FACULTAD ECONOMÍA Y NEGOCIOS
UNIVERSIDAD DE CHILE
DEPARTAMENTO DE ECONOMÍA

SERIE DE DOCUMENTOS DE TRABAJO

SDT 510

Estimating the Effects of School Subsidies Targeted at Low-Income Students: Evidence from Chile

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Santiago, Diciembre de 2020

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Estimating the effects of school subsidies targeted at low-income students: Evidence from Chile

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Abstract

The aim of this paper is to evaluate the effect of school subsidies targeted at socioeconomically disadvantaged students on academic performance. To do so, the empirical strategy relies on comparing the standardised test scores of different cohorts of students over time. These cohorts have been exposed differentially to the Preferential School Subsidy Law, promulgated in Chile in 2008. In particular, I develop suitable differences-in-differences and individual fixed-effect estimators to compare the differential growth of test scores among four cohorts of students. The results indicate that, overall, the intervention has a positive effect on the average gain in reading and maths test scores. In addition, the estimations suggest that the longer the exposure to the programme the larger the effect on the average growth in test scores. However, the effect is larger for non-priority students than for priority students. The effect can be ascribed to the pedagogical actions taken by schools and not to school choice.

Keywords: educational vouchers, school choice, fixed-effect estimators.

JEL classification: H52, I22, I24.

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1 Introduction

Socioeconomic status is a decisive factor in students' performance in the education system. Empirical research has shown that households' per-capita income, family wealth, parents' education, or similar variables, are positively correlated with the results obtained by pupils in standardised tests. Accordingly, significant gaps in students' achievement emerge from the correlation between socioeconomic status and academic performance and appear in all levels of education. This is a stylised fact that is observed in several countries (Mayer 1997, Ludwig and Bassi 1999, Machin and McNally 2006, Carneiro 2007, Heckman 2011). Chile is no exception. This country presents a significant socioeconomic gap in pupils' achievement within the education system. At all levels of education, students with the highest socioeconomic status perform significantly better academically than students with a lower socioeconomic status (see Figure 1).

The socioeconomic gap in students' achievement has consequences for subsequent stages of life. The evidence has demonstrated that low performance in primary education affects the progression of academic performance in subsequent levels of the education system and even in later stages of life such as in the labour market (Bekhradnia 2003, Cassen and Kingdon 2007, Palardy 2008, Cunha and Heckman 2007). This fact is also present in Chile. Figure 2 presents the achievement progression in the national reading test exhibited by fourth graders in 2007 and, correspondingly, eighth graders in 2011, by socioeconomic status. It is possible to note that the students' achievement progression is positively correlated with their socioeconomic status.

The evidence for Chile supports the general conclusion that is widely accepted in the literature: the income-based gap in education persists over time. Systematically, students with a low-socioeconomic status do not perform as well as students with a higher socioeconomic status during their life in the education system (Galindo-Rueda and Vignoles 2003).

In order to tackle the socioeconomic gap in achievement at primary school level, the Chilean government promulgated the Preferential School Subsidy Law (Ley de Subvención Escolar Preferencial, hereinafter referred to as SEP) in February 2008. This law introduces a new subsidy delivered to state funded schools for each student identified as a priority in terms of his or her socioeconomic status.

Before SEP, there was only one per-student subsidy delivered by the government to state funded schools (public and private subsidised), and it was completely determined by the student's grade and the length of the school day: a half or full-day, without taking into account students' socioeconomic status. As a consequence, the implementation of SEP is an important milestone in the Chilean education policy. It breaks the principle of a uniform school subsidy that had existed since 1981 to compensate for students' background disadvantages and to reduce the prediction power of socioeconomic status on future academic attainment.

The aim of this paper is to evaluate the effect of school subsidies targeted at socioeconomically

disadvantaged students on academic achievement. An understanding of the effectiveness of an intervention in the education system, such as SEP, is important for several reasons. Firstly, the available research on SEP effects is far from being conclusive. Secondly, the problem of the income-based gap in education has not been solved in many countries. Therefore, evidence of the effectiveness of educational programmes focused on tackling achievement inequality may be useful for policy makers from countries that exhibit similarities to Chile. Thirdly, human capital accumulation is a fundamental factor in terms of economic growth, social mobility, and diminishing social inequalities; consequently, it is necessary to generate evidence regarding how to moderate the perpetuation of the inequality in the education system in order to enhance the process of human capital formation. This is especially important to Latin American economies due to detected deficits in the accumulation of human capital (Attanasio et al. 2011).

This research contributes to generate evidence regarding educational policies with the aim of reducing education inequality. The related literature is focused on the causes of the inequality in students' achievement but evidence about how to narrow the income-based gap in achievement at primary education is scarce.[1] Accordingly, whether and how schools can tackle social disadvantages is far from clear. Therefore, it is necessary to conduct further research about the effectiveness of experiences that attempt to reduce the influence of socioeconomic status on students' achievement in primary education.

Since the implementation of SEP in 2008, several authors have analysed its effects on students' performance. However, the evidence is not conclusive. While some researchers find a positive impact on standardised test at student or school level (Murnane et al., 2017; Navarro-Palau, 2017; Correa et al., 2014; Mizala & Torche, 2013; Neilson, 2013 and MINEDUC, 2012), others find no effect (Aguirre, 2020). Furthermore, some authors are skeptical about the origin of the gains experienced in test score and they present evidence suggesting that it is originated from a strategic behaviour taken by the schools[2](Feigenberg et al., 2019 and Sánchez, 2017).

The empirical strategies used by previous studies consist in the implementation of differences in differences (DiD) models that compare fourth graders test scores in different years between or within schools (Feigenberg et al. (2019), Sánchez (2017), Correa et al. (2014), Mizala and Torche (2013) and MINEDUC (2012)). However, this strategy could lead biased estimators as it does not account for differences between cohorts.

The second main strategy taken by previous studies to evaluate the SEP policy is a regression discontinuity design (RDD). Aguirre (2020) use a fuzzy specification with a socioeconomic ranking of 2012 to estimate the probability of being eligible for SEP and its effects on both second and fourth graders' academic performance. Navarro-Palau (2017) uses the date of birth and the age

[1] In general, the literature has focused on evaluating interventions to reduce the inequality in cognitive development in early childhood, but not in primary or secondary schools.

[2] A strategic behaviour implies that schools discourage low-performing students to take the national standardised test in order to raise the school test average.

cut-off normative for enrollment to measure the differences in fourth graders' results, given different periods of exposure to the policy. Some limitations of this strategy include that RDD estimators represent just a local effect, and they do not allow for accumulative effects that SEP policy could have on academic achievement.

This study proposes a different empirical strategy to identify the effect of SEP on students' achievement. In particular, suitable DiD and fixed effect (FE) at student level estimators are developed in order to compare the average gain in test scores over two time periods, in fourth and eighth grade, among four different cohorts of students: fourth graders 2005, fourth graders 2007, fourth graders 2009, and fourth graders 2011. This empirical strategy exploits the differential effect of the SEP subsidy on these cohorts of students because they differ in terms of how long they have been exposed to SEP. By comparing these cohorts and assuming common trends it is possible to identify the average treatment effect of two, four and six additional years of participation in SEP on the gain in students' achievement.

The results in the preferred specification indicate a differential impact of the SEP subsidy on students' achievement that is positive and statistically significant. In the case of the subject of reading, the estimated effect is increasing with the time of exposure to SEP. In fact, the estimated average gain in the achievement of the fourth graders 2007 is 0.03 standard deviations higher than the estimated average gain in the achievement of the for fourth graders 2005. This figure is 0.06 standard deviations for the fourth graders 2009 and 0.08 standard deviations for the fourth graders 2011. In the case of maths, the estimated effect is also increasing with the time of exposure to SEP, but it is stabilised after four years of intervention. Indeed, the estimated effect is 0.03 standard deviations for fourth graders 2007 and 0.06 standard deviations for both, fourth graders 2009 and 2011.

Additionally, the results show that there is heterogeneity in the impact of the SEP subsidy by student's status (priority or not priority) and type of school (public and private subsidised schools). For the subject of reading the effect is 0.12 standard deviations for non-priority students in 4th grade in 2011 enrolled in private subsidised schools. In contrast, the effect is reduced to 0.6 standard deviations for priority students in 4th grade in 2011 in the same type of school. In the public sector, students are benefited from SEP but not as much as in the private subsidised sector. The estimated effect on the average gain in achievement is 0.08 standard deviations for non-priority students and 0.07 standard deviations for priority students in 4th grade in 2011.

This evidence suggests a focalisation problem of the SEP policy as non-priority students are getting more benefits in terms of gains in achievement than priority students. Even though the subsidy is targeted at priority students, the estimated effect on test scores of non-priority students is larger than the effect on test scores of priority students in both public and private subsidised schools.

The rest of the paper is organised as follows. Section 2 contains a description of the SEP policy implemented in Chile since 2008. Section 3 discusses the identification of the average effect of

SEP on students' achievement given the policy design and it contains a description of the data used in this study. Section 4 presents and discusses the empirical results. Section 5 discusses the potential transmission channels through which SEP would work in order to better understand the estimated effects on students' academic performance. Finally, Section 6 concludes and establishes the directions for future research.

2 The Preferential School Subsidy

The Chilean education system has three types of schools at the primary and secondary levels. Firstly, there are public schools, which are administrated by councils and are completely funded by the government through a voucher-type per-student subsidy. Secondly, the private subsidised schools are also funded by the government through the same per-student subsidy but they are administrated by private agents who may or may not be profit-seekers. Until 2016, the Chilean law allowed private subsidised agents to establish a tuition fee to be paid for by the families, which complements the per-student subsidy delivered by the government.[3] Therefore, when the SEP subsidy was established, there were two school categories inside the private subsidised sector: private subsidised schools with family co-payments and private subsidised schools without family co-payments. The third type corresponds to private schools, which are funded by fees paid by the families and are administrated by private agents who are generally for-profit.

This structure of educational funding allows families to choose a school independently of the place where they live. Parents are able to select a subsidised school (public or private) with no tuition fees, a private subsidised school with co-payments or a private school if they are able to pay the tuition fees.[4] According to administrative data provided by the Ministry of Education, in 2008, 44 percent of students in primary education were enrolled in public schools and 49 percent of pupils were enrolled in private subsidised schools. That is, over 90 percent of primary students attend schools financed by the government.

In 2008 the government of Chile promulgated the SEP law[5]. This reform established three specific goals: Firstly, to improve the students' academic performance, particularly, that of priority students; secondly, to reduce the performance gap between priority students and non-priority students; and thirdly, to enhance pedagogical practices inside state funded schools. In practice, this educational policy introduced a new subsidy delivered to public schools and private subsidised schools for each student identified as a priority due to his or her socioeconomic characteristics. In addition,

[3]The tuition fees paid by the parents were between 0.5 and 4 School Subsidy Units (Unidad de Subvención Educacional, USE). Up to 0.5 USE, the private agent received all of the per-student subsidy, between 0.5 and 1 USE, there was a discount of 10% in the per-student subsidy, between 1 and 2 USE the discount was 20%, and between 2 and 4 USE the discount was 35%. If the school established tuition fees higher than 4 USE the school was considered private. One USE corresponds to ch$26,153, equivalent to £25 in 2020.

[4]Mizala and Romaguera (2000) describe the Chilean Education System and family choices in detail.

[5]See Law N20,248 for details.

SEP provides an extra subsidy, which is increasing with the percentage of priority students enrolled in schools.

The participation of state funded schools in the programme is voluntary. Taking part in SEP involves developing a four-year Educational Improvement Plan (*Plan de Mejoramiento Educativo*, hereinafter referred to as PME), which is exclusively funded with the subsidy delivered by SEP. The PME has been created by the Ministry of Education in order to give autonomy to schools in establishing their academic goals and activities, to be developed over four years, according to their circumstances.[6]

Table 1 shows schools' participation in SEP during the first year of its implementation. Almost all public schools are participating in SEP compared with only 56 percent of private subsidised schools. Elacqua et al. (2009) analysed the factors that affect participation in SEP. They suggest that a high number of priority students make participation more likely. This is an expected result because the higher the priority student enrolment the higher the subsidy received. The existence of co-payments negatively affects negatively the probability of participation suggesting that private agents prefer to keep the co-payments rather than receive the SEP subsidy. Finally, profit-seeking private agents who administer one school are less likely to participate than those who administer more schools. This result suggests that the administration of numerous private subsidised schools could generate economies of scale reducing the costs associated with participation in SEP.

SEP has been gradually implemented at the primary level of the education system. In fact, in 2008 the law delivered resources for priority students enrolled from first grade to fourth grade. Then, fifth grade was incorporated in 2009, sixth grade in 2010, seventh grade in 2011, and finally eighth grade in 2012. Afterwards, each grade of secondary education was incorporated gradually, starting with ninth grade in 2013 and finishing with twelfth grade in 2016.

In order to deliver the SEP subsidy, the Ministry of Education conducts the process of priority students' identification every year. The law establishes that priority students are:

(a) Students whose families belong to the *Chile Solidario* System.[7]

(b) Students whose families do not satisfy (a) above, but are in the first third of the most vulnerable families according to the *Ficha de Protección Social* or the prevailing instrument defined by the government.[8]

[6] A non-priority student can be a beneficiary of SEP. According to the law, the subsidy is not exclusively for priority students. In fact, the additional resources delivered by SEP can be used for improving the pedagogical practices of the whole school and for all students attending the school.

[7] Chile Solidario System: Psycho-social programme targeted at families in a high social vulnerability condition as a governmental strategy oriented to tackle poverty (http://www.chilesolidario.gob.cl/).

[8] Ficha de Protecció Social (FPS): Instrument of social stratification that was utilised by the government to identify people who are eligible for social programmes from 2007 to 2015 (http://www.fichaproteccionsocial.gob.cl/). The Registro Social de Hogares replaced the FPS at the end of 2015 and it is the current instrument used by the government to characterise people according to their socio-economic status and to assign social programmes.

(c) Students whose families do not satisfy (a) or (b) above, but are assigned in the segment A of the *Fondo Nacional de Salud*.[9]

(d) Students whose families do not satisfy (a), (b) or (c) above, but whose family income, mother's education level, rural location, together with the level of poverty in the borough of residence indicate vulnerability.

According to the administrative data, in the first year of SEP, there were 349,411 priority students enrolled from first to fourth grade in SEP schools, which represents half of the enrolment of schools that participate in the programme.

The students' priority status is reported to the families, councils and private agents who administer state funded schools. The priority students' families are able to use this information to make choices about the school in which they enrol their children because the SEP law establishes that schools should eliminate selection and any type of family co-payment for these students. Councils and private agents use this information to calculate the expected resources to be received every year and to decide whether to continue in the programme after four years of participation.

Given the priority students' identification, the councils and private subsidised agents that administer SEP schools receive two subsidies. Firstly, the Preferential School Subsidy is a monthly amount of money assigned for each priority student and is expressed in terms of the School Subsidy Unit (*Unidad de Subvención Educacional*, hereinafter referred to as USE[10]). In 2008, the monthly per-student SEP subsidy was 1.4 USE for each priority student enrolled from first to fourth grade. Secondly, the monthly Subsidy for Percentage of Priority Students is assigned for the proportion of priority students enrolled at the school. This is calculated according to a cumulating factor, which is also expressed in terms of USE. For instance, if a school displays between 15 and 30 percent of priority students between first and fourth grade, it receives a monthly subsidy equal to 0.098 USE for each student enrolled in the school. In comparison, schools with 60 percent of priority students receive a monthly subsidy of 0.252 USE for each student enrolled in the school.

The SEP subsidy constitutes an important source of additional resources. In fact, when the SEP law was promulgated in 2008, the per-priority student SEP subsidy represented about 50 percent of the regular per-student subsidy. Currently, the SEP subsidy is equivalent to the 70 percent of the regular per-student subsidy, as shown in Table 2. At the end of every year, schools must report how the SEP subsidy has been expended by presenting receipts and invoices, and the progress on the implementation of the PME.

[9] Fondo Nacional de Salud: Public institution that provides health coverage to people registered in it. Beneficiaries are classified in four segments: A, B, C and D. People without labour income or a formal job are assigned to segment A. For them, the access to the public health service is guaranteed.

[10] USE: Measure utilised by the Ministry of Education to determine the subsidies in the Chilean education system. It is adjustable according to the increment exhibited by the salaries in the public sector. The value of USE in 2020 is ch$26,153 that is equivalent to £25.

3 Methodology

According to the standard framework of programme evaluation, the central evaluation problem is that an individual may either be treated or may not, but no individual is able to be in both statuses simultaneously (Blundell et al. 2004, Blundell and Costa Dias 2008). Therefore, it is necessary to create a convincing comparison group that allows for inferring the outcome that would be obtained by treated individuals if they had not participated in the programme.

In the context of SEP, there is no experimental data to estimate the effects of the SEP subsidy on students' achievement. Actually, the SEP law was designed to deliver a new school subsidy targeted at socioeconomically disadvantaged students attending state funded schools with no possibility of delivering the subsidy at random. In addition, participation is almost universal for public schools and for private subsidised schools it is not random at all. Therefore, a non-experimental setting must be considered to find a suitable comparison group. Nevertheless, several aspects of the design and implementation of SEP affect the construction of a convincing control group.

In particular, the universal participation of public schools in SEP implies that there is no similar group within students enrolled in the private sector that can be used as a suitable comparison group for students that attend public schools. In terms of observable variables, students enrolled in public schools are significantly different from students enrolled in private or private subsidised schools (Elacqua, Schneider and Buckley 2006, Henríquez, Mizala, and Repetto 2009). Furthermore, even though 56 percent of private subsidised schools are participating in SEP it is not possible to find similar schools in the remaining 44 percent. Non-participating schools in the private subsidised sector are significantly different in terms of their observable characteristics from participating schools (Elacqua et al (2009)). Additionally, the participation of schools is voluntary, and the identification of priority students depends on the characteristics of families. Accordingly, there is neither a score nor a cut-off that determines the participation in SEP or the priority status. Therefore, it is not possible to compare the outcomes around a specific cut-off.

The limitation regarding the construction of a convincing comparison group is attributable to the design of SEP. However, it is possible to use the timing of the implementation of SEP and the available data from the standardised tests of the Chilean Quality of Education Measurement System (hereinafter referred to as SIMCE) to compare cohorts of students who are affected differently by the SEP subsidy.

Table 3 shows the data available from SIMCE. The first two rows indicate the years when standardised tests are taken by students in primary education attending fourth grade and eighth grade. The bottom line exhibits the gradual implementation of SEP in primary schools. The SEP subsidy was delivered for priority students enrolled from first grade to fourth grade in the year 2008. Thereafter, one grade was added every year, completing all primary levels in 2012, when the eighth grade was included.

According to the schedule of SIMCE, the national standardised tests are implemented in fourth grade every year and every other year in eighth grade. In addition, a cohort with two measurements of a standardised test, in fourth grade and eighth grade, is available every two years. This research focuses on four cohorts of students with SIMCE test results for fourth grade and eighth grade. Specifically, fourth graders in 2005 have taken the SIMCE test twice, in 2005 when they attended fourth grade and in 2009 when they attended eighth grade. Fourth graders in 2007 took the SIMCE test in fourth grade and eighth grade, in 2007 and 2011, respectively. Similarly, fourth graders 2009 took the SIMCE test in fourth grade in 2009 and eighth grade in 2013. Finally, fourth graders 2011 took SIMCE test in fourth grade in 2011 and eighth grade in 2015.

Therefore, an empirical strategy can be proposed to evaluate the effect of SEP on students' performance. In fact, it is feasible to track the aforementioned four cohorts of students who have been affected differentially by SEP due to the years in which they were exposed to this intervention. In particular, it is possible to exploit the differential effect of the SEP subsidy on different cohorts of students. Specifically, it is possible to restrict the analysis to schools that were participating in SEP in 2008 and develop a suitable DiD estimator in order to compare the average gain in test scores over two time periods among four cohorts of students: fourth graders 2005, fourth graders 2007, fourth graders 2009, and fourth graders 2011.

Table 4 presents the cohorts of students under analysis by year, grade and exposure to SEP. Although the fourth graders 2005 and 2007 have never been considered by the government in terms of delivering the SEP subsidy, they have benefited from the SEP subsidy due to the priority students enrolled in grades considered by the policy.[11] Fourth graders 2009 were in third grade in 2008, and consequently they have been considered in terms of delivering the SEP subsidy since the policy started. In the case of fourth graders 2011, they have been been considered by the SEP policy over their whole primary education as they were enrolled in first grade in 2008.

In addition, it is possible to observe that the four cohorts differ in terms of how long they have been exposed to SEP. In particular, the fourth graders 2005 were exposed to SEP when they attended seventh grade in 2008 and eighth grade in 2009. The fourth graders 2007 were exposed to SEP from fifth to eighth grade, between 2008 and 2011. The fourth graders 2009 were exposed to SEP from third grade onwards. Finally, the fourth graders 2011 were exposed to SEP from first grade onwards.

Accordingly, the cohort of fourth graders 2005 has been exposed to activities funded by the SEP subsidy for two years. In comparison, the cohort of fourth graders 2007 has been exposed to activities funded by the SEP subsidy for four years, the fourth graders 2009 have been exposed to SEP funding for six years, and the fourth graders 2011 have been exposed to SEP funding for eight years. In consequence, by comparing the fourth graders 2005 and the fourth graders 2007, it

[11] Schools have autonomy in relation to using the resources of SEP. According to the law, schools are allowed to expend the SEP subsidy on activities for all students enrolled in the school, not only for priority students.

is possible to obtain the effect of two additional years of participation in SEP on the average gain in achievement. Similarly, by comparing the fourth graders 2005 and the fourth graders 2009, it is possible to estimate the effect of four additional years of participation in SEP on the average gain in achievement. Then, by comparing the fourth graders 2005 and the fourth graders 2011, it is possible to estimate the effect of six additional years of participation in SEP on the average gain in achievement. In consequence, the differential growth in test scores will reflect the differential impact of the intervention on students' academic performance.

Even though the available data and the design of SEP reduce the options for the evaluation of this intervention it is possible to implement both a difference-in-difference approach (hereinafter referred to as DiD) and an individual fixed-effect approach (hereinafter referred to as FE) to address the effect of SEP on students' performance by comparing the growth in test scores of these three cohorts of students. These evaluation methods are feasible due to the availability of information on test results, students' background, teachers' and schools' characteristics in the two time periods.

3.1 Difference-in-difference estimators

The simplest set up of the DiD method requires that the outcome of interest is observed for two groups for two moments in time. One group is exposed to the treatment in the second period and the other group is not exposed to the treatment in either period. Denote the first group as the treated group and the second group as the control group.

The linear model of DiD for a generic member of any of the groups can be written as:

$$y_{it} = \alpha + \beta T_t + \gamma D_i + \theta T_t D_i + X_{it}\delta + u_{it} \tag{1}$$

Where y_{it} is the outcome of interest for individual i in period t, and T_t is a binary variable that defines the time period, it is one for the second time period and zero for the first time period. This variable captures aggregate factors that would cause changes in the outcome variable of both the treatment group and control group even in the absence of the intervention. Variable D_i is a binary variable that defines the treatment status. It is one if the observation corresponds to the treated group and zero otherwise. Therefore, D_i captures the possible differences between the treatment and control groups prior to the intervention. The interaction term, $T_t D_i$, multiplies the parameter of interest, θ, which represents the average treatment effect on the outcome of interest. The vector X_{it} is included to correct for differences in observable characteristics between groups.

Following Blundell and Costa Dias (2008) it is possible to define u_{it} as an error term, where $E[u_{it}|D_i, T_t, X_i] = E[n_i|D_i, X_i] + m_t$, n_i corresponds to an unobservable fixed effect and m_t is an aggregate macro shock. To identify the average treatment effect it is supposed that the outcome for the treatment and control groups follows the same time trend in the absence of the treatment. This is the common trend assumption. Under this assumption, the average treatment effect is identified

by taking the difference between the average gain in the treated group and the average gain in the control group.

It is possible to demonstrate that, under the common trend assumption, the estimation of equation 1 by Ordinary Least Squares (OLS) provides the unbiased DiD estimate of the parameter θ, which is the average treatment effect.[12]

$$\hat{\theta}_{ols} = E[\theta|D_i = 1, X_i] = \Delta y^1 - \Delta y^0 \tag{2}$$

The implementation of DiD provides a robust estimate of the average impact of the treatment. This methodology rules out the biases that might arise from permanent differences between the treatment and control groups. In addition, it eliminates biases that could be the result of trends (Card and Krueger 1994, Blundell et al. 2004).

In practice, given the available data in the Chilean education system, a suitable DiD estimator can be estimated following a similar approach as the one proposed by Imbens and Wooldridge (2009) for more than two groups and time periods in order to address the effect of the SEP subsidy on the average gain in students' achievement.

By applying the DiD approach to the SEP context, it is possible to estimate by OLS a simple linear model of the form:

$$y_{it} = \alpha + \beta T_t + \gamma D_i + T_t D_i \theta + X_{it}\delta + S_{it}\eta + u_{it} \tag{3}$$

Where y_{it} is the test score of student i at time t, and T_t is a dummy variable for the second time period; specifically, it is one when the observation corresponds to eighth grade and zero when the observation corresponds to fourth grade. D_i is a categorical variable that identifies the cohort of students: fourth graders 2005, fourth graders 2007 and fourth graders 2009. The vector X_{it} contains individual characteristics and the family background of student i at time t, and the vector S_{it} includes observable variables of teachers and schools' characteristics where student i is enrolled in period t. Both vectors are included to correct for potential differences in observable characteristics among the cohorts of students and increase the precision of estimations.

Vector θ, which multiplies the interaction term, $T_t D_i$, contains the parameters of interest, and the estimators correspond to the differential impact of the SEP subsidy on the average gain in students' achievement; that is, the average effect of two additional years of participation in SEP on students' achievement when the comparison is between fourth graders 2005 and fourth graders 2007, the average effect of four additional years when the comparison is between fourth graders 2005 and fourth graders 2009, and the average effect of six additional years when the comparison is between fourth graders 2005 and fourth graders 2011.

[12] Appendix A presents the proof of the identification of the average treatment effect in this setting.

In order to identify the noted average treatment effect, it is supposed that the common trend assumption holds. Therefore, $E[u_{it}|D_i, T, X_i, S_i] = E[n_i|D_i, X_i, S_i] + m_t$, where n_i corresponds to an unobservable fixed effect and m_t is an aggregate macro shock. This is the crucial identification assumption.

The identification assumption is strong. Nevertheless, it can be argued that the cohorts of students under analysis have only two, four or six years of difference within the education system and the sample of schools considered in the model is the same over time; that is, schools that have participated in SEP from year 2008 to year 2015. In consequence, it is reasonable to argue that fourth graders 2005, fourth graders 2007, fourth graders 2009 and fourth graders 2011 have experienced the same macro shocks. To illustrate how the macro shocks have affected the cohorts considered in the empirical strategy, Figure 3 presents the percentage of students who repeat a school year between fourth grade and eighth grade by year and cohort of students. It can be seen that the trend in the percentage of students who repeat a school year between fourth grade and eighth grade is similar for the four cohorts of students over time.

To better understand the previous figure, it is possible to normalise the information on the percentage of students who repeat a school year exhibited by fourth graders 2005, fourth graders 2007, fourth graders 2009, and fourth graders 2011. In doing so, Figure 4 shows the percentage of students who repeat a school year between fourth grade and eighth grade by grade rather than by year.

Figure 4 suggests that macro shocks have affected all groups similarly, making the cohorts of fourth graders 2005, 2007, 2009 and 2011 comparable. The context in the life time of fourth graders in 2005, 2007, 2009 and 2011 is similar and the trends in the test scores achieved by the three cohorts are uniquely affected by the intervention of SEP over the time considered in the empirical strategy. In consequence, the common trend assumption holds in this setting.

Additionally, it is important to consider carefully what is being estimated. The model presented in equation 3 differs from the standard case of DiD for two reasons.

Firstly, the first time period is the year when the students were enrolled in fourth grade. Similarly, the second time period is the year when the students were enrolled in eighth grade, as shown in Table 5. In other words, the first and second time periods are not contemporaneous for the cohorts of students used in this approach.

In the standard case, the DiD approach considers that comparison groups are contemporaneous and the difference in the average gain among the groups is estimated by using information obtained at the same moment of time. Nevertheless, DiD allows the normalisation of time periods when the groups have been exposed to the intervention at different points in time. Accordingly, in the SEP context it is possible to normalise the fourth year of primary education to zero and the eighth year of primary education to one, as defined in T_t.

This type of normalisation has been implemented in other evaluations of social policies. For instance, Autor (2003) analysed the effect of increased employment protection on temporary help services in the United States. However, each state increased the employment protection at different points in time. Therefore, the author established, for each state, the year when the increased employment protection was adopted as the time zero.

Secondly, the empirical strategy relies on comparing the average gain in test scores over two time periods for four groups of students, fourth graders 2005, 2007, 2009 and 2011. The standard DiD requires that the control group is not affected by the intervention in any time period. However, in the SEP context, these cohorts of students are affected by the intervention, but differently. In fact, the fourth graders 2005, 2007, 2009 and 2011 were exposed to SEP for two, four, six and eight years, respectively.

In consequence, the empirical model described in equation 3 exploits the differential growth in the test scores across the four cohorts of students. These differential changes will reflect the differential impact of SEP on these students. In other words, the method in the context of SEP is able to obtain the average effect of two, four and six additional years of participation in SEP on students' achievement.

Blundell et al. (1998) implemented a similar approach to estimate the effect of tax reforms in the United Kingdom on labour supply responses. Specifically, the authors developed suitable DiD estimators by comparing the labour supply responses over time between different groups defined by cohort and education level. In doing so, the authors restricted the sample to workers and ran a regression of the log after-tax wage rate on time dummies interacted with the group dummies.

Attanasio et al. (2011) used this methodology to evaluate the effect of the 2008 Chilean pension reform on the labour market participation. In particular, the authors exploited the differential effects of the reform on several year-of-birth cohorts and gender by including in their estimations time dummies interacted with group dummies, which is an extended version of the DiD approach.

3.2 Individual fixed-effect estimators

According to Blundell and MaCurdy (1999), it is possible to generalise the DiD approach by implementing FE estimators. Suppose that vectors X_{it} and S_{it} in equation 3 contain time-invariant variables that vary across individuals but are unmeasured. Therefore, these variables cannot be included in the regressions to obtain DiD estimators, leading to an omitted variable bias problem. In that case, it is possible to specify a model that removes the individual-level average of observables and unobservables from both sides of the equation. Note that demeaning variables at the individual level is equivalent to estimating an FE estimator for each individual. Equation 4 presents the implementation of the FE model:

$$y_{it} = \alpha + \beta T_t + \gamma_i + T_t D_i \theta + u_{it} \tag{4}$$

Where y_{it} is the test score of student i at time t, T_t is a dummy variable, which is one when the observation corresponds to eighth grade and zero when the observation corresponds to fourth grade, and γ_i denotes a fixed effect unique to individual i. Similarly to the DiD approach, vector θ contains the parameters of interest: the differential impact of SEP on the average test score exhibited by fourth graders 2007, 2009 and 2011. Consequently, the FE approach also identifies the average gain in test scores experienced by the cohorts of students under analysis if the common trend assumption holds.[13]

To summarise, as the SEP law started gradually in 2008, cohorts of students have been affected differently by this intervention. Therefore, the empirical strategies implemented by this study exploit the differential effects of the SEP subsidy by comparing the average gain in test scores over two time periods obtained by fourth graders 2005, 2007, 2009, and 2011. Specifically, the estimation of both a DiD model and an FE model allows for the identification of the average effect of the SEP subsidy on the gain in test scores by assuming that the four cohorts of students would have exhibited the same test scores trend in the absence of the programme.

3.3 Data

This study uses data from several sources that can be merged together to create a consolidated database with information about students' academic performance, schools', teachers', individuals' and families' characteristics, and the identification of priority status given by the SEP law.

Firstly, the SIMCE reports students' achievement in various subjects of the curriculum. Specifically, SIMCE is a standardised test that evaluates reading, maths, and natural and social sciences. It is implemented at national level in fourth grade every year and alternates for eighth and tenth grade. It also contains information about schools', teachers', students' and families' characteristics, through the application of specific questionnaires. This study utilises the SIMCE of fourth graders in 2005, 2007, 2009 and 2011, and correspondingly, the SIMCE of eighth graders in 2009, 2011, 2013 and 2015.

Secondly, the Priority Students Database of the Ministry of Education includes the priority students' identification in grades that are considered in SEP, that is, from first grade to eighth grade. Also, the data set contains a key variable that allows for merging priority status with SIMCE information. The Ministry of Education has conducted the priority students' identification since the year 2008, when the SEP started. In order to identify priority students in the years before the implementation of SEP, that is, from 2005 to 2007, the following method is used: as students attending fourth grade in year 2005 were in seventh grade during 2008, the priority students' identification of seventh graders in 2008 is used. Similarly, for fourth graders in 2007, the identification

[13] Appendix B presents the proof of the identification of the average treatment effect of the intervention under the individual FE specification.

of fifth graders in 2008 is used. Priority students from the cohorts of both fourth graders 2009 and 2011 are identified directly from the administrative data.

Finally, administrative information about schools participating in SEP from 2008 to 2015 is used to restrict the analysis to participating schools. This is a school-level dataset, which includes the date when the schools began their participation in SEP, the total number of priority students and the total SEP subsidy received by each participating school every year.

Table 6 shows descriptive statistics for the final sample used in the estimations, that is, for fourth graders 2005, 2007, 2009 and 2011, who attended public and private subsidised schools that participate in SEP until completing primary education in eighth grade. Similarly, table 7 presents the descriptive statistics for the four cohorts under analysis when they were enrolled in eight grade.

4 Results

This section presents the parameter estimates of the differential effect of the SEP subsidy on test scores in the subjects of reading and maths by implementing both a DiD specification and an FE approach. The dependent variable used in both methods is the standardised test score; that is, it has been transformed such that the mean of the test score is zero and the standard deviation is one. In this manner, the estimates can be interpreted in terms of the standard deviation of the test score.

As previously noted, DiD estimations allow for including controls of students', schools', and teachers' characteristics as well as for geographic region to correct for differences in the observable characteristics among the cohorts of students. Additionally, FE estimations allow for solving the bias problem that arises when relevant variables are excluded from the regressions by assuming that such variables vary across individuals but do not change over time.

4.1 Effect on the average gain in students' academic performance

Firstly, the estimations are conducted over the whole sample. Table 8 presents the results of the estimations of both the DiD and the FE models for the subject of reading. In particular, column (1) shows the DiD estimates when controls for students', schools', and teachers' characteristics are added to the specification. Column (2) presents the results of the DiD estimations without including control variables. Posteriorly, column (3) displays the results of the individual FE estimation.

The results suggest a differential impact of the SEP subsidy on students' reading achievement that is positive and statistically significant. In fact, the results of the FE estimations indicate that the estimated average gain in the achievement of the fourth graders 2007 in the subject of reading is 0.031 standard deviations higher than the estimated average gain in the achievement of the fourth graders 2005. Furthermore, the effect is larger for students who have been exposed to the policy

for a longer period of time. Specifically, this figure is 0.062 and 0.084 for the fourth graders 2009 and 2011, respectively.

Similar results are obtained for the subject of maths. The effect of SEP on students' achievement is increasing with exposure time, but this is stabilised after 4 extra years of intervention. In effect, table 9 presents the results of the estimations of the DiD model for the subject of math that include control variables, the DiD model without control variables and the FE model. It can be noted from the FE estimations that the estimated average gain in the achievement of the fourth graders 2007 in the subject of math is 0.036 standard deviations higher than the estimated average gain in the achievement of the fourth graders 2005. In comparison, this effect is 0.65 and 0.63 for fourth graders 2009 and 2011, respectively.

In order to analyse whether the effect of SEP is heterogeneous, the model is estimated separately by type of school, public and private subsidised, and by type of student, priority and non-priority, given the different composition of these groups and their characteristics.[14] With the aim of assessing statistic differences among the estimates, Figure 5 and Figure 6 present the coefficients from the individual FE estimation with the corresponding confidence intervals for the subject of reading and maths by cohort, priority status and type of school, respectively.

The results indicate that the average effect of SEP on reading test scores is larger for the youngest cohort of students due to a longer exposure to activities funded by the SEP subsidy. This occurs in both public and private subsidised schools. Additionally, it can be seen that, in the public sector, the effect of SEP on reading test scores is positive and statistically significant for both priority and non-priority students. In comparison, in the private subsidised sector, the effect of two or four additional years of exposure to SEP is positive and statistically significant only for non-priority students. Then, the effect of six additional years of exposure to SEP on students' achievement is positive and statistically significant for both, priority and non-priority students.

In terms of the size of the effect, the estimations of the individual FE model shows that in public schools the average gain in the test scores of priority students in the cohort of fourth graders 2007 is 0.02 standard deviations higher than that of the priority students who attended fourth grade in 2005. This figure is 0.07 standard deviations for priority students in both the cohort of fourth graders 2009 and 2011. In the case of non-priority students the effect is 0.05 for fourth graders 2007 and it is stabilised at 0.08 standard deviations for the cohort of fourth graders 2009 and 2011, respectively.

In private subsidised schools, there is no evidence of a positive effect on priority students' test scores for the cohort of fourth graders 2007 and 2009. The effect is positive, statistically significant and equal to 0.06 standard deviations only for the youngest cohort. Nevertheless, non-priority students exhibit an effect which is increasing with time of exposure. In particular, those who attended fourth

[14] Appendix C contains the tables that present the estimated differential effect of SEP on reading test scores by type of school and type of student from the following three specifications: DiD model with control variables, DiD model without control variables and FE model.

grade in 2007 show an effect of 0.04 standard deviations higher than non-priority students in the cohort of fourth graders 2005. This figure is 0.05 for non-priority students in the cohort of fourth graders 2009 and 0.12 for non-priority students in the cohort of fourth graders 2011.

Similar conclusions can be established by analysing the subject of maths in private subsidised schools. The effect of SEP on the average gain in achievement is increasing with time of exposure to the programme for both, priority and non-priority students. However, in public schools, the effect on students' achievement is increasing with time only up to four extra years of exposure to the SEP subsidy. The estimated effect of SEP on the youngest cohort's test scores is smaller than for the cohorts of fourth graders 2007 and 2009, especially for priority students whose estimated effect is negative (-0.02 standard deviations) in comparison to results exhibited by fourth graders 2005 (see Figure 6).

In sum, the results from the implementation of both the DiD approach and FE model suggest three main findings:

1. Overall, the SEP subsidy positively affects the average gain in test scores experienced by students between fourth grade and eighth grade in primary schools.

2. Even though the subsidy is targeted at low-income students the effect on the test scores of non-priority students is larger than the effect on the test scores of priority students in both public and private subsidised schools. This finding suggests that the average achievement gap between priority and non-priority students holds over time

3. The longer the exposure to activities funded by SEP the larger the effect on the average growth in test scores, especially, for the subject of reading.

4.2 Effect sizes

To better interpret the magnitude of the estimated effects of SEP on the average gain in test scores, the effects obtained by other education interventions can be considered as a benchmark. There are hundreds of studies that evaluate educational interventions designed to improve students' achievement. Hill et al. (2007) reviewed more than four hundred studies that evaluate randomised educational interventions based on rigorous impact designs. The authors report that the overall average effect size is 0.23 standard deviations for students in primary education, 0.27 standard deviations for students in secondary education, and 0.24 standard deviations for students in higher education.

Moreover, Krueger (1999) claims that a class reduction intervention in the United States had an estimated effect of 0.15 standard deviations on students' achievement. Borman et al. (2002) found effect sizes from 0.09 to 0.15 standard deviations in their evaluation of comprehensive school reforms. Similarly, Lauer et al. (2004) show that the effect of out-of-school interventions varies

from 0.06 to 0.13 standard deviations in the subject of reading, and from 0.09 to 0.17 standard deviations in the subject of maths. Finally, Lipsey and Wilson (1993) argue that effect sizes from 0.10 to 0.20 should be considered as important in evaluations of educational interventions.

Therefore, the evidence that has emerged from the evaluations of interventions conducted in the education system suggests that the interpretation of the estimated effects should be carried out using the following empirical benchmark: an effect of 0.25, 0.15, and 0.05 to 0.10 standard deviations on students' achievement should be interpreted as a large effect, a medium effect, and a small effect, respectively. Additionally, the evidence available in Chile allows for the comparison of the estimated effects of the SEP subsidy on the average gain in students' achievement with other variables that affect the academic performance of students. For instance, according to Bravo et al. (2008) an effect of 0.09 standard deviations would be equivalent to the effect of one additional year of parents' education.

Furthermore, Contreras et al. (2011) observed the earnings of students who had taken the SIMCE test ten years earlier. The authors found that one standard deviation in the reading test score implies an increase of £7 (US$11) in monthly earnings. In the case of maths, the effect is higher than for the subject of reading; one standard deviation in the test score implies an increase of £60 (US$96) in monthly earnings. For instance, an effect of 0.09 standard deviations in the reading test score implies a modest effect of £1 in the future monthly earnings of students. An effect of 0.05 standard deviations in the math test score implies a modest effect of £3 in the future monthly earnings of students.

As noted previously, the estimated effect of the SEP subsidy on the average gain in the reading test scores is between 0.03 and 0.08 standard deviations depending on the specification. According to the empirical benchmark, these effect sizes should be interpreted as small for an educational policy.

5 Transmission channels

The estimations of the DiD model and the individual FE model imply that the SEP subsidy is improving the reading test scores in both public and private subsidised schools. Furthermore, younger cohorts exhibit larger effects on test scores than the oldest cohort under analysis. However, the gap in achievement between priority and non-priority students is still present.

These findings result from estimations of reduced form specifications that do not allow for inferring the mechanisms through which the policy works. Nevertheless, it is possible to raise some hypotheses about the transmission channels through which the SEP subsidy operates by analysing the incentives for families and schools established by the intervention.

In particular, the SEP law establishes incentives on both the demand and the supply sides of primary education in Chile. These incentives may change the behaviour of families and schools and consequently students' test scores. Therefore, the reactions and interactions of these agents must be accounted for in order to better understand the effect of SEP on the average gain in students' achievement estimated by the reduced forms.

5.1 School choice

The SEP subsidy may affect the school choice of families, especially families of priority students. Effectively, the priority status is reported to families as well as the benefits of being involved in the intervention, such as the elimination of any type of co-payment paid by parents and the abolition of any type of selection.[15]

Therefore, SEP means a change in the price of education for families of priority students. In fact, there are private subsidised schools with family co-payments that were not affordable for priority students' families before SEP. Therefore, the set of state funded schools available for priority students after the implementation of SEP is bigger than the set of schools available before the intervention. Accordingly, families are able to use the information about priority status to make school choices. Hence, the policy could change the allocation of students, affecting the composition of schools and, consequently, the educational outcomes through peer effects.

[15] In the private subsidised sector it is possible to find three main attributes through which schools select students:

1. Academic performance: Students need to take an admission test to ask for a place in the school. According to the parents' report of SIMCE 2008, 72 percent of students in private subsidised schools took an admission test before their enrolment.
2. Socioeconomic status: Families need to submit household income statements. According to the parents' report of SIMCE 2008, 37 percent of students in private subsidised schools submitted household income statements before their enrolment.
3. Religion: Students need to submit religious certificates, such as baptism or parents' marriage certificates, among others. According to the parents' report of SIMCE 2008, 15 percent of students in private subsidised schools submitted religious certificates before their enrolment.

Several studies have argued that academic performance is influenced not only by students' characteristics, but also by the performance, behaviour and socioeconomic characteristics of their classmates (Hoxby 2000, Angrist and Lang 2004, Ammermueller and Pischke 2009, Angrist 2014). Therefore, it is relevant to analyse whether the SEP policy affects students' mobility across schools. For instance, suppose that the SEP subsidy reduces school segregation by increasing the proportion of priority students in private subsidised schools. This could raise the concern that low-income students with low academic performance on average are detrimental to the performance of students with a higher socioeconomic status (Glewwe 1997, McEwan 2003).

To analyse this phenomenon, it is possible to compare the mobility among schools exhibited by different cohorts of students. In particular, in order to compare families' decisions before and after the implementation of SEP, six different cohorts of students are considered for the analysis, from first graders 2004 to first graders 2009. These cohorts have been differentially exposed to SEP and, consequently, the priority status identification of these students varies across cohorts, as shown in Table 10.

Figure 7 shows the percentage of students who switched schools between first grade and fourth grade by priority status and cohort. The information from the six cohorts of students under analysis shows that around 30 percent of students change schools between first and fourth grade, and there is no difference between priority and non-priority students. Furthermore, there is no difference over time. Systematically, all cohorts of students exhibit similar figures.

Additionally, it is possible to analyse the type of school chosen by students who change school over the period. Two types of schools are defined: schools that participate in SEP and non-participating schools. If the intervention affects families' decisions, it will be possible to observe an increase in the percentage of priority students who switched to an SEP school in cohorts that have longer periods of exposure to SEP.

Figure 8 illustrates the percentage of students who changed to an SEP school between first grade and fourth grade by priority status and cohort. It can be seen that there are differences between the choices made by families of priority students and non-priority students. The information for all cohorts indicates that around 50 percent of non-priority students who changed schools were enrolled in an SEP school to continue their primary education. In comparison, this figure is around 80 percent for priority students.

This may indicate that families of priority students exhibit higher preferences towards SEP schools. However, it is not possible to assign this conclusion to the implementation of SEP because the choices are similar among all cohorts. This suggests that the characteristics of SEP schools that induce participation in the intervention coincide with the characteristics preferred by families of priority students. Moreover, it is possible that SEP schools are less selective than other schools, and therefore priority students are more likely to be enrolled in this type of school than non-priority students.

Furthermore, it is possible to implement a Probit model to estimate the correlation between priority status and the probability of changing schools between first grade and fourth grade. Table 11 shows the marginal effect of being a priority student on the probability of changing schools for each cohort of students, from first graders 2004 to first graders 2009. It can be seen that priority status is negatively related to the probability of changing schools. This fact is true for all cohorts under analysis. However, the estimated marginal effects are between -0.02 and -0.01, which means a low correlation between being a priority student and the probability of changing school. Also, the estimations for the cohorts before and after the implementation of SEP are similar, suggesting that the SEP policy has not affected the school choice of families.

The similarity in the figures among all cohorts of students suggests that the implementation of the SEP policy has not affected families' decisions regarding changing schools or the type of school chosen by parents for their children. This fact could be explained for two main reasons.

Firstly, the school choice of families is already made when the child is enrolled in first grade. Hanushek et al. (2004) argue that once a child is enrolled in school the decision to change schools is more often related to family or work reasons, such as a job change, divorce, or other changes in family structure, than the pursuit of higher school quality. Consequently, parents who have decided which school they want for their children are not affected by the information regarding the priority status of the SEP policy. The evidence suggests that this information is not strong enough to change the school choice. This could be due to the SEP design and the manner in which the policy informs families about the benefits for priority students. This is relevant due to socially disadvantaged families having more difficulty obtaining information about school quality than high income families (Hanushek et al. 2007).

Secondly, staying at one school can be explained by the existence of switching costs. Even though parents might like to change their children's school, they consider other factors, not only school quality. This fact has been evidenced by Gallegos et al. (2011) and Hanushek et al. (2004). These studies concur that changing school affects parents and students in several ways. In general, parents resist moving their children to another school because it changes students' social circle and increases transport costs. Additionally, students have to adapt to a new school, teachers, classmates and possibly a new neighbourhood, creating stress for parents and children. Accordingly, it can be argued that in the context of the SEP policy, several switching costs discourage parents of priority students from changing school.

In sum, from the evidence presented above it is possible to conclude that the status of priority student is not making a behavioural change in the demand for primary education. Hence, it can be argued that the policy does not change the allocation of students or the composition of schools. Consequently, the positive effect of SEP on educational outcomes is not a result of peer effects. This suggests that the impact of the policy on the average gain in students' test scores that was estimated by reduced forms can be ascribed to the actions taken by schools.

5.2 Expenditure allocation

The implementation of the SEP may change the behaviour of education suppliers and the activities implemented by state funded primary schools and in consequence students' test scores could be affected.

Firstly, the SEP subsidy is delivered by the government to schools for each priority student. This could generate a preference towards placing more socially disadvantaged students due to a higher subsidy, thereby affecting the composition of schools and test scores via peer effects. However, in the case of private subsidised schools with family co-payments, this effect is counteracted by the fact that schools must eliminate any co-payment paid by families of priority students. In particular, schools with co-payments receive the regular subsidy for each enrolled student in addition to a co-payment, which is defined between £12.5 and £100.[16] Nevertheless, if the school is participating in SEP, it stops receiving the co-payments paid by families of priority students and starts receiving the SEP subsidy, which is approximately 51 per priority student. In consequence, the net effect depends on the level of family co-payments established by each state funded school and the proportion of enrolled priority students.

Figure 9 shows the proportion of priority students enrolled in each type of school; that is, total priority students over total enrolment between first and fourth grade of the system. It is possible to note that the largest proportion of priority students is enrolled in public schools that participate in SEP. However, this proportion has decreased over time, while the proportion of priority students in private subsidised schools in SEP increased from 24 percent to 31 percent between 2008 and 2013.

In addition, Figure 10 displays the proportion of priority students by school type. Private subsidised schools in SEP have been classified into: Private schools with fees in SEP if they charge a co-payment and Private schools without fees in SEP. It can be seen that the increase in the percentage of priority students in private subsidised schools in SEP is absorbed by private schools with fees in SEP.

Secondly, the requirement to implement an educational improvement plan focused on students' learning could generate a change in the practices undertaken by SEP schools. The structure of this plan gives flexibility and autonomy to schools in establishing their academic performance goals and pedagogical practices, to be developed over four years, taking into account the particular needs of each school. This plan should be funded with the SEP subsidy, and, the expenditure must be reported to the government through invoices and bills.

Figure 11 illustrates the use of the SEP subsidy made by participating schools in order to fund the activities established in the PME from 2008 to 2012.[17] In particular, it shows the allocation of

[16] Before 2016, the co-payments paid by parents were between 0.5 and 4 School Subsidy Units (Unidad de Subvención Educacional, USE) and one USE corresponds to ch$26,153, equivalent to £25, in the year 2020. Up to 0.5 USE, the private agent received all of the regular per-student subsidy, between 0.5 and 1 USE, there were a discount of 10% in the per-student subsidy, between 1 and 2 USE the discount were 20%, and between 2 and 4 USE the discount were 35%.

[17] Appendix D presents the expenditure allocation made by participating schools by year and type of school.

the SEP subsidy across the following expenditure categories: operating costs, teaching resources, school equipment, human resources, staff training, and others.

Every year, around 20 percent of the SEP subsidy is spent on operating costs. Expenditure on teaching resources such as books, traditional didactic resources, audio visual resources and educational software, among others, have represented around 15 percent of total expenditure over the period. In comparison, the share of expenditure on school equipment such as computers, printers, projectors, interactive whiteboards and portable devices, among others, has decreased over time from 18 percent in 2008 to 9 percent in 2012, which is reasonable due to the durable characteristics of these educational inputs.

Additionally, it can be noted that most of the SEP subsidy is used to fund human resources, which consider the extension of hours worked of hired staff, indefinite hiring of new staff, and temporary hiring of new staff required by schools to implement the educational improvement plan. In fact, the share of human resources expenditure has fluctuated from 29 percent to 38 percent of the total expenditure over the period. Whereas, expenditure on training such as courses, workshops and tutorials for staff of schools in SEP has decreased over time from 13 percent of total expenditure in 2008 to 5 percent of total expenditure in 2012.

The data on SEP expenditure over the period under analysis has the following caveat. According to the law, for every year of participation schools must report the use of the SEP subsidy by reporting invoices and bills. This information was processed by the Ministry of Education to construct a dataset of SEP expenditure at school level. However, until 2012 schools were not required to report all expenditure that they execute by using state resources. In particular, during the first years of the SEP policy, schools did not report the allocation of the regular per student subsidy provided by the government[18]. In consequence, the information on the use of resources made by state funded schools is incomplete and the estimation of educational production functions is unfeasible. Moreover, given the available data it is not possible to analyse a change in behaviour of education suppliers during the first years of the SEP policy, that is, whether schools were implementing new activities with the SEP subsidy or they were just reporting expenditure on regular activities.

Finally, the SEP policy generates incentives for education suppliers to enter the market in areas where they had not entered before the policy. Because of the SEP subsidy, socially disadvantaged areas are more attractive to education suppliers for constructing new schools. Consequently, more schools in the market produce a higher degree of competition. Incumbent schools have to react by changing their own practices in order to maintain their enrolment level and the level of resources received from the government. One limitation to analysing this hypothesis is that there is no

[18]The Superintendency of Education was created by the law N20,529 in August 2011 and began its functions in September 2012. Since that year, state funded schools are mandated to report to the Superintendency all their incomes and expenditures, specifying the source of funding (regular subsidy, SEP subsidy, donations, parents' contributions, among others.)

information on potential entrants. Therefore, it is not possible to analyse the entry decision of education suppliers.

6 Conclusions

Chile presents a significant socioeconomic gap in pupils' achievement within the education system. At all levels of education, students with the highest socioeconomic status perform significantly better academically than students with a lower socioeconomic status. Furthermore, the evidence for Chile supports the general conclusion that is widely accepted in the literature, which is that the income-based gap in education persists over time. In other words, low performance in primary education affects the progression of academic performance at subsequent levels of the education system and at even later stages of life such as in the labour market.

In order to tackle the socioeconomic gap in achievement at primary school level, in 2008 the Chilean government promulgated the SEP law, which introduced a subsidy delivered for each student identified as priority in terms of his or her socioeconomic status. The promulgation of SEP is an important milestone in the Chilean education policy because it breaks the principle of a uniform subsidy that has existed since 1981.

Despite the SEP being implemented in 2008, there is scarce research regarding its effects on students' achievement and, among the available evaluations, results are not conclusive. Consequently, the aim of this paper is to evaluate the effect of school subsidies targeted at socioeconomically disadvantaged students on academic achievement.

Using administrative data that contains information of four cohorts of students in two time periods, an empirical strategy is proposed to evaluate the effect of SEP on students' achievement. In particular, suitable DiD and FE estimators are developed in order to compare the average gain in test scores over two time periods among fourth graders 2005, fourth graders 2007, fourth graders 2009 and fourth graders 2011. This empirical strategy exploits the differential effect of the SEP subsidy on these cohorts of students because they differ in terms of how long they have been exposed to SEP. By comparing these cohorts and assuming common trends it is possible to identify the average treatment effect of two, four and six additional years of participation in SEP on the gain in students' achievement.

The results suggest a differential impact of the SEP subsidy on students' achievement, which is positive, statistically significant and increasing with time of exposure to the policy. In fact, the results of the FE estimations for the subject of reading indicate that the estimated average gain in achievement for the fourth graders 2007 is 0.03 standard deviations higher than the estimated average gain in achievement for the fourth graders 2005. Furthermore, the effect is larger for students who have been exposed to the policy for a longer period of time. Specifically, this figure is 0.06 standard deviations for the fourth graders 2009 and 0.08 for the fourth graders 2011. Similar

results are obtained for the subject of maths for the oldest cohorts. However, the effect is stabilised at 0.06 standard deviations for the two youngest cohort.

Additionally, the DiD estimations are conducted separately by type of school, public and private subsidised, and by type of students, priority and non-priority students. The results indicate that, in the public sector, the effect of SEP on reading test scores is positive and statistically significant for both priority and non-priority students. In comparison, in the private subsidised sector, the effect of two or four additional years of exposure to SEP is positive and statistically significant only for non-priority students. Then, the effect of six additional years of exposure to SEP on students' achievement is positive and statistically significant for both, priority and non-priority students. These results imply that the SEP subsidy is improving the test scores in both public and private subsidised schools. However, the gap in achievement between priority and non-priority students is still present. In addition, according to an empirical benchmark, the estimated effect sizes should be interpreted as small for an educational policy.

The results of the reduced-form estimations do not allow for inferring the mechanisms behind the effects of SEP on students' achievement. To better understand the mechanisms through which the SEP subsidy works, it is necessary to go further in the study of the effects of subsidies targeted at low-income students in primary education.

Effectively, the evidence presented in this study demonstrates that the SEP policy is not changing the behaviour of students' families. The comparison of the mobility among schools of several cohorts of students, before and after the implementation of SEP, shows that the status of priority student is not making a behavioural change in the demand for primary education. This suggests that the effect of SEP on the average gain in students' test scores can be ascribed to the pedagogical actions taken by schools.

In consequence, gathering new data on total school expenditure is suggested. This information would permit the construction and estimation of a dynamic model of expenditure allocations to analyse whether the state funded schools are changing their expenditure decisions due to the SEP subsidy, and which activities affect students' achievement the most, which is an exciting new avenue to explore in future research. The results would contribute to generating more reliable evidence on how to tackle the achievement inequality in primary schools, and consequently how to reduce the income gap at later stages in the life time of students.

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Tables

Table 1: Participation of state funded schools in SEP by school type

School type	All schools	Participating	Percentage of participation
Public	5,016	4,886	97%
Private Subsidised	3,369	1,874	56%
Total	8,385	6,760	81%

Source: Elaborated on the basis of information from the year 2008 from the Ministry of Education, Government of Chile.

Table 2: Total per-priority student subsidy received by a participating school by proportion of priority students

Priority students proportion (%)	Regular per-student subsidy	Per-priority student SEP subsidy	Cumulated priority students subsidy	Total per-priority student subsidy
60% or more	78.2	51.1	7.6	136.8
45% and less than 60%	78.2	51.1	6.8	136.0
30% and less than 45%	78.2	51.1	5.1	134.3
15% and less than 30%	78.2	51.1	3.0	132.2
0% and less than 15%	78.2	51.1	0.0	129.2

Notes: Values are calculated for a student attending to a full-school-day in fourth grade, on the basis of the USE at December 2019 (ch$26,153) and an exchange rate of one British pound sterling to 1,041 Chilean pesos.

Table 3: Implementation of SIMCE tests and SEP law in primary education by year and grade

Grade	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
4th	x	x	x	x	x	x	x	x	x	x	x
8th			x		x		x		x	x	x
SEP				1st-4th	1st-5th	1st-6th	1st-7th	1st-8th			

Source: Ministry of Education, Government of Chile.
Note: The cross indicates when the test is taken.

Table 4: Cohorts of students for the empirical strategy by year, grade and exposure to SEP

Cohorts of students	Year and grade									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Fourth graders 2005	4th	5th	6th	7th	8th						
Fourth graders 2007	2nd	3rd	4th	5th	6th	7th	8th				
Fourth graders 2009		1st	2nd	3rd	4th	5th	6th	7th	8th		
Fourth graders 2011				1st	2nd	3rd	4th	5th	6th	7th	8th
SEP implementation				1st-4th	1st-5th	1st-6th	1st-7th	1st-8th	1st-9th	1st-10th	1st-11th

Notes: Year 2008 is the first year of implementation of SEP.

Table 5: Normalisation of two time periods for implementing a DiD approach

Cohort of students	First time period (T=0)	Second time period (T=1)
Fourth graders 2005	4th grade in year 2005	8th grade in year 2009
Fourth graders 2007	4th grade in year 2007	8th grade in year 2011
Fourth graders 2009	4th grade in year 2009	8th grade in year 2013
Fourth graders 2011	4th grade in year 2011	8th grade in year 2015

Table 6: Descriptive statistics for the sample of students used in the DiD and FE estimations - 4th graders

Variables	Cohort 1 4th graders 2005	Cohort 2 4th graders 2007	Cohort 3 4th graders 2009	Cohort 4 4th graders 2011
Reading test score	254.52	252.89	259.25	264.32
	(48.73)	49.41	50.09	48.39
Math test score	246.42	243.27	248.52	255.58
	(50.89)	51.82	51.13	47.41
Type of student	0.49	0.48	0.47	0.44
(1: Priority)	(0.50)	(0.50)	(0.50)	(0.50)
Student's gender	0.48	0.48	0.49	0.49
(1: Male)	(0.50)	(0.50)	(0.50)	(0.50)
Household per capita income	64.86	93.52	78.94	-
(British pounds in 2020)	(63.94)	(94.55)	(87.66)	-
Mother schooling	10.08	10.32	10.51	10.64
(Years)	(3.35)	(3.30)	(3.34)	(3.27)
Father schooling	10.05	10.31	10.44	10.56
(Years)	(3.43)	(3.37)	(3.40)	(3.34)
Type school	0.24	0.23	0.21	0.19
(1: Private subsidized)	(0.43)	(0.42)	(0.41)	(0.39)
Students mobility	0.33	0.34	0.39	0.41
(1: Change schools)	(0.47)	(0.47)	(0.49)	(0.50)
Socioeconomic status	0.42	0.38	0.37	0.38
(1: Medium)	(0.49)	(0.49)	(0.48)	(0.48)
Socioeconomic status	0.11	0.07	0.06	0.06
(1: Medium-high and high)	(0.31)	(0.26)	(0.24)	(0.24)
Total enrolment in 4th grade	69.54	64.18	61.88	57.59
(School level)	(49.11)	(44.42)	(42.52)	(39.63)
Proportion of priority students	47.73	48.8	48.63	44.5
(School level)	(21.54)	(23.47)	(23.00)	(19.28)
Zone	0.83	0.83	0.83	0.86
(1: Urban)	(0.38)	(0.38)	(0.38)	(0.35)
Teacher's gender	0.16	0.15	0.15	0.13
(1: Male)	(0.37)	(0.35)	(0.36)	(0.34)
Teacher's experience	22.76	25.94	18.79	17.06
(Years)	(11.88)	(11.03)	(12.88)	(12.51)
Observations	115,723	112,217	92,364	88,012

Source: Elaborated on the basis of information from the Ministry of Education, Government of Chile.
Notes: Standard deviations are in parentheses. Household per-capita income is expressed in pounds considering an exchange rate of ch$1011.17 per £1, and is adjusted by inflation. The symbol denotes no information available.

Table 7: Descriptive statistics for the sample of students used in the DiD and FE estimations - 8th graders

Variables	Cohort 1 8th graders 2009	Cohort 2 8th graders 2011	Cohort 3 8th graders 2013	Cohort 4 8th graders 2015
Reading test score	246.05	249.05	250.83	240.39
	(48.06)	(47.87)	(48.28)	(48.25)
Math test score	251.41	251.34	254.05	255.78
	(47.25)	(45.11)	(44.31)	(45.86)
Type of student	0.49	0.48	0.47	0.44
(1: Priority)	(0.50)	(0.50)	(0.50)	(0.50)
Student's gender	0.48	0.48	0.49	0.49
(1: Male)	(0.50)	(0.50)	(0.50)	(0.50)
Household per capita income	85.1	103.29	-	130.75
(British pounds in 2020)	(95.05)	(105.93)	-	(124.95)
Mother schooling	10.27	10.33	10.46	10.74
(Years)	(3.39)	(3.34)	(3.34)	(3.34)
Father schooling	10.24	10.26	10.31	10.54
(Years)	(3.46)	(3.40)	(3.40)	(3.44)
Type school	0.24	0.23	0.21	0.19
(1: Private subsidized)	(0.43)	(0.42)	(0.41)	(0.39)
Students mobility	0.36	0.36	0.4	0.42
(1: Change schools)	(0.48)	(0.48)	(0.49)	(0.49)
Socioeconomic status	0.34	0.35	0.31	0.33
(1: Medium)	(0.47)	(0.48)	(0.46)	(0.47)
Socioeconomic status	0.07	0.06	0.04	0.05
(1: Medium-high and high)	(0.26)	(0.24)	(0.21)	(0.22)
Total enrolment in 4th grade	65.95	60.58	60.47	60.59
(School level)	(45.41)	(38.50)	(38.22)	(37.80)
Proportion of priority students	47.54	42.95	47.34	44.65
(School level)	(21.27)	(20.30)	(21.60)	(19.18)
Zone	0.86	0.86	0.86	0.87
(1: Urban)	(0.35)	(0.35)	(0.35)	(0.33)
Teacher's gender	0.17	0.18	0.18	0.4
(1: Male)	(0.38)	(0.38)	(0.38)	(0.49)
Teacher's experience	19.61	19.18	-	-
(Years)	(13.18)	(13.36)	-	-
Observations	115,723	112,217	92,364	88,012

Source: Elaborated on the basis of information from the Ministry of Education, Government of Chile.
Notes: Standard deviations are in parentheses. Household per-capita income is expressed in pounds considering an exchange rate of ch$1011.17 per £1, and is adjusted by inflation. The symbol denotes no information available.

Table 8: Effect of SEP on reading test scores estimated by implementing DiD and FE approaches over the whole sample of students

Dependent variable: Standardised reading test score	DID (1)	DID (2)	FE (3)
Time effect (1: 8th grade)	-0.063*** (0.005)	-0.102*** (0.004)	-0.096*** (0.002)
Group 1 (1: 4th graders 2007)	-0.009** (0.005)	-0.017*** (0.004)	
Group 2 (1: 4th graders 2009)	-0.044*** (0.005)	-0.059*** (0.004)	
Group 3 (1: 4th graders 2011)	-0.053*** (0.005)	-0.072*** (0.004)	
Effect on 4th graders 2007 (Time*Group 1)	0.021*** (0.007)	0.034*** (0.005)	0.031*** (0.003)
Effect on 4th graders 2009 (Time*Group 2)	0.061*** (0.007)	0.066*** (0.006)	0.062*** (0.003)
Effect on 4th graders 2011 (Time*Group 3)	0.075*** (0.007)	0.089*** (0.006)	0.084*** (0.004)
Controls	Yes	No	No
Observations	543,960	816,632	816,632
R-squared	0.088	0.040	0.825

Notes: Robust standard errors in parenthesis, *** significant at 1% level, ** significant at 5% level, * significant at 10% level. All models control for geographic region. Group defines the oldest cohort of students, fourth graders 2005, as the base category against which the other two cohorts of students are assessed. Group is excluded to estimate the FE model due to collinearity.

Table 9: Effect of SEP on math test scores estimated by implementing DiD and FE approaches over the whole sample of students

Dependent variable: Standardised math test score	DID (1)	DID (2)	FE (3)
Time effect (1: 8th grade)	-0.113*** (0.004)	-0.153*** (0.004)	-0.146*** (0.002)
Group 1 (1: 4th graders 2007)	-0.013*** (0.005)	-0.026*** (0.004)	
Group 2 (1: 4th graders 2009)	-0.064*** (0.005)	-0.092*** (0.004)	
Group 3 (1: 4th graders 2011)	-0.068*** (0.005)	-0.095*** (0.004)	
Effect on 4th graders 2007 (Time*Group 1)	0.018*** (0.006)	0.040*** (0.005)	0.036*** (0.003)
Effect on 4th graders 2009 (Time*Group 2)	0.062*** (0.007)	0.070*** (0.006)	0.065*** (0.003)
Effect on 4th graders 2011 (Time*Group 3)	0.046*** (0.007)	0.068*** (0.006)	0.063*** (0.003)
Controls	Yes	No	No
Observations	548,598	818,762	818,762
R-squared	0.111	0.051	0.844

Notes: Robust standard errors in parenthesis, *** significant at 1% level, ** significant at 5% level, * significant at 10% level. All models control for geographic region. Group defines the oldest cohort of students, fourth graders 2005, as the base category against which the other two cohorts of students are assessed. Group is excluded to estimate the FE model due to collinearity.

Table 10: Priority status identification by year, grade and cohort of students

Priority status identification	Year and grade								
	2004	2005	2006	2007	2008	2009	2010	2011	2012
Never	1st	2nd	3rd	4th					
From 4th grade onwards		1st	2nd	3rd	4th				
From 3th grade onwards			1st	2nd	3rd	4th			
From 2th grade onwards				1st	2nd	3rd	4th		
From 1st grade onwards					1st	2nd	3rd	4th	
From 1st grade onwards						1st	2nd	3rd	4th

Notes: Year 2008 is the first year of implementation of SEP.

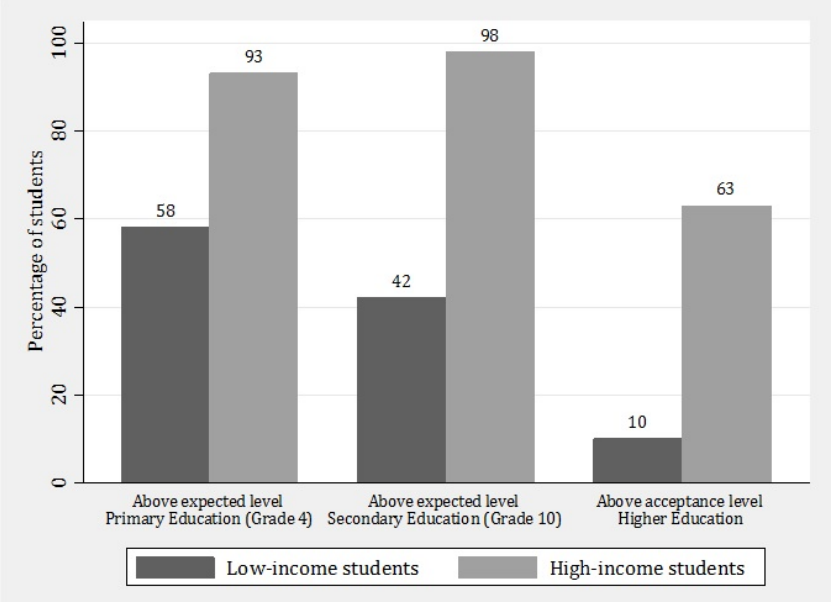
Table 11: Marginal effect of being a priority student on the probability of changing schools, Probit model estimations

Cohort	Marginal effect of being priority student	Robust standard error	Observations
First graders 2004	-0.016***	0.002	223,275
First graders 2005	-0.016***	0.002	219,124
First graders 2006	-0.022***	0.002	211,763
First graders 2007	-0.022***	0.002	217,518
First graders 2008	-0.016***	0.002	207,666
First graders 2009	-0.018***	0.002	204,589
All cohorts (with time dummies)	-0.012***	0.001	1,283,945

Notes: *** significant at 1% level, ** significant at 5% level, * significant at 10% level.

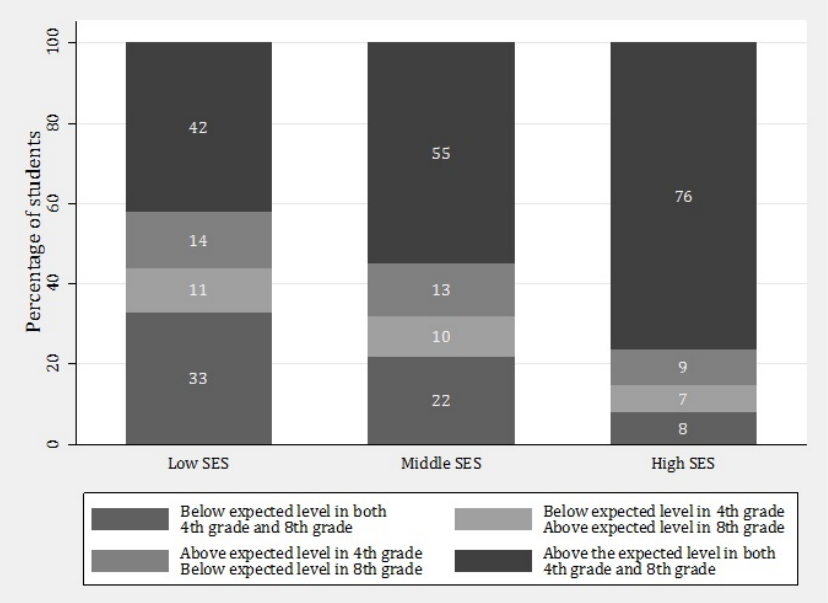
Figures

Figure 1: Percentage of students that achieve the expected level at primary and secondary schools, and the acceptance level for higher education by income level in Chile.



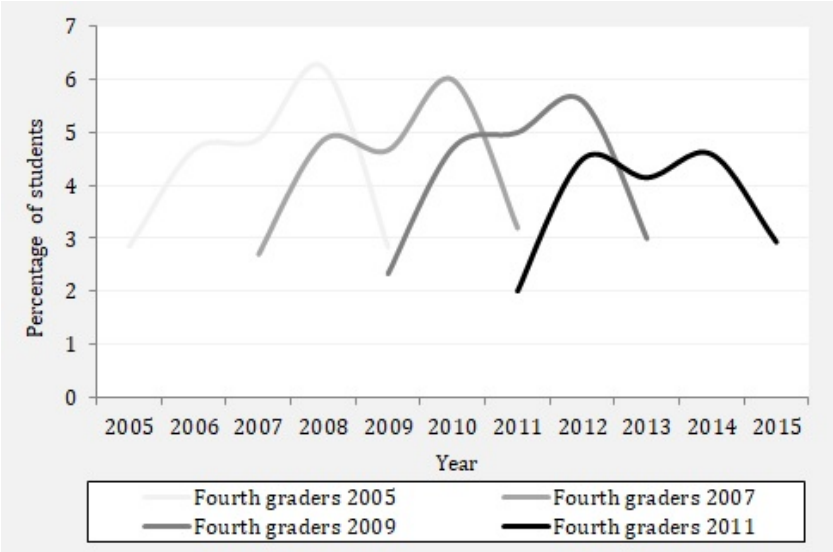
Notes: The expected level in primary and secondary education corresponds to a score of 240 or above in the National Reading Test of the Chilean Quality of Education Measurement System (Sistema the Medición de la Calidad de la Educación). A score of or above the expected level indicates the attainment of intermediate or advanced level. The reading test scores vary from 180 to 330. The acceptance level for entry into higher education corresponds to a score of 600 or above in the National Test for University Selection (Prueba de Selección Universitaria). The scores vary from 150 to 850. Low-income status includes students from the bottom and second income quintiles. High-income status includes students from the fourth and top income quintiles. Source: This figure is elaborated on the basis of information from the year 2010 from the Ministry of Education, Government of Chile.

Figure 2: Students' achievement progression from fourth grade in 2007 to eighth grade in 2011 in the national reading test by socioeconomic status (SES) in Chile.



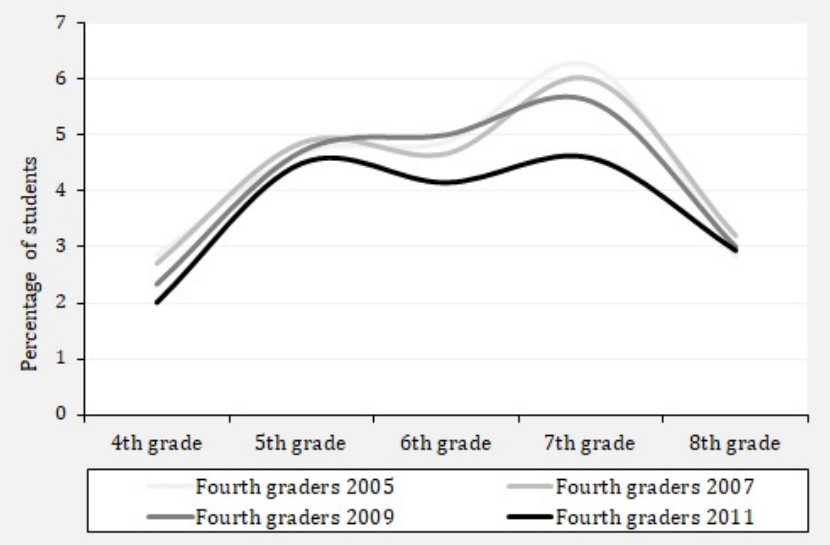
Notes: The expected level in primary and secondary education corresponds to a score of 240 or above in the National Reading Test of the Chilean Quality of Education Measurement System (Sistema the Medición de la Calidad de la Educación). A score of or above the expected level indicates the attainment of intermediate or advanced level. The reading test scores vary from 180 to 330. The cohort of students corresponds to students attending fourth grade in 2007 and correspondingly, attending eighth grade in 2011. Low SES includes students from the bottom and second income quintiles, middle SES includes students from the third income quintile, and high SES includes students from the fourth and top income quintiles.
Source: This figure is elaborated on the basis of information from the Ministry of Education, Government of Chile.

Figure 3: Percentage of students who repeat a school year by year and cohort



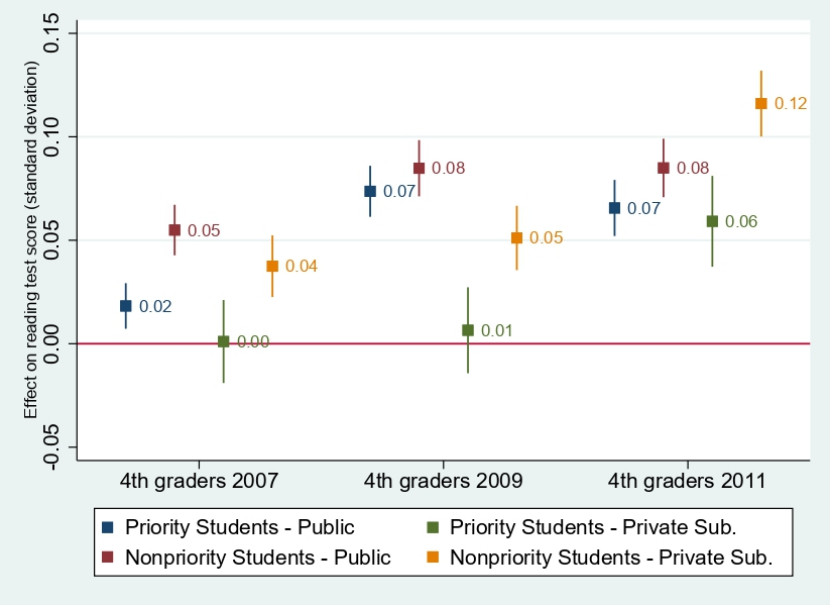
Notes: Percentages between fourth grade and eighth grade. Therefore, there are five time periods for each cohort of students.
Source: This figure is elaborated on the basis of information from the Ministry of Education, Government of Chile.

Figure 4: Normalisation of percentage of students who repeat a school year by grade and cohort



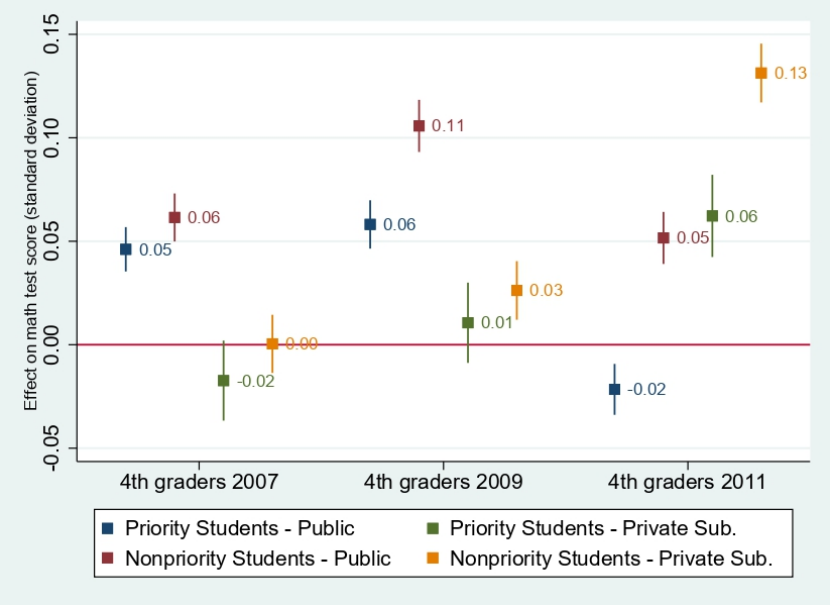
Notes: Percentages from fourth grade to eighth grade. Therefore, there are five time periods for each cohort of students.
Source: This figure is elaborated on the basis of information from the Ministry of Education, Government of Chile.

Figure 5: Estimates and confidence intervals from the individual FE model estimation for the subject of reading by cohort, priority status and type of school



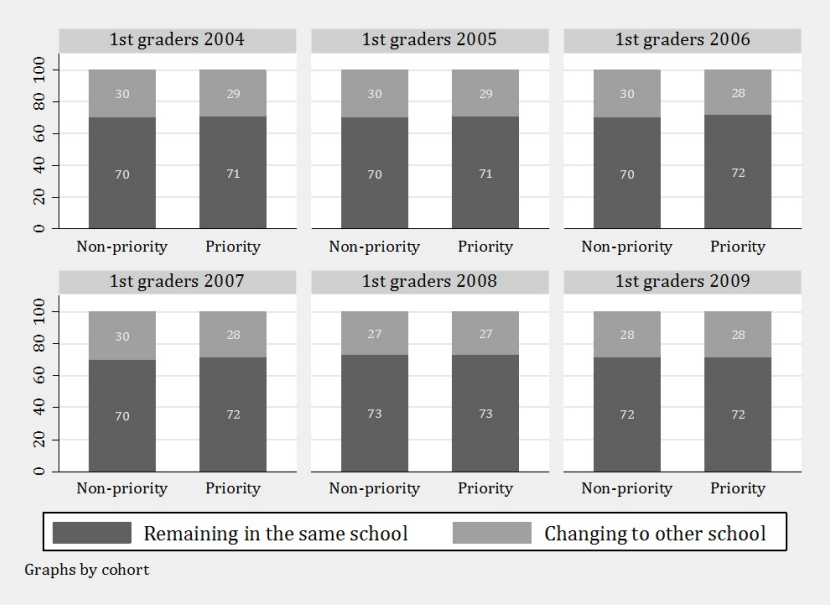
Notes: *** significant at 1% level, ** significant at 5% level, * significant at 10% level. FE model controls for geographic region. The oldest cohort of students, fourth graders 2005, is the base category against which the other two cohorts of students are assessed.

Figure 6: Estimates and confidence intervals from the individual FE model estimation for the subject of maths by cohort, priority status and type of school



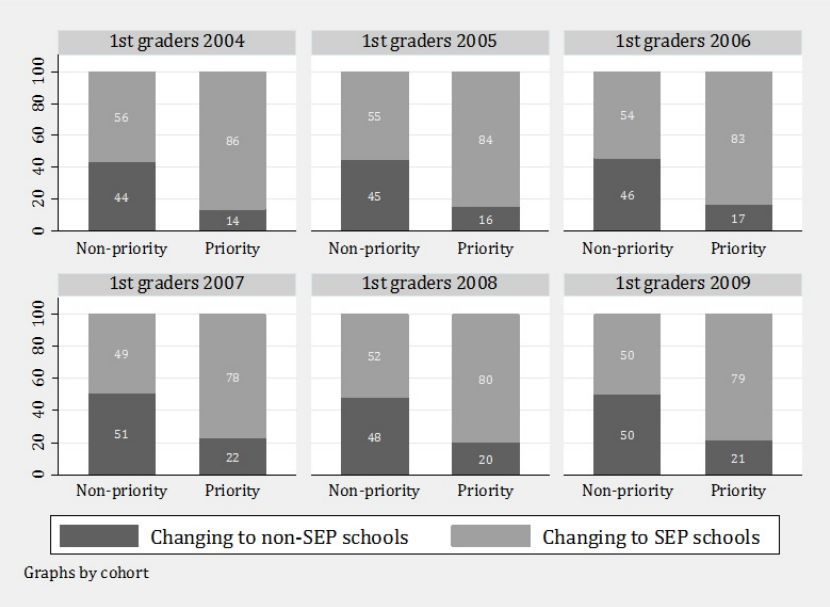
Notes: *** significant at 1% level, ** significant at 5% level, * significant at 10% level. FE model controls for geographic region. The oldest cohort of students, fourth graders 2005, is the base category against which the others two cohorts of students are assessed.

Figure 7: Percentage of students who switched schools between first grade and fourth grade by priority status and cohort



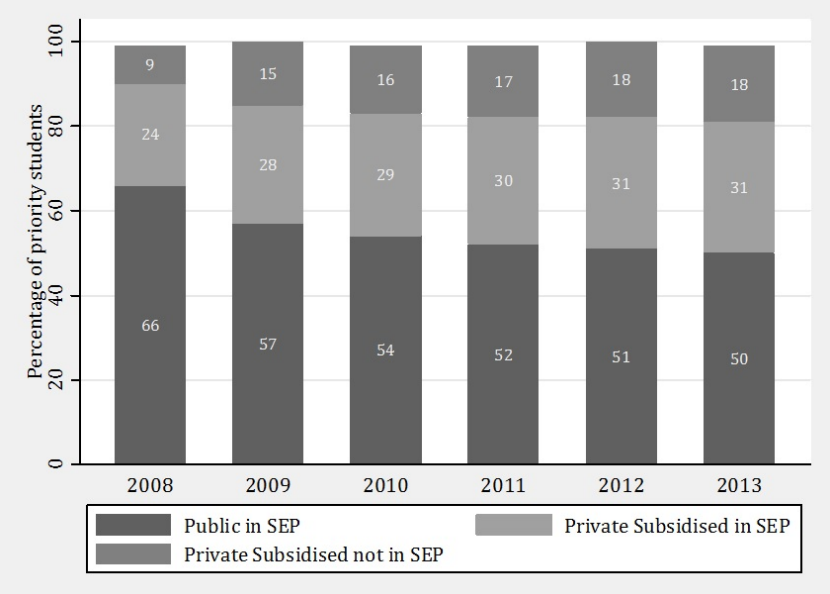
Notes: All cohorts include students who are observed in both first and fourth grade. The cohort of first graders in 2004 is the only cohort of students who are not exposed to SEP between first and fourth grade. In order to identify priority students from this cohort, the identification from fifth grade in 2008 is used.
Source: This figure is elaborated on the basis of the Enrolment dataset from year 2004 to year 2012 from the Ministry of Education, Government of Chile.

Figure 8: Percentage of students who switched to an SEP school between first grade and fourth grade by priority status and cohort



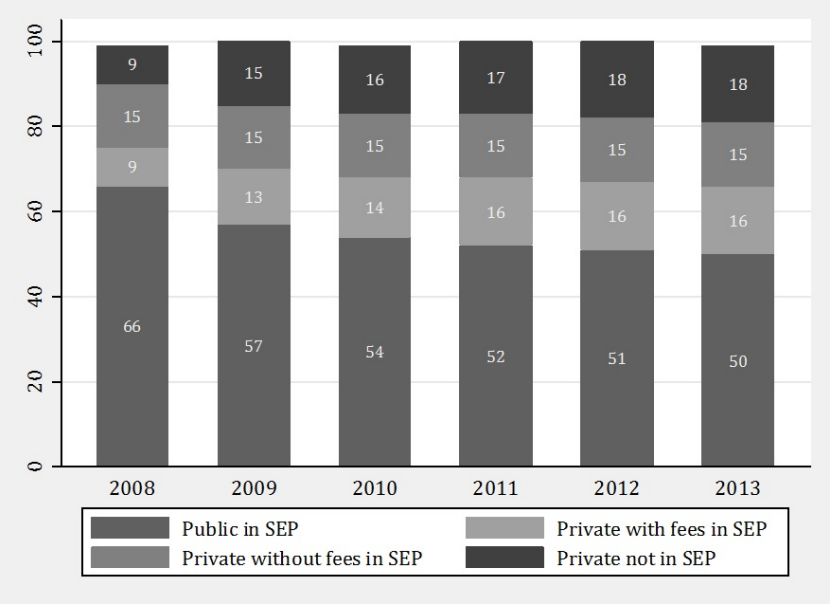
Notes: All cohorts include students who are observed in both first and fourth grade and have changed school between first and fourth grade. The cohort of first graders in 2004 is the only cohort of students who are not exposed to SEP between first and fourth grade. In order to identify priority students from this cohort, the identification from fifth grade in 2008 is used. Similarly, the participation of schools in 2008 is used to identify SEP schools.
Source: This figure is elaborated on the basis of the Enrolment dataset from year 2004 to year 2012 from the Ministry of Education, Government of Chile.

Figure 9: Proportion of priority students between first and fourth grade by school type and year



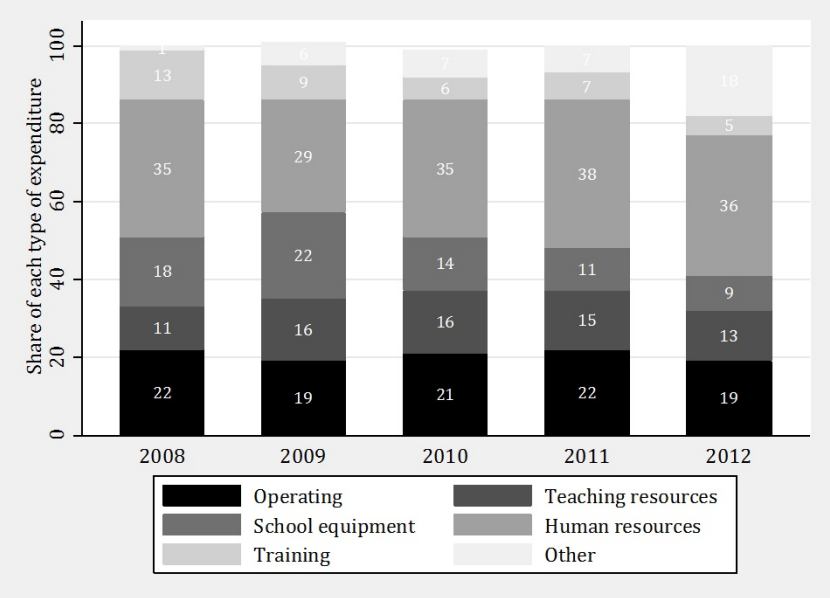
Notes: Public schools that not participate in SEP are not reported as they represent less than 3 percent of public schools.
Source: Elaborated on the basis of information from the Ministry of Education, Government of Chile.

Figure 10: Proportion of priority students between first and fourth grade by school type, co-payment existence and year



Notes: Public schools that not participate in SEP are not reported as it represents less than 3 percent of public schools.
Source: Elaborated on the basis of information from the Ministry of Education, Government of Chile.

Figure 11: Overall allocation of the preferential school subsidy by year



Source: Elaborated on the basis of information from the Ministry of Education, Government of Chile.

Appendix

A Identification of the average treatment effect of the intervention under DiD specification

Consider the following specification:

$$y_{it} = \alpha + \beta T + \gamma D_i + \theta T D_i + X_{it}\delta + u_{it} \tag{A.1}$$

Where y_{it} is the outcome of interest for individual i in period t, and T is a binary variable that defines the time period. It is one for the second time period and zero for the first time period. D_i is a binary variable. It is one if the observation corresponds to the treated group and zero otherwise. The interaction term, TD_i, multiplies the parameter of interest, θ, which represents the average treatment effect on the outcome of interest. The vector X_{it} is included to correct for differences in observable characteristics between groups.

In order to demonstrate the identification of the average treatment effect, define by y_{it}^1 the outcome variable for individual i in period t when the observation is in the treated group, denoted by one in the superscript. Similarly, y_{it}^0 is the outcome variable for individual i in period t when the observation corresponds to the control group.

Then, by taking expectations on equation A.1 for each possible outcome and assuming that $E[u_{it}|D_i, T, X_i] = E[n_i D_i, X_i] + m_t$, where n_i corresponds to an unobservable fixed effect and m_t is an aggregate macro shock, the following equations are obtained:

$$E[y_{i1}^1|T=1, D_i=1, X_{it}] = \alpha + \beta + \gamma + E[\theta|D_i=1, X_i] + X_{i1}^1\delta + E[n_i|D_i=1, X_{i1}^1] + m_1 \tag{A.2}$$

$$E[y_{i0}^1|T=0, D_i=1, X_{it}] = \alpha + \gamma + X_{i0}^1\delta + E[n_i|D_i=1, X_{i0}^1] + m_0 \tag{A.3}$$

$$E[y_{i1}^0|T=1, D_i=0, X_{it}] = \alpha + \beta + X_{i1}^0\delta + E[n_i|D_i=0, X_{i1}^0] + m_1 \tag{A.4}$$

$$E[y_{i0}^0|T=0, D_i=0, X_{it}] = \alpha + X_{i0}^0\delta + E[n_i|D_i=0, X_{i1}^0] + m_0 \tag{A.5}$$

Posteriorly, the first difference between the average gain in the treated group and the average gain in the control group is presented in equations A.6 and A.7, respectively.

$$\Delta y^1 = E[y_{i1}^1|T=1, D_i=1, X_{it}] - E[y_{i0}^1|T=0, D_i=1, X_{it}] = \beta + E[\theta|D_i=1, X_i] + m_1 - m_0 \tag{A.6}$$

$$\Delta y^0 = E[y_i^0|T_t = 1, D_{i1} = 0, X_{it}] - E[y_{i0}^0|T = 0, D_i = 0, X_i t] = \beta + m_1 - m_0 \tag{A.7}$$

Finally, by taking the difference between the average gain in the treated group and the average gain in the control group it is possible to identify the average treatment effect:

$$\Delta y^1 - \Delta y^0 = E[\theta|D_i = 1, X_i] \tag{A.8}$$

B Identification of the average treatment effect of the intervention under individual FE specification

Consider the following specification:

$$y_{it} = \alpha + \beta T + \gamma_i + \theta T D_i + X_{it}\delta + u_{it} \tag{B.1}$$

Where y_{it} is the outcome of interest for individual i in period t, T is a binary variable, which is one for the second time period and zero for the first time period and γ_i denotes a fixed effect that is unique to individual i. D_i is a binary variable. It is one if the observation corresponds to the treated group and zero otherwise. The interaction term, TD_i, multiplies the parameter of interest, θ, which represents the average treatment effect on the outcome of interest. The vector X_{it} is included to correct for differences in observable characteristics between groups.

Firstly, it is possible to write equation B.1 for each time period:

$$y_{i1} = \alpha + \beta + \gamma_i + \theta D_i + X_{i1}\delta + u_{i1} \tag{B.2}$$

$$y_{i0} = \alpha + \gamma_i + X_{i0}\delta + u_{i0} \tag{B.3}$$

By taking the first difference and assuming that the observable characteristics do not vary over time, the following equation is obtained:

$$\Delta y_i = y_{i1} - y_{i0} = \beta + \theta D_i + u_{i1} - u_{i0} \tag{B.4}$$

Then, by taking expectations on equation B.4 for each possible group, the following equations are obtained:

$$E[\Delta y_i|D_i = 1, X_i] = \beta + E[\theta|D_i = 1, X_i] + E[u_{i1}|D_i = 1, X_i] - E[u_{i0}|D_i = 1, X_i] \tag{B.5}$$

$$E[\Delta y_i|D_i = 0, X_i] = \beta + E[u_{i1}|D_i = 0, X_i] - E[u_{i0}|D_i = 0, X_i] \tag{B.6}$$

Secondly, in order to identify the average treatment effect, it is supposed that $E[u_{it}|D_i, T, X_i] = E[n_i|D_i, X_i] + m_t$, where n_i corresponds to an unobservable fixed effect and m_t is an aggregate macro shock:

$$E[\Delta y_i|D_i = 1, X_i] = \beta + E[\theta D_i = 1, X_i] + E[n_i|D_i = 1, X_i] + m_1 - E[n_i|D_i = 1, X_i] - m_0 \tag{B.7}$$

$$E[\Delta y_i|D_i = 0, X_i] = \beta + E[n_i|D_i = 0, X_i] + m_1 - E[n_i|D_i = 0, X_i] - m_0 \tag{B.8}$$

The equations above are equivalent to:

$$E[\Delta y_i|D_i = 1, X] = \beta + E[\theta D_i = 1, X] + m_1 - m_0 \tag{B.9}$$

$$E[\Delta y_i|D_i = 0, X] = \beta + m_1 - m_0 \tag{B.10}$$

Posteriorly, it is possible to obtain the average treatment effect by taking the difference between the average gain in the treated group and the average gain in the control group.

$$E[\Delta y_i|D_i = 1, X] - E[\Delta y_i|D_i = 0, X] = E[\theta|D_i = 1, X_i] \tag{B.11}$$

C Results from DiD and FE estimations by type of school and type of student

Table C1: Effect of SEP subsidy on reading test scores by type of school and type of student

Dependent variable:	DID model including control variables				DID model without control variables				FE model			
	Public		Private Subsidised		Public		Private Subsidised		Public		Private Subsidised	
Standardised reading test score	Priority Students (1)	Non-priority Students (2)	Priority Students (3)	Non-priority Students (4)	Priority Students (5)	Non-priority Students (6)	Priority Students (7)	Non-priority Students (8)	Priority Students (9)	Non-priority Students (10)	Priority Students (11)	Non-priority Students (12)
Time effect	-0.068***	-0.110***	0.023*	-0.044***	-0.113***	-0.150***	0.004	-0.071***	-0.095***	-0.135***	-0.030***	-0.086***
(1: 8th grade)	(0.008)	(0.008)	(0.013)	(0.010)	(0.006)	(0.007)	(0.010)	(0.008)	(0.004)	(0.004)	(0.007)	(0.005)
Group 1	-0.010	-0.029***	0.031**	-0.017*	-0.001	-0.042***	0.027***	-0.037***				
(1: 4th graders 2007)	(0.008)	(0.008)	(0.013)	(0.010)	(0.006)	(0.007)	(0.011)	(0.008)				
Group 2	-0.051***	-0.079***	0.030**	-0.047***	-0.050***	-0.092***	0.021**	-0.077***				
(1: 4th graders 2009)	(0.009)	(0.009)	(0.013)	(0.010)	(0.007)	(0.007)	(0.011)	(0.008)				
Group 3	-0.036***	-0.078***	0.004	-0.083***	-0.041***	-0.094***	0.002	-0.122***				
(1: 4th graders 2011)	(0.009)	(0.009)	(0.013)	(0.010)	(0.007)	(0.008)	(0.011)	(0.008)				
Effect on 4th graders 2007	0.015	0.039***	-0.027	0.035**	0.024***	0.055***	-0.006	0.037***	0.018***	0.055***	0.001	0.037***
(Time*Group 1)	(0.011)	(0.012)	(0.018)	(0.014)	(0.009)	(0.010)	(0.015)	(0.012)	(0.006)	(0.006)	(0.010)	(0.008)
Effect on 4th graders 2009	0.065***	0.079***	-0.012	0.063***	0.081***	0.082***	-0.009	0.049***	0.074***	0.085***	0.007	0.051***
(Time*Group 2)	(0.012)	(0.013)	(0.018)	(0.014)	(0.010)	(0.011)	(0.015)	(0.012)	(0.006)	(0.007)	(0.011)	(0.008)
Effect on 4th graders 2011	0.054***	0.081***	0.030	0.104***	0.074***	0.092***	0.032**	0.108***	0.066***	0.085***	0.059***	0.116***
(Time*Group 3)	(0.013)	(0.013)	(0.018)	(0.013)	(0.010)	(0.011)	(0.016)	(0.012)	(0.007)	(0.007)	(0.011)	(0.008)
Controls	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No
Observations	172,558	165,451	73,510	132,441	270,785	241,031	114,851	189,965	270,785	241,031	114,851	189,965
R-squared	0.054	0.064	0.078	0.077	0.018	0.018	0.013	0.014	0.834	0.838	0.847	0.835

Notes: Robust standard errors in parenthesis, *** significant at 1% level, ** significant at 5% level, * significant at 10% level. All models control for geographic region. Group defines the oldest cohort of students, fourth graders 2005, as the base category against which the others two cohorts of students are assessed. Group is excluded to estimate the FE model due to collinearity.

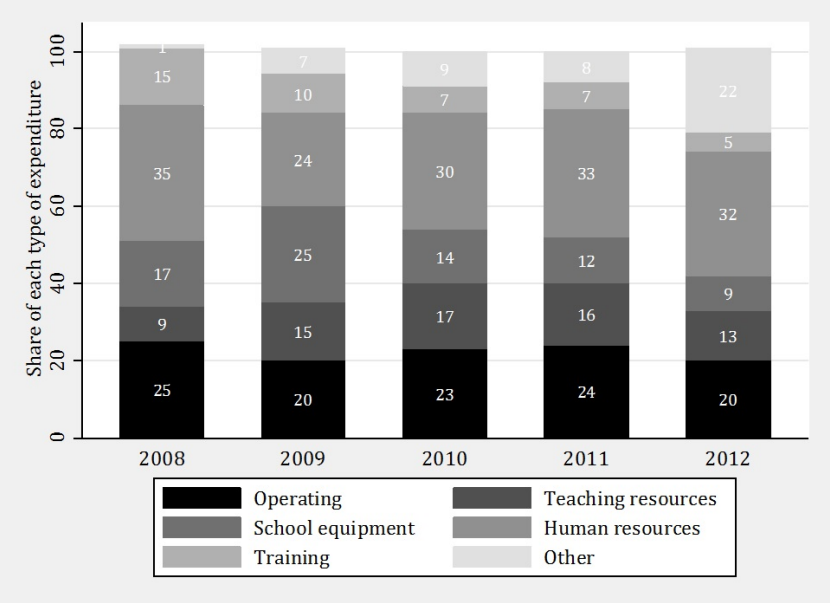
Table C2: Effect of SEP subsidy on math test scores by type of school and type of student

Dependent variable:	DID model including control variables				DID model without control variables				FE model			
	Public		Private Subsidised		Public		Private Subsidised		Public		Private Subsidised	
Standardised math test score	Priority Students (1)	Non-priority Students (2)	Priority Students (3)	Non-priority Students (4)	Priority Students (5)	Non-priority Students (6)	Priority Students (7)	Non-priority Students (8)	Priority Students (9)	Non-priority Students (10)	Priority Students (11)	Non-priority Students (12)
Time effect	-0.147***	-0.191***	-0.005	-0.018**	-0.182***	-0.228***	-0.026**	-0.062***	-0.165***	-0.212***	-0.055***	-0.070***
(1: 8th grade)	(0.008)	(0.008)	(0.013)	(0.009)	(0.006)	(0.007)	(0.010)	(0.008)	(0.004)	(0.004)	(0.007)	(0.005)
Group 1	-0.033***	-0.038***	0.043***	0.008	-0.029***	-0.051***	0.035***	-0.020**				
(1: 4th graders 2007)	(0.008)	(0.008)	(0.013)	(0.009)	(0.006)	(0.007)	(0.011)	(0.008)				
Group 2	-0.088***	-0.117***	0.015	-0.012	-0.102***	-0.138***	0.001	-0.059***				
(1: 4th graders 2009)	(0.009)	(0.009)	(0.013)	(0.010)	(0.007)	(0.007)	(0.011)	(0.008)				
Group 3	-0.054***	-0.105***	-0.017	-0.058***	-0.065***	-0.131***	-0.017	-0.111***				
(1: 4th graders 2011)	(0.009)	(0.009)	(0.013)	(0.009)	(0.007)	(0.008)	(0.011)	(0.008)				
Effect on 4th graders 2007	0.038***	0.041***	-0.031*	-0.010	0.051***	0.063***	-0.011	0.009	0.046***	0.061***	-0.017*	0.000
(Time*Group 1)	(0.011)	(0.011)	(0.018)	(0.013)	(0.009)	(0.010)	(0.015)	(0.012)	(0.005)	(0.006)	(0.010)	(0.007)
Effect on 4th graders 2009	0.051***	0.102***	0.001	0.034**	0.067***	0.104***	-0.004	0.036***	0.058***	0.106***	0.011	0.026***
(Time*Group 2)	(0.012)	(0.012)	(0.018)	(0.013)	(0.009)	(0.010)	(0.015)	(0.012)	(0.006)	(0.006)	(0.010)	(0.007)
Effect on 4th graders 2011	-0.043***	0.044***	0.042**	0.105***	-0.011	0.060***	0.044***	0.127***	-0.022***	0.052***	0.062***	0.131***
(Time*Group 3)	(0.012)	(0.012)	(0.018)	(0.013)	(0.010)	(0.010)	(0.015)	(0.012)	(0.006)	(0.006)	(0.010)	(0.007)
Controls	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No
Observations	174,214	166,854	74,126	133,404	270,745	241,891	115,355	190,771	270,745	241,891	115,355	190,771
R-squared	0.059	0.077	0.112	0.096	0.018	0.023	0.015	0.014	0.843	0.855	0.868	0.861

Notes: Robust standard errors in parenthesis, *** significant at 1% level, ** significant at 5% level, * significant at 10% level. All models control for geographic region. Group defines the oldest cohort of students, fourth graders 2005, as the base category against which the others two cohorts of students are assessed. Group is excluded to estimate the FE model due to collinearity.

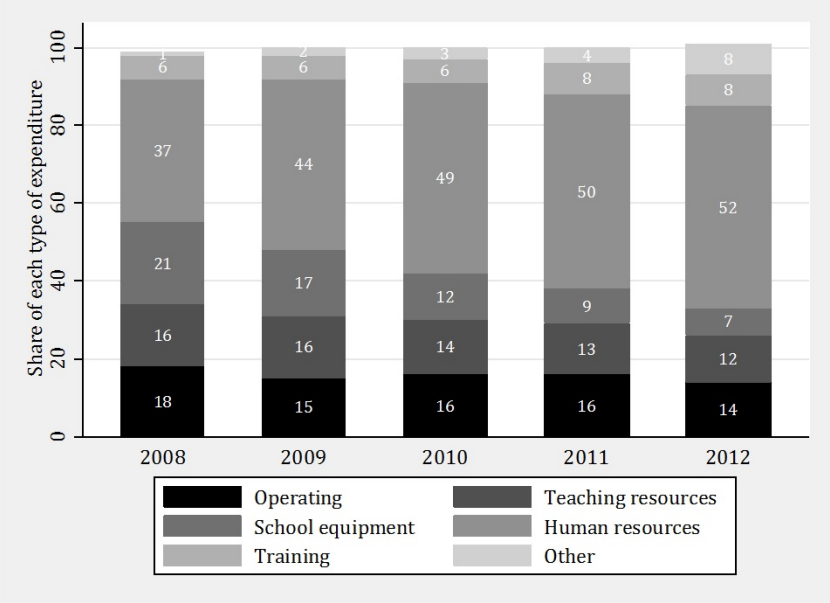
D Allocation of the preferential school subsidy by type of school

Figure D1: Overall preferential school subsidy allocation made by public schools by year



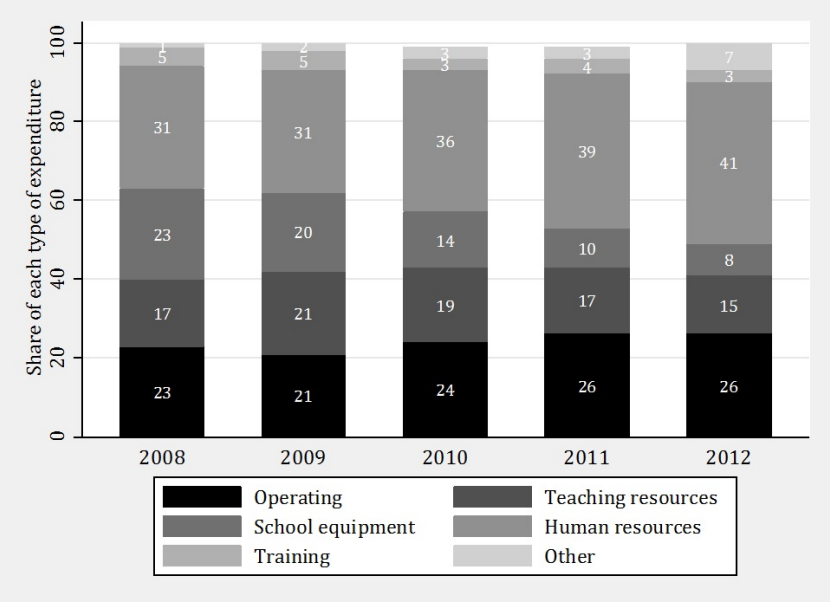
Source: Elaborated on the basis of information from the Ministry of Education, Government of Chile.

Figure D2: Overall preferential school subsidy allocation made by private subsidised schools with co-payments paid by parents by year



Source: Elaborated on the basis of information from the Ministry of Education, Government of Chile.

Figure D3: Overall preferential school subsidy allocation made by private subsidised schools without co-payments paid by parents by year



Source: Elaborated on the basis of information from the Ministry of Education, Government of Chile.