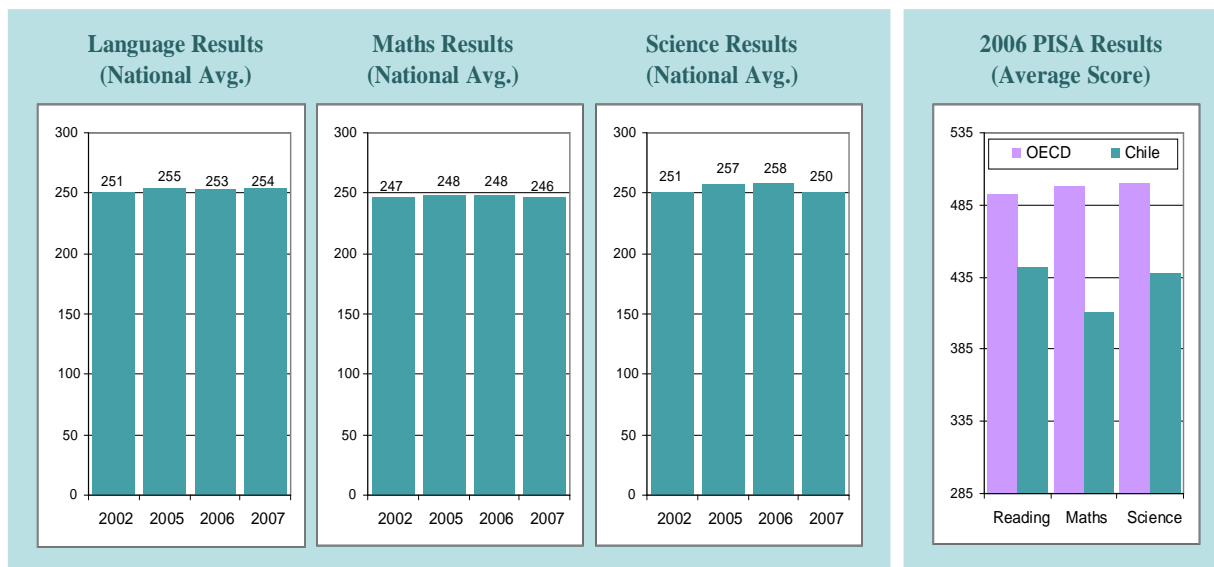
research agenda for evaluating the initial impacts of SEP on the distribution of schools attended by Priority students and on the achievement of Priority students on the SIMCE tests.

## **II. Brief Background on the Chilean Voucher System and SEP**

In the early 1980s, the Government of Chile transferred the administration of public schools to the municipal governments. The reform also opened the way for private sector participation as a provider of publicly financed education by establishing a voucher-type student-based subsidy. Three types of schools were established: municipal schools, financed by the central student-based subsidy and managed by municipalities; private subsidized schools, financed by the central student-based subsidy and managed by the private sector; and private fee-paying schools, financed by fees paid by parents and managed by the private sector. The per-student subsidy is the equivalent for municipal and private subsidized schools and is allocated based on student attendance. However, it varies by level of education (pre-primary, lower primary (1<sup>st</sup>-6<sup>th</sup> grades), upper primary (7<sup>th</sup> and 8<sup>th</sup> grades) and secondary or technical); length of the school day (regular or full-time); and type of education (regular or special).

By the early 2000s, the reforms had led to important increases in education enrollment and completion rates, but lackluster performance in cognitive achievements, as measured by students' learning outcomes. For example, Hsieh and Urquiola (2003, 2006) found that the country's relative performance in international tests did not change much between 1970 and 1999. Its performance on the 2000 and 2006 Programme for International Student Assessment (PISA) was significantly below the OECD average. Also, scores on the national assessment tests, SIMCE, for grade 4 students showed no improvement over time in mastery of Spanish, mathematics, and science (see Figure 1).

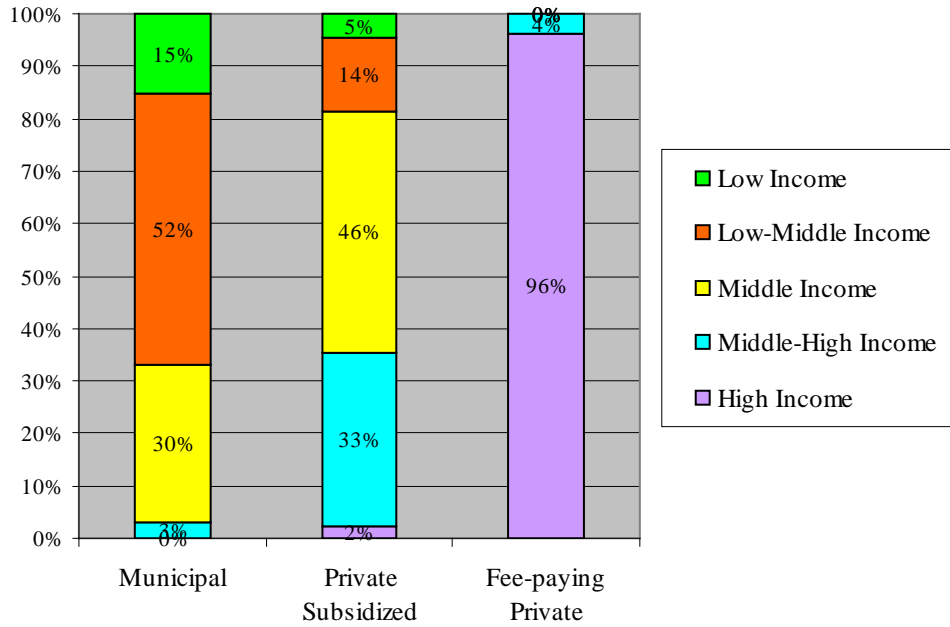
**Figure 1: Chile's Student Performance in National and International Assessments**  
**No improvement in learning since 2002 according to national standardized achievement tests (SIMCE)**      **Low performance in international standardized achievement tests**



**Sources:** SIMCE (2002, 2005, 2006 and 2007) scores are for fourth-graders; and PISA (2006) scores are for 15-year old students.

Researchers have documented that the Chilean education system has become highly segregated by socio-economic background over time, with students from poor socio-economic backgrounds attending schools with students of similar backgrounds, while students from middle- and high-income backgrounds also attend schools with students of similar backgrounds (Hsieh and Urquiola 2003, 2006). Indeed, Figure 2, which is based on the distribution of the nation's grade 4 students in 2007 shows that 67 percent of the students in municipal schools attended schools classified as serving primarily low-income or low-middle income students, while only 19 percent of students attending subsidized schools did so. Eighty-one percent of the 4<sup>th</sup> grade students in private subsidized schools attended schools classified as serving primarily middle- or higher-income households, while only 33 percent of 4<sup>th</sup> grade students attending municipal schools did so. Finally, 96 percent of 4<sup>th</sup> grade students attending fee-paying schools attended schools serving primarily students from high income families.

**Figure 2:** Average Student Socio-Economic Background by Type of School, 2007<sup>2</sup>



Source: Authors' estimates using Ministry of Education data

While research has documented the segregation of students by student socio-economic background across types of school in Chile, it has been more difficult to demonstrate empirically the channels through which this segregation has taken place. What is clear is that, while municipal and private subsidized schools receive equal financing on a per-student basis, they have operated under substantially different rules in terms of student selection, teacher contracting, and the ability to count on alternative sources of financing. Private schools (both subsidized and fee-paying) have complete freedom to accept, reject, and dismiss students as well as to establish their own selection processes. Moreover, they can set their own tuition levels. In contrast, every municipal school is required to accept any student who wishes to enroll unless it can be demonstrated that there are no vacancies at the school. While elementary municipal

<sup>2</sup> These socio-economic categories are constructed by SIMCE based on information reported by parents on their income and education background in the parent questionnaire that is administered as part of the national assessment, SIMCE.

schools may not charge fees to parents of enrolled children, some municipal schools do receive additional funding from municipal governments. One significant change in the rules of the school financing mechanism was introduced in 1993. Under the new rule, private subsidized schools and secondary municipal schools may charge fees in addition to the value of the voucher. When subsidized schools charge fees, the public subsidy is reduced.

The rules governing the compensation of teachers also are different for municipal schools and private schools. Teachers in municipal schools are governed by special legislation (the Teacher Statute), involving a centralized collective-bargaining process which has resulted (although it is not stipulated in the Statute) in teacher salaries in the public sector that are based on uniform pay-scales that reward training, experience, and working under difficult conditions, but not teaching performance. Private schools (both subsidized and fee-paying) operate as firms, and their teachers come under the same Labor Code as other private-sector workers in the country. Private fee-paying and subsidized schools set their own salaries and can select, hire, and dismiss their teachers. In contrast, municipal governments centrally hire and assign teachers to municipal schools. Because teachers in municipal schools are governed by the Teacher Statute, their dismissal is also much more difficult to bring about than dismissals of teachers from private schools. In addition, in 2003, a national teacher evaluation program was introduced that establishes significant consequences for teachers based on their performance in the evaluation, including dismissal from the profession for teachers who are evaluated at the lowest level of performance for three consecutive years. This program applies only to municipal school teachers.

Segregation of students by socio-economic background across types of school is problematic for at least two reasons. First, schools in which all students come from homes in

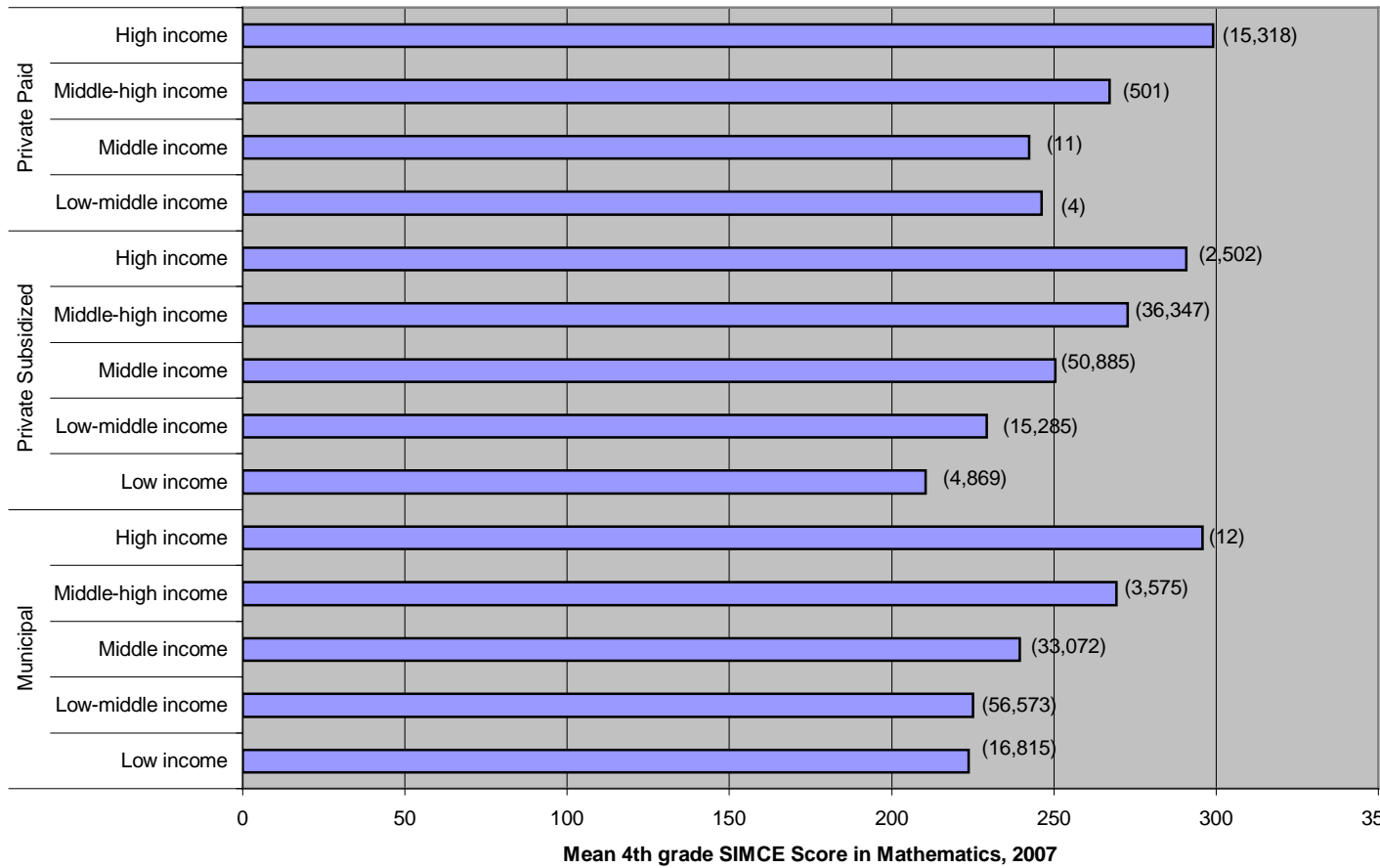
which parents have quite low educational attainments lack the effective voice for school improvement that well educated parents typically bring. Second, as a growing number of studies of peer-group effects have documented, low-achieving children learn more when they are in classes with higher-achieving students. While not all children from low socio-economic backgrounds are low-achieving, they are much more likely to be low achieving than are students living in high socio-economic households. These forces help to explain why, as Figure 3 shows, schools serving middle- to high-income students have higher average test scores than do schools serving primarily students from low-income families. This pattern holds, regardless of whether the school is run by municipalities, or private (subsidized or unsubsidized) providers.<sup>3</sup>

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<sup>3</sup> It is not appropriate to draw inferences about the relative effectiveness of municipal schools, subsidized private schools, and fee-paying private schools from Figure 3. In fact, the evidence to date on this question is not clear-cut, in part because the results of studies addressing this question depend on model specifications, especially the way in which differences in student backgrounds are taken into account.



**Figure 3: Mean 2007 SIMCE 4<sup>th</sup> Grade Mathematics Scores by Type of School and Average Socio-Economic Background of the Students**



Notes: (1) Numbers of students who took the tests in each school are included in parentheses.  
 (2) The mean scores for Spanish and science by type of school and student socio-economic background are very similar, and thus we omit their presentation.  
 Source: Chilean Ministry of Education Data.

### II.1 The Preferential School Subsidy Law, SEP

The SEP law was designed primarily to address the inequality in student learning outcomes. The law explicitly recognizes that it is more costly to educate students from low-income families; it provides a larger per-student subsidy for schools serving students from low-income backgrounds. It also increases school accountability and provides some restrictions on the rules under which municipal and private subsidized schools in Chile operate.

More specifically, the SEP law introduces three key innovations to education financing in Chile:

- (i) *Additional resources for schools serving low-income, Priority students.* SEP provides an additional 50 percent, on average, over the base per-student subsidy for students classified as Priority Students and a differential per-student amount for all students in schools depending on the share of Priority Students (concentration bonus);
- (ii) *Increased accountability for student learning outcomes.* The law mandates that every school receiving funds under SEP develop a school improvement plan focused on student learning outcomes, report progress toward the achievement of the plan to the Ministry of Education and the community. The law also forbids participating schools from selecting/dismissing students or charging fees to Priority students.
- (iii) *Differential allocation of resources and Ministry intervention based on school performance.* Schools participating in SEP are classified into one of three categories: Autonomous, Emerging, or In Recuperation. The classification of each school depends on students' scores on the national assessment, SIMCE, and on other indicators of performance, including the results of teacher performance evaluations, progression and retention rates, and information about school improvement, initiative and integration.<sup>4</sup>

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<sup>4</sup> Indicators of school improvement, initiative and integration are provided by the Sistema Nacional de Evaluación del Desempeño de los Establecimientos Educacionales, SNED, and are conceptually defined as follows:

- *Improvement* in working conditions and in the degree of compliance with statutory regulations created by the Ministry of Education;
- *Initiative* by the school to incorporate innovations in education and to obtain support from external actors.
- *Integration* with the community and participation by teachers and parents in the development of school policies.

1. Autonomous schools are those with a stable record of comparatively high student test scores over time and adequate learning environments. They have complete autonomy in how to invest SEP resources to achieve their explicit goals in the school improvement plan.
2. Emerging schools show room for improvement, while having average or slightly below average student test scores. They have autonomy over 67 percent of SEP resources, and they must consult with the Ministry of Education over how to spend the remaining 33 percent.
3. Schools classified as In Recuperation are those with test scores below expectations and inadequate learning environments. They have no discretion over how to spend the additional SEP resources, and instead these are mandated by the Ministry of Education, which closely monitors these schools. No schools will be placed in the “In Recuperation” category until the 2011 school year.

To achieve the objectives of SEP, the Ministry of Education had to assume new responsibilities. Specifically, under SEP the Ministry must: (i) classify schools based on performance; (ii) provide guidelines for and evaluate the quality of school improvement plans for participating schools; (iii) identify qualified external providers of technical support to schools and provide direct technical assistance to schools; and (iv) monitor and evaluate each school’s progress toward achieving the goals of its school improvement plan.

*SEP in the Context of a Major Overhaul of the Chilean Education System*

In 2007 and 2008, President Michelle Bachelet’s government proposed other significant education reforms that are currently undergoing parliamentary review. The proposed Education

Quality Assurance Law and the Public Education Strengthening Law would introduce institutional reforms to the education sector and would alter the rights and responsibilities of individuals and the State.

These initiatives have elements in common with SEP. As a result, some of the innovations introduced by SEP will inform the implementation of these other reforms. This makes it especially important to understand the effects of SEP on education quality and equity as well as the channels through which these effects take place.

*General Law of Education (Ley General de Educación) Proposal.* The previous law regulating the education sector was approved in March 7, 1990, three days prior to the end of the military regime of Augusto Pinochet. The Organic Constitutional Law of Instruction (Ley Orgánica Constitucional de Enseñanza or LOCE) set the basis for increased private sector provision of education, reducing the requirements to become an officially recognized educational institution and limiting the role of the State to enforcing compliance with those requirements. In practice, the Law allowed almost anyone to set up a school, and it granted schools substantial freedom on how to provide education.

Moreover, the LOCE recognized the right to teach as a constitutional entitlement that had to be protected. The right to learn did not receive an equivalent recognition; the Law commanded the State to ensure access to education services, but it did not give the State the responsibility to ensure that everyone receive a high quality education. As stated in Article 6 of the LOCE, “the instruction imparted in educational institutions will have no limitations other than those imposed by moral, public order and national security.” Over the years, the spirit of the LOCE led to a strong tradition of teacher and school autonomy on how to provide education, with very limited

State authority to ensure the quality of education. The LOCE was often interpreted as favoring the right to teach over the right to learn.

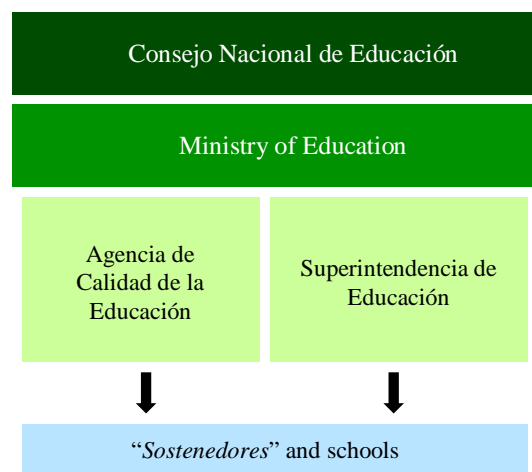
The new General Education Law, approved by Parliament on April 7, 2009 and currently undergoing Presidential review, attempts to redefine the balance between students' rights to receive quality education and schools' and teachers' rights to decide how to impart education. Some key aspects of the General Education Law are:

- The State has a responsibility to ensure that all children have access to quality education;
- A new school structure: primary school includes 1st to 6th grade, secondary schools include 7th to 12th grade (the previous structure had primary education from 1st to 8th grade, secondary from 9th to 12th grade);
- Publicly-financed schools may not select students in primary (grades 1-6);
- Publicly-financed schools must publicly report on the use of public resources;
- A new role and composition of the National Education Council (to sanction curricula and standards, certification requirements in primary through higher education).

*New Education Quality Assurance System Law Proposal.* A second proposed law currently under review by Parliament would redefine the role of the Ministry of Education and create two new agencies: a Superintendency of Education and an Agency for Education Quality. Through the Ministry of Education, the central government will be in charge of setting education policy decisions including the following: setting performance goals for students, teachers, schools and school owners; determining the requirements to operate as a school and to enter and remain in the teaching profession, and providing funding for municipal and private subsidized

schools. For some decisions, the Ministry will need the approval of the National Education Council. The Agency for Education Quality will oversee the overall quality of education provided by municipal and private subsidized schools, and will classify schools based on performance in similar categories to those of SEP (though with an additional, intermediate category). It will be responsible for evaluating the performance of school owners, schools, school administrators, teachers, and students. The Superintendency of Education will oversee how schools manage public resources and whether they comply with statutory regulations, as well as make recommendations to the Ministry of Education concerning sanctions for schools that fail to comply with existing regulations (see Figure 4).

**Figure 4:** Institutions in the Proposed New Education Quality Assurance System of Chile



*A New Institutional Framework for Public Education Provision.* In December 2008, the Government of Chile proposed a new law that involves a redesign of the institutional framework for public education. The goal of the proposed legislation is to improve the quality of the education services provided by public schools and to strengthen accountability in the public sector. Key components of the proposal are:

- The creation of a National Education Service, the function of which will be to execute public policies and programs (set by the Ministry of Education) and to provide technical-pedagogic support to public primary and secondary schools. According to the proposal, the creation of this new institution responds to a perceived deficiency in the relationship between the Ministry of Education and local education providers.
- The creation of Local Education Corporations (similar to Local Education Administrations), which will be responsible for managing public schools. These LECs – whose members will include the mayor(s) of the municipal governments in which they operate, two officials appointed by the Ministry of Education, and a number (to be defined by the regulatory process) of local elected officials – will be responsible for channeling the per-student subsidy, supervising and providing technical assistance to public schools.

### **III. Methodological Approach**

Since SEP was introduced as a nationwide, voluntary program in 2008 to improve the effectiveness of participating schools and the educational opportunities and achievement of Priority students throughout the country, it was not possible to use a random assignment experiment to test its impact on eligible students. Nor is there a contemporaneous group of low-income students that can serve as a comparison group against which the achievement of Priority students can be compared. For that reason, the common difference-in-differences evaluation strategy could not be used to estimate the impact of SEP on schooling outcomes for Priority students.

Given the national scope of SEP, we believe that the best evaluation design is an interrupted time series.<sup>5</sup> The essence of this approach is to use data on grade 4 “Priority” students for the three years prior to the introduction of SEP to predict what the distribution of outcomes for Priority students would have been at the end of 2008 had SEP not been introduced. **Figure 5** graphically illustrates the use of this approach in predicting the counterfactual average score for Priority students on the 2008 SIMCE mathematics test. The triangles represent the hypothetical average SIMCE math score for those grade 4 students in 2005, 2006, and 2007, who would have been eligible for Priority student status, had SEP been in place. The dashed line represents the hypothetical extension of the best fitting linear regression line through the three triangles. The shaded triangle at the right end of the dashed line segment represents the hypothetical prediction of the “counterfactual” outcome, defined as the estimate of what the average mathematics score of Priority students would have been at the end of 2008 in the absence of SEP.<sup>6</sup> The rectangle represents the hypothetical actual average score on the 2008 mathematics exam for Priority students. Thus, the vertical distance between the actual outcome and the shaded triangle graphically provides an estimate of the first year’s impact of SEP on the mathematics proficiency of grade 4 Priority students.

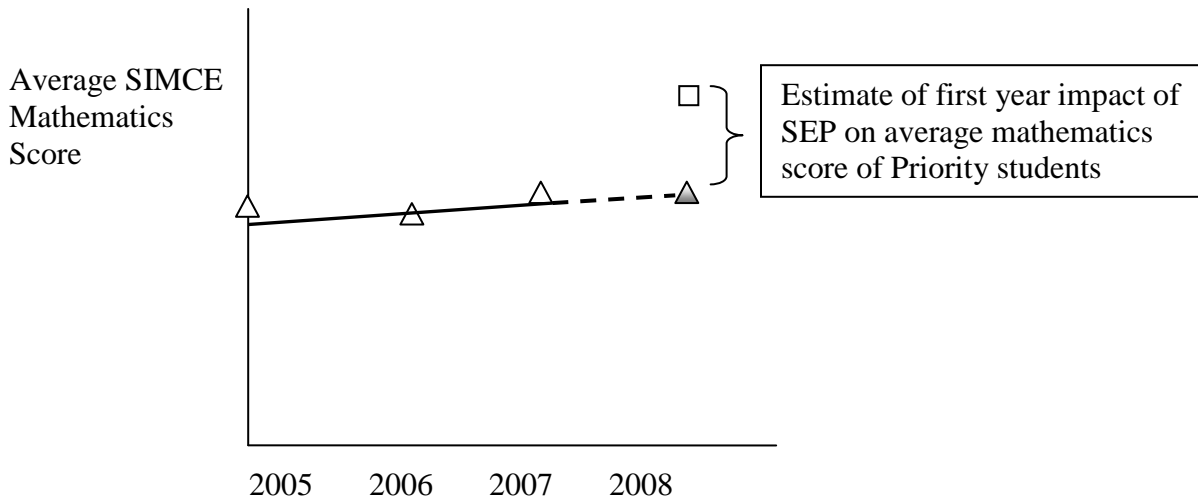
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<sup>5</sup> For a discussion of the interrupted time series approach, see Shadish, Cook, and Campbell (2002), pp. 171-206.

<sup>6</sup> While the figure illustrates the idea behind the interrupted time series approach, we actually make use of the individual scores of every “Priority” student for the years 2005-2007 (rather than simply using the average score in each year) in fitting the regression models that provide the basis for estimating the counterfactual outcomes for 2008. We do this to maximize the precision of our predictions of the counterfactual outcomes, the values of which will be reported in our next paper.



**Figure 5: Illustration of the Interrupted Time Series Approach**



A first step in carrying out the interrupted time-series approach was to identify those grade 4 students in the years 2005, 2006, and 2007 who would have been Priority students had SEP already been in place. Ministry of Education staff did this by implementing the following steps. First, they created a file that contained the student identification numbers for all students in grades 4 through 7 who were identified as eligible for Priority student status in 2008. They then merged this file with files containing information on all grade 4 students in the country in each of the years 2005, 2006, and 2007. This process enabled them to add to the record of each grade 4 student in the years 2005 through 2007 information indicating whether the student was eligible for Priority student status in 2008. If one critical assumption holds, this process identified every student in grade 4 in the years 2005 through 2007 who would have been eligible for Priority student status had SEP been in place. This assumption is that there were no changes in family circumstances between the year when a child was in grade 4 and the year 2008 that would have

made the child eligible for Priority status in one year but not in the other.<sup>7</sup> For ease of explication, we will subsequently refer to these students as Priority students. This same process also provided information for each student on family participation in Chile Solidario and in the other social safety net programs that determined eligibility for Priority student status. Since Chile Solidario serves the most economically disadvantaged families in the country, we are especially interested in the impact of SEP on outcomes for children whose families are eligible for this program. For that reason, we provide estimates of counterfactual outcomes in 2008 for students whose families were eligible for Chile Solidario (we will refer to this group as Chile Solidario students) as well as for the larger group of Priority students.

Since the interrupted time series approach predicts 2008 counterfactual outcomes by extending linear trends from the previous three years, it is important to document that the distributions of characteristics of grade 4 Priority students in 2005, 2006, 2007 are similar to those of grade 4 students in 2008. The results of our comparisons, which are summarized in Table 1 and Table 2, are reassuring. The decline over the years 2005-2008 in the total number of

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<sup>7</sup> An alternative strategy would have been to apply the 2008 rules for Priority student status to the characteristics of families in the year in which each student was enrolled in grade 4. We examined the merits of this strategy, but found that it did not work well. In particular, we attempted to use student background information on household income, household size and parental education to make a prediction of student “pseudo-Priority” status. Where true status was also known, we were able to compare our predictions to true priority status. The results were not compelling. While we were able to properly classify 81% of non-priority students (specificity), our correct classification rate for priority students was far lower at 57% percent (sensitivity). One reason for the poor performance of this approach was the extent of partial or complete data missingness on student background characteristics. Therefore, our strong preference is for the approach outlined above, where we apply known 2008 priority status to all previous years. While this approach is recognized as a marked improvement over the prediction of “pseudo-Priority” status, given that it does not rely on having student background information, it is not without assumptions, violations to which may induce some bias in our estimates. In particular, issues regarding proper classification must be recognized. It is possible, for example, that students identified as Priority in 2008 would not have qualified for Priority status in 2005. It is similarly possible that students identified as non-Priority in 2008 would have qualified for Priority status in 2005. To the extent that true differences in measures of academic achievement do exist between those who would and would not have been Priority students in the years prior to 2008, we recognize that our estimates of those differences may potentially be biased to the extent that this approach suffers from issues of misclassification. The direction of this bias is not readily identifiable, however, given that misclassification is conceivably more likely for those students whose circumstances put them at the margin of Priority or non-Priority status. Nevertheless, we contend that the application of 2008 Priority status to previous years remains the best option among those considered for identifying pre-2008 “Priority” status.

students in grade 4 in Chile reflects a well documented trend. As shown in Table 1, the percentage of grade 4 students designated as Priority students in each of the four years was very stable, at approximately 40 percent. Also, in each year, the families of 11 to 12 percent of students were living in households that were eligible for Chile Solidario. Moreover, the rates of participation in other programs relevant to Priority status eligibility were also very stable over the four years.

**Table 1:** Distribution of Grade 4 students by SEP status and SEP eligibility criteria, by year

	2005	2006	2007	2008
<b>N</b>	268,513	266,256	256,186	254,886
<b>%SEP</b>	39.94	40.31	39.60	39.59
<b>% Chile Solidario</b>	11.19	11.37	11.23	11.65
<b>% in 3<sup>rd</sup> most vulnerable</b>	20.76	20.97	19.37	19.20
<b>% Fonasa A</b>	2.02	1.95	2.64	2.87
<b>% Other Criteria</b>	5.98	6.02	6.31	5.87

Note: Official records from the Chilean Ministry of Education indicate that total (end of year) 4<sup>th</sup> grade enrollment for years examined is as follows: 280,022 (2005), 276,691 (2006), and 267,531 (2007). End of year figures for 2008 are not yet available. Registro de Estudiantes de Chile. Ministerio de Educación de Chile.

Table 2 provides information on the geographic distributions of grade 4 students, classified by Priority status, in each of the years from 2005 – 2008. The information in the table illustrates two striking patterns. The first is that the geographic distributions of grade 4 Priority students and non-Priority students were remarkably stable across the four years. For example, in each of the four years, approximately 28 percent of Priority students lived in the Metropolitan region and about 17 percent lived in the Biobío region. This pattern gives us confidence that extrapolation of trends in outcomes for Priority students in the years 2005-2007 provides a solid basis for predicting counterfactual outcomes for Priority students in 2008 – meaning the outcomes that would have occurred had SEP not been introduced.

The second pattern illustrated by the figures in **Table 2** is that the geographic distribution of Priority students is quite different from that of non-Priority students. For example, the

percentage of 2007 grade 4 non-Priority students living in the Metropolitan region (46) was 18 percentage points higher than the comparable figure for grade 4 Priority students. In contrast, the percentage of 2007 grade 4 non-Priority students living in the Biobío region (9%) was 8 percentage points lower than the comparable percentage of 2007 Priority students. In Section VI, we examine whether the regional differences in the distribution of students play a role in explaining the gap between the average academic achievement of Priority students and that of non-Priority students.

**Table 2:** Distribution of students by region for Priority and non-Priority students (%)

<b>Region</b>	<b>Priority</b>				<b>Non-Priority</b>			
	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>
<b>Región Metropolitana</b>	28.80	28.68	27.93	28.11	45.91	45.72	45.77	45.77
<b>Región de Aisén del General Carlos Ibañez del Campo</b>	0.87	0.78	0.83	0.76	0.52	0.54	0.55	0.53
<b>Región de Antofagasta</b>	2.45	2.51	2.58	2.54	4.36	4.64	4.38	4.37
<b>Región de Atacama</b>	2.09	2.14	2.01	2.09	1.76	1.70	1.70	1.66
<b>Región de Coquimbo</b>	4.43	4.68	4.55	4.54	3.78	4.12	3.75	3.85
<b>Región de Los Lagos*</b>	9.48	9.83	9.75	9.85	5.86	5.92	6.03	6.01
<b>Región de Magallanes y de la Antártica Chilena</b>	0.57	0.56	0.61	0.58	1.08	1.24	1.18	1.15
<b>Región de Tarapacá**</b>	3.05	3.18	3.97	3.11	2.98	3.08	3.16	3.08
<b>Región de Valparaíso</b>	9.25	8.92	9.26	9.03	10.46	10.14	10.37	10.33
<b>Región de la Araucanía</b>	8.82	8.33	9.38	9.56	3.73	3.33	3.67	3.71
<b>Región del Biobío</b>	16.88	17.04	16.98	16.68	9.25	9.46	9.13	9.34
<b>Región del Libertador General Bernardo O' Higgins</b>	5.61	5.51	5.46	5.39	5.42	5.19	5.44	5.33
<b>Región del Maule</b>	7.71	7.85	7.68	7.76	4.88	4.92	4.87	4.88

Notes: Frequency Missing = 19466 (2005), 18856 (2006), 19263 (2007)

\*Región Los Lagos comprised of Los Lagos and los Rios in 2007. These regions are combined here to remain consistent across the three years examined.

\*\*Región Tarapacá comprised of Tarapacá and Arica – Parinacota in 2007. These regions are combined here to remain consistent across the three years examined.

#### IV. Data on Students and Schools

In conducting the analyses reported in this paper, we made use of information on all students who were in grade 4 in Chile in 2005, 2006, or 2007, for whom we had a valid indicator of Priority status. The number of students included in our analysis sample in each year constitutes more than 92 percent of the total number of students enrolled in grade 4 in Chilean schools at the end of that year. For some students, test score information was totally or partially missing. For example, a student may have taken the Spanish examination but not the mathematics examination. Table 3 lists the number of students included in our analysis sample in each year, the percentage of Priority students, the percentage of Chile Solidario students, and the percentage of students that have scores on each of the three SIMCE tests.

**Table 3:** Sample sizes and descriptive statistics regarding valid measures of priority status and academic achievement, 2005 – 2007.

<b>Year</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
<b>N</b>	268,513	266,256	256,186
<b>% Priority</b>	39.94	40.31	39.60
<b>% Chile Solidario</b>	11.19	11.37	11.23
<b>% valid Spanish score</b>	91.77	90.40	91.92
<b>% valid mathematics score</b>	91.70	90.38	92.03
<b>% valid science score</b>	91.72	90.37	91.93

Table 4 lists the total number of schools serving grade 4 students in each year, and the number (and the percentage of all schools) of each school type. Over the three year period the total number of schools declined by 120, from 8355 to 8235, reflecting the drop in student enrollment. However, the mix of schools changed markedly during this period, with the number of municipal schools declining by 5 percent and the number of subsidized private schools increasing by 5 percent. The number of fee-charging private schools that did not participate in the school voucher program remained quite stable, with 432 in operation in 2005 and 429 in 2007. During this period 14 schools switched their status from fee-paying private schools that did not participate in the voucher program to subsidized private schools that do participate.

Since SEP alters the incentives for private schools to participate in the voucher program and the incentives to enroll Priority students, it will be important to examine whether the introduction of SEP results in changes in trends in the distribution of school types and in the mix of students served by subsidized private schools.

**Table 4:** Number of schools serving grade 4 students and distribution of schools by school type

<b>Year</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
<b>N schools</b>	8355	8266	8235
<b>N municipal (%)</b>	5030 (60.20%)	4881 (59.05%)	4771 (57.94%)
<b>N subsidized private (%)</b>	2893 (34.63%)	2967 (35.89%)	3035 (36.85%)
<b>N unsubsidized private (%)</b>	432 (5.17%)	418 (5.06%)	429 (5.21%)

Table 5 provides information for the years 2005-2007 on the distribution across school types of three groups of students: Priority students, Chile Solidario students, and non-Priority students. The figures in the table reveal two striking patterns. First, the distribution of school types for Priority students is very different from that of non-Priority students. While approximately two-thirds of Priority students attend municipal schools, less than 40% of non-Priority students do so. In contrast, only about one in three Priority students attend a private school while about two out of three non-Priority students do so. About 10 percent of non-Priority students attend unsubsidized private schools, which tend to have high fees, while almost no Priority students attend these schools. The segregation of students by socio-economic status is even more evident for Chile Solidario students, the most economically disadvantaged Priority students; three-fourths of this group attend municipal schools, while only approximately 25% attend private schools.

The second pattern illustrated in Table 5 is that, for all student groups, the percentage of students attending municipal schools is declining and the percentage attending subsidized private schools is growing. The rates of change are somewhat different, however. We fitted linear regression models to estimate the rates of change, as follows:

$$\begin{aligned} \%STUDENTS = & \hat{\beta}_0 + \hat{\beta}_1TIME + \hat{\beta}_2MUNICIPAL + \hat{\beta}_3SUBPRIVATE \\ & + \hat{\beta}_4MUNICIPALxTIME + \hat{\beta}_5SUBPRIVATExTIME \end{aligned}$$

where,

$\hat{\beta}_1$  represents the estimated trend in proportion of students attending unsubsidized private schools,

$\hat{\beta}_1 + \hat{\beta}_4$  represents the estimated trend in proportion of students attending municipal schools, and

$\hat{\beta}_1 + \hat{\beta}_5$  represents the estimated trend in the proportion of students attending subsidized private schools, and

In fitting this model, all observations were weighted by the inverse of the variance of the measures of proportion to account for the precision with which each proportion was estimated. This model was fitted separately for non-priority students, all non-priority students, and Chile Solidario students.

One assumption implicit in our methodology is that the trend over time is linear. This assumption is necessary because we have outcome data for only three years prior to the introduction of SEP. Our examination of the point estimates for each outcome verified that the average values changed only very slowly. For that reason, we do not feel that the assumption of linearity is a serious constraint on our analysis.

Over the three year period, the percentage of Priority students attending subsidized private schools grew at an estimated rate of 0.8 percentage points per year. The corresponding rate of increase for Chile Solidario students was also 0.8 percentage points per year. In contrast, the estimated rate of increase for non-Priority students was 1.9 percentage points per year.

**Table 5:** Distribution of students by school type and SEP status

	All Priority Students			Chile Solidario Students			Non-priority Students		
	2005	2006	2007	2005	2006	2007	2005	2006	2007
<b>School type</b>									
<b>Municipal</b>	72253 (67.36%)	70822 (65.98%)	66781 (65.83%)	22531 (75.02%)	22340 (73.77%)	21092 (73.34%)	63199 (39.19%)	58771 (36.98%)	54312 (35.10%)
<b>Subsidized Private</b>	34906 (32.54%)	36468 (33.97%)	34645 (34.15%)	7496 (24.96%)	7940 (26.22%)	7667 (26.66%)	80847 (50.14%)	83054 (52.26%)	83469 (53.94%)
<b>Unsubsidized Private</b>	97 (0.09%)	48 (0.04%)	20 (0.02%)	7 (0.02%)	2 (0.01%)	2 (0.01%)	17211 (10.67%)	17093 (10.76%)	16959 (10.96%)
<b>School location</b>									
<b>Non-rural</b>	84534 (78.82%)	84585 (78.80%)	79841 (78.70%)	21254 (70.77%)	21416 (70.72%)	20488 (71.24%)	148706 (92.22%)	147146 (92.59%)	143738 (92.89%)
<b>Rural</b>	22722 (21.18%)	22753 (21.20%)	21605 (21.30%)	8780 (29.23%)	8866 (29.28%)	8273 (28.76%)	12551 (7.78%)	11772 (7.41%)	11002 (7.11%)

To predict what the distribution across schools would have been in 2008 for each of the three student groups had SEP not been introduced, we will extrapolate trends from the fitted linear models to generate predictions and associated 95% confidence intervals.<sup>8</sup>

<sup>8</sup> Given that we estimate a separate slope for each type of school, it would have been equally possible to estimate separate models by school type. A benefit of utilizing this fully interacted model is that it allows us to make a unified set of predictions regarding the distribution of students by school type in 2008. One mechanism through which SEP may improve the achievement of Priority students is by increasing the choice of schools in which their parents can afford to enroll them. Since SEP may result in changes in the distribution of schools that Priority students, Chile Solidario students, and non-Priority students attend, it is important to have predictions of the counterfactual 2008 distributions of school types for each of these groups of students. In our modeling approach, time was coded as -3, -2, and -1 so that the intercept terms estimated by the model fitting process would yield our 2008 predictions. We constrained the model so that the estimated proportions of students in each type of school in 2008 summed to 1.



## **V. The Distribution of Student Test Scores of Priority Students and Non-Priority Students**

Table 6 presents descriptive statistics on the performances of Priority students, Chile Solidario students, and non-Priority students on the 2005, 2006, and 2007 SIMCE Spanish examination. Table 7 and Table 8 provide the analogous information for the mathematics and science examinations. The scores are reported in an IRT-scaled metric, designed to have a standard deviation of 50 points. As the descriptive statistics in the tables indicate, the average score of Priority students on each of the examinations is approximately one-half a standard deviation below that of non-Priority students, and the average score of Chile Solidario students is about 0.6 standard deviations below that of non-Priority students.

**Table 6:** Descriptive statistics on test performance for Priority, Chile Solidario and non-Priority students, Spanish assessment, 2005, 2006, 2007

SEP	Year	N	N Miss	Mean	Median	SD	Min	Max
<b>Priority</b>	2005	97259	9997	241.29	244.48	51.34	104.02	364.77
	2006	95243	12095	240.10	241.39	51.95	102.93	373.44
	2007	90924	10522	240.38	240.67	50.94	110.77	379.35
<b>Chile Solidario</b>	2005	26244	3790	229.65	231.29	49.56	104.02	364.77
	2006	25978	4304	230.14	230.41	50.12	103.92	373.44
	2007	24930	3831	230.94	229.72	48.57	111.02	379.35
<b>Non-Priority</b>	2005	149162	12095	264.92	271.28	52.40	103.11	397.18
	2006	145448	13470	262.04	267.04	53.33	101.86	373.44
	2007	144563	10177	263.68	267.40	53.19	109.64	379.35

**Table 7:** Descriptive statistics on test performance for Priority, Chile Solidario and non-Priority students, mathematics assessment, 2005, 2006, 2007

SEP	Year	N	N Miss	Mean	Median	SD	Min	Max
<b>Priority</b>	2005	97114	10142	232.40	232.44	53.30	90.83	363.62
	2006	95143	12195	231.98	232.58	54.50	75.84	359.43
	2007	91018	10428	229.16	228.26	54.06	87.10	369.55
<b>Chile Solidario</b>	2005	26165	3869	220.43	218.68	51.74	91.23	363.62
	2006	25944	4338	219.71	219.11	52.99	75.84	359.43
	2007	24923	3838	217.21	214.73	51.73	87.74	369.55
<b>Non-Priority</b>	2005	149114	12143	257.66	262.06	54.32	90.70	363.62
	2006	145491	13427	258.13	262.32	54.29	74.27	359.43
	2007	144751	9989	256.67	259.79	55.23	89.14	369.55

**Table 8:** Descriptive statistics on test performance for Priority, Chile Solidario and non-Priority students, science assessment, 2005, 2006, 2007

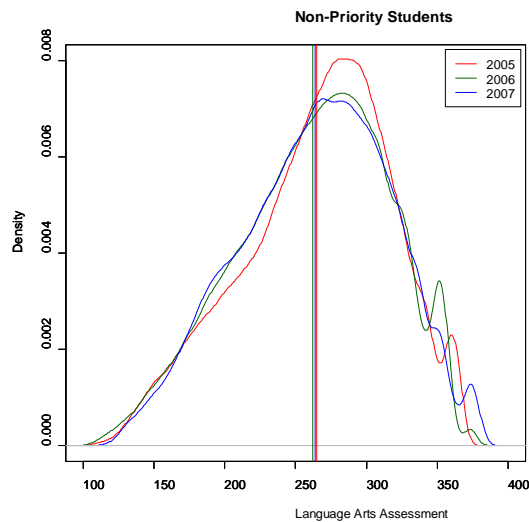
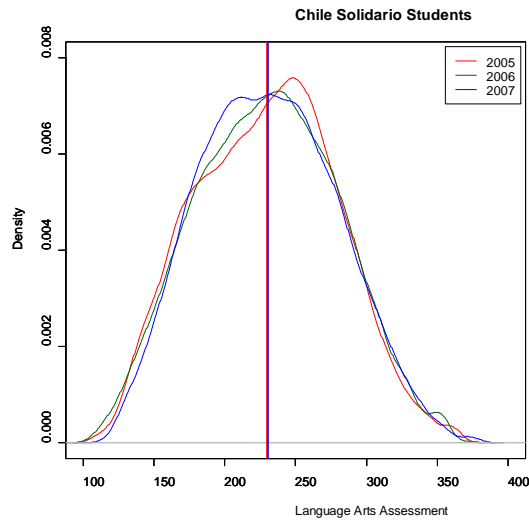
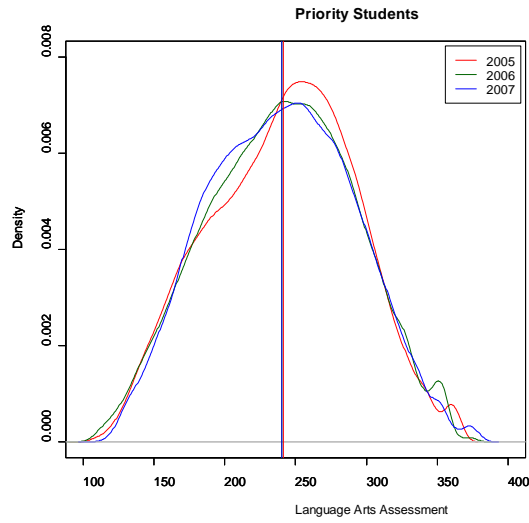
SEP	Year	N	N Miss	Mean	Median	SD	Min	Max
<b>Priority</b>	2005	97108	10148	240.79	242.93	52.11	107.22	363.69
	2006	95087	12251	241.59	242.45	52.06	96.63	361.54
	2007	90892	10554	233.84	232.76	47.04	115.86	364.72
<b>Chile Solidario</b>	2005	26152	3882	226.98	226.87	50.67	107.22	363.69
	2006	25910	4372	228.98	228.52	50.26	96.63	361.54
	2007	24889	3872	222.68	220.30	44.43	115.86	364.72
<b>Non-Priority</b>	2005	149179	12078	267.71	272.50	51.79	106.46	363.69
	2006	145516	13402	268.43	272.25	52.05	96.63	361.54
	2007	144626	10114	260.49	262.36	49.04	114.07	364.72

Figure 6 provides density curves for the distributions of scores on the Spanish test in 2005, 2006, and 2007 for Priority students, Chile Solidario students, and non-Priority students. The vertical lines in the middle of the distributions show the means in each year. Figure 7 and Figure 8 provide the analogous information for scores on the mathematics examination and the science examination respectively. Notice that the right hand tail of the distributions for non-Priority students has considerable “wobble,” indicating an unexpectedly high density of scores at the top of the test score distribution. This is especially the case for the distribution of non-Priority students’ scores on the science examination. The explanation is that an unexpectedly large percentage of non-Priority students answered almost all of the questions correctly on the examination. Notice also that there is much less “wobble” in the distributions of scores for Priority students.

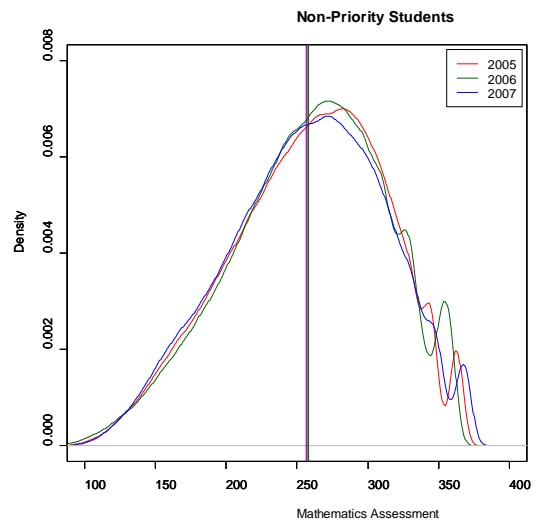
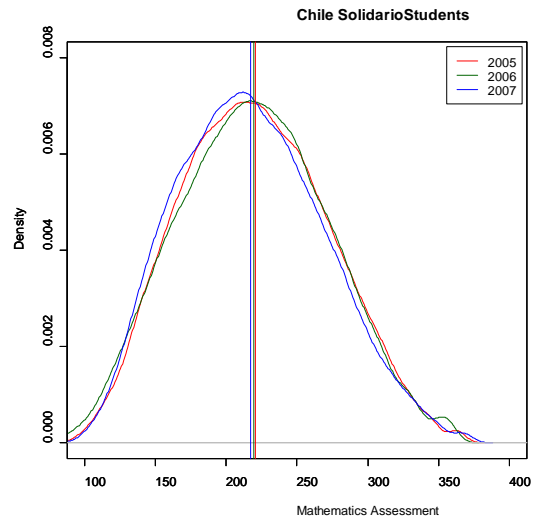
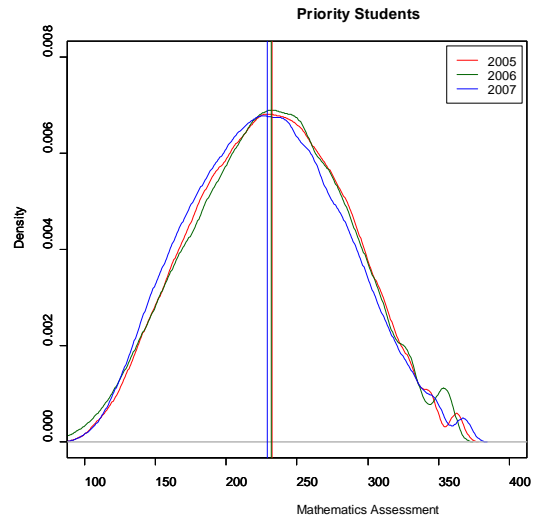
Figure 6 illustrates that the distributions of Priority students’ scores on the Spanish examination in 2005, 2006, and 2007 are very similar. This is also the case for the score distributions of Chile Solidario students. Figure 7 illustrates that the same pattern holds for the distributions of scores of these groups on the mathematics examination. These patterns provide reassurance that extrapolation of the means of these distributions to 2008 will provide good estimates of counterfactual mean test scores on these examinations for Priority students and Chile Solidario students. In contrast, the distribution of scores on the science examination is much less stable across the three years for each group of students. For example, as shown in Table 8, the average score for Priority students on the SIMCE science examination is almost 8 points lower in 2007 than in 2006, and the standard deviation in the scores is five points lower. Similar patterns hold for Chile Solidario students and Priority students. For this reason we have somewhat less confidence in our estimates of the counterfactual 2008 average scores on the

science examination than we have in the estimates of the counterfactual 2008 average scores on the Spanish and mathematics examinations.

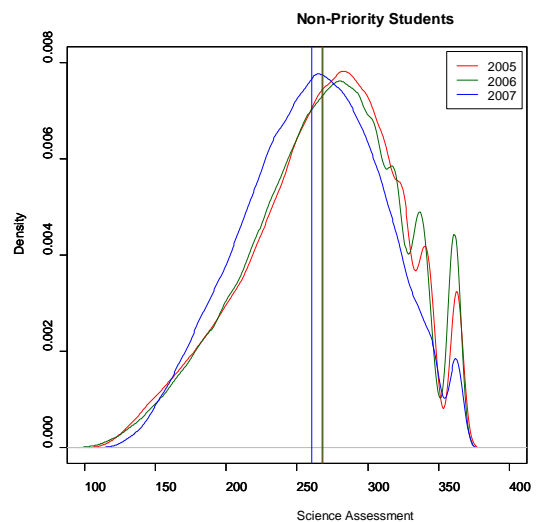
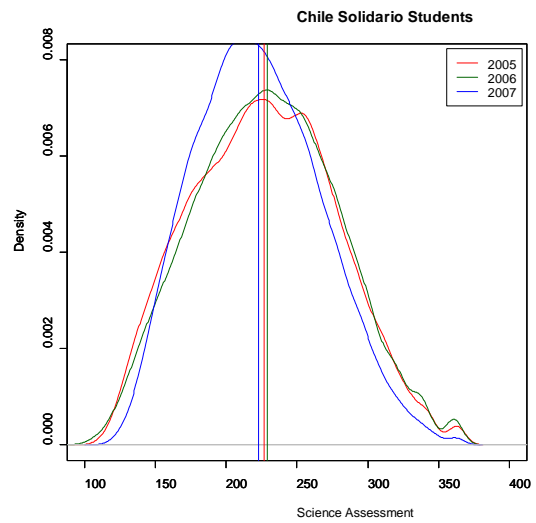
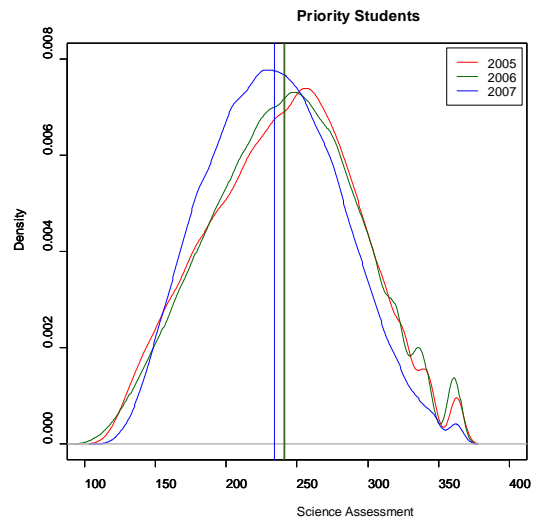
**Figure 6:** Distributions of Spanish test scores for Priority, Chile Solidario and non-Priority students, 2005, 2006 and 2007 (vertical lines represent means by year)



**Figure 7:** Distributions of mathematics test scores for Priority, Chile Solidario and non-Priority students, 2005, 2006 and 2007 (vertical lines represent means by year)



**Figure 8:** Distributions of science test scores for Priority, Chile Solidario and non-Priority students, 2005, 2006 and 2007 (vertical lines represent means by year)



To create our estimates of 2008 counterfactual average test scores for each group, we will fit multiple regression models with linear time trends using 2005-2007 data for all students in each of three groups (Priority students, Chile Solidario students, and non-Priority students). For example, we will fit the following prediction model to estimate trends for Priority and non-Priority students:<sup>9</sup>

$$SC\hat{O}RE = \hat{\beta}_0 + \hat{\beta}_1 TIME + \hat{\beta}_2 PRIORITY + \hat{\beta}_3 PRIORITY \times TIME$$

Where,

$\hat{\beta}_1$  represents the estimated trend in a given test score for non-Priority students,

and

$\hat{\beta}_1 + \hat{\beta}_3$  represents the estimated trend in a given test score for Priority students.<sup>10</sup>

We will then use the estimated coefficients from these fitted regression models to predict counterfactual average test scores and associated confidence intervals for 2008 for each group on each of the three examinations.

## VI. Test Score Gaps and their Decomposition

There is one significant limitation of predicting 2008 counterfactual average test scores for Priority students by extrapolating from the trends in the average test scores of Priority students over the previous three years. This limitation is the implicit assumption that year-to-year

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<sup>9</sup> As the equation indicates, we assume a linear specification for trends in time. This assumption is driven by necessity, given that we have relatively few years of data from the period before SEP was initiated. In addition, it should be noted that we are not including other covariates in this model. The reason is that other possible covariates, such as family income, contribute to the definition of Priority status. Consequently, it would be confusing to estimate counterfactual predictions of test scores for Priority students, conditional on their family incomes.

<sup>10</sup> For all such models, robust standard errors will be calculated to account for the clustering of students within schools.



differences in the average scores of Priority students reflect real differences in the average achievement level of Priority students rather than year-to-year differences in the tests or the way they are scored.

One way to adjust for the year-to-year differences in the difficulty of the tests is to examine the trend in the gap between the average score of Priority students (or Chile Solidarity students) and the average score of non-Priority students who took the same test in the same year. **Table 9** displays these gaps for each test for the years 2005 – 2007.

**Table 9:** Gaps (2005-2007) and in average achievement between Priority and non-Priority students

	2005	2006	2007
<b>Priority vs. Non-Priority Gap</b>			
Spanish	-23.63	-21.94	-23.30
Mathematics	-25.26	-26.15	-27.51
Science	-26.92	-26.84	-26.65
<b>Solidario vs. Non-Priority Gap</b>			
Spanish	-35.27	-31.90	-32.74
Mathematics	-37.23	-38.42	-39.46
Science	-40.73	-39.45	-37.81

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Note: We will fit linear regression models to estimate counterfactual gaps and associated 95% confidence intervals for 2008. In so doing, we will adjust standard errors for the non-independence of observations due to the clustering of students within schools. This adjustment does not impact the point estimate predictions but will result in somewhat wider confidence intervals around those predictions.

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To explore the sources of achievement gaps between Priority and non-Priority students, we employed the methodology developed by Reardon (2007) and explained in detail in Page,

Murnane, and Willett (2008) to decompose the achievement gaps in each year. These decompositions help us to understand the sources of achievement gaps. For example, recall from Table 2 that the geographical distribution of Priority students is quite different from the geographical distribution of non-Priority students. In particular, a much higher percentage of non-Priority students than Priority students live in the Metropolitan region. As a result, it is possible that a large part of the achievement gap could be explained by differences in the average scores of students attending schools in different regions.

To examine the role of regional differences in explaining gaps between the average achievement of Priority students and that of non-Priority students, we decomposed the achievement gaps in each year into three parts: one part attributable to differences in achievement for Priority and non-Priority students living in the same region, a second part attributable to differences in the distribution of Priority and non-Priority students across regions, and a third “ambiguous” part that can not be clearly attributed to either within-region or between-region differences in achievement. The results of this decomposition showed that more than 90% of the gap between the average achievement of Priority students and that of non-Priority students in each of the three subject areas consisted of within-region differences in average achievement. Thus, the difference between the average achievement of Priority students and non-Priority students living in the same region is the statistical source of almost all of the achievement gaps. In contrast, the difference between the geographic distribution of Priority students and that of non-Priority students plays very little role in explaining achievement gaps.

One other respect in which Priority students are distributed differently from non-Priority students is that they tend to attend different schools. We documented this segregation by socio-economic status in Section III of this paper. This segregation raises the question of the extent to

which gaps between the average achievement of Priority students and that of non-Priority students consists of differences between the average achievement of Priority students and non-Priority students attending the same schools and the extent to which they consist of differences in the distributions of Priority and non-Priority students across schools. To examine this question, we used the methodology developed by Reardon (2007) to decompose gaps in average achievement into three parts: within-school differences, between school differences, and an ambiguous portion that cannot be attributed to either. The results are displayed in Table 10.

As the figures in Table 10 show, in all three years and for all three examinations, approximately 70 percent of the gap between the average achievement of Priority students and non-Priority students consists of differences between the average achievement of students attending different schools. Less than one quarter of the gap consisted of differences between the scores of Priority students and non-Priority students attending the same schools (The ambiguous component is even smaller at less than 10% of the gap.). This pattern suggests the importance of the segregation of Priority students in particular schools that serve relatively few non-Priority students. The decomposition results also show that there are only modest differences between the average achievement of Priority students and non-Priority students attending the same school. (As a point of comparison, Page, Murnane, and Willett (2008, Table 4) found that the percentage of the gap in average reading scores between black students and white students in the U.S. in 1988 that consisted of within-school differences was much larger than the comparable percentage of the gap between Priority students and non-Priority students in Chile.)

The statistical decompositions of achievement gaps in the years 2005-2007 serve as a baseline against which to compare analogous decompositions of achievement gaps in 2008, the

first year in which SEP was in operation and in subsequent years as well. For example, one possible consequence of SEP is that the segregation of Priority students may decrease because the higher-valued vouchers given to Priority students increase their school choices. This may reduce the gap between the achievement of Priority students and non-Priority students, with most of the reduction of the size in the gap stemming from a decline in the size of the between-school gap.

**Table 10:** Decomposition of achievement gap between Priority and non-Priority students into within-school, between-school and ambiguous components

	<b>Gap</b>	<b>Within</b>	<b>Between</b>	<b>Ambiguous</b>
<b>Spanish</b>				
2005	-23.63	-5.16 21.84%	-16.56 70.05%	-1.92 8.10%
2006	-21.95	-4.94 22.51%	-15.02 68.44%	-1.99 9.05%
2007	-23.31	-5.23 22.44%	-15.77 67.67%	-2.30 9.89%
<b>Mathematics</b>				
2005	25.25	-5.36 21.21%	-17.91 70.91%	-1.99 7.88%
2006	26.15	-5.16 19.73%	-18.92 72.33%	-2.08 7.94%
2007	27.51	-5.42 19.69%	-19.70 71.63%	-2.39 8.67%
<b>Science</b>				
2005	26.92	-5.90 21.91%	-18.84 69.96%	-2.19 8.13%
2006	26.84	-5.61 20.89%	-18.98 70.72%	-2.25 8.40%
2007	26.65	-5.69 21.36%	-18.45 69.23%	-2.51 9.41%

## VII. Summary

The evidence provided in this baseline paper documents that Priority students attend schools that are quite different, on average, than those attended by non-Priority students. In particular, Priority students are more likely than non-Priority students to attend municipal schools. While the percentage of Priority students attending subsidized private schools is growing slowly, the percentage of non-Priority students attending this type of school is growing more rapidly. If this pattern were to continue, it is likely to increase the socio-economic segregation in Chile's elementary schools. It will be important to examine whether the patterns change in the years after the introduction of SEP.

Another pattern documented in this paper is that there is a gap between the average achievement of Priority students and that of non-Priority students. This gap of approximately half a standard deviation is present in scores on the Spanish , the mathematics, and the natural and social sciences examinations. The gaps between the average achievement of Chile Solidario students and that of non-Priority students are larger, approximately 0.60 standard deviations. Decomposition of these gaps shows that they consist overwhelmingly of differences between the average achievement of Priority students and non-Priority students living in the same region, with very little role played by the differences in the geographic distributions of students in the two groups. In contrast, approximately 70% of the achievement gaps consist of differences between the achievement of students attending different schools, with less than one quarter of the gaps explained by differences between the average achievement of Priority students and non-Priority students attending the same school. Not surprisingly, the decompositions also show that the greater the percentage of Priority students enrolled in a school, the lower the average achievement of the students attending that school.

## References

- Hsieh, Chang-Tai, and Miguel Urquiola. 2003. "When Schools Compete, How Do They Compete? An Assessment of Chile's Nationwide School Voucher Program." Working paper 10008. Cambridge, MA: National Bureau of Economic Research.
- . 2006. "The Effects of Generalized School Choice on Achievement and Stratification: Evidence from Chile's Voucher Program." *Journal of Public Economics* 90(8–9): 1477–503.
- Page, Lindsay C., Murnane, Richard J. and Willett, John B. 2008. Trends in the Black-White Achievement Gap: Clarifying the Meaning of Within- and Between-School Achievement Gaps. Working Paper 14213. Cambridge, MA: National Bureau of Economic Research.
- Reardon, Sean F. 2007. Thirteen Ways of Looking at the Black-White Achievement Gap. Unpublished manuscript. Graduate School of Education, Stanford University.
- Shadish, William R., Cook, Thomas D., and Campbell. 2002. Donald T. *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. Boston: Houghton Mifflin