

THE UNIVERSITY OF CHICAGO

EVALUATING THE IMPACT OF SUPPLEMENTAL FUNDS ON DISADVANTAGED  
SCHOOLS: EVIDENCE FROM CHILE

A DISSERTATION SUBMITTED TO  
THE FACULTY OF THE IRVING B. HARRIS  
GRADUATE SCHOOL OF PUBLIC POLICY STUDIES  
IN CANDIDACY FOR THE DEGREE OF  
DOCTOR OF PHILOSOPHY

BY  
CAROLINA PATRICIA MÉNDEZ VARGAS

CHICAGO, ILLINOIS

JUNE 2016

Copyright © 2016 by Carolina Patricia Méndez Vargas  
All Rights Reserved

To Olga, my mother, a teacher who has worked all her life in a disadvantaged school and who has been always my source of inspiration.

# TABLE OF CONTENTS

LIST OF FIGURES . . . . .	vi
LIST OF TABLES . . . . .	viii
ACKNOWLEDGMENTS . . . . .	x
ABSTRACT . . . . .	xii
1 IMPACT OF COMPENSATING DIFFERENTIALS ON TEACHER LABOR SUPPLY IN HARD-TO-STAFF SCHOOLS: EVIDENCE FROM CHILE . . . . .	1
1.1 Introduction . . . . .	1
1.2 Literature Review . . . . .	4
1.3 Teacher Pay in Chile and the Difficult Conditions Bonus . . . . .	7
1.3.1 Chilean Teacher Pay . . . . .	7
1.3.2 The Difficult Conditions Bonus . . . . .	9
1.4 Data . . . . .	12
1.5 Analytic Framework . . . . .	15
1.6 Theoretical Framework . . . . .	18
1.7 Results . . . . .	21
1.8 Robustness checks . . . . .	25
1.9 Discussion . . . . .	29
1.10 Appendix A: Components of Chilean Teacher Salaries . . . . .	30
1.11 Appendix B: Relationship between Difficult Conditions Score and Difficult Conditions Bonus, by region and year . . . . .	33
1.12 Appendix C: Calculating the Difficult Conditions Score . . . . .	35
1.13 Appendix D: Additional Descriptive Context . . . . .	43
1.14 Appendix E: Results . . . . .	49
1.15 Appendix F: Results in $t + 1$ . . . . .	55
1.16 Appendix G: Alternate Bandwidths . . . . .	61
2 EVALUATING A TARGETED VOUCHER POLICY: A NON-PARAMETRIC BOUND ANALYSIS . . . . .	67
2.1 Introduction . . . . .	67
2.2 The Chilean education system, the SEP and its coverage . . . . .	70
2.2.1 The Chilean Education System . . . . .	70
2.2.2 Targeted Voucher (Subvención Escolar Preferencial - Preferential School Subsidy (SEP)) . . . . .	72
2.2.3 Evolution and Coverage of the SEP . . . . .	75
2.3 Previous literature evaluating SEP . . . . .	77
2.4 Data . . . . .	80
2.5 Methodology . . . . .	85
2.6 Results . . . . .	97
2.6.1 Comparison of Results . . . . .	99

2.7	Conclusion . . . . .	104
2.8	Appendix H: Additional Tables and Figures of Chapter 2 . . . . .	105
3	THE IMPACT OF TARGETED VOUCHERS ON TEACHER TURNOVER: THE CASE OF CHILE . . . . .	109
3.1	Introduction . . . . .	109
3.2	The Chilean education system, the SEP policy . . . . .	115
3.2.1	The education system in Chile . . . . .	115
3.2.2	Teachers' labor market . . . . .	116
3.2.3	Subvención Escolar Preferencial - Preferential School Subsidy (SEP) . . . . .	117
3.3	Description of the data . . . . .	120
3.4	Methodology . . . . .	123
3.5	Results . . . . .	125
3.6	Conclusion . . . . .	128
3.7	Appendix I: Additional Figures of Chapter 3 . . . . .	129
	REFERENCES . . . . .	132

## LIST OF FIGURES

1.1	Difficult Conditions Score and teacher bonuses for Regions 6 and 7 in 2014 . . .	10
1.2	Distribution of Difficult Conditions Bonus in 2014 . . . . .	12
1.3	Distribution of Difficult Conditions Score in 2014 . . . . .	12
B.1	Relationship between Difficult Conditions Score and Difficult Conditions Bonus, regions 1 to 4 from 2008 to 2014 . . . . .	33
B.2	Relationship between Difficult Conditions Score and Difficult Conditions Bonus, regions 5 to 8 from 2008 to 2014 . . . . .	34
B.3	Relationship between Difficult Conditions Score and Difficult Conditions Bonus, regions 9 to 12 from 2008 to 2014 . . . . .	34
B.4	Relationship between Difficult Conditions Score and Difficult Conditions Bonus, regions 13 to 14 from 2008 to 2014 . . . . .	35
D.1	Relationship between socioeconomic level of the school and SIMCE score . . . .	43
D.2	Number of students by sector and year . . . . .	44
D.3	Number of schools by sector and year . . . . .	44
D.4	Number of schools by type and year . . . . .	45
2.1	Number of students by sector and year (in thousands) . . . . .	71
2.2	Number of priority students by sector and year . . . . .	73
2.3	Number of schools participating in SEP by type and year . . . . .	76
2.4	Number of priority of students with and without SEP . . . . .	77
2.5	Socioeconomic composition of subsidized private schools with and without SEP over time . . . . .	82
2.6	Evolution of SIMCE math scores for subsidized private schools that have had SEP for 4 years in 2011 and those who have never had it . . . . .	84
2.7	Evolution of SIMCE language score for subsidized private schools that have had SEP for 4 years in 2011 and those who have never had it . . . . .	84
2.8	Effect of having SEP on the average SIMCE score in language and math . . . .	98
2.9	Effect of having SEP one year versus never having had it on the average SIMCE scores in language and math . . . . .	99
2.10	Effect of having SEP for two years versus never having had it on the average SIMCE scores in language and math . . . . .	100
2.11	Effect of having SEP for three years versus never having had it on the average SIMCE scores in language and math . . . . .	101
2.12	Lower bounds for $ATE(0,s)$ in language and math . . . . .	102
H.1	Cumulatives: percentage of priority students in private subsidized schools with versus without SEP in 2014 . . . . .	106
H.2	Socioeconomic composition of private subsidized schools by SEP status . . . .	107
3.1	Average probability of teacher/school separation in $t + 1$ between private subsi- dized schools that got SEP in 2008 and those who never received SEP . . . . .	123
I.1	Socioeconomic composition of schools by SEP status . . . . .	129
I.2	Number of students by sector and year (in thousands) . . . . .	130
I.3	Average Marginal effects with 95% CIs . . . . .	130

I.4 Average Marginal effects with 95% CIs for teachers in their first job . . . . . 131

## LIST OF TABLES

1.1	Distribution of the Difficult Conditions Bonus in 2014 . . . . .	11
1.2	Descriptive statistics by year at the school level . . . . .	14
1.3	Results for teacher-level outcomes . . . . .	22
1.4	Results for teacher-level outcomes by sector . . . . .	23
1.5	Results for teacher-level outcomes using a Geographically-Limited Sample . . .	24
1.6	Alternate Bandwidth Results . . . . .	26
1.7	Results for outcomes in $t + 1$ . . . . .	26
1.8	Alternate Sample Results . . . . .	28
A.1	Components of Chilean Teacher Salaries . . . . .	30
C.1	Calculating the Difficult Conditions Score . . . . .	36
C.2	Population Conditions: Vulnerable students . . . . .	38
C.3	Population Conditions: Bicultural, bilingual, and integrated students . . . . .	38
C.4	Population Conditions: Living away from home and Incarcerated students . . .	39
C.5	Rural Geographic Isolation: Distance from reference city . . . . .	39
C.6	Rural Geographic Isolation: Difficulty of access to school . . . . .	39
C.7	Rural Geographic Isolation: Public transit quality . . . . .	40
C.8	Rural Geographic Isolation: Type of teacher's residence . . . . .	40
C.9	Rural Geographic Isolation: Number of teachers; multi-grade classes . . . . .	40
C.10	Urban Hardship Conditions: Average class size . . . . .	41
C.11	Urban Hardship Conditions: District-level Crime-District-level poverty . . . . .	41
C.12	Urban Hardship Conditions: Ease of Access . . . . .	42
D.1	Number of schools by year and type of sample . . . . .	45
D.2	Total teachers by year and type of sample . . . . .	46
D.3	Total Students by year and type of sample . . . . .	46
D.4	Average Standardized Test Scores (SIMCE) in math by year . . . . .	47
D.5	Average Standardized Test Scores (SIMCE) in language by year . . . . .	48
E.1	Results on Contract Hours . . . . .	49
E.2	Results on Experience (years) . . . . .	50
E.3	Results on Hour teacher-per student . . . . .	51
E.4	Results on Retention Rate . . . . .	52
E.5	Results on SIMCE 4th grade Math . . . . .	53
E.6	Results on SIMCE 4th grade Language . . . . .	54
F.1	Results on Contract Hours in $t + 1$ . . . . .	55
F.2	Results on Experience (years) in $t + 1$ . . . . .	56
F.3	Results on Hour teacher-per student in $t + 1$ . . . . .	57
F.4	Results on Retention Rate in $t + 1$ . . . . .	58
F.5	Results on SIMCE 4th grade Math in $t + 1$ . . . . .	59
F.6	Results on SIMCE 4th grade Language in $t + 1$ . . . . .	60
G.1	Results on Contract Hours with alternate bandwidths . . . . .	61
G.2	Results on Experience with alternate bandwidths . . . . .	62
G.3	Results on Hours Per Student with alternate bandwidths . . . . .	63
G.4	Results on Retention rate with alternate bandwidths . . . . .	64
G.5	Results on SIMCE 4th grade Math with alternate bandwidths . . . . .	65

G.6	Results on SIMCE 4th grade Language with alternate bandwidths . . . . .	66
2.1	Subsidized private schools in the data by SEP status and year . . . . .	81
2.2	Number of subsidized private schools in the data, by SEP status, SES level, and year . . . . .	82
2.3	Number of subsidized private schools in the data by number of years with SEP	83
2.4	Results of fixed effect models . . . . .	103
H.1	Percentage of priority students as a function of the total enrollment in the school, by type of school and year . . . . .	105
H.2	Summary of results for first classification scheme $ATE(0, 1)$ . . . . .	106
H.3	Summary of results for second classification scheme $ATE(0, s)$ . . . . .	108
3.1	Number of teachers by cohort. . . . .	120
3.2	Descriptive statistics, all cohorts . . . . .	121
3.3	Results . . . . .	127

## ACKNOWLEDGMENTS

I would like to express my sincere gratitude to all those who contributed to the success of this study and made it an unforgettable experience for me.

To begin, I thank the members of my committee. Professor Ofer Malamud, thank you for chairing my committee. I appreciate your contributions of time and ideas, especially your willingness to meet with me every time I needed. Your research in the field of education has been a source of motivation. To Professor Dan Black, thank you for your willingness to discuss random ideas and helping me figure out how to incorporate them into my research. To Professor Susan Mayer, thank you for your time, for asking tough but relevant questions, and for helping me to find simple words to explain complex (or complex to me) ideas. To Professor Alicia Menéndez, to whom I am extremely indebted, thank you for going line by line through my papers. Through the especially tough times in the PhD program (they were not few), you were truly a source of inspiration. Also, I am thankful to Professors Mayer and Menéndez for being excellent examples of successful women in academia.

Second, I also would like to thank other members from the Harris School of Public Policy. Specifically, Professor Robert Lalonde for always being willing to meet with and help students; Professor Jeffrey Grogger for giving me the opportunity to learn from him, especially while working as his TA in the applied econometric course; and Cynthia L. Cook-Conley, Lydia Veliko, and May Woodard-Hickey for all their great work at Harris.

Third, thanks to my classmates and friends from the program, especially Rebecca Hinze-Pifer, my coauthor, with whom I have been working with for a long time and to whom I am extremely grateful. Thanks also to Bocar Ba, Sebastián Gallegos, Rebecca Myerson, and Carolyn Slone for being an important part of my life all these years and a source of friendship.

Fourth, thanks to my advisors in Chile who were the first in motivating me to follow this journey: Alejandra Mizala, Patricio Meller, Joseph Ramos, Ricardo Ffrench Davis, and Pilar Romaguera.

Fifth, I gratefully acknowledge the funding sources that made my Ph.D. work possible. Thanks to the Advanced Human Capital Programme of the National Commission for Scientific and Technological Research of the Government of Chile (CONICYT), the FULBRIGHT Commission, and the Harris School of Public Policy.

Lastly, thanks to my mother, Olga Vargas, for all her encouragement and support during all my life. To my closest friends Vicente Lagos, Diego Medel, Cristian Montero, Nicolas Muñoz and Valentina Quiroga for being with me all these years regardless of the distance. Most of all I want to thank to my supportive, encouraging, and patient partner, Jorge Catepillán for always being there.

## ABSTRACT

A number of policy interventions have attempted to reduce educational inequity by providing more monetary resources to schools or teachers. The three papers that compose my dissertation use Chilean educational data to explore the impact of two programs that provide supplemental funds to persistently disadvantaged schools in different ways: by increasing teacher salaries, and by providing somewhat discretionary funds directly to particular schools.

The first chapter examines the effects of a compensating wage differential program, the Difficult Condition Bonus, for teachers in disadvantaged schools. My coauthor Rebecca Hinze-Pifer and I use discontinuities in the bonus assignment to estimate the impact of this program on the labor supply of teachers at the school-level. Our results show that teachers who get a higher bonus work, on average, fewer hours per week. This is potential evidence that teaching at such schools is unpleasant and teachers wish to work less if they can afford to.

The second paper evaluates a voluntary policy, Subvención Especial Preferencial (Preferential School Subsidy or SEP), which provides an additional per-student payment to schools that accept disadvantaged students. I address the selection problem by using a nonparametric analysis to bound the effect of SEP on fourth grade standardized test scores. Motivated by the nature of policy and economic theory, I employ Monotone Treatment Selection (MTS), no time trend, policy invariance, and Monotone Treatment Response (MTR) assumptions, among others. Some of these assumptions are very strong, but without them I am not able to definitely state that there is a positive impact of SEP on academic achievement.

SEP was created with the main goal of improving academic performance of disadvantaged students with the purpose of equalizing educational opportunities for all students. However, when policies are implemented, there are other outcomes, planned or not. In the third chapter, I make an effort to measure the impact of SEP on one of those different outcomes: teacher turnover. I find evidence that SEP increases teacher turnover and that the effect

increases with the number of years of SEP implementation. The mechanisms underlying these effects are unclear and more research needs to be conducted to be able to say if this is a desirable outcome or not.

# CHAPTER 1

## IMPACT OF COMPENSATING DIFFERENTIALS ON TEACHER LABOR SUPPLY IN HARD-TO-STAFF SCHOOLS: EVIDENCE FROM CHILE

### 1.1 Introduction

Schools serving socially and economically disadvantaged students often have difficulty attracting and retaining high quality teachers, both in the United States and internationally (Lankford et al., 2002). Studies suggest rigid wage structures are partially responsible for this<sup>1</sup>, as these structures make it challenging to adjust wages to compensate teachers for difficult working conditions and reward teacher quality. In recent years, there has been substantial interest among policymakers and researchers in creating more flexible teacher pay structures. While most papers have focused on evaluating the impact of teacher pay-for-performance reforms on student performance and teacher quality (Podgursky & Springer, 2007), relatively less attention has been placed on how compensating wages influence labor supply in disadvantaged schools. The overall effect of a policy that alters wages includes changes in the labor supply at the extensive margin (e.g. sorting of teachers) and on the intensive margin (e.g. number of hours of worked) (Heckman, 1993). Changes in the intensive margin could be important for student outcomes. For instance, teacher absenteeism and/or teachers working fewer hours could be very harmful in general and in particular for disadvantaged students (Duflo et al., 2012). In this paper, we use a Chilean educational policy<sup>2</sup> to study the impact of increasing the hourly base wage in hard-to-staff schools on

---

0. Join work with Rebecca Hinze-Pifer

1. In most American school districts, teachers automatically move up a uniform salary scale with experience and may move onto higher pay tracks with additional education or training (Cohn, 1996; Odden, 2011).

2. Similar to other Latin American countries and to the United States, schools serving disadvantaged students in Chile have fewer resources, and students with low socioeconomic status (SES) perform sub-

the labor supply of existing teachers.

This policy, called the Difficult Conditions Bonus, offers a nominal bonus between 4% and 30%, for teaching in some disadvantaged schools. The bonus incrementally increases teacher pay based on a school's index score, which summarizes various sources of disadvantage in the school environment. Schools with higher index scores receive higher bonuses. The rationale is that a higher wage is needed to attract and retain teachers to work in schools in remote locations or with disadvantaged children. All teachers at an eligible school receive the same bonus. The bonus is not necessarily permanent because schools must reapply for the bonus every two years and the mapping of scores to bonuses changes on the same schedule. The bonus changes the hourly wage, thus theory predicts changes on the extensive and intensive margin.

Along the extensive margin the bonus can attract new and existing teachers. More teachers might be willing to work in this type of school<sup>3</sup>. However, if the bonus is neither large nor permanent, then we do not expect a large increase in the number of people willing to work in these hard-to-staff-schools. If so, we do not expect changes in teacher quality that might arise due to changes in the pool of applicants.

Along the intensive margin, given the change in the hourly wage, we expect to see teachers adjusting the number of hours they work. In a simple model of teacher utility maximization wherein teachers care about consumption and leisure, an increase in hourly wages can increase or decrease the number of hours that a teacher works. The ambiguity in the final result is because an increase in wages increases income and, therefore, increases the demand

---

stantially below students from more privileged backgrounds (see Appendix D). Among OECD and partner countries, Chile is consistently in the bottom third in measures of equitable educational resource distribution (OECD, 2010). On the international PISA exam, student socioeconomic background (SES) predicts 18.7% of the variance in Chilean student performance. In comparison, only 7 of the 61 participating countries had stronger relationships between SES and student performance; SES explains 16.8% of the variance in student performance on PISA in the United States (OECD, 2010).

3. It is important to note that the bonus must actually compensate for the worse working conditions. If it under compensates there is likely to have non effects. If it over compensates could attract teachers from other schools or attract teachers who have left the profession back to it and if it just compensates it might retain teachers in the schools but it will have little effect on sorting.

for all normal goods, including leisure. Therefore, the increase in the wage increases the demand for leisure, which reduces hours of work (income effect). But this is not all that happens. The wage increase also makes leisure more expensive, which tends to reduce the hours of leisure (substitution effect). Whether the income or substitution effect dominates depends on the rate at which a person is willing to give up leisure hours in exchange for additional consumption. A person with a lot of wealth that can afford a lot of consumption might value leisure more relative to consumption, wherefore when such a person is given higher wages she might prefer to spend more on leisure than on consumption. The same might happen for someone with low job satisfaction. Increasing leisure by a small amount gives her a lot of happiness, while to obtain an equivalent amount of happiness through consumption, she would need to work much more.

We explore the effects of the Difficult Conditions Bonus on the teacher labor supply by exploiting its structure. Publicly-funded schools<sup>4</sup> apply to receive the Difficult Conditions Bonus every 2 years. Each school receives a Difficult Conditions Score, calculated as an index of various measures of disadvantage using a formula defined at the national level (see Appendix C). The score translates into a percentage increase in teacher pay according to a region-specific scheme. The relationship between score and bonus must be increasing, but regions are free to choose gradual or stepped increases (see Appendix B).

We exploit the discontinuities in the pay structure produced in regions using stepped increases. We use a regression discontinuity approach (Imbens & Lemieux, 2008) to identify the impact of a marginal increase in the bonus, conditional on receiving the bonus, on the average hours worked weekly, the average number of teacher-hours per student, average years of teacher experience, and rate of teacher retention. We compare outcomes for schools with similar Difficult Conditions Scores but with different pay structures, where schools with scores just larger than the cutoff score receive a consequential increase in pay relative to those with slightly lower scores.

---

4. See section 1.3 for details on the structure of the Chilean education system

We use administrative data from the Chilean Ministry of Education and follow schools receiving the bonus between 2008 and 2014. We match this data with teacher and student data for the same period. At the school level in each year, we observe a rich set of descriptive information (student characteristics, teacher characteristics, administrative structure, location, etc.), including the size of the Difficult Conditions Bonus and the eligibility score for the set of schools that received the bonus.

We find that the bonus in hard-to staff schools produces a statistically significant decrease in the average number of hours worked, and in the average number of teacher-hours per student.

The paper proceeds as follows. In Section 1.2, we present a summary of available research on the impact of similar wage policies. In Section 1.3, we describe teacher pay structure and other salient aspects of the Chilean context, including the details of the Difficult Conditions Bonus policy. Section 1.4 contains the description of data used in this study. In sections 1.5 and 1.6 we present the analytical and theoretical framework. Section 1.7 presents our findings while Section 1.8 covers the relevant robustness checks. Finally, Section 1.9 concludes with a discussion of the findings' implications.

## 1.2 Literature Review

Many papers study how changes in wages affect labor supply in different dimensions. We divide them in three groups. The first group of papers studies how changes in wages affect teacher sorting. The second group of papers studies the impact of using monetary incentives on teacher performance. The third group of papers studies how changes in wages affect choices at the intensive margin (i.e. hours of work) of already staffed workers. This last group is closely related to this research, although we are unaware of any relevant work in the education sector.

**Teacher sorting:** Clotfelter et al. (2011) suggest that large wage differentials would be required to create an equitable distribution of high quality teachers across schools, which

they partially attribute to higher quality teachers being less responsive to salary incentives. Glazerman et al. (2013) study the impact of selective transfer incentives through an experimental policy that gives a large bonus (\$20,000) to the top 20% of district teachers who transfer to low-achieving schools for at least two years. They find that students taught by teachers hired by the treatment program improve their academic performance. In the same line, Steel et al. (2009) study a \$20,000 competitive bonus offered to academically talented and certified novice teachers who agreed to teach in low-performing California schools for at least 4 years.<sup>5</sup> The probability that a recipient taught in a high-need school increased by 28 percentage points, compared with those who would have been eligible but graduated in years that did not have the program. Finally, using a narrower policy in North Carolina which paid an \$1,800 annual retention bonus to teachers in hard-to-staff specialties (math, science, special education) in schools serving predominantly low-income or poorly performing students, Clotfelter, et al. (2008) found that turnover rates were 17 percent lower.

**Teacher wages and teacher performance:** For the impact of wages on performance, Lavy (2003) evaluates the impact of an Israeli program that rewarded teachers with cash bonuses for improving their students' performance, he found that the reward was associated with higher test scores in English and Math. Figlio and Kenny (2006), using data from the National Education Longitudinal Survey in the US and their own survey, found a positive correlation between test scores and schools offering individual financial incentives for good performance. Fryer (2011) analyzes the impact of incentives using a school-based randomized trial in over 200 New York City high-needs public schools where each participating school could earn \$3,000 for every staff member, which the school could distribute at its own discretion. He found no evidence of an impact on student performance.

**Teacher hours worked:** We are unaware of any studies of teachers' intensive margin responses to wage changes. Researchers have been more interested in changes in the extensive

---

5. The program awarded some 1,200 fellowships to two cohorts in 2000 and 2001. Recipients who did not complete the four years were required to repay \$5,000 for each committed year not completed.

margin outcomes (i.e. who becomes a teacher and where) than in the intensive margin. However, we believe that in schools that serve disadvantaged students, changes in hours worked is worth of analyzing, since it might be another source of inequality. Related work by Duflo et al. (2012) studies the impact of financial incentives on teacher absence and student learning in India. In the experiment, teacher pay was adjusted according to attendance. Within the context of high teacher absenteeism, they found that absenteeism fell in the treatment group and student performance improved.

The intensive margin has been widely studied in the labor literature, both from a micro and macro point of view. Heckman (1993) summarized many important findings in this topic, for instance finding taxes have only minimal effects on hours worked (MaCurdy et al., 1990; Mroz, 1987). Zavodny (2000) finds that an increase in the minimum wage in the US did not affect the hours worked by low-wage teens. Fehr et al. (2007) conduct a randomized field experiment at a bicycle messenger service in Zurich, Switzerland to estimate the elasticity of hours worked in a setting where workers were free to choose hours worked and effort per hour. They introduced an exogenous and transitory increase of 25% in the commission rate and observed that workers worked substantially more hours. While it is more difficult to study in the context of American education, many districts offer part time contracts, contracts with extra pay for a heavier teaching load, and contracts for teaching electives or extracurricular activities outside of normal working hours, making it salient to understand teacher responses on the hours margin.

## 1.3 Teacher Pay in Chile and the Difficult Conditions Bonus

### 1.3.1 *Chilean Teacher Pay*

The Chilean education system consists of three distinct sectors, each with its own approach to determining teacher pay<sup>6</sup>. Families can choose among different types of schools (Figure D.2 in Appendix D shows the number of students by sector over time). Municipal public schools, serving 38.2% of students in 2014, follow a rigid salary structure and negotiate with teachers via the national government, constrained by a sector-specific Teachers' Statute (Estatuto Docente). Municipal schools are free for students. Private subsidized schools<sup>7</sup>, which served 54.2% of students in 2014, may determine teacher salaries on a case-by-case basis and are governed by the private sector Labor Code, with additional rules from the Teachers' Statute<sup>8</sup>. During the study period, private subsidized schools were allowed to charge tuition up to about twice the amount of the publically funded amount<sup>9</sup>; however, the overwhelming majority of such schools charged relatively nominal student fees. Fully private schools, which served 7.6% of students in 2014, are also free to determine teacher salaries within the constraints of the private Labor Code, and without restriction from the Teachers' Statute. Private schools receive no public funding and charge students substantial tuition. In all three school types, teachers are contracted for a specific number of hours (up to 44) and paid a set hourly wage for those contract hours. This paper focuses on teacher pay in municipal and private subsidized schools, both of which were eligible for the Difficult Conditions Bonus; fully private schools are ineligible for the bonus and thus excluded from the study. The remainder of this section describes the structure of teacher pay at municipal

---

6. See Mizala & Romanguera (2005) for a more detailed description of the distinctions between the three school types.

7. These schools are sometimes referred to as publically-funded voucher schools or establecimientos particulares subvencionados.

8. Including the bonuses noted in Appendix A, minimum hourly wage, minimum monthly income, working hours, holidays, and some hiring and firing provisions.

9. The 20.845 law, passed in 2015, increased the per-student voucher and will gradually eliminate copayments over multiple years, ultimately prohibiting private subsidized schools from charging any tuition.

and private subsidized schools in more detail; the next section details how the Difficult Conditions Bonus policy functions in these two sectors.

Pay in municipal schools follows a rigid formula, established in national law. A teacher's hourly wage is calculated based on a fixed national base rate (the Remuneración Básica Mínima Nacional, or RBMN), adjusted upwards by up to 13 factors<sup>10</sup> described in Appendix A. The most substantial adjustment is for teaching experience, which doubles the national base rate for the most experienced teachers (30 years of experience). Four programs establish bonuses for individual teacher and collective school performance, although the bonuses are relatively small and uptake is low<sup>11</sup>. Additional adjustments exist for individual locations, for taking on leadership roles, and for pursuing additional training. Finally, the Difficult Conditions Bonus adjusts pay for teaching in economically disadvantaged schools.

In contrast, private subsidized schools are relatively free to determine how teachers are paid. As noted in Appendix A, private subsidized schools are obligated to pay individual teachers a minimum amount according to the bonuses above. However, in private subsidized schools where students pay additional fees, they are able to selectively pay higher amounts to some teachers, resulting in differentiated teacher pay and possibly higher returns to teacher skill. In a representative national teacher survey,<sup>12</sup> monthly wages in private subsidized and private schools were about 10% higher than in public schools, but the standard deviation of the monthly wages was almost 40% larger (Correa et al., 2014).

Research has shown that private subsidized schools attract better teachers than public schools (Behrman et al., forthcoming) and that teachers with better unobservable skills self-select into private schools (Correa et al., 2014). There is more churn among relatively inexperienced teachers, with transfers typically moving between schools of the same type.

---

10. As noted by Mizala & Romanguera (2005), there are a number of other bonuses extant in law, but they are rarely used and typically small amounts received for a short period of time (including bonuses to Professional Improvement Units (UMP), Red de Maestros, Bono SAE, Refuerzo Educativo, and extra hours).

11. These are the SNED, ADVI, AEP, desempeño colectivo. See Appendix A for details.

12. Encuesta Longitudinal Docente 2009.

Similar to the United States, teachers tend to teach in schools similar to those they attended for high school (Cabezas et al., 2011), and teachers who studied in less selective universities are concentrated in disadvantaged schools (Ortúzar et al., 2009). Finally, there is a negative correlation between a teacher’s results on the INICIA test<sup>13</sup> and the socioeconomic level of the school where the teacher works (Bascopé & Meckes, 2010).

### *1.3.2 The Difficult Conditions Bonus*

In 1996, Chile established a bonus for teachers working in disadvantaged schools. The “Asignación de Desempeño en Condiciones Dificiles”, hereafter the Difficult Conditions Bonus, was intended to encourage teachers to work in hard-to-staff schools, particularly schools which are geographically isolated or serve particularly vulnerable student populations. In broad strokes, schools have a “Difficult Conditions Score”, which translates into a percentage increase in teacher pay according to a region-specific scheme. All teachers at eligible schools receive the same bonus, calculated as a percentage increase on the base pay rate. Fully private schools are ineligible.

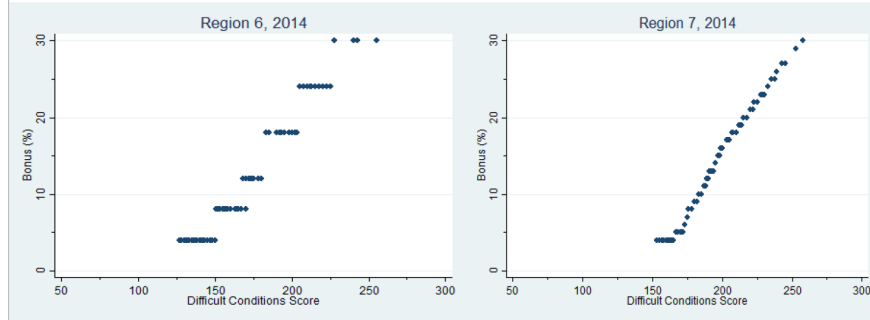
The authorizing legislation dictates a complex formula by which each school’s Difficult Conditions Score is calculated. Scores range from 0-300 points, with half of the points based on student population characteristics. In rural areas, the other half is based on geographic isolation and school structure; in non-rural schools, the other half is based on a combination of teaching conditions and district-level characteristics. Appendix C outlines the full formula.

Receipt of the bonus is not automatic; school leaders are required to apply for the bonus and provide evidence for their expected score. When school leaders prepare their applications, they do not know how their score will translate into bonuses, although they do know that higher scores may result in larger bonuses as well as how scores have translated to bonuses in the past. Schools submit these applications to the regional government at the

---

13. INICIA is a voluntary exam taken at by novice teachers at graduation administered at all levels since 2009. In our data, roughly 9% of teachers who graduated after 2008 have INICIA scores

Figure 1.1: Difficult Conditions Score and teacher bonuses for Regions 6 and 7 in 2014



Note: These graphs show how two regions map score onto bonuses. Region 6 chose a stepped function and Region 7 a gradual function.

end of the academic year. Once all of the applications are received, the regional government is legally required to verify the score<sup>14</sup>. Schools are then ranked by score taking the number of eligible staff members into account. Regional officials combine this ranking with available funding to determine how scores will map onto bonuses. Legally, the relationship between score and bonus must be weakly increasing, but regions are free to choose gradual or stepped increases. Figure 1.1 shows the schemes used by Regions 6 and 7 in 2014<sup>15</sup>, representing the two approaches. The amount of the bonus must be an integer number between 4% and 30%. Appendix B provides graphs showing the score-bonus mapping for all 15 regions during each time period.

Bonus schemes are set for periods of 2 years. The application period occurs during October-November of the previous academic year. Schools typically complete their hiring during the December-February summer vacation period, and are notified of the bonus scheme in mid-March, after the beginning of the academic year<sup>16</sup>. Teachers are paid the resulting

14. If the regional government finds an error in the application, they must inform the school. The school has 5 days to rectify the score. If the school does not comply, the local regional government can modify the final score using the information that they have. We were unable to verify how extensive this review is or how often scores are modified.

15. Chile is currently broken into 15 administrative regions. In 1974, the country was divided into 12 regions from north to south, with a 13th region for the capital, Santiago. In 2007, a 14th region was created from portions of Regions 9 and 10, and a 15th region was created from the northernmost portion of Region 1.

16. The Chilean academic year typically runs from March-December, with a two-week winter break in July,

Table 1.1: Distribution of the Difficult Conditions Bonus in 2014

	# of urban school	Urban with bonus	# of rural schools	Rural with bonus	Total	Total with bonus
Municipal	2,924	1,683	2,917	2,246	5,851	3,929
Private subsidized	5,921	1,024	896	664	6,817	1,688
Total	8,845	2,707	3,823	2,910	12,668	5,617

Source: School Finance Unit (Unidad de Subvenciones), Ministry of Education (MINEDUC), and personal communication, 2014.

bonus for the remainder of that year and again for the subsequent year. For example, schools submitted applications during November 2013, regions set pay schemes and notified schools of bonuses by March 2014, and teachers received bonuses during the 2014 and 2015 academic years. Schools would then reapply to receive a bonus in 2016. There is currently a bill in the Chilean Congress that would eliminate the bonus starting in 2018<sup>17</sup>.

As shown in Table 1.1, 5,617 schools received the bonus, covering 67% of municipal schools and 25% of private subsidized schools. In 2014, nearly 97,000 teachers received the bonus, 1.4 million students (40%) attended schools receiving the bonus, and it accounted for 1.8% of national education spending, or about \$46 million (School Finance Unit, Ministry of Education, personal communication, 2014). We do not observe all of the factors contributing to the Difficult Conditions Scores; however, based on the factors we observe, it seems that most eligible schools apply for the bonus. We suspect the lower coverage rate for urban private subsidized schools arises from a combination of different student populations and a larger number of eligible schools electing not to apply for the bonus. While the number of schools receiving the bonus has remained roughly constant in recent years, the number of impacted teachers has been increasing as the education sector grows.

As shown in Figure 1.2 , while the majority of recipient schools received bonuses of less

---

so each calendar year corresponds with a single school year. Teachers are paid in January and February based on their contract hours from the previous year.

17. The currently proposed reauthorization of the Estatuto Docente (Law 19,070) does not include this bonus. It is replaced it with a less complex formula, where the compensation will be in function of the vulnerability index of the school.

Figure 1.2: Distribution of Difficult Conditions Bonus in 2014

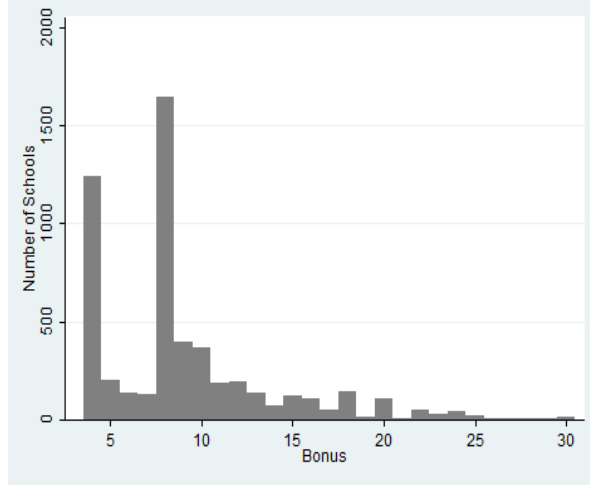
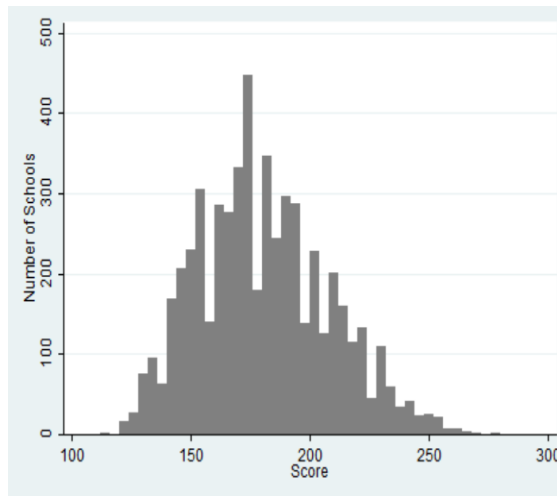


Figure 1.3: Distribution of Difficult Conditions Score in 2014



than 10%, just less than one fifth (14%) of the schools received bonuses of 15% or higher.

Figure 1.3 shows the distribution of the score in 2014.

## 1.4 Data

This study uses administrative data from the Chilean Ministry of Education. At the school level, we have information about the Difficult Conditions Score and Bonus received by eligible schools between 2008 and 2014, allowing us to construct a mapping between the Difficult Conditions Score and the Difficult Conditions Bonus in each region and each year. There

are 15 regions in Chile, and the regional bonus scheme changes every two years. Therefore, during the 2008-2014 period we observe 60 distinct score-bonus mappings. Bonuses increase monotonically with scores under all 60 regimes. Less than 0.5% of the sample appears to violate the regional scheme, with roughly half of the problem schools being from Regions 9 and 13 under the 2010-2011 bonus scheme; we exclude those region-years from the analysis entirely. From here on, we only use regions that have stepped increases in the bonus. Tables D.1, D.2, and D.3 in Appendix D provides the number of schools included in our different analytic samples each year as well as the number of impacted teachers and students. The different samples depend on the discontinuities that we include. For instance, sometimes we include only discontinuities where the bonus increases at the discontinuity by at least 2 percentage points, because we want to include differences in the pay structure that are meaningful enough to motivate changes.

We match this data with teacher and student data for the same period. At the school level for each year, we observe a rich set of descriptive information (student characteristics, teacher characteristics, administrative structure, location, etc.). We also observe school average performance on the SIMCE standardized test in 4th grade (2008-2013). Table D.4 in Appendix D shows the number of schools in our samples with SIMCE scores by year as well as the mean and the standard deviation of the SIMCE in each subject.

Table 1.2 provides selected descriptive statistics for the schools in our preferred analytic sample by year. This sample is composed of schools serving primary and/or secondary students with scores within a fixed bandwidth of 5 points (schools that have a score of +/-5 points with respect to the score where the discontinuity occurs) and only those discontinuities associated with a jump of 2 percentage points or more in the pay base salary (hereafter sample C). On average, schools in the analytic sample received bonuses around 12% of the teacher base pay. In 2014, the average bonus for the 1,891 schools in our sample was 10.85%, and the average Difficult Conditions Score was 187 points on a 300-point scale. Rural schools represented 77% of the sample in 2008, which fell to only 55% in 2014, reflecting a national

trend toward closure of small rural schools (see Figure D.3 in Appendix D). The share of public schools was 68% in 2014 (see national trends in Figure D.4 in Appendix D). The average school in the sample retained roughly 80% of their teachers in the subsequent year, implying roughly 20% turnover from one year to the next. There is also a gradual decline in average teacher age, from 47 in 2008 to 43 in 2014.

Table 1.2: Descriptive statistics by year at the school level

		2008	2009	2010	2011	2012	2013	2014
D. C. Bonus	mean	12.46	12.47	12.35	12.33	12.24	12.26	10.85
	(sd)	(5.36)	(5.35)	(5.86)	(5.89)	(6.04)	(6.06)	(5.56)
D.C. Score	mean	176.74	176.62	181.76	181.53	187.79	187.76	186.95
	(sd)	(28.36)	(28.37)	(27.85)	(27.85)	(28.68)	(28.76)	(29.31)
Rural	mean	0.77	0.77	0.72	0.72	0.64	0.64	0.55
	(sd)	(0.42)	(0.42)	(0.45)	(0.45)	(0.48)	(0.48)	(0.5)
Public	mean	0.70	0.70	0.82	0.82	0.64	0.64	0.68
	(sd)	(0.47)	(0.47)	(0.39)	(0.39)	(0.48)	(0.48)	(0.48)
Contract Hours	mean	38.17	38.21	37.49	37.37	36.57	36.07	35.97
	(sd)	(6.21)	(6.14)	(6.85)	(7.10)	(6.92)	(7.24)	(7.36)
Number of teachers	mean	6.06	6.17	7.2	7.51	9.13	9.75	10.82
	(sd)	(8.47)	(8.66)	(9.51)	(9.97)	(11.74)	(12.04)	(13.23)
Enrollment	mean	88.12	85.99	95.92	95.40	115.23	114.24	118.24
	(sd)	(162.7)	(163.2)	(180.7)	(178.1)	(207.1)	(204.7)	(219.9)
Age	mean	47.85	47.89	47.44	47.4	46.58	45.75	45.4
	(sd)	(7.96)	(8.16)	(8.34)	(8.19)	(8.38)	(8.13)	(8.37)
Retention rate	mean	0.84	0.84	0.77	0.83	0.76	0.80	
	(sd)	(0.26)	(0.27)	(0.32)	(0.26)	(0.28)	(0.26)	
Experience	mean	19.77	19.62	19.37	19.08	18.07	17.12	16.98
	(sd)	(9.47)	(9.7)	(9.72)	(9.44)	g (9.38)	(9.03)	(9.08)
N		1,891	1,865	896	859	1,762	1,731	1,658

Note: This table reports the number of schools by year and some descriptive statistics. The sample include schools that have Difficult Condition Scores and Difficult Condition Bonuses that are within a fixed bandwidth of 5 points (schools that have a score of +/-5 points with respect to the cutoff score where the discontinuity occurs) and that the closest cutoff associated has a jump of 2 percentage points or more in the pay base salary. The standard deviation is in parentheses. Rural indicates that the school is a rural area, public that the school is municipal, contract hours is at the school level and reflects teachers' average number of hours contracted by week. The rate of retention is defined as the share of current teachers teaching in the same school in the subsequent year. Experience is measured in years and reflects the number of years working in the educational system.

## 1.5 Analytic Framework

In order to examine the impact of a marginal increase in the Difficult Conditions Bonus on teachers' labor supply, we examine a variety of school-level measures of teacher behavior. Exploiting the discontinuities in the pay structure produced in regions using stepped increases, we use a regression discontinuity approach to identify the causal impact of the program. We compare outcomes for schools with similar Difficult Conditions Scores but different pay structure, where schools with scores just larger than the cutoff score receive a significant increase in pay relative to those with slightly lower scores. This approach implicitly assumes that schools around the discontinuity are sufficiently similar that the difference in scores does not reflect a meaningful difference in working conditions, student characteristics, or any other relevant factor<sup>18</sup>. It additionally relies on the assumption that schools are not able to manipulate their scores in ways that would cause certain types of schools to be disproportionately represented on either side of the discontinuity.

Many of the regions adopted stepped bonus structures similar to that of Region 6 as seen in Figure 1.1. Within these schemes, it is possible for small differences in the Difficult Conditions Score to translate into substantial differences in teachers' hourly wages. For instance, consider schools with scores around 150 points in Region 6: the 17 schools with scores between 146 and 150 points receive a bonus of 4% of the hourly wage RBMN, while the 17 schools with scores between 151 and 155 points receive a bonus of 8%.

We exploit this type of discontinuity to compare otherwise similar schools in order to estimate the marginal impact of having a larger bonus. While the score may be associated with the outcome of interest, the regression discontinuity framework allows identification under these conditions as long as the association is smooth in the region of the cutoff. Any

---

18. We check that on average there are not differences in school characteristics for schools that are at either side of the cutoff, specifically important outcomes as: vulnerability index, socioeconomic level, percentage of priority students, enrollment, the ratio of students per teacher, type of school (municipal/private subsidized) and if the school has SEP (another voluntary and important subsidy for the school). We only find differences in the total number of students enrolled in the schools. Given that, we control for enrollment in all the specifications.

difference in the conditional distribution of the potential outcome is considered the impact of the treatment (Imbens & Lemieux, 2008).

We use a Sharp Regression Discontinuity approach (SRD), which identifies a Local Average Treatment Effect (LATE) at each cutoff by comparing the schools on either side of the threshold (Imbens & Lemieux, 2008). The estimated effect has a causal interpretation as long as treatment assignment is strictly determined by the score and the expected outcome under the control condition is a continuous function of the score, making units on either side of the cutoff valid counterfactuals for one another. Formally,  $E(Y_0 | S = s)$  and  $E(Y_1 | S = s)$  are continuous in  $s$ .

Under these assumptions:

$$E(Y_0 | S = s) = \lim_{S \uparrow s} E(Y | S = s) \text{ and } E(Y_1 | S = s) = \lim_{S \downarrow s} E(Y | S = s)$$

Thus, at each cutoff,  $d$ , the SRD identifies:

$$\lim_{S \downarrow s} E(Y | S = s) - \lim_{S \uparrow s} E(Y | S = s)$$

As mentioned, we exploit a large number of discontinuities. In addition to differing by year and region, the discontinuities also differ from one another on two additional characteristics: (1) they occur at different values of the Difficult Conditions Score, implying appreciably different conditions at each discontinuity; and (2) the increase in pay at a discontinuity, hereafter the “pay jump”, varies from 2 percentage points to 8 percentage points<sup>19</sup>. Accordingly, we estimate a pooled impact.

$$Y_{id} = \beta_0 + \delta J_d T_{id} + \beta_1 (S_{id} - C_d) + \beta_2 E_{id} + \varphi_d + \eta_c + \varepsilon_{id} \quad (1)$$

where  $i$  is a school,  $J_d$  is the percentage point increase in teacher pay at discontinuity  $d$

---

19. For most of the discontinuities in the sample, the bonus increases by between 2 and 5 percentage points of the base pay rate. We also try restricting the sample to jumps greater than 3%.

(the pay jump),  $Y_{id}$  is the outcome associated with school  $i$  whose score is near discontinuity  $d$ ,  $S_{id}$  is the Difficult Conditions Score of school  $i$  whose score is near discontinuity  $d$ ,  $C_d$  is the score at which discontinuity  $d$  occurs,  $T_{id} = 1 \{S_{id} - C_d > 0\}$  indicates that  $i$ 's score is above the cutoff score for the higher pay rate at discontinuity  $d$ ,  $(S_{id} - C_d)$  is the distance between school  $i$ 's score and cutoff score for discontinuity  $d$ ,  $E_{id}$  is the enrollment of school  $i$  whose score is near discontinuity  $d$ ,  $\varphi_d$  is a discontinuity fixed effect<sup>20</sup>,  $\eta_c$  is a comuna fixed effect<sup>21</sup>, and  $\varepsilon_{id}$  a random disturbance term. Some specifications include the term  $\beta_2 (S_{id} - C_d) \times T_{id}$ , which fits a separate trend above and below the discontinuity in the running variable  $(S_{id} - C_d)$ .

We expect heterogeneous treatment effects so the parameter of interest,  $\delta$ , is a weighted average across cutoffs of the local average treatment effects across all units facing each particular cutoff value. In a model without a trend in the running variable  $(S_{id} - C_d)$  it can be shown (Black et al., 2003; Angrist, 1998) that our pooled estimator is:

$$\hat{\delta} = \sum_d w_d \hat{\Delta}_d \text{ with } w_d = \frac{r_d (1 - r_d) N_d}{\sum_k r_k (1 - r_k) N_k}$$

where  $r_d$  is the proportion of the schools in sample around discontinuity  $d$  which are above the cutoff (i.e. receiving the higher bonus).  $N_d$  is the number of observations at cutoff  $d$  and  $k$  is the number of cutoffs. Note that in addition to giving more weight to discontinuities with more schools contributing to the estimate, the pooled estimator gives greater weight to discontinuities with relatively equal numbers of schools on either side of the relevant discontinuity.

---

20. Controlling for it is important. First, each cutoff is related to a particular group of schools with a specific profiling score in a particular region and year including the fixed effect implicitly conditioning on these factors which reduce the residual variation. Second, the outcomes of interest may vary among cutoffs in the absence of treatment in a way that is correlated with the assignment.

21. Comunas are administrative units similar to counties or medium-sized municipalities. Small cities and towns are typically a single comuna, while large urban areas are divided into multiple comunas. In sparsely populated rural areas, comunas often cover large geographic areas. This choice reflects a recognition that teacher labor markets are typically local.

Determining the appropriate sample of observations to include in a regression discontinuity is rarely a clear exercise, as there is a clear tradeoff between plausibility of assumptions and sample size (bias versus variance). The sample selection rule for fixed bandwidth estimates has the form:

$$|(S_{id} - C_d)| \leq \alpha$$

where  $\alpha$  is a constant value between 4 and 6 depending on the specification. The main results section uses a bandwidth of 5, chosen because the modal sub-score increases in five-point increments (see Appendix C). For instance, two schools that are equal in everything but class size, one with 26 students per classroom and the other with 25 students, will have a difference of only 5 points in the score.

## 1.6 Theoretical Framework

In this section I discuss how an increment in the hourly wage may affect teacher labor supply along the extensive and intensive margin.

In the neoclassical theory of labor supply, a person has to decide how to divide her time between leisure and paid work. Working will produce income to consume goods, and it is generally assumed that an individual desires to consume the greatest possible quantity of goods and leisure. The optimal combination of goods and leisure is the one that leads to the highest affordable level of utility, and depends on the preferences of each individual.

In this simple model there are two important decisions: one at the extensive margin (working or not working) and another in the intensive margin (how much to work). At the extensive margin, a person stays out of the labor market if the marginal rate of substitution between consumption and leisure is bigger than the wage. In other words, if the rate at which a person is willing to give up one hour of leisure in exchange for additional consumption to have the same utility is bigger than the amount of consumption she can get for giving up

one hour of leisure (wage), she will not work<sup>22</sup>.

At the intensive margin, once the person is willing to work, she needs to decide the number of hours to work. She will work as many hours as it takes to reach the point at which the marginal rate of substitution is equal to the wage the point at which the market compensation for an hour of work is equivalent to the utility she would receive from the hour of leisure she foregoes.

Accordingly, an increment in the hourly wage, as in the case of the Difficult Conditions Bonus here, can produce changes at both the extensive and intensive margins. At the extensive margin, teachers that were not willing to work in these schools (hard-to-staff schools) before the bonus, because the wage was not enough to compensate them for the reduction in leisure, might be willing to work there after the wage increase. Teachers who are induced to work in hard-to-staff schools by the policy can be of two types: teachers that were not participating in the labor market, or teachers that were working but in other types of schools. If sufficient teachers from the second group are influenced by the policy, it could produce a net sorting effect.

At the intensive margin the change in the number of hours a teachers works is ambiguous because labor supply is not a monotonic function of wages. In fact, if leisure is a normal good, any rise in wage leads to a rise in the consumption of leisure, and thus to a fall in labor supply (income effect). But, also an increase in wages makes leisure more expensive, the result being that people prefer to consume less leisure (substitution effect). If the income effect dominates the substitution effect under a higher wage, a person will consume more leisure. In general, an increase in wages increases labor supply when the wage is low, and subsequently diminishes with the wage when the latter is sufficiently high. But, the labor supply can decrease even if the person is a low wage worker if the disutility of labor is high. In other words, if a person dislikes to work, the rate at which she is willing to substitute leisure for consumption is high and an increment in wages can reduce the total number of

---

22. The market is not paying enough to make her reduce her leisure.

hours worked.

Given this, we can expect more teachers willing to work in schools that pay more per hour (*ceteris paribus*) if and only if the extra wage is enough to compensate them for the reduction of leisure. Also, since in most countries -including Chile- teachers' wages are not in the right tail of the wages distribution, one may think that teachers would increase their hours of work. However, it could be that working in these schools is so difficult that, if teachers are able, they would rather work less and maintain their current level of consumption than work more and increase their consumption accordingly. Therefore, if we observe a negative impact on hours worked, and the decision was made by the teacher, it could be that teachers in hard-to-staff schools have a particularly high disutility of labor in those jobs.

In addition, we expect heterogeneous effects, because the rate at which each person is willing to substitute leisure for consumption depends on the preferences of each individual. In Chile, teacher wages have two main components: the hourly base salary and increments on top of the base salary. Experience accounts for the vast majority of the incremental pay for most teachers. Given that the Difficult Conditions Bonus is applied to the hourly base salary, inexperienced teachers have proportionally a larger increase in their total salary than experienced teachers for any given level of bonus. Therefore, inexperienced teachers should be more responsive to the bonus. In addition, rural and urban schools differ not only in their location but also in the kind of teachers they can attract (teacher's personal preferences may play an important role in this type of decision). For instance, it could be that teachers who work in rural areas value consumption less than teachers who work in urban areas, or that labor conditions are worse in rural areas, in which case the marginal cost of working an extra hour is higher for rural teachers than for teachers who work in urban schools. Therefore, they may react differently to wage changes. Also, we expect differences between private subsidized schools and municipal schools. Teachers who work in the municipal sector are protected by a special labor code that is less flexible, and there is a sorting of teachers by sector. For instance, research has shown that privately subsidized schools attract better teachers than

public schools (Behrman et al., forthcoming) and that teachers with better unobservable skills self-select into private and private subsidized schools (Correa et al., 2014).

## 1.7 Results

In this section we report the estimated impact of a marginal increase in the bonus, conditional on receiving the bonus, on: the average contracted hours for teachers working at school  $i$ , the average number of hours per student<sup>23</sup> in school  $i$ , average years of experience for teachers working at school  $i$  and rate of teacher retention<sup>24</sup> at school  $i$ . We use a bandwidth ( $\alpha$ ) of 5 points.

To obtain the impact estimates, we compare schools with very similar scores (similar working conditions) but with different bonus amounts. Our results, which are robust to a variety of specifications, suggest that marginal increases in wages at eligible schools lead teachers to contract for fewer hours of work each week. These results differ by sector (school type and urban areas).

Tables 1.3 reports the results of equation 1 when we use sample C. We find increased pay produces a statistically significant decrease in the average number of hours worked and in the average number of hours per student. In fact, we estimate that among eligible schools, a one percentage point increase in the bonus reduces the average contract hours by approximately 15 minutes per week. Scaling these results for the typical jump in our sample, we estimate that a 4 percentage point increase in teacher base pay results in a reduction in teachers' contract hours of 1 hour weekly<sup>25</sup>.

It is reasonable to think that inexperienced teachers are more attracted to work in these school under this policy, as it represents a substantially larger share of their overall pay.

---

23. This variable is the ratio between the total hours under contract at a school and the total number of students.

24. Retention is measured as the share of teachers at a school who continue at the same school in the following year.

25. For a teacher who works 40 weeks per year this implies almost 40 fewer hours.

Table 1.3: Results for teacher-level outcomes

	Contract hours	Experience (years)	Teacher-hours per student	End of Year Retention (%)
Jump*T	-0.264*** (0.092)	-0.066 (0.187)	-0.123* (0.068)	-0.438 (0.371)
N	9,375	9,375	9,375	8,018

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

This table shows the estimators of  $\delta$ , the impact of having a one percentage point increase in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The rate of retention is defined as the share of current teachers teaching in the same school in the subsequent year. Teacher-hours per student is the ratio of total contracted hours over total enrollment of the school.

However, we did not find significant result in average years of teaching experience<sup>26</sup>. In addition, we did not find evidence of an impact on teacher retention. This could be because the incentive is neither large nor permanent enough to produce changes on the extensive margin.

The results on contract hours and the related outcomes could be driven by two forces: schools reducing hours or teachers deciding to work less. If this result is mostly driven by teachers' choices, it suggests the average teacher in the sample has a relatively high marginal disutility of work. Given a small wage increase, such teachers are able to work slightly less.

These results are robust to the inclusion of an interaction term between the trend in relative score and treatment  $(S_{id} - C_d) \times T_{id}$ . The sign, the magnitude, and the significance level are not affected<sup>27</sup>.

We also explore the hypothesis that the impact of the treatment is different by sector (municipal urban, municipal rural, private subsidized rural, and private subsidized urban). To do this we run the following regression:

---

26. We also evaluate the impact of the bonus on the share of teacher with less the 4 years of experience and on the share of new teachers in the school. We did find significant results.

27. Results available by request.

Table 1.4: Results for teacher-level outcomes by sector

	Contract hours	Teacher-hours per student
Jump*T Municipal-urban	-0.018 (0.116)	-0.139* (0.069)
Jump*T Municipal-rural sector	-0.270*** (0.097)	-0.086 (0.076)
Jump*T Private Subsidied-urban	-0.447** (0.198)	-0.160* (0.091)
Jump*T Private Subsidied-rural	-0.436** (1.368)	-0.301*** (0.101)
N	9,375	9,375

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

This table shows the estimators of  $\delta$ , the impact of having a one percentage point increase in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The rate of retention is defined as the share of current teachers teaching in the same school in the subsequent year. Teacher-hours per student is the ratio of total contracted hours over total enrollment of the school.

$$Y_{id} = \beta_0 + \sum_k \delta_k J_d T_{id} D_i^k + \beta_1 (S_{id} - C_d) + E_{id} + \varphi_d + \varphi_k + \eta_c + \varepsilon_{id} \quad (2)$$

where  $D_i^k$  takes the value of 1 if school  $i$  belongs to sector  $k$ , and  $\varphi_k$  is a sector fixed effect<sup>28</sup>. Table 1.4 reports selected results of specification 2, which are generally consistent with our overall findings, but are often concentrated in specific sectors. The impact on contract hours seems to be present in all sectors except in municipal urban schools. The policy also produces a significant and consequential declines in the number of contracted teacher hours per student mostly in the private subsidized schools in rural areas. These results lead us to think that there is potential evidence that the rural sector is more affected in the intensive margin by the bonus, which may be driven by teachers' preferences, limited consumption options or worse working conditions, among other factors.

Recognizing that teacher labor markets are typically local, we created a geographically

---

28. Some specifications include the term  $(S_{id} - C_d) \times T_{id}$

Table 1.5: Results for teacher-level outcomes using a Geographically-Limited Sample

	Contract hours	Teacher-hours per student
Jump*T	-0.386*** (0.115)	-0.096 (0.076)
N	5,948	5,948

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Note: This table shows the estimators of  $\delta$ , the impact of having a one percentage point increase in the bonus. All regressions include trends in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. Teacher-hours per student is the ratio of total contract hours total enrollment of the school

limited sample (geography sample). Consider a school whose score was within the bandwidth of some cutoff,  $A$ , located in comuna  $X$ . In order to be included in the geographically limited sample, there had to be at least one other school in comuna  $X$  within the bandwidth of cutoff  $A$  but on the other side of the cutoff. Conceptually, this sample is limited to sets of schools likely to be in competition for the same teachers, where a small difference in working conditions translates to a consequential difference in pay. Table 1.5 reports selected outcomes for this geographically limited sample (see Appendix E for all results).

Using this geographically restricted sample, we reduce sample and we get larger estimated impact on teachers' contract hours. For contracted teacher hours the magnitude remains similar, although it is less the significance goes away. A one percentage point increase in pay reduces the average hours under contract by almost 23 minutes per week. Scaled to the average increase at the discontinuities in the 4 percentage point sample, this translates to a reduction of 1 hour and 30 minutes per week.

## 1.8 Robustness checks

In addition to the multiple specifications reported throughout, we pursued three additional strategies to check the robustness of our results. First we repeated all models using bandwidths of 4 and 6 points, rather than the 5 reported above. Second, we verified that impacts were still present in the subsequent year<sup>29</sup>. Third, we changed the analytical sample, using only those discontinuities associated with a jump of 1 percentage points or more or 3 percentage points or more in the pay base salary (sample B and D respectively).

Table 1.6 compares results for all three bandwidths for selected outcomes; see Appendix G for all outcomes and sector-specific results. Here we are comparing results for three different bandwidths using a sample that includes discontinuities with a difference in pay of 2 percentage points or more. Regardless of bandwidth, a marginal increase in the bonus level on teachers' contract hours, and on the average number of hours per student. For those outcomes, the estimated effect size increases as the bandwidth decreases, a pattern consistent with the assumptions of the regression discontinuity design.

Next, in recognition of possible frictions in the teacher labor market and the collective and gradual pace of education production, we examined second year impacts for all outcomes using a similar model to equation (1):

$$Y_{id,t+1} = \beta_0 + \delta J_{d,t} T_{id,t} + \beta_1 (S_{id,t} - C_{d,t}) + E_{id,t} + \varphi_{d,t} + \eta_i + \varepsilon_{id} \quad (3)$$

Appendix F reports these findings, and Table 1.7 shows the results of only selected outcomes, which are again consistent with our main results. The results of average contract hours is no longer significant. However, the sign is still negative and the result is significant in the private subsidized sector. The following year schools with marginally higher bonuses decrease the average number of teacher hours per student, effect that is concentrated in private subsidized schools.

---

29. We do this because the duration of the bonus is for 2 years, so teachers may adjust some outcomes in the next year.

Table 1.6: Alternate Bandwidth Results

	Contract hours	Teacher-hours per student
Jump* $T$ $\alpha = 4$	-0.323*** (0.099)	-0.140* (0.074)
N	8,366	8,366
Jump* $T$ $\alpha = 5$	-0.264*** (0.092)	-0.123* (0.068)
N	9,375	9,375
Jump* $T$ $\alpha = 6$	-0.264*** (0.092)	-0.082 (0.062)
N	10,531	10,531

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Note: This table shows the estimators of  $\delta$ , the impact of having a one percentage point increase in the bonus. All regressions include trends in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. Teacher-hours per student is the ratio of total contract hours total enrollment of the school

Table 1.7: Results for outcomes in  $t + 1$

	Contract hours	Teacher-hours per student
Jump* $T$	-0.164 (0.104)	-0.168** (0.075)
N	7,839	7,839

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Note: This table shows the estimators of  $\delta$ , the impact of having a one percentage point increase in the bonus. All regressions include trends in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. Hour teacher-per student is the ratio of total contract hours over total enrollment of the school

We also check our results using a sample set that includes more discontinuities (sample B includes discontinuities with jumps of 1 percentage points or more) and a sample that includes fewer discontinuities (sample D includes discontinuities with jumps of 3 percentage points or more). Table 1.8 shows the results for the selected outcomes. As expected, including more discontinuities increases the sample size significantly, but the magnitude of our results decrease. This may be because we are considering changes in the bonus that are too small to produce a change in teacher behavior. Including discontinuities with a salary jump of at least 3 percentages points reduces the sample size but increases the impact magnitude on average contract hours and the number of teacher hours that a student receives.

Finally, given that the policy has a negative effect on the number of hours worked, one may think that there could be a negative impact on academic performance as a result of the policy's effect on hours worked. In order to test if the bonus has an effect on student performance, we estimate the impact of a one percentage point increase in the bonus on measures of school performance (fourth grade standardized test scores). While the point estimates are consistently negative, none are statistically significant (see table E5 and E6 in Appendix E). Moreover, we do not have enough information to check if the reduced number of contracted hours translates into a reduced number of actual hours worked, instructional hours received by students, or changes in class size.

Table 1.8: Alternate Sample Results

	Contract hours	Teacher-hours per student
Jump* <sup>T</sup> Sample B	-0.194** (0.078)	-0.118* (0.059)
N	22,822	22,822
Jump* <sup>T</sup> Sample C	-0.264*** (0.092)	-0.123* (0.068)
N	9,375	9,375
Jump* <sup>T</sup> Sample D	-0.310** (0.123)	-0.278*** (0.091)
N	3,595	3,595

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Note: This table shows the estimators of  $\delta$ , the impact of having a one percentage point increase in the bonus. All regressions include trends in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. Teacher-hours per student is the ratio of total contract hours over total enrollment of the school. Sample B include schools that have Difficult Condition Score and Difficult Condition Bonus that are within a fixed bandwidth of 5 points (schools that have a score of +/-5 points with respect to the score of the cutoff at which the discontinuity occurs) and are associated to discontinuities with a jump of 1 percentage point or more in the base salary. Sample C restricts sample B to only those discontinuities associated with a jump of 2 percentage points in the base salary. Sample D restricts sample B to only those discontinuities associated with a jump of 3 percentage points in the base salary.

## 1.9 Discussion

In this paper we evaluate a Chilean policy that provides a compensating wage for teachers working disadvantaged schools. Specifically, we study how the Difficult Conditions Bonus affects labor supply along the extensive margin (the extent of participation in the labor market) and along the intensive margin (intensity of labor supply). Using a Regression Discontinuity approach, we do not find any changes in outcomes related to the extensive margin, but we do find effects on outcomes related to the intensive margin: a decrease in the average number of hours worked, and in the average number of contracted teacher hours per student.

The fact that we do not find results on the extensive margin and that our results on the intensive margin are not large in magnitude may be related to the fact that our identification strategy exploits small and ephemeral changes in the wage. For instance, if a teacher gets 20 dollars per hour (2014 hourly wage), a bonus of a bonus of 10% implies a hourly wage of 22.

Finally, we did not find results in our measures on school performance. This is not necessarily a sign that decreasing the average number of contracted teaching hours does not produce a negative impact on student performance, but in our data we did not find significant results.

Our analysis is limited by several factors, with two being the most important. First, the identification strategy assumes schools are appreciably the same on either side of each discontinuity, which may not be true if schools are able to manipulate their Difficult Conditions Scores and/or the score does not reflect properly school's working conditions. While we don't find any empirical or anecdotal evidence for manipulation, it may be possible for schools to manipulate the score determination process in ways we cannot observe. Second, we focus on the marginal impacts of the policy within a narrow set of schools impacted by a discontinuous change in pay rather than estimating its overall impact on teacher supply.

Even given these substantial limitations, our findings are troubling. If teacher choices are

driving the changes to the intensive margin, this is further evidence that teaching at such schools is particularly unpleasant and likely driving teachers behavior. Combined with the large literature on the salience of working conditions for teachers (e.g. Loeb et al., 2005), our work further highlights that education policies aiming to reduce inequality in disadvantaged schools may need to address the reasons behind the high cost of working in these types of schools to avoid undesired effects on teacher behavior.

## 1.10 Appendix A: Components of Chilean Teacher Salaries

Table A.1: Components of Chilean Teacher Salaries

Salary Component	Description	Public	Private Subsidized
Basic hourly salary (RBMN)	Primary: 11,597 Chilean pesos (CLP). Secondary: 12,203 CLP (\$21) (\$20) <sup>a</sup>	X	X
Experience	Adds 6.76% of the RBMN for each of the first two years of teaching. Adds 6.66% of the RBMN for each additional two year years, up to 30 years of experience.	X	
Locality	Increment in the basic salary established by national law for all public employees in certain areas, ranging from 15%-190% of the RBMN. Slightly less than half of schools (6,202) receive this bonus.	X	X
Administrative role <sup>b</sup>	Teachers who take on administrative responsibilities have their hourly salary increased by 15% (members of the curriculum committee), 20% (dean of the curriculum), or 25-100% (principal) of the RBMN. The amount for principals depends on the enrollment of the school (larger schools receive higher bonuses). Principals in schools with a large share of priority <sup>c</sup> status students receive an additional bonus between 25% and 200% of the RBMN.	X	X

Table A.1: Components of Chilean Teacher Salaries (Continuation)

Salary Component	Description	Public	Private Subsidized
Training	May add up to 40% of the RBMN for participating in certified training programs.	X	
Difficult conditions	Teachers at eligible schools earn a bonus of between 4% and 30% of the RBMN.	X	X
Special /Additional Bonus	Municipal governments may decide to increase wages for some or all teachers, but very few do so. When used, this bonus is typically temporary.	X	
Education degree (BRP) <sup>d</sup>	Teachers with education degrees earn a lump sum bonus of 58,055 CLP (\$101) <sup>a</sup> each month.	X	X
Major (BRP) <sup>d</sup>	Teachers with specialized education degrees (all non-generalists) earn an additional bonus of 19,353 (\$34) <sup>a</sup> .	X	X
Teacher-lead schools	Teachers working in schools without a principal who take on administrative responsibilities earn a bonus of 101,336 CLP (\$178) <sup>a</sup> . This affected 2,092 small schools in 2014.	X	X
School performance 1 (SNED)	In 2014, 3,303 schools received this group incentive, worth 4,390 CLP (\$7.70) per student. The Ministry of Education (MINEDUC) selects recipients based on an indicator that compares a school's SIMCE standardized test scores to the school in previous years and to similar schools. Ninety percent of the funds are divided among teachers proportionally to their contract hours; principals determine which teachers receive the remaining 10%.	X	X
School performance 2	Principals negotiate a set of goals with school governance, constrained by MINEDUC requirements; the administrative group (principal and curriculum committee) receives 10-20% of the RBMN if the school meets the goals. Only large schools are eligible.	X	X

Table A.1: Components of Chilean Teacher Salaries (Continuation)

Salary Component	Description	Public	Private Subsidized
Individual performance (ADVI, AEP)	Teachers with the highest scores on the AEP exam (up to a maximum of 9,000 teachers) receive a monthly bonus of 50,000 -150,000 CLP (\$88-\$263). Teachers with high scores on the ADVI exam can earn a bonus of 5-25% of the RBMN. Both exams are voluntary exams taken by the teachers, and the resulting bonuses are paid for four years. Bonuses are increased by 40% and 30%, respectively, in schools with more than 60% priority <sup>c</sup> students. In 2013, 2,078 teachers got the AEP and 7,548 teachers got the ADVI bonus.	X	Only AEP
Complementary bonus	If the combination of the RBMN and the BP, BRP, and Locality bonuses come to less than 12,245 CLP (\$21) hourly, this bonus brings the hourly wage rate up to that level.	X	X

a. All amounts for the 2014 school year. Currency conversions use the official 2014 exchange rate (1 USD = 590.01 CLP).

b. Principals in Chilean schools are typically members of the teaching staff, who agree to take on administrative responsibilities. They often continue to teach, sometimes with a reduced teaching load.

c. Priority students are identified by any of several markers of family poverty: (1) participation in the Chile Solidario social benefits program, (2) being in the most vulnerable third of families as measured by the Ficha de Protección Social, a score used for social program eligibility, (3) receiving section A health coverage under the Fondo Nacional de Salud, or (4) disproportionately low family income and maternal education in rural, high-poverty areas.

d. Bonus for contracts of 30 hours or more weekly. Teachers working less receive a prorated amount.

# 1.11 Appendix B: Relationship between Difficult Conditions Score and Difficult Conditions Bonus, by region and year

These graphs show the mapping from Difficult Conditions Score to Difficult Conditions Bonus for all the years and regions included in this study. For clarity, the graphs exclude the 1.6% of schools in the sample with scores below 100 or above 250. All the analysis in this paper excludes non-compliant Regions 9 and 13 in 2009-2010 and drop an additional 357 non-compliant schools.

Figure B.1: Relationship between Difficult Conditions Score and Difficult Conditions Bonus, regions 1 to 4 from 2008 to 2014

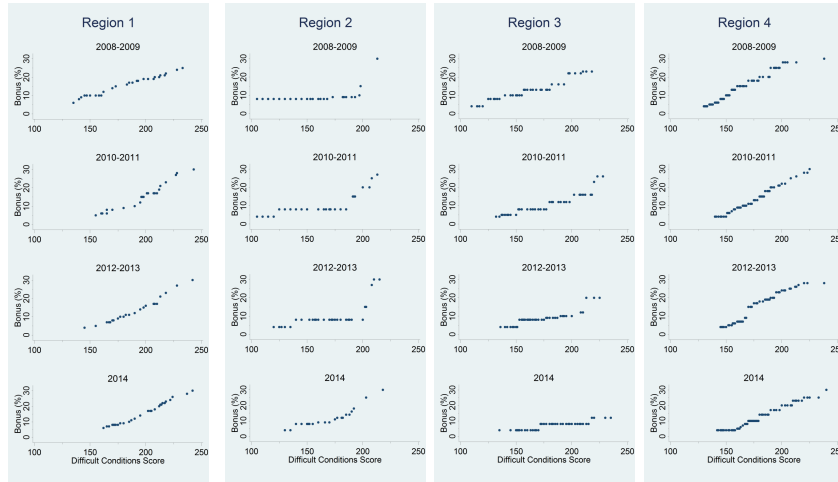


Figure B.2: Relationship between Difficult Conditions Score and Difficult Conditions Bonus, regions 5 to 8 from 2008 to 2014

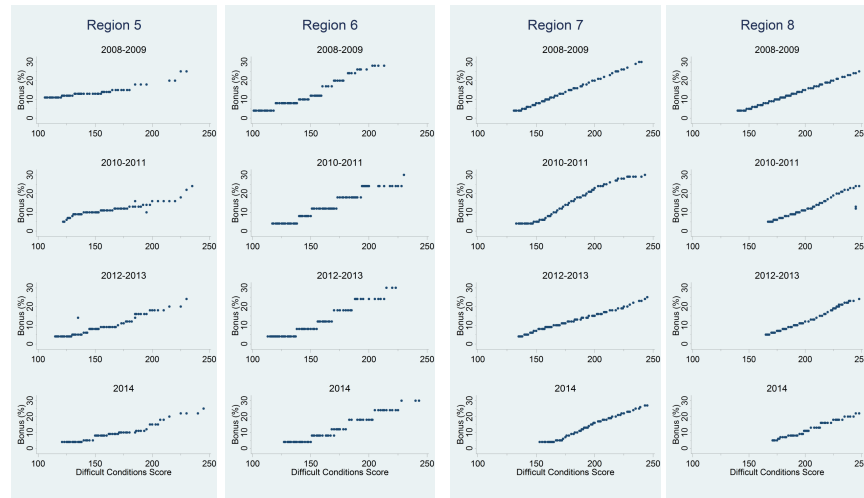


Figure B.3: Relationship between Difficult Conditions Score and Difficult Conditions Bonus, regions 9 to 12 from 2008 to 2014

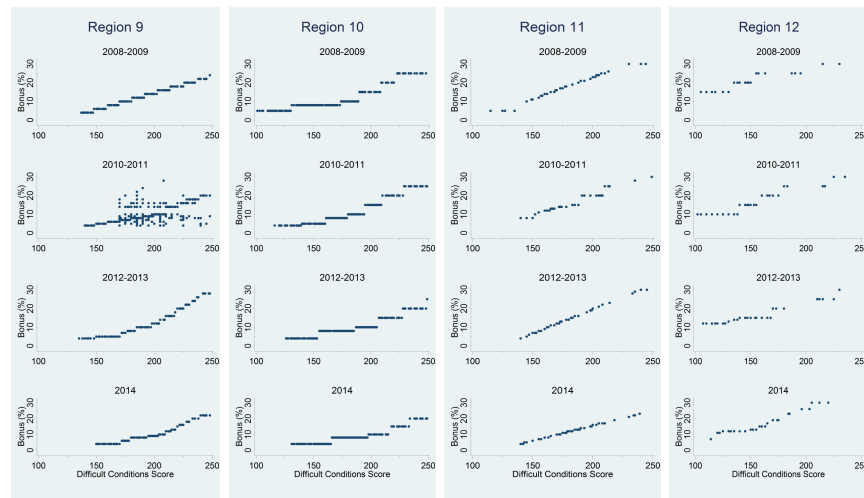
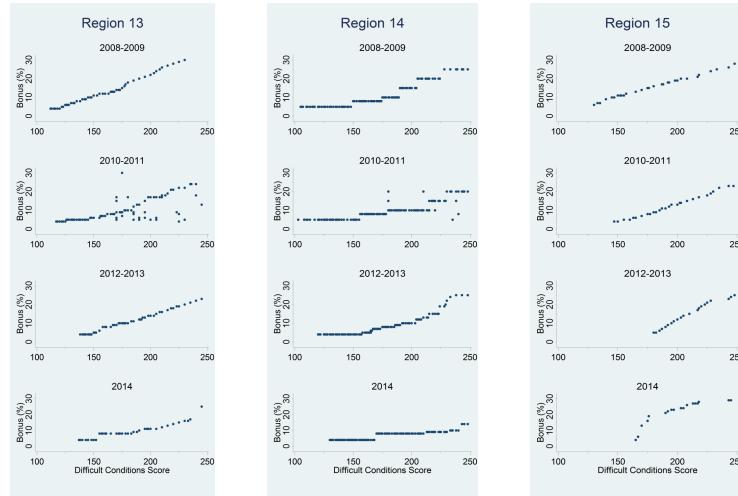


Figure B.4: Relationship between Difficult Conditions Score and Difficult Conditions Bonus, regions 13 to 14 from 2008 to 2014



## 1.12 Appendix C: Calculating the Difficult Conditions Score

The Difficult Conditions Score is based on a combination of factors including geographic isolation, student population, and other hardship conditions. Every two years, interested schools prepare applications with evidence of their eligibility in each of the categories described below. Scores are calculated as the sum of all the points for which a school qualifies.

Regional Ministry officials are responsible for verifying the submitted information. Schools apply between October and November (at the end of the school year), learn the size of their bonus in March (after the start of the subsequent year), and the bonus remains in effect for two school years.

Once the application period is closed, the regional Ministry of Education ranks schools by their scores. Based on the rankings, the number of teachers, and the regional budget constraints, Ministry officials determine how scores will translate to bonuses. Legally, all bonus levels must be integers between 4% and 30%, with no more than 20% of the regional budget spent on schools with bonuses between 4% and 8%.

As shown in Table C1, all schools may receive up to 150 points based on student population. For the remaining 150 points, rural and urban schools are scored in different areas.

Rural subcategories focus on the extent to which the school is small and isolated. The remainder of this appendix provides an overview of the various subcategories and how school conditions translate into points.

Table C.1: Calculating the Difficult Conditions Score

<b>Category</b>	<b>Subcategory</b>	<b>Points</b>
Population Conditions (150 points)	a) Share of low income or otherwise vulnerable students	0 - 70
	b) Share of bilingual or bicultural students	0 - 40
	c) Share of students incarcerated or living away from home	0 - 40
For rural schools: Geographical isolation (150 points)	a) Distance from large city	0 - 30
	b) Difficulty of access to school (unpaved, etc.)	0 - 30
	c) Regional public transit quality	0 - 30
	d) Type of teacher's residence	0 - 30
	e) 1-3 teacher schools & multi-grade classes	5 - 30
For urban schools: Additional Hardship Conditions(150 points)	a) Average class size	0 - 40
	b) District-level Crime rate	0 - 35
	c) District-level poverty rate	0 - 40
	d) Difficulty of public transit access to school	0 - 35

Note: Scores range between 0-300 points. Within each category, points are awarded in increments, increasing with severity of difficulty. For example, schools receiving 30 points on “difficulty of access” are accessible only by water or air.

### **Population Conditions:**

All schools receive up to 150 points in the three population conditions categories, as shown from table C2 to C4. Students are classified as vulnerable based on a combination of economic and individual considerations including eligibility for the Chile Solidario benefits program, low maternal education, health coverage or a combination of low family income and a learning disability or past history of disconnection from school. It also includes all formerly incarcerated students, pregnant students, and students with children. For the second subcategory, schools receive points for the share of their students who are immigrants from other countries, those who speak a language other than Spanish at home, and members of indigenous groups. Finally, all schools receive points for the share of their students who are either incarcerated or boarding away from home due to large travel distance between home and school. There are separate scales for the two groups; schools receive the higher of the two scores.

### **Rural Geographic Isolation:**

Rural schools are eligible for the remaining 150 points based on five factors related to their geographic isolation. The first category is based on the distance to a nearby large city (the reference city) identified by the Ministry of Education as the local reference city (see Table C5). The second is for the most difficult type of road encountered when traveling between the school and the reference city (see Table C6). The third is for the type of public transportation between the reference city and the school (see Table C7). The final two categories apply to schools where the teacher is required to live at the school (typically in remote areas) and to schools where low enrollment results in multi-grade classrooms (see Table C8 and C9).

### **Urban Hardship Conditions :**

For urban schools, the remaining 150 points are calculated based on a combination of school and district factors ((see Table C10 to C12). For the first, schools with larger class sizes receive points; schools serving special needs students and adults are scored on different scales (available on request). The district level crime rate is calculated as the number of complaints

registered in the police for each 1,000 habitants. The poverty rate is based on the most recent CASEN survey<sup>30</sup>. Finally, ease of access is based on available public transportation; night schools and those in prisons are scored on different scales (available on request).

Table C.2: Population Conditions:  
Vulnerable students

<b>Vulnerable students</b>	<b>Score</b>
0-10%	0
10.1% -20%	10
20.1%-30%	20
30.1%-40%	35
40.1%-60%	50
60.1%-80%	60
80.1%-100%	70

Table C.3: Population Conditions: Bicultural, bilingual, and integrated students

<b>Bicultural, bilingual, and integrated students</b>	<b>Score</b>
0-1%	0
5.1%-10%	10
10.1%-20%	15
20.1%-30%	20
30%	30
>30%	40

---

30. Encuesta de Caracterización Socioeconómica Nacional. The Chilean poverty rate was 14.4 in 2013 (22.2 in 2011). Since 2013 the poverty line depends on the number of members in household.

Table C.4: Population Conditions: Living away from home and Incarcerated students

<b>Living away from home</b>	<b>Incarcerated students</b>	<b>Score</b>
0-2%		0
2.1% -6%		10
6.1%-10%		15
10.1%-15%	0-2%	20
15.1%-20%	2.1% -10%	30
20%	10%	40

Table C.5: Rural Geographic Isolation: Distance from reference city

<b>Distance from reference city</b>	<b>Score</b>
$\leq 5$ km	0
$\leq 5.1$ km & $\leq 25$ km	5
$\leq 25.1$ km & $\leq 50$ km	10
$\leq 50.1$ km & $\leq 75$ km	15
$\leq 75.1$ km & $\leq 100$ km	20
$\leq 100.1$ km & $\leq 25$ km	25
$\leq 130$ km	30

Table C.6: Rural Geographic Isolation: Difficulty of access to school

<b>Difficulty of access to school</b>	<b>Score</b>
Paved road with little difficulty	0
Unpaved road with little difficulty	6
Paved road in bad condition	12
Unpaved road with difficulty of access	18
Accessible only by land and water	24
Accessible only water or air	30

Table C.7: Rural Geographic Isolation:Public transit quality

<b>Public transit quality</b>	<b>Score</b>
Public transportation at least twice daily, every school day	0
Public transportation at least twice daily most (but not all) days	10
Public transportation less than twice daily	20
Public transportation requires water or air travel	25
Public transportation requires more than 1 km by horse, bike or walking	30

Table C.8: Rural Geographic Isolation: Type of teacher's residence

<b>Type of teacher's residence</b>	<b>Score</b>
The teacher does not need to live at the school	0
The teacher needs to live at the school, residence is provided	10
The teacher needs to live at the school, residence is provided for some teachers	20
The teacher needs to live at the school, residence is not provided	30

Table C.9: Rural Geographic Isolation: Number of teachers; multi-grade classes

<b>Number of teachers; multi-grade classes</b>	<b>Score</b>
Many teachers, no multi-grade classrooms	5
Many teachers, less than 50% of the classrooms are multi-grade	10
Many teachers, more than 50% of the classrooms are multi-grade	15
3 teachers	20
2 teachers	25
1 teacher	30

Table C.10: Urban Hardship  
Conditions: Average class size

<b>Average class size</b>	<b>Score</b>
$\leq 20$	0
21-25	15
26-30	10
31-35	20
36-40	30
$> 40$	40

Table C.11: Urban Hardship Conditions: District-level Crime-District-level poverty

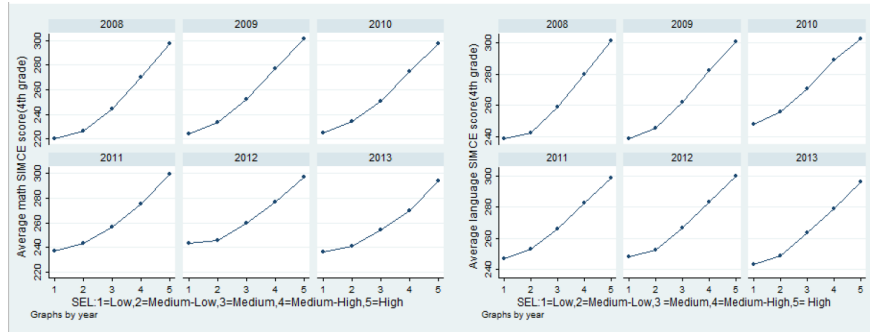
<b>District-level Crime</b>	<b>Score</b>
0-4%	0
4.1% -8%	5
8.1%-12%	10
12.1%-16%	15
16.1%-20%	20
20.1%-25%	25
25.1%-30%	30
$>30\%$	35
<b>District-level poverty</b>	<b>Score</b>
0-10%	0
10.1%-16%	10
16.1%-22%	20
22.1%-28%	25
28.1%-34%	30
34.1%-40%	35
$>40\%$	40

Table C.12: Urban Hardship Conditions: Ease of Access

<b>Ease of Access</b>	<b>Score</b>
Public transportation stops between 1 and 3 blocks from the school	0
Public transportation stops between 4 and 6 blocks from the school	5
Public transportation stops more than 6 blocks from the school	10
Public transportation stops between 1 and 3 blocks from the school, but requires walking through difficult terrain	20
Public transportation stops between 4 and 6 blocks from the school, but requires walking through difficult terrain	25
Public transportation stops more than 6 blocks from the school, but requires walking through difficult terrain	35

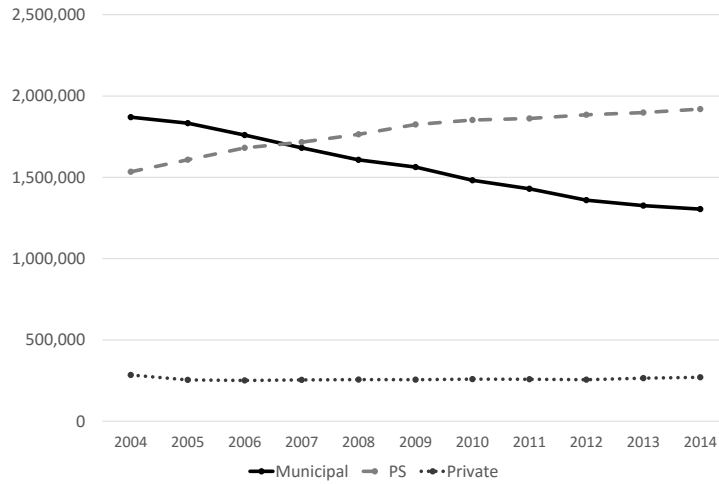
## 1.13 Appendix D: Additional Descriptive Context

Figure D.1: Relationship between socioeconomic level of the school and SIMCE score



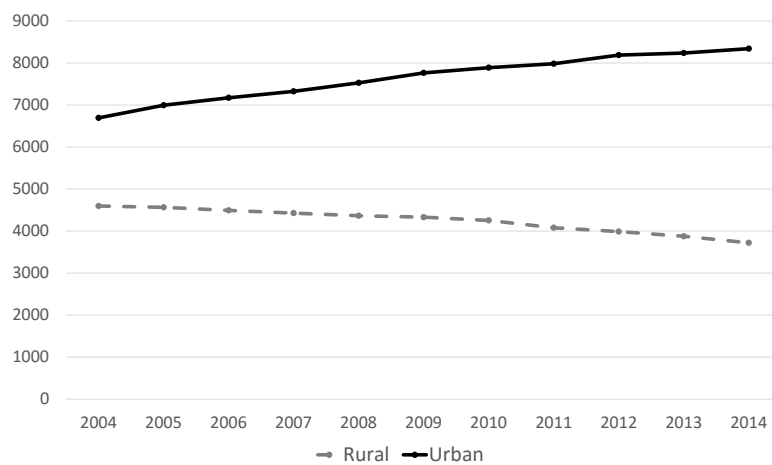
Note: Each graph shows the relationship between socioeconomic level (SEL) and SIMCE score for 6 different years and for math and language. Schools are officially categorized into five SEL levels, where 1 is the least affluent and 5 is the most. Each dot represents the average SIMCE score of the schools in the relevant group. Across years and subjects, the difference between the lowest and highest SEL level is equivalent to roughly 1.2 standard deviations of the empirical distribution of school average SIMCE scores.

Figure D.2: Number of students by sector and year



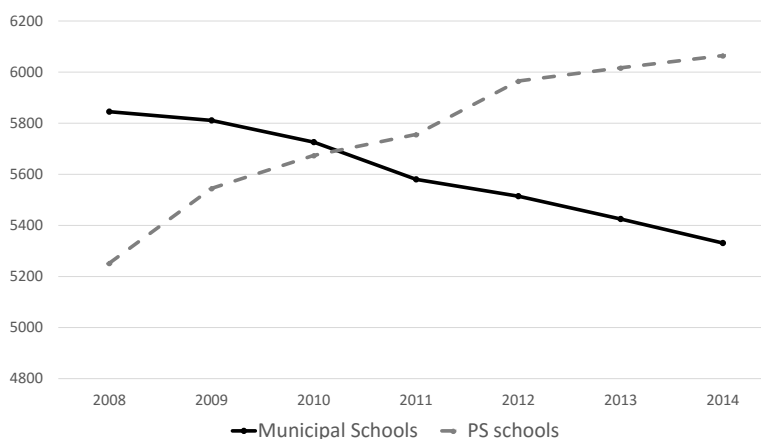
The solid line shows the number of students in municipal (public) schools, the dashed line shows the number of students in private subsidized (PS) schools, and the dotted line shows the number of students enrolled in purely private schools.

Figure D.3: Number of schools by sector and year



The The solid line shows the number of urban schools and the dashed line shows the number of rural schools.

Figure D.4: Number of schools by type and year



The solid line shows the number of municipal schools and the dashed line shows the number of private subsidized (PS) schools.

Table D.1: Number of schools by year and type of sample

	2008	2009	2010	2011	2012	2013	2014
Schools in Chile	11,894	12,097	12,144	12,063	12,174	12,114	12,061
Schools with Bonus and Score	5,623	5,554	5,630	5,480	5,680	5,591	5,454
Schools in the sample A	5,622	5,522	3,670	3,566	5,675	5,586	5,453
Schools in Sample B	4,516	4,465	2,638	2,560	4,633	4,571	3,577
Schools in Sample C	1,891	1,865	896	859	1,762	1,731	1,658
Schools in Sample D	606	599	593	567	467	456	856

Note: Sample A are schools that have Difficult Condition Score and Difficult Condition Bonus. Sample B is composed by schools of sample A that are within a fixed bandwidth of 5 points (schools that have a score of +/-5 points with respect to the score of the cutoff at which the discontinuity occurs). Schools in the sample C restricts sample B to only those discontinuities associated with a jump of 2 percentage points in the pay base salary. Schools in the sample D restricts sample B to only those discontinuities associated with a jump of 3 percentage points in the pay base salary. The 2014 numbers of school in Schools in the sample A category is smaller than the total sample reported in Table 1 (5,617), due to missing score data for 163 schools.

Table D.2: Total teachers by year and type of sample

		2008	2009	2010	2011	2012	2013	2014
Teachers	in	48,281	49,019	29,961	32,180	62,914	64,379	65,082
sample A								
Teachers	in	39,991	40,774	21,029	22,584	51,911	53,024	40,306
sample B								
Teachers	in	10,578	10,602	5,602	6,050	15,342	15,768	16,891
sample C								
Teachers	in	3,451	3,401	4,149	4,408	4,004	4,121	10,604
sample D								

Note: We considered in our sample as teachers those are working in an administrative role in the school or teaching in primary or/and high school education. Sample A are schools that have Difficult Condition Score and Difficult Condition Bonus. Sample B is composed by schools of sample A that are within a fixed bandwidth of 5 points (schools that have a score of +/-5 points with respect to the score of the cutoff at which the discontinuity occurs). Schools in the sample C restricts sample B to only those discontinuities associated with a jump of 2 percentage points in the pay base salary. Schools in the sample D restricts sample B to only those discontinuities associated with a jump of 3 percentage points in the pay base salary

Table D.3: Total Students by year and type of sample

		2008	2009	2010	2011	2012	2013	2014
Students	in	866,370	838,310	459,031	439,059	848,206	820,002	795,840
sample A								
Students	in	721,285	698,028	310,248	296,532	701,600	678,289	468,812
sample B								
Students	in	166,638	160,369	85,945	81,939	203,036	197,514	196,035
sample C								
Students	in	54,897	50,916	64,688	61,449	52,892	51,835	130,598
sample D								

Note: Students are those that are enroll in K-12. Sample A are schools that have Difficult condition score and Difficult Condition Bonus. Sample B is composed by schools of sample A that are within a fixed bandwidth of 5 points (schools that have a score of +/-5 points with respect to the score of the cutoff at which the discontinuity occurs). Schools in the sample C restricts sample B to only those discontinuities associated with a jump of 2 percentage points in the pay base salary. Schools in the sample D restricts sample B to only those discontinuities associated with a jump of 3 percentage points in the pay base salary

Table D.4: Average Standardized Test Scores (SIMCE) in math by year

	2008	2009	2010	2011	2012	2013
4th Grade Math in Sample A	225.45	232.45	232.63	240.64	239.65	237.16
(sd)	(32.16)	(25.7)	(31.18)	(30.89)	(31.6)	(29.92)
N	4,047	2,148	2,221	2,089	3,478	3,404
4th Grade Math in sample B	224.75	231.29	231.68	239.53	238.91	235.85
(sd)	(32)	(25.35)	(30.98)	(30.97)	(31.84)	(30.34)
N	3,191	1,725	1,553	1,446	2,788	2,733
4th Grade Math in sample C	222.11	230.99	233.7	240.97	234.57	233.57
(sd)	(33.35)	(26.11)	(32.78)	(33.25)	(34.27)	(31.90)
N	1,295	526	508	487	1,057	1,023
4th Grade Math in sample D	226.12	236.21	234.87	242.91	244.33	242.81
(sd)	(33.76)	(24.59)	(32.11)	(31.84)	(33.58)	(34.66)
N	404	155	362	350	263	260

Note: Item response theory (IRT) is used to estimate the SIMCE scores (same method used in PISA scores). This allow us to compare the scores across the years and among different cohorts. The mean of the SIMCE is 250 points and the standard deviation is 50. Sample A are schools that have Difficult Condition Score and Difficult Condition Bonus. Sample B is composed by schools of sample A that are within a fixed bandwidth of 5 points (schools that have a score of +/-5 points with respect to the score of the cutoff at which the discontinuity occurs). Schools in the sample C restricts sample B to only those discontinuities associated with a jump of 2 percentage points in the pay base salary. Schools in the sample D restricts sample B to only those discontinuities associated with a jump of 3 percentage points in the pay base salary

Table D.5: Average Standardized Test Scores (SIMCE) in language by year

	2008	2009	2010	2011	2012	2013
4th Grade language in sample A	246.43	251.5	259.41	256.5	254.79	254.12
(sd)	(22.65)	(21.03)	(26.6)	(27.46)	(30.16)	(26.77)
N	4,055	2,148	2,229	2,092	3,478	3,408
4th Grade language in sample B	245.57	244.79	256.59	254.66	251.34	249.93
(sd)	(30.35)	(22.46)	(28.57)	(29.03)	(29.35)	(27.27)
N	3,194	1,722	1,558	1,451	2,792	2,738
4th Grade language in sample C	246.82	244.79	259.75	256.72	251.15	251.68
(sd)	(32.08)	(22.46)	(29.45)	(29.43)	(31.91)	(28.19)
N	1,298	524	510	486	1,063	1,027
4th Grade language in sample D	250.63	250.29	260.43	257.69	255.86	256.72
(sd)	(32.52)	(21.36)	(28.44)	(28.36)	(32.27)	(29.91)
N	407	155	350	350	264	260

Note: Item response theory (IRT) is used to estimate the SIMCE scores (same method used in PISA scores). This allow us to compare the scores across the years and among different cohorts. The mean of the SIMCE is 250 points and the standard deviation is 50. Sample A are schools that have Difficult Condition Score and Difficult Condition Bonus. Sample B is composed by schools of sample A that are within a fixed bandwidth of 5 points (schools that have a score of +/-5 points with respect to the score of the cutoff at which the discontinuity occurs). Schools in the sample C restricts sample B to only those discontinuities associated with a jump of 2 percentage points in the pay base salary. Schools in the sample D restricts sample B to only those discontinuities associated with a jump of 3 percentage points in the pay base salary

## 1.14 Appendix E: Results

All results in this section are using a bandwidth of 5 points and sample C. Sample C has schools that have Difficult Condition Score and Difficult Condition Bonus, that are within a fixed bandwidth of 5 points (schools that have a score of +/-5 points with respect to the score of the cutoff at which the discontinuity occurs), and it only considers those discontinuities associated with a jump of 2 percentages points or more in the pay base salary.

Table E.1: Results on Contract Hours

	(1)	(2)	(3)	(4)
Treatment	-0.264** (0.0919)		-0.386*** (0.115)	
T x Municipal Non Rural		-0.0184 (0.116)		-0.0889 (0.139)
T x Municipal Rural		-0.270** (0.0966)		-0.401** (0.122)
T x Priv.Subs Non Rural		-0.447* (0.198)		-0.444+ (0.227)
T x Priv.Subs Rural		-0.436* (0.208)		-0.470+ (0.264)
Sector FE		x		x
Geography Sample			x	x
Comuna FE	x	x	x	x
Cutoff FE	x	x	x	x
Observations	9,375	9,375	5,948	5,948

+ p<0.10, \* p<0.05, \*\* p<0.01, \*\*\* p<0.001

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

Table E.2: Results on Experience (years)

	(1)	(2)	(3)	(4)
Treatment	-0.0656 (0.142)		0.0984 (0.176)	
T x Municipal Non Rural		-0.0915 (0.164)		0.115 (0.198)
T x Municipal Rural		-0.0616 (0.149)		0.0713 (0.183)
T x Priv.Subs Non Rural		0.171 (0.259)		0.189 (0.311)
T x Priv.Subs Rural		-0.469 (0.287)		0.0687 (0.326)
Sector FE		x		x
Geography Sample			x	x
Comuna FE	x	x	x	x
Cutoff FE	x	x	x	x
Observations	9,375	9,375	5,948	5,948

+ p<0.10, \* p<0.05, \*\* p<0.01, \*\*\* p<0.001

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

Table E.3: Results on Hour teacher-per student

	(1)	(2)	(3)	(4)
Treatment	-0.123+		-0.0957	
	(0.0682)		(0.0755)	
T x Municipal Non Rural		-0.139*		-0.0918
		(0.0697)		(0.0751)
T x Municipal Rural		-0.0862		-0.0525
		(0.0759)		(0.0865)
T x Priv.Subs Non Rural		-0.160+		-0.226*
		(0.0912)		(0.106)
T x Priv.Subs Rural		-0.301**		-0.234*
		(0.101)		(0.108)
Sector FE		x		x
Geography Sample			x	x
Comuna FE	x	x	x	x
Cutoff FE	x	x	x	x
Observations	9,375	9,375	5,948	5,948

+  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

Table E.4: Results on Retention Rate

	(1)	(2)	(3)	(4)
Treatment	-0.438 (0.371)		-0.505 (0.450)	
T x Municipal Non Rural		-0.128 (0.435)		-0.304 (0.527)
T x Municipal Rural		-0.296 (0.399)		-0.348 (0.491)
T x Priv.Subs Non Rural		-0.984 (0.838)		-1.459 (0.993)
T x Priv.Subs Rural		-1.404+ (0.735)		-0.632 (0.793)
Sector FE		x		x
Geography Sample			x	x
Comuna FE	x	x	x	x
Cutoff FE	x	x	x	x
Observations	8,018	8,018	5,149	5,149

+  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

Table E.5: Results on SIMCE 4th grade Math

	(1)	(2)	(3)	(4)
Treatment	-0.0194 (0.0125)		-0.0107 (0.0158)	
T x Municipal Non Rural		-0.0325+ (0.0168)		-0.0357+ (0.0209)
T x Municipal Rural		-0.0164 (0.0132)		-0.00282 (0.0169)
T x Priv.Subs Non Rural		-0.0542* (0.0255)		-0.0668* (0.0296)
T x Priv.Subs Rural		-0.0388+ (0.0216)		-0.0192 (0.0255)
Sector FE		x		x
Geography Sample			x	x
Comuna FE	x	x	x	x
Cutoff FE	x	x	x	x
Observations	4,896	4,896	3,133	3,133

+  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

Table E.6: Results on SIMCE 4th grade Language

	(1)	(2)	(3)	(4)
Treatment	-0.0132 (0.0119)		-0.0101 (0.0146)	
T x Municipal Non Rural		-0.0206 (0.0149)		-0.0216 (0.0182)
T x Municipal Rural		-0.0110 (0.0126)		-0.00602 (0.0160)
T x Priv.Subs Non Rural		-0.0249 (0.0226)		-0.0361 (0.0265)
T x Priv.Subs Rural		-0.00825 (0.0218)		0.00228 (0.0238)
Sector FE		x		x
Geography Sample			x	x
Comuna FE	x	x	x	x
Cutoff FE	x	x	x	x
Observations	4,908	4,908	3,143	3,143

+ p<0.10,\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

## 1.15 Appendix F: Results in $t + 1$

This appendix reports results for outcomes measured in the subsequent year. The specifications for each column are the same as in those in Appendix E. We use Sample C. Sample C has schools that have Difficult condition score and Difficult condition bonus, that are within a fixed bandwidth of 5 points (schools that have a score of +/-5 points with respect to the score of the cutoff at which the discontinuity occurs), and it only considers those discontinuities associated to a jump of 2 percentage points or more in the pay base salary.

Table F.1: Results on Contract Hours in  $t + 1$

	(1)	(2)	(3)	(4)
Treatment	-0.164 (0.104)		-0.261* (0.128)	
T x Municipal Non Rural		0.133 (0.134)		0.0445 (0.160)
T x Municipal Rural		-0.171 (0.109)		-0.259+ (0.134)
T x Priv.Subs Non Rural		-0.606* (0.285)		-0.666* (0.334)
T x Priv.Subs Rural		-0.373 (0.226)		-0.351 (0.281)
Sector FE		x		x
Geography Sample			x	x
Comuna FE	x	x	x	x
Cutoff FE	x	x	x	x
Observations	7,839	7,839	5,029	5,029

+  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

Table F.2: Results on Experience (years) in  $t + 1$

	(1)	(2)	(3)	(4)
Treatment	0.0610 (0.162)		0.247 (0.203)	
T x Municipal Non Rural		0.0575 (0.194)		0.329 (0.238)
T x Municipal Rural		0.0992 (0.170)		0.239 (0.210)
T x Priv.Subs Non Rural		-0.0746 (0.346)		0.00739 (0.431)
T x Priv.Subs Rural		-0.433 (0.322)		0.178 (0.351)
Sector FE		x		x
Geography Sample			x	x
Comuna FE	x	x	x	x
Cutoff FE	x	x	x	x
Observations	7,839	7,839	5,029	5,029

+  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

Table F.3: Results on Hour teacher-per student in  $t + 1$

	(1)	(2)	(3)	(4)
Treatment	-0.168*		-0.140	
	(0.0749)		(0.0889)	
T x Municipal Non Rural		-0.121 (0.0888)		-0.0285 (0.105)
T x Municipal Rural		-0.116 (0.0797)		-0.0909 (0.0940)
T x Priv.Subs Non Rural		-0.170 (0.120)		-0.126 (0.145)
T x Priv.Subs Rural		-0.419*** (0.121)		-0.253+ (0.146)
Sector FE		x		x
Geography Sample			x	x
Comuna FE	x	x	x	x
Cutoff FE	x	x	x	x
Observations	7,839	7,839	5,029	5,029

+  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

Table F.4: Results on Retention Rate in  $t + 1$

	(1)	(2)	(3)	(4)
Treatment	-0.342		-0.368	
T x Municipal		-0.260		-0.449
Non Rural		(0.500)		(0.607)
T x Municipal		-0.167		-0.139
Rural		(0.476)		(0.580)
T x Priv.Subs		-0.387		-1.343
Non Rural		(0.809)		(1.015)
T x Priv.Subs		-1.572+		-1.163
Rural		(0.806)		(0.921)
Sector FE		x		x
Geography Sample			x	x
Comuna FE	x	x	x	x
Cutoff FE	x	x	x	x
Observations	6,370	6,370	4,162	4,162

+  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

Table F.5: Results on SIMCE 4th grade Math in  $t + 1$

	(1)	(2)	(3)	(4)
Treatment	-0.0212 (0.0135)		-0.0320+ (0.0173)	
T x Municipal Non Rural		-0.0388* (0.0181)		-0.0622** (0.0228)
T x Municipal Rural		-0.0170 (0.0142)		-0.0221 (0.0183)
T x Priv.Subs Non Rural		-0.0541+ (0.0285)		-0.0880** (0.0326)
T x Priv.Subs Rural		-0.0532* (0.0254)		-0.0613+ (0.0316)
Sector FE		x		x
Geography Sample			x	x
Comuna FE	x	x	x	x
Cutoff FE	x	x	x	x
Observations	3,620	3,620	2,357	2,357

+  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

Table F.6: Results on SIMCE 4th grade Language in  $t + 1$

	(1)	(2)	(3)	(4)
Treatment	-0.00948 (0.0124)		-0.0247 (0.0151)	
T x Municipal Non Rural		-0.00363 (0.0160)		-0.0271 (0.0197)
T x Municipal Rural		-0.0130 (0.0131)		-0.0254 (0.0163)
T x Priv.Subs Non Rural		-0.0151 (0.0248)		-0.0406 (0.0290)
T x Priv.Subs Rural		0.00750 (0.0237)		-0.00696 (0.0274)
Sector FE		x		x
Geography Sample			x	x
Comuna FE	x	x	x	x
Cutoff FE	x	x	x	x
Observations	3,626	3,626	2,368	2,368

+  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

## 1.16 Appendix G: Alternate Bandwidths

This appendix reports results for when the bandwidth for sample inclusion is decreased ( $\alpha = 4$ ) or increased ( $\alpha = 6$ ). We use Sample C. Sample C has schools that have Difficult Condition Score and Difficult Condition Bonus, that are within a fixed bandwidth of 5 points (schools that have a score of +/-5 points with respect to the score of the cutoff at which the discontinuity occurs), and it only considers those discontinuities associated with a jump of 2 percentage points or more in the pay base salary.

Table G.1: Results on Contract Hours with alternate bandwidths

	$\alpha = 4$		$\alpha = 5$		$\alpha = 6$	
	(1)	(2)	(1)	(2)	(1)	(2)
Treatment	-0.323*** (0.099)		-0.264*** (0.092)		-0.239*** (0.081)	
T x Municipal Non Rural		-0.147 (0.127)		-0.019 (0.116)		-0.075 (0.104)
T x Municipal Rural		-0.314*** (0.104)		-0.270*** (0.096)		-0.223*** (0.085)
T x Priv.Subs Non Rural		-0.591*** (0.204)		-0.447** (0.198)		-0.490 (0.183)
T x Priv.Subs Rural		0.415* (0.229)		-0.436** (0.208)		-0.403** (0.190)
Sector FE		x		x		x
Comuna FE	x	x	x	x	x	x
Cutoff FE	x	x	x	x	x	x
Observations	8,366	8,366	9,375	9,375	10,531	10,531

+  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

Table G.2: Results on Experience with alternate bandwidths

	$\alpha = 4$		$\alpha = 5$		$\alpha = 6$	
	(1)	(2)	(1)	(2)	(1)	(2)
Treatment	-0.180 (0.149)		-0.0656 (0.142)		-0.0413 (0.124)	
T x Municipal Non Rural		-0.254 (0.179)		-0.0915 (0.164)		-0.0380 (0.149)
T x Municipal Rural		-0.160 (0.157)		-0.0616 (0.149)		-0.0261 (0.132)
T x Priv.Subs Non Rural		0.0476 (0.268)		0.171 (0.259)		0.171 (0.249)
T x Priv.Subs Rural		-0.474 (0.308)		-0.469 (0.287)		-0.491+ (0.258)
Sector FE		x		x		x
Comuna FE	x	x	x	x	x	x
Cutoff FE	x	x	x	x	x	x
Observations	8,366	8,366	9,375	9,375	10,531	10,531

+  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

Table G.3: Results on Hours Per Student with alternate bandwidths

	$\alpha = 4$		$\alpha = 5$		$\alpha = 6$	
	(1)	(2)	(1)	(2)	(1)	(2)
Treatment	-0.140+		-0.123+		-0.0818	
	(0.0740)		(0.0682)		(0.0620)	
T x Municipal Non Rural		-0.187*		-0.139*		-0.107
		(0.0791)		(0.0697)		(0.0653)
T x Municipal Rural		-0.0913		-0.0862		-0.0394
		(0.0827)		(0.0759)		(0.0699)
T x Priv.Subs Non Rural		-0.149		-0.160+		-0.182*
		(0.101)		(0.0912)		(0.0895)
T x Priv.Subs Rural		-0.234*		-0.301**		-0.257**
		(0.111)		(0.101)		(0.0908)
Sector FE		x		x		x
Comuna FE	x	x	x	x	x	x
Cutoff FE	x	x	x	x	x	x
Observations	8,366	8,366	9,375	9,375	10,531	10,531

+  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

Table G.4: Results on Retention rate with alternate bandwidths

	$\alpha = 4$		$\alpha = 5$		$\alpha = 6$	
	(1)	(2)	(1)	(2)	(1)	(2)
Treatment	-0.676+		-0.438		-0.354	
	(0.399)		(0.371)		(0.324)	
T x Municipal Non Rural		-0.0690 (0.462)		-0.128 (0.435)		-0.0710 (0.379)
T x Municipal Rural		-0.577 (0.435)		-0.296 (0.399)		-0.209 (0.350)
T x Priv.Subs Non Rural		-1.251 (0.877)		-0.984 (0.838)		-1.367+ (0.758)
T x Priv.Subs Rural		-1.551+ (0.829)		-1.404+ (0.735)		-1.166+ (0.650)
Sector FE		x		x		x
Comuna FE	x	x	x	x	x	x
Cutoff FE	x	x	x	x	x	x
Observations	7,110	7,110	8,018	8,018	9,010	9,010

+  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

Table G.5: Results on SIMCE 4th grade Math with alternate bandwidths

	$\alpha = 4$		$\alpha = 5$		$\alpha = 6$	
	(1)	(2)	(1)	(2)	(1)	(2)
Treatment	-0.0177 (0.0135)		-0.0194 (0.0125)		-0.0151 (0.0111)	
T x Municipal Non Rural		-0.0241 (0.0186)		-0.0325+ (0.0168)		-0.0195 (0.0152)
T x Municipal Rural		-0.0169 (0.0144)		-0.0164 (0.0132)		-0.0143 (0.0119)
T x Priv.Subs Non Rural		-0.0416 (0.0285)		-0.0542* (0.0255)		-0.0405+ (0.0237)
T x Priv.Subs Rural		-0.0328 (0.0233)		-0.0388+ (0.0216)		-0.0351+ (0.0197)
Sector FE		x		x		x
Comuna FE	x	x	x	x	x	x
Cutoff FE	x	x	x	x	x	x
Observations	4,352	4,352	4,896	4,896	5,500	5,500

+  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

Table G.6: Results on SIMCE 4th grade Language with alternate bandwidths

	$\alpha = 4$		$\alpha = 5$		$\alpha = 6$	
	(1)	(2)	(1)	(2)	(1)	(2)
Treatment	-0.0132 (0.0129)		-0.0132 (0.0119)		-0.00637 (0.0103)	
x Municipal Non Rural		-0.0145 (0.0166)		-0.0206 (0.0149)		-0.00812 (0.0127)
T x Municipal Rural		-0.0117 (0.0137)		-0.0110 (0.0126)		-0.00607 (0.0111)
T x Priv.Subs Non Rural		-0.0174 (0.0253)		-0.0249 (0.0226)		-0.0143 (0.0204)
T x Priv.Subs Rural		-0.00878 (0.0242)		-0.00825 (0.0218)		-0.00653 (0.0193)
Sector FE		x		x		x
Comuna FE	x	x	x	x	x	x
Cutoff FE	x	x	x	x	x	x
Observations	4,364	4,364	4,908	4,908	5,515	5,515

+  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: This table shows the estimators of  $\delta$ , the impact of having one percentage more in the bonus. All regressions include trend in the relative score, enrollment control, as well as comuna and cutoff fixed effects. Standard errors are clustered at the school level. All regressions are of school-level averages. The geography sample is limited to schools with at least one school from the same comuna on the other side of the cutoff.

# CHAPTER 2

## EVALUATING A TARGETED VOUCHER POLICY: A NON-PARAMETRIC BOUND ANALYSIS

### 2.1 Introduction

The inverse relationship between the socioeconomic status of students and their academic achievement has been well established (Reschovsky & Imazeki, 2001). Future opportunities as adults are also likely to be determined by social background (Carneiro (2007), Cunha & Heckman (2007) Heckman (2011)). To address these issues Chile passed a law in 2008, the “Subvención Escolar Preferencial” (SEP - Preferential School Subsidy), to provide an additional per-student payment to schools that accept certain types of disadvantaged students for the purpose of equalizing educational opportunities for all students. In the words of the President at that time, Michele Bachelet, “our principal task at this time is to equalize learning opportunities for those students whose economic and social background generates a disadvantage [...]. Our schools should strive to reduce the weight of the differences on academic achievement outcomes that are not related to the talent of our students” (President Michele Bachelet, Presidential Address at the Signing of the SEP Law).

There is no consensus in the literature as to whether increasing monetary resources actually improves academic achievement (Kruger, 2003; Papke, 2005; Hanushek, 2006; Machin et al., 2010). For this reason, the effectiveness of this change in the Chilean voucher system in 2008 have been a popular topic of academic research (Mizala & Torche, 2013; Neilson, 2013; Peticara et al., 2013; Valenzuela et al., 2013; Correa et al. 2014). Most of the results of this literature report a positive but moderate impact of SEP on academic achievement. However, the validity of these results may be questionable due to the reliance on many parametric assumptions that may be problematic given the selection issues at play. In this analysis of the SEP voucher, I show what can be achieved with non-parametric assumptions regarding its effects.

The SEP Law made an additional school subsidy available for each student identified as a priority student in terms of socioeconomic status. In addition, it introduces an additional subsidy for priority or non-priority students attending schools with more than 15% priority students. However, if a school wishes to receive these extra funds, it has to propose an improvement plan, accept higher levels of supervision, and forgo student selection. Schools have the choice of whether or not to accept the additional benefits. Some eligible schools may have chosen to not accept SEP vouchers due to these requirements.

Despite the voluntary nature of the program, SEP has grown to a substantial size. In 2015, 75% of priority students <sup>1</sup>(more than 1,000,000) were enrolled in the 7,960 schools that received SEP vouchers<sup>2</sup>. The government spent in 2014 approximately 2.5 trillion Chilean pesos (4.2 billion U.S. dollars<sup>3</sup>) on the regular voucher system and 377 billion Chilean pesos (633 million U.S. dollars) on SEP vouchers. Notably, in many cases it is unclear how the additional SEP funds were spent. It has come to light that some schools spent the additional money on items that are not allowed under the law. In other cases, the government was not provided with the required accounting regarding how the money was spent.

Using panel data for schools, I investigate the impact of SEP on standardized test scores (SIMCE) of subsidized private schools. I study the impact of two treatments: having the SEP the year before the SIMCE assessment and having the SEP for 1, 2, or 3 consecutive years prior to the assessment. The second treatment is important because the length of the treatment could have significant policy implications; for example, a policy-maker could decide that a school must accept SEP for at least X years in order to qualify for SEP at all.

The main contribution of this paper is that I approach this policy evaluation issue using a non-parametric bound estimation which uses few and weak assumptions making it very robust. This allows me to deal with the selection problem. I first use a conventional non-

---

1. From first to tenth grade.

2. 66% of Chilean students were enrolled in a school with SEP.

3. Approximately \$595 Chilean pesos to the US dollar in 2014

parametric bounding method (Manski, 1989) to examine our data and see what can be learned without any assumptions. This first estimate provides broad bounds under a worst-case scenario. Thereafter, several non-parametric assumptions are described and applied to estimate a lower bound for the average treatment effect (ATE). Each one of these assumptions is motivated by the nature of the policy and economic theory, although they still do not warrant unquestioned acceptance. This estimation method has the disadvantage of not being able to create a single point estimate of the ATE.

I first assume Stable Unit Treatment Value Assumption (SUTVA), or Individualistic Treatment Response (ITR) in Manski's terminology, which implies that a school's outcome varies only with its own treatment. In addition, I employ the Monotone Treatment Selection (MTS) and Monotone Treatment Response (MTR) assumptions among others. The MTS concerns how schools decide whether or not to accept SEP. Schools that opt for SEP have lower socioeconomic levels, which are highly correlated with worse academic outcomes. Hence, MTS states that schools that do not opt for SEP have slightly higher SIMCE scores regardless of the realization of treatment. The MTR implies that the expected SIMCE score is non-decreasing in the numbers of years the school has had SEP.

I find, under a set of assumptions (Monotone Treatment Selection (MTS), no time trend, and policy invariance) that having SEP increases the SIMCE score in language in at least two points ( $0.04\sigma$ ). Of course, these results are valid only if the assumptions are correct. When I take into consideration the time that a school has been getting SEP (1, 2, or 3 years), I find that under certain assumptions the impact of the policy on language test scores increases over time (or having SEP for longer is better) until the second year (having 2 years of SEP is better than having just one). After the second year, I am not sure that having SEP for an additional year will yield to higher scores in expectation. Under this methodology, I cannot guarantee positive results in mathematics.

I also compare my results with a popular parametric approach that has been used for evaluating SEP. As in Mizala and Torche (2013), I estimate the impact of SEP on school

academic performance using a school fixed effect model. The point estimators are inside the estimated non-parametric bounds and show positive results of SEP on language and math SIMCE scores ( $0.06\sigma$  and  $0.08\sigma$  respectively). I clearly state the assumptions behind this methodology.

The paper proceeds as follows. In section 2.2, I describe the Chilean educational system, the SEP and the coverage of the SEP policy. In section 2.3, I present the previous literature evaluating SEP. Section 2.4 contains the description of data used in this study. Section 2.5 presents the methodology. Section 2.6 discusses the results. Finally, section 7 concludes.

## **2.2 The Chilean education system, the SEP and its coverage**

### *2.2.1 The Chilean Education System*

Schooling is mandatory in Chile from kindergarten to 12th grade. The K-12 Chilean school system is divided into primary education (from kindergarten to eighth grade) and secondary education (from ninth to twelfth grade)<sup>4</sup>.

Chile has three types of schools, which vary in how they are funded. Public schools are financed by the Chilean government; subsidized private schools are financed by the Chilean government and possibly with tuition from parents<sup>5</sup>, and private schools are only privately financed. The first type of school is non-profit, while the last two types can be either for profit or non-profit. Municipalities have been responsible for the administration of public schools since 1981; the other types of schools are privately administrated. Families can choose freely among these types of schools.

In 2014 Chile had 12,061 schools, of which 5,331 were public and 6,065 were subsidized private schools. There were 3.5 million students<sup>6</sup>, of whom 36.8% attended public schools

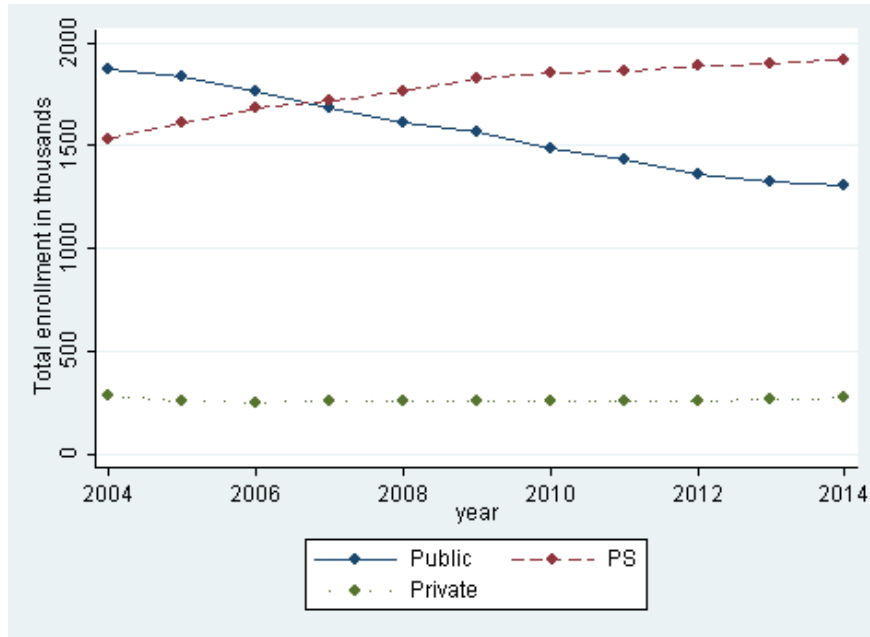
---

4. Kindergarten has been mandatory since 2013. Secondary education has been mandatory since 2003.

5. Subsidized private schools have been able to require tuition payments since 1993. In fact, in 2015, approximately 36% of subsidized private schools have co-payments.

6. 94% of children between 5 and 14 years of age attend school, as well as 76% of adolescents between 15

Figure 2.1: Number of students by sector and year (in thousands)



Note: Solid line shows the number of students in municipal (public) schools, the dashed line is the number of students in private subsidized schools, and the dotted line shows the number of students enrolled in private schools

and 54.2% attended subsidized private schools. Figure 2.1 shows the total number of students enrolled each year by sector.

The central government provides a flat per-student subsidy to public schools and subsidized private schools through the voucher system<sup>7</sup>. This flat voucher is approximately \$104<sup>8</sup> per month per student. The subsidy under question, the “Subvención Escolar Preferencial” (SEP - Preferential School Subsidy), was introduced in 2008. This subsidy includes an additional component that changes the value of the voucher depending on the student characteristics of the school. The total payment received by schools from the government is a function of average monthly student attendance.

In 2012, Chile spent 6.9% of its GDP on primary education, more than the OECD average of 3.4% of GDP. In 2011, 17.7% of total public expenditure was spent on education (Education and 19 years of age (OECD, 2013).

7. It varies according to the educational level and geographic location, as well as other factors not related to the student’s socioeconomic characteristics.

8. In December of 2014 was 61,854 Chilean pesos for primary education

cation at a glance, 2014). In 2014, expenditure for the normal voucher program amounted to 2.5 trillion Chilean pesos (4.2 billion U.S. dollars) and expenditure on the targeted voucher (SEP) program amounted to 377 billion Chilean pesos (633 million U.S. dollars).

Each year, specific grades are required to take a standardized test called “Sistema de Medición de la Calidad de la Educación” (SIMCE). It is mandatory for all students enrolled in the selected grades to sit for the test regardless of school type. The average SIMCE score of each school has been public information since 1995, and the government provides an analysis of the scores by school so that parents can understand how their children’s school compares with others. Since 2000, the SIMCE score has been calculated using IRT (Item Response Theory) methodology allowing comparison across years.

### *2.2.2 Targeted Voucher (Subvención Escolar Preferencial - Preferential School Subsidy (SEP))*

On February 1, 2008, after more than two years of congressional debate, the Preferential School Subsidy Law (SEP) was enacted. This law amended the Chilean education financing system, which had been based on a uniform demand subsidy from 1981 until that date.

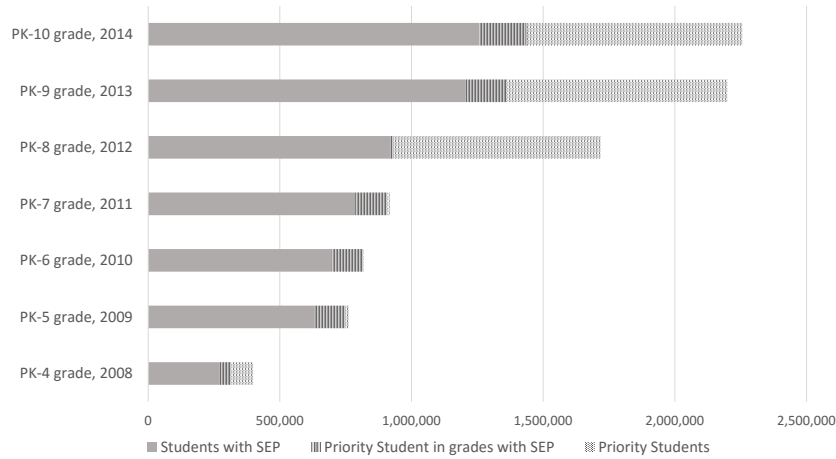
The overall purpose of the law was to provide additional monetary resources to those schools that accept the most disadvantaged students. The SEP is comprised of two parts. The first one is an additional subsidy for students denominated priority students by the Ministry of Education<sup>9</sup>. The second part is known as payment by concentration, which is a payment per student, whether priority or not, depending on the percentage of priority students enrolled in schools receiving SEP. The subsidy per priority student varies decreasingly by grade level. The subsidy for concentration varies increasingly according to the percentage of priority students attending the school.

In 2008, there were 398,968 priority students in the system with 66% of them attending

---

9. According to the SEP law a priority student is the child whose socioeconomic situation obstructs the educational process.

Figure 2.2: Number of priority students by sector and year



Note: The solid line shows the number of priority students enrolled in municipal (public) schools since 2008. The dashed line represents the same for private subsidized schools

municipal schools. However, by 2,257,212 students were identified as priority, but only 37% of them were in municipal schools. Figure 2.2 shows the evolution of priorities students over time and sector<sup>10</sup>. Until 2012 in absolute terms most of the priority students were enrolled in municipal schools.

The percentage of priority students inside the school is an important factor. It is related to the concentration payment, as mentioned above, and it gives us an idea of the school's characteristics. Table H.1 in Appendix H shows the number of municipal and private subsidized schools by year, as well the mean, the 25th percentile, 50th percentile (median), and the 75th percentile of the percentage of priority students in a school (as a function of the total enrollment in the school). This table reflects the fact that the municipal schools have higher concentration of priority students. In fact, for each percentile the percentage of priority students is less for private subsidized schools.

The SEP is a subsidy that all public (municipal) and private subsidized schools can opt into. The school administrator is the one who must decide whether she wants to receive

10. The main reason behind the jump from 2008 to 2009 has to do with the change in one of the instruments used for classifying students.

an increase in the subsidy in exchange for undertaking a series of commitments linked to specific learning goals and the elimination of general discriminating conditions. The fact that a student qualifies as a priority student does not guarantee that she will receive the additional subsidy. As noted above, the student must be a priority student and the school must be willing to receive SEP.

Should the school decide to adhere to SEP, it must sign the “Equal Opportunities and Educational Excellence Agreement” with the Ministry of Education, which has a four-year term and may be renewed for the same period of time. During this period the school undertakes education improvement plan utilizing the additional resources solely for this purpose, accounting for the use of the resources, and eliminating discrimination when accepting students<sup>11</sup>. Although the law was created for improving the performance of priority students, it only states that the resources should preferably be spent on priority students, and the use of SEP is not in any way restricted to this type of students.

2012 was the year in which the first schools that opted for SEP in 2008 could renew their agreements. The first requirement for renewing agreements had to do with reporting and use of the monies received. In this regard, the law stated that at least 70% of the SEP funds had to be used. However, this had to be modified in order to continuing with the program, since 70% was an absolutely restrictive requirement. Thus, the minimum use requirement was modified to at least 50%. It is important to mention that in the calculation of this percentage, the law<sup>12</sup> allowed for up to 15% of the subsidy to be considered for purposes other than those stipulated in the Equal Opportunities and Educational Excellence Agreement. Thus, for the first renewal, it sufficed to prove that 35% of the transferred funds had been invested.

The agreements of those schools that requested renewal were considered as extended for a maximum of 12 months. As stipulated in the law, the payment of the SEP continued during

---

11. (i) No copayment for priority students (ii) No selection based on performance or student socioeconomic levels from pre-kindergarten through 6th grade (iii) The educational establishment’s option to end the enrollment of students from pre-kindergarten through 6th grade due to poor academic performance is limited

12. Law 20.550

this period. It must be pointed out that most of the agreements<sup>13</sup> were renewed, and in the case of those that were not renewed, the unused balances should have been returned to the Ministry of Education. Now, in the case of renewed agreements, balances that have not used should be part of the obligations of the new agreements. However, I could not verify the status of the balances.

The public questioning of the management of the SEP resources by schools deserves special mention. This is directly related to the lack of connection to accountability, performed with a one-year time lag, proper control of the use of resources, and a payment system that operates independently. For example, several reports by the Comptroller General of the Republic have revealed the use of significant sums of money for purposes other than those stipulated in the law by some schools (Romero & Zarate, 2013).

### *2.2.3 Evolution and Coverage of the SEP*

In this section I review how schools have responded to the SEP 6 years after its implementation.

Figure 2.3 shows the evolution of the number of schools with SEP according to their administrative dependence between 2008 and 2014. As previously documented, a stable number (nearly 100%) of public schools participated at some point during this period.

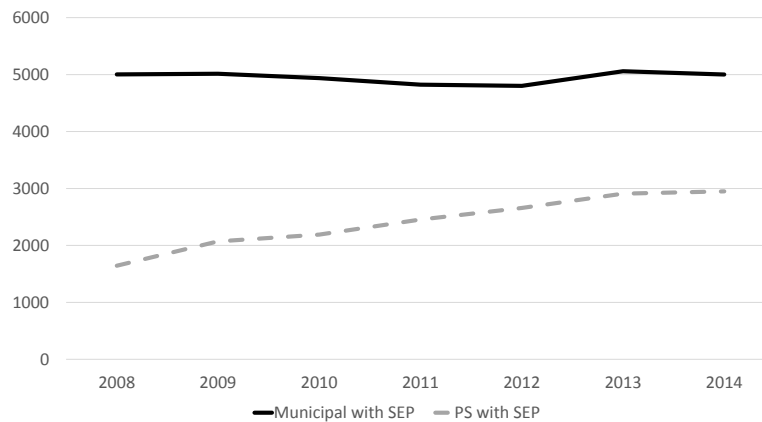
Subsidized private schools, on the other hand, have increasingly applied for SEP, but these applications have been at a decreasing rate since the introduction. It is interesting to note that the greatest increase in their participation occurred at the end of the first year of SEP's implementation. In fact, 428 subsidized private schools decided to accept the SEP in 2009. One explanation for this fact is that those schools decided to wait before taking part so as to have a notion of how SEP could affect their situation. By 2014, 2,950 subsidized private schools had started receiving the SEP (49% of those eligible).

Figure 2.4 shows the number of priority students in schools getting and not getting the

---

13. I inquired as to the exact number, but did not receive a reply.

Figure 2.3: Number of schools participating in SEP by type and year



Note: The solid line shows the number of municipal (public) schools that accepted SEP each year since 2008. The dashed line represents the same but for private subsidized schools.

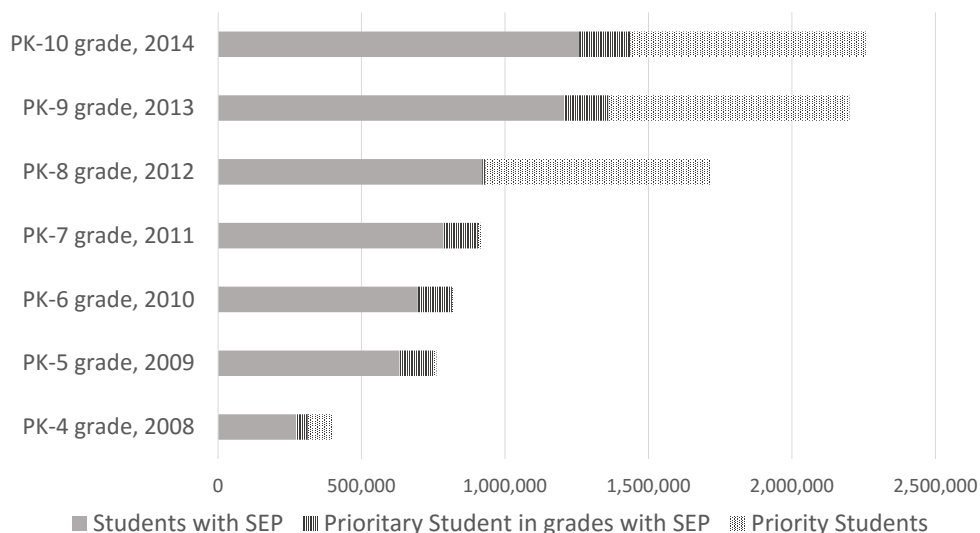
SEP per year and covered educational level. This shows how the number of priority students has evolved over time.

Each year the number of priority students covered by SEP grow because of an inclusion of an additional educational level<sup>14</sup>. The increase in 2009 is not only explained by the inclusion of an additional level (5th grade). The official Ministry of Education data shows that the number of priority students doubled in each grad. The main reason for this increase has to do with the change in one of the instruments used for classifying students. A further significant increase occurred in 2013 when students enrolled in 9th grade were included. This is the grade with the highest repetition rate in the system, and therefore the one with the most students, which explains the additional increase in priority students with SEP in 2013.

In general, SEP has become part of the school system 6 years after its implementation. In 2014, more than 70% of the Chilean schools get the voucher. In fact, the number of subsidized private schools receiving SEP almost doubled between 2008 and 2014 (from 1,600 to almost 3,000). Additionally, of a total of 1.4 million priority students in grades covered by

14. SEP has been gradually implemented. In 2008 the government paid SEP for students from first grade to fourth grade. Then, each year an additional grade was included. Currently, all grades are covered.

Figure 2.4: Number of priority of students with and without SEP



Note: This graph shows the number of priority students in the educational system, the number of whom are enrolled in grades covered by SEP and the number of priority students enrolled in a SEP school by year.

SEP in 2014, nearly 1.2 million attend schools receiving SEP. In practice, this represents one third of total national enrollment, which illustrates the importance that SEP has acquired in the Chilean education system over time.

## 2.3 Previous literature evaluating SEP

The Preferential School Subsidy (SEP) has generated particular interest among researchers. A series of articles, mostly still in working document format, have been written published within the last two years. Although diverse in terms of identification strategies, samples analyzed, and results of interest, most of these studies coincide in reporting a positive and moderate impact of SEP.

Several of the studies attempt to identify the impact of SEP on standardized test results. Mizala & Torche (2013) find that schools that received SEP in the previous year increased their SIMCE scores by between 4 and 5 points. This result increases to almost 7 points when schools have been exposed to SEP for longer periods of time. These increases correspond to

close to 0.20 standard deviations, considering that deviation at the school level is approximately 30 points. The rest of the research estimates impacts at the student level. Flores Arenas (2015) finds a positive effect of between 0.02 and 0.11 standard deviations which she identifies as small; Valenzuela, Villarroel, & Villalobos (2013) report a low and heterogeneous positive effect of 3 to 5 points, corresponding to 0.06 and 0.10 standard deviations. Meanwhile, Correa, Parro & Reyes (2014) estimate a positive impact of 2 to 4 points (0.04 - 0.08 standard deviations).

Across the studies, the estimated effect is larger when considering students/schools of lower socioeconomic status. Neilson (2013), for example, reports an impact of 0.20 standard deviations for the most disadvantaged student group. Nonetheless, there does not appear to be consensus on the ability of SEP to reduce gaps in outcomes by socioeconomic status (SES). Indeed, Neilson (2013) reports a one-third reduction in the SIMCE score gap between priority and non-priority students, while Flores Arenas (2015) states that the gap persists. Peticara, Roman, & Selman (2013) also state that the gap persists over time.

Valenzuela et al. (2013), specifically review impacts on school segregation measured by the Duncan index. Their results show no improvement in the rate of segregation under analysis, and furthermore suggest that segregation could increase in future given the migration of families to more selective subsidized schools. However, the articles of Neilson (2013) and Flores Arenas (2015) analyze the responses of families, and they agree: there do not appear to be significant changes in demand. Flores Arenas (2015) does not find any changes in the behavior of families, suggesting that the SIMCE score effects originate in school level changes. Neilson (2013) separates supply and demand mechanisms and concludes that more than two-thirds of the effect is the result of improvements in school quality (understood as higher SIMCE scores) and not the sorting of students to different schools.

Another aspect of SEP that has been analyzed is the use of the new resources that affiliated schools have access to. Peticara et al. (2013) finds that the pattern and intensity of the expenditure of SEP resources is closely related to changes observed in SIMCE scores.

In particular, they report that the potentially most relevant expenses correspond to resources for learning, and hiring consultants and new staff.

Finally, the voluntary nature of SEP implies that affiliated schools differ by definition from those that are not. The study by Elacqua & Santos (2013) reviews the cost-benefit analysis undertaken by schools when deciding whether apply for SEP or not. They find that schools with higher socioeconomic status refrain from participating. However, few of the studies mentioned above make a detailed analysis of the decision to participate in SEP and how it could affect their estimates. Valenzuela et al. (2013) estimate a discrete model of participation for all schools, which they do not use in their evaluation, but is informative regarding which establishments participate and which do not. Their findings indicate that the vulnerability index of schools goes a long way in explaining participation in SEP, whereas the tuition required by establishments is inversely related to participation in SEP. These results are consistent with the cost-benefit analysis carried out by schools (Elacqua & Santos, 2013), given the limitations imposed by the SEP law and the high correlation of the vulnerability index with the number of priority students.

It is important to mention that the policy has been evaluated for different groups, in accordance with the research design of each article. Since the voluntary nature of SEP results in practice in universal coverage for public schools, Mizala & Torche (2013), Valenzuela et al. (2013) and Correa et al. (2014) focus their analysis of results in subsidized private schools where participation is partial; Elacqua et al. (PREAL, 2013) use a sample of urban schools in the Metropolitan Region. The most common parametric approach has been fixed effects and differences in differences methods, but some authors have attempted to isolate a causal effect through the use of instrumental variables (Peticara et al., 2013), matching (Valenzuela et al., 2013) and discontinuous regression (Elacqua et al., 2013). The divergence in results in different dimensions may be due to differences in identification assumptions or the estimation of different average local effects. One way to solve such problems is to perform a partial identification exercise based on weaker assumptions than those implied by

the parametric methods mentioned above.

## 2.4 Data

I use data from the standardized 4th grade tests (SIMCE) for the years 2006 to 2011<sup>15</sup> and administrative data from the Ministry of Education.

Our sample comprises a panel of 1,703 subsidized private schools that I observed for 6 years, for which I have information on SIMCE scores in both language and mathematics as well as the socioeconomic status of the school, the year it started SEP, the number of priority students, location, and enrollment<sup>16</sup>.

Table 2.1 shows the number of schools participating in SEP each year. The years prior to the implementation of SEP are 2006 and 2007, since schools only began participating in 2008. In the first year, 44% of these schools accepted SEP. This percentage increases over time reaching 60% of the sample in 2011.

This participation in the policy follows a clear pattern in terms of schools' socioeconomic status. Figure 5 2.5 shows participation in SEP according to the socioeconomic composition of schools<sup>17</sup>. In 2006, 40% of the schools in our sample were considered to have of medium-high socioeconomic status, 44% of middle socioeconomic status, and 16% of medium-low socioeconomic status. From 2008 onward, the participation in SEP of subsidized private schools is notoriously segmented according to their socioeconomic level. Whereas 81% of the

---

15. Item response theory (IRT) was used to estimate the SIMCE scores (same method used in PISA scores). This allows us to compare the scores across years and among different cohorts. The mean of the SIMCE is 250 points and the standard deviation is 50.

16. This data was constructed following Mizala & Torche (2013).

17. Socioeconomic status at the school level is constructed using mother's years of schooling, father's years of schools household income, and a vulnerability index (computed by the national agency in charge of scholarships in Chile). Averages of these four variables are computed at the school level and then standardized. Then, a cluster analysis is applied, aiming to code school socioeconomic status into five groups, from A (poorest) to E (richest). In 2013, 30% of schools were in group A, 34% of schools in group B, 21% of schools in group C, 10% of schools in group D, and 6% of schools in group E. For these purposes, I group categories A and B as "medium-low" socioeconomic status, category C represents "medium" socioeconomic status, and categories D and E as "Medium-high" socioeconomic status.

Table 2.1: Subsidized private schools in the data by SEP status and year

Year		No SEP	SEP	Total
2006	N	1,703	0	1,703
	%	100%	0%	100%
2007	N	1,703	0	1,703
	%	100%	0%	100%
2008	N	950	753	1,703
	%	56%	44%	100%
2009	N	797	906	1,703
	%	47%	53%	100%
2010	N	753	950	1,703
	%	44%	56%	100%
2011	N	677	1,026	1,703
	%	40%	60%	100%

Note: This table shows the 1,703 subsidized private schools in our sample for the period of our study (2006-2011) by SEP status.

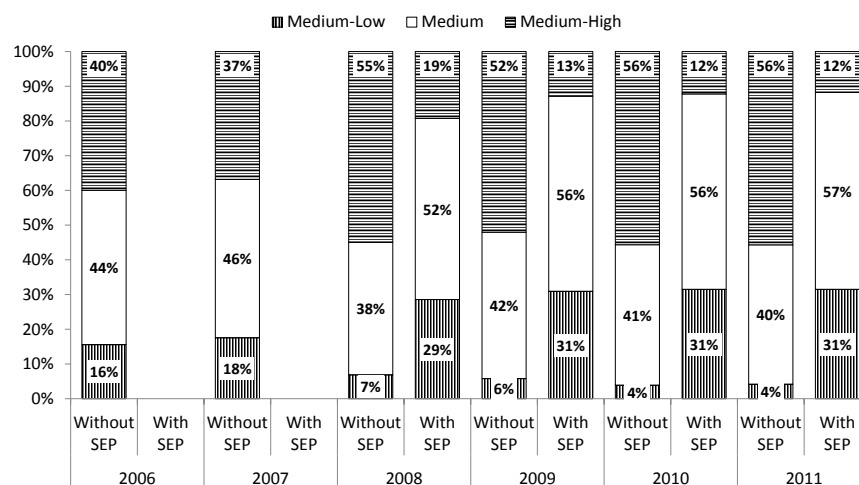
schools participating in SEP in 2008 are of low and medium-low socioeconomic status, 55% of those not participating are of medium-high socioeconomic status.

It is interesting to note how this composition changes over time. Table 2.2 shows the number of subsidized private schools by socioeconomic level for each year of their participation in SEP. Schools classified as being of medium-low and medium socioeconomic level have been increasingly participating in SEP. On the other hand, the number of schools in the medium-high group falls slightly from 2008 to 2009 and then remains constant until 2011.

Since educational establishments voluntarily decide when to apply for SEP, there is a natural difference in the amount of time in which establishments have been receiving the SEP. Table 2.3 shows the number and percentage of schools by the number of years that they have received SEP. About 40% never received SEP, but 44% started in 2008 and have therefore been receiving SEP for four years.

Figures 2.6 and 2.7 show the average SIMCE scores in mathematics and language for schools that have never participated in the SEP and those that have participated for four

Figure 2.5: Socioeconomic composition of subsidized private schools with and without SEP over time



Note: Subsidized private schools with and without SEP and their socioeconomic composition (SES). Horizontal lines represent medium-high SES, no lines are medium SES, and vertical lines are medium-low SES.

Table 2.2: Number of subsidized private schools in the data, by SEP status, SES level, and year

year	Without SEP			With SEP		
	Socioeconomic Level			Socioeconomic Level		
	Medium-Low	Medium	Medium-High	Medium-Low	Medium	Medium-High
2006	265	757	681			
2007	299	777	627			
2008	65	363	522	215	393	145
2009	46	336	415	280	509	117
2010	29	305	419	299	535	116
2011	28	272	377	323	582	121

Note: This table shows the 1,703 subsidized private schools in the sample divided their SEP status and SES level.

Table 2.3: Number of subsidized private schools in the data by number of years with SEP

Years under SEP	N	%
0	667	39.17
1	73	4.29
2	70	4.11
3	150	8.81
4	743	43.63
Total	1,703	100

Note: This table shows the number of schools in our sample receiving SEP for 0 to 4 consecutive years between 2008 and 2011.

years (from 2008 to 2011). The results suggest a positive and growing impact on mathematics scores, but seemingly no changes in language scores.

Figure 2.6: Evolution of SIMCE math scores for subsidized private schools that have had SEP for 4 years in 2011 and those who have never had it

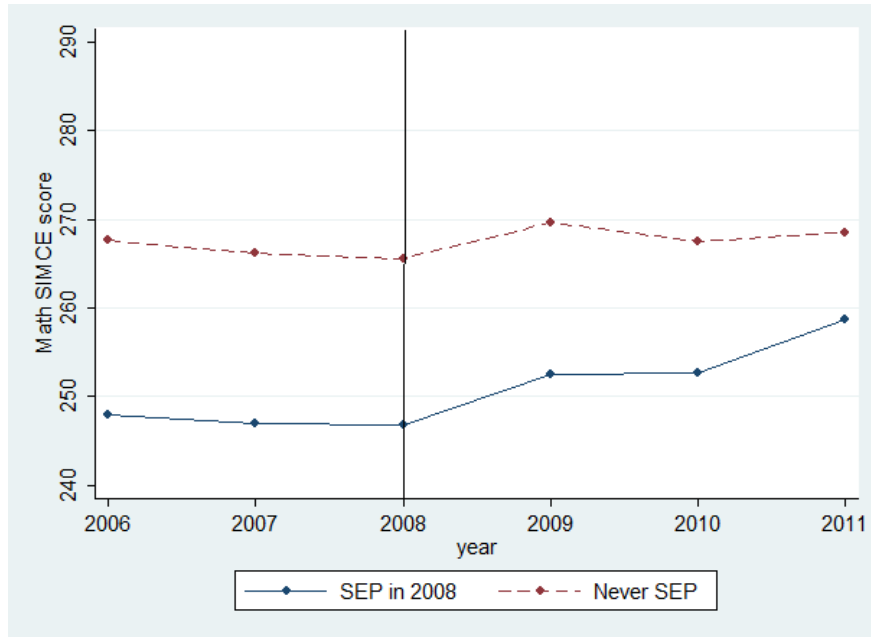
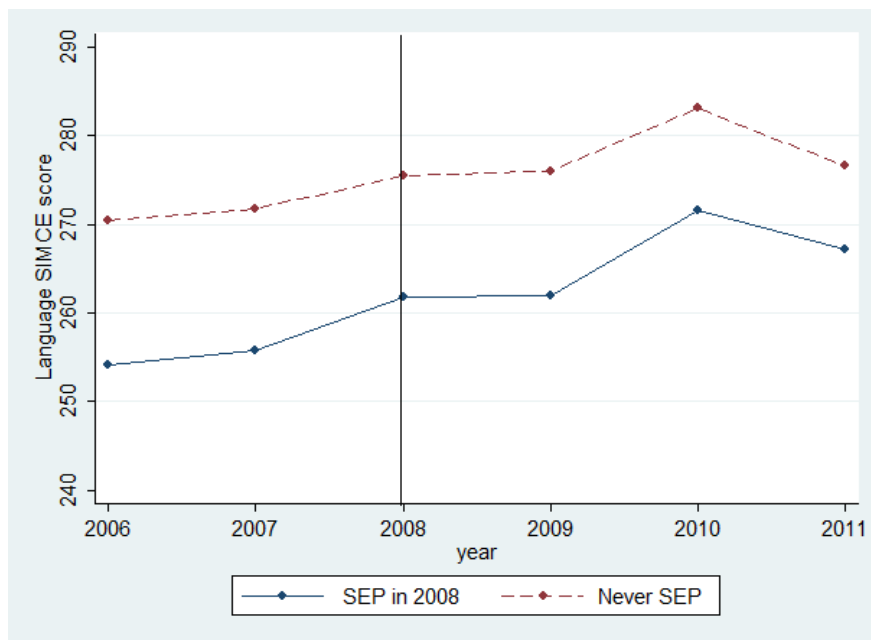


Figure 2.7: Evolution of SIMCE language score for subsidized private schools that have had SEP for 4 years in 2011 and those who have never had it



## 2.5 Methodology

In this section I use a conventional non-parametric approach, initiated by Manski in the early 1990s, to overcome the selection problem faced when trying to evaluate the impact of SEP. This method allows me to estimate the bounds of the causal effect of SEP on standardized test scores.

In our data, each school  $i$  in a year  $t$  has values for  $S, Y_s$ , and  $X$ , where  $S$  is a variable that indicates what “treatment” the school receives or its “treatment status”.  $Y_s$  is the achieved outcome, the average score on the SIMCE exam in school  $i$  and year  $t$  under treatment  $S = s$ ;  $Y_{s'}(s' \neq s)$  is a latent outcome, what the outcome would have been for that school year if  $S = s'$ ; and  $X$  is a vector of covariates, which are characteristics of school  $i$  in year  $t$ . The goal of this paper is to estimate:

$$ATE(s, s') = E(Y_s) - E(Y_{s'}) \quad \forall s > s'$$

$ATE(s, s')$  tell us the difference in expected outcome if all schools were assigned to treatment  $s$  or  $s'$ .

In order to perform this estimate, I am forced to make assumptions regarding the data, specifically the Stable Unit Treatment Value Assumption (SUTVA), or Individualistic Treatment Response (ITR) in Manski’s terminology, which implies that a school’s outcome varies only with its own treatment. In other words, the outcome of a school does not depend on the treatment status of other schools. The SEP status of other schools could affect the outcome of a particular school if, for example, this changes the sorting of the students and therefore the type of students in the school. However, Nielsen (2013) shows that there is not any changes in student sorting due to SEP.

Using only this first assumption and quantities readily calculated with the data at hand, I can start to form bounds on the potential outcome of a school given its treatment status. By the Law of Iterated Expectation (LIE):

$$E(Y_s) = \underbrace{E(Y_s|S = s)P(S = s)}_{\text{identified}} + \underbrace{E(Y_s|S \neq s)P(S \neq s)}_{\text{identified}}$$

$$E(Y_{s'}) = \underbrace{E(Y_{s'}|S = s')P(S = s')}_{\text{identified}} + \underbrace{E(Y_{s'}|S \neq s')P(S \neq s')}_{\text{identified}}$$

The sampling process does not identify  $E(Y_s|S \neq s)$  or  $E(Y_{s'}|S \neq s')$ . However, as Manski (1989) shows, if  $Y$  is concentrated in a given interval  $[K_0, K_1]$ , the conditional expectations of  $Y$  must also be concentrated within that interval. This allows us to obtain a bound for  $E(Y_s)$  and  $E(Y_{s'})$ .

$$E(Y_s) \in [A, B]$$

$$E(Y_{s'}) \in [C, D]$$

Where  $A$  and  $C$  are the values for  $E(Y_s)$  and  $E(Y_{s'})$  when I use  $K_0$  for  $E(Y_s|S \neq s)$  and  $E(Y_{s'}|S \neq s')$  respectively. Similarly,  $B$  and  $D$  are the values for  $E(Y_s)$  and  $E(Y_{s'})$  when I use  $K_1$  for  $E(Y_s|S \neq s)$  and  $E(Y_{s'}|S \neq s')$  respectively.

So, under the assumptions above:

$$ATE(s, s') \in [A - D, B - C]$$

This is the worst-case (broadest) bound and shows us what can be learned from the data with minimal assumptions. In this case, the bound always includes zero (Manski, 1990)<sup>18</sup>. Subsequently, I will add non-parametric assumptions that allow us to increase the lower bound.

---

18. This is easy to see for the case of two treatments:  $S = 1$  and  $S = 0$

$$\begin{aligned} A - D &= E(Y_1|S = 1)P(S = 1) + K_0P(S = 0) - E(Y_0|S = 0)P(S = 0) - K_1P(S = 1) \\ &= \underbrace{[E(Y_1|S = 1) - K_1]}_{\leq 0} P(S = 1) + \underbrace{[K_0 - E(Y_0|S = 0)]}_{\leq 0} P(S = 0) \end{aligned}$$

Before proceeding, I define the treatments analyzed in the paper. This considers two possible ways to classify treatment status. In the first classification scheme, each school's treatment status is binary: either a school accepted SEP vouchers the year before  $t$  or it did not. Thus, the treatment variable  $S$  will take the value of 1 if the school had SEP the year before or 0 if it did not. In the second classification scheme, each school's treatment status can take four values: the school's treatment status  $S$  at time  $t$  equals the number of consecutive years the school has accepted SEP vouchers before year  $t$ , i.e.,  $S$  can assume values between 0 and 3.

I start by describing the non-parametric assumptions that I use for the binary classification.

I start by describing the non-parametric assumptions that I use for the binary classification.

**1. First classification scheme: The effect of accepting SEP vouchers the year before  $t$  on school SIMCE scores in year  $t$ .**

I explore four different sets of assumptions to get an estimate of the ATE(1,0) bound

- (a) **Monotone Treatment Selection (Manski & Pepper, 2009):** The expectation is that schools with the treatment cannot perform better in terms of potential outcomes than schools without the treatment.

As described in Section ??, SEP provides additional monetary resources to schools accepting the most disadvantaged pupils. I showed in Section 2.2 that the schools opting for the SEP program had lower socioeconomic levels, which is highly correlated with worse academic outcomes. Also, schools with SEP have higher concentration of priority students, which by definitions are students whose socioeconomic situation obstructs the educational process (see Figure H.1 in the Appendix H). Therefore, it seems reasonable to impose a Monotone Treatment Selection (MTS) assumption, formally stated as:

$$E(Y_k|S = 1) \leq E(Y_k|S = 0) \quad \forall k = 0, 1 \tag{MTS.1}$$

The MTS concerns how schools decide whether or not to accept SEP. In this case I assume that, on average, disadvantaged schools opt for SEP. So, I argue that schools that do not opt for SEP have non-decreasing SIMCE scores regardless of the realization of the treatment<sup>19</sup>.

$$E(Y_1) = \underbrace{E(Y_1|S = 1)P(S = 1)}_{\textit{identified}} + E(Y_1|S = 0) \underbrace{P(S = 0)}_{\textit{identified}}$$

$$E(Y_0) = \underbrace{E(Y_0|S = 0)P(S = 0)}_{\textit{identified}} + E(Y_0|S = 1) \underbrace{P(S = 1)}_{\textit{identified}}$$

Imposing *MTS.1* I have that:

$$E(Y_1) \in [E(Y_1|S = 1), E(Y_1|S = 1)P(S = 1) + K_1P(S = 0)]$$

$$E(Y_0) \in [E(Y_0|S = 0)P(S = 0) + K_0P(S = 1), E(Y_0|S = 0)]$$

**(b) No time trends and policy invariance for schools' potential outcomes:**

**No time trend.** For every school (*Sch*)*i*, and years *t, t'*, the potential test score

---

19. It is important to note that MTS does not imply that every school with SEP is worse than every school without SEP.

outcomes with or without SEP ( $Y_1$ , and  $Y_0$ ) are independent of the calendar year:

$$E(Y_k|Sch = i, S = k, T = t) = E(Y_k|Sch = i, S = k, T = t') \quad \forall k = 0, 1 \quad (\text{iid.1})$$

In other words, this implies that there is nothing in the calendar time that affects the potential outcome. This may not hold if there are structural changes over the period besides SEP<sup>20</sup>.

**Policy invariance**<sup>21</sup>. The potential outcomes ( $Y_0, Y_1$ ) of a school are independent of the realization of the school's treatment status:

$$E(Y_k|Sch = i, S = 1, T = t) = E(Y_k|Sch = i, S = 0, T = t) \quad \forall k = 0, 1 \quad (\text{iid.2})$$

Policy invariance implies that the potential outcomes with or without SEP do not change based on whether or not school  $i$  actually opts for SEP.

It is important to note that using these two assumptions I fully identified  $E(Y_0)$ .

This is because:

$$E(Y_0) = \underbrace{E(Y_0|S = 0)P(S = 0)}_{\text{identified}} + E(Y_0|S = 1) \underbrace{P(S = 1)}_{\text{identified}}$$

---

20. I test if  $E(Y_0|S = 0, T = t)$  is different for  $t = 2005, 2006, 2007$  using an ANOVA test. I could not reject the null that all these expectations are equal. However, if I look at schools who received SEP in 2008 I observe that  $E(Y_1|S = 1, T = t)$  is different for  $t \geq 2008$ . This may be because there is a time trend or because the treatment is different over time as I try to test in our second classification schema.

21. Note that this is in fact a definition of potential outcomes at the school level.

$$\begin{aligned}
E(Y_0|S = 1) &= \sum_{i,t} E(Y_0|Sch = i, S = 1, T = t)P(Sch = i, T = t|S = 1) \\
&= \sum_{i,t} E(Y_0|Sch = i, S = 0, T = t)P(Sch = i, T = t|S = 1) \\
&= \sum_{i,t} \underbrace{E(Y_0|Sch = i, S = 0)}_{\text{identified}} P(Sch = i, T = t|S = 1)
\end{aligned}$$

For all the schools in our data I observe the outcomes without SEP (2006 and 2007 are years without SEP).

In the case  $E(Y_1)$  I partially identify it.

$$E(Y_1) = \underbrace{E(Y_1|S = 1)P(S = 1)}_{\text{identified}} + E(Y_1|S = 0) \underbrace{P(S = 0)}_{\text{identified}}$$

$$\begin{aligned}
E(Y_1|S = 0) &= \sum_{i,t} E(Y_1|Sch = i, S = 0, T = t)P(Sch = i, T = t|S = 0) \\
&= \sum_{i,t} E(Y_1|Sch = i, S = 1, T = t)P(Sch = i, T = t|S = 0) \\
&= \sum_{i,t} E(Y_1|Sch = i, S = 1)P(Sch = i, T = t|S = 0)
\end{aligned}$$

Under *iid.1* and *iid.2* I am able to observe  $E(Y_1|Sch = i, S = 1)$  for some schools. Specifically, for schools that change their treatment status at some point. I denote this group of schools as group  $G$ .

So, what matters is if schools  $i$  belongs or does not to  $G$ .

$$E(Y_1) = \underbrace{E(Y_1|Sch \in G)P(Sch \in G)}_{\text{identified}} + \underbrace{E(Y_1|Sch \notin G)P(Sch \notin G)}_{\text{identified}}$$

Using the fact that  $E(Y_1|Sch \notin G) \in [K_0, K_1]$ , I can bound  $E(Y_1)$ .

$$E(Y_1) \in [E(Y_1|Sch \in G)P(Sch \in G) + K_0P(Sch \notin G), E(Y_1|Sch \in G)P(Sch \in G) + K_1P(Sch \notin G)]$$

It is important to note that I can fully identify the  $ATE(i)$  for schools that change their treatment status at some point ( $Sch \in G$ ). In other words, the  $ATE(i)\forall i \in G = ATET$ .

- (c) **Monotone treatment selection 2:** Schools that never had the treatment cannot have worse potential outcomes than other schools.

This is a modification and a more restrictive version of MTS.1 and allows us to compare schools from both groups:

$$E(Y_1|Sch \in G) \leq E(Y_1|Sch \notin G) \tag{MTS.2}$$

MTS.2 assumes that if those schools that never accepted SEP vouchers ( $\notin G$ ) had accepted SEP vouchers in any year  $t$ , their test score outcomes cannot be worse on average than the schools (in  $G$ ) that received the SEP in any year  $t$ . The justification is similar to that of MTS.1: on average, the schools that did not accept SEP had a less vulnerable student population (see Figure H.2 in Appendix H), and before 2008 the SIMCE score for schools that have not get SEP were higher. Therefore, I expect the results of the SIMCE test to be better among students with more resources.

This assumption will allow us to bound  $E(Y_1|Sch \notin G)$

$$E(Y_1|Sch \notin G) \in [E(Y_1|Sch \in G), K_1]$$

Then,

$$E(Y_1) \in [E(Y_1|Sch \in G), E(Y_1|Sch \in G)P(Sch \in G) + K_1P(Sch \notin G)]$$

In the next section, I will show how *MTS.1* alone, *iid.1 + iid.2*, and *iid.1 + iid.2 + MTS.2* affect our estimates of the bounds.

2. **Second classification schema:** having the SEP for  $j$  consecutive years before the evaluation.

In this case  $S$  can take values between 0 and 3.

In order to evaluate our second treatment, I impose three sets of assumptions; two of which are modifications of the ones already explained.

(a) **No time trend and policy invariance for schools:**

In our database, whenever I observe a school that has received SEP vouchers for 2 consecutive years, I also observe it in the previous period in which the school had only accepted SEP vouchers for 1 year. The following non-parametric assumptions, which are modifications of assumptions *iid.1* and *iid.2*, allow us to exploit this fact in order to infer something about the incremental impact of receiving SEP vouchers:

$$E(Y_s|Sch = i, S = s, T = t) = E(Y_s|Sch = i, S = s, T = t') \quad \forall t, t', s \tag{iid.3}$$

$$E(Y_s|Sch = i, S = s, T = t) = E(Y_s|Sch = i, S = s', T = t) \quad \forall s \neq s' \quad (\text{iid.4})$$

*iid.3* assumes that there is nothing in time that changes the potential outcomes of a school. *iid.4* implies that the potential outcomes are independent of the realization of the treatment.

By assuming *iid.3* and *iid.4* I am saying that the six observations that I have per school are independent and identical distributed realizations of the vector  $(Y_s, S)$ . For some schools I will observe draws from all potential  $Y_s$ , and for others maybe only one. With this assumption I am not ruling out selection since I am not making comparisons across schools.

This defines a new variable for each school. Let's say that a school is in group  $G_s$  if treatment  $s$  is observed at some point. Given the above assumptions, if the school belongs to  $G_s$  I can identify its potential output given treatment  $s$  for any period.

Using this group notation and LIE I have:

$$E(Y_s) = E(Y_s|Sch \in G_s)P(Sch \in G_s) + E(Y_s|Sch \notin G_s)P(Sch \notin G_s)$$

Using *iid.3* and *iid.4* I fully identify  $E(Y_0)$ , because all the schools in our sample are observed without SEP at some point (i.e., before the introduction of the SEP program in 2008). So, all the schools  $\in G_0$ .

$E(Y_s)$  for  $s > 0$  are not necessarily identified for each school. For example, let's observe  $E(Y_1)$ .

$$E(Y_1) = \underbrace{E(Y_1|Sch \in G_1)P(Sch \in G_1)}_{\text{identified}} + E(Y_1|Sch \notin G_1) \underbrace{P(Sch \notin G_1)}_{\text{identified}}$$

The first term is identified for all the school in  $G_1$  (schools that received SEP for at least one year). The second term,  $E(Y_1|Sch \notin G_1)$ , is not identified because not all schools get SEP. Still this term can be bound using the fact that  $E(Y_1|Sch \notin G_1) \in [K_0, K_1]$ .

- (b) **Monotone treatment selection 3:** Schools that never received SEP vouchers ( $\notin G_1$ ) cannot have worse potential outcomes than other schools.

$$E(Y_s|Sch \in G_s) \leq E(Y_s|Sch \notin G_1) \quad \forall s > 0 \tag{MTS.3}$$

In other words for a school that never received SEP, the mean potential outcome with SEP for  $s$  years cannot be worse than the mean realized outcome of the schools observed getting SEP for  $s$  years. This assumption relies in the fact that schools that never got SEP  $\notin G_1$  have fewer priority students and higher socioeconomic levels than those schools that got SEP at some moment during the period.

Then, for example, in the case of  $E(Y_1)$  I can use  $E(Y_1|Sch \in G_1)$  as a lower bound for  $E(Y_1|Sch \notin G_1)$  instead of  $K_0$  <sup>22</sup>.

$$E(Y_1) \in [E(Y_1|Sch \in G_1), E(Y_1|Sch \in G_1)P(Sch \in G_1) + K_1P(Sch \notin G_1)]$$

In the case of:

---

22.  $E(Y_1|Sch \in G_1) \leq E(Y_1|Sch \notin G_1)$

$$E(Y_2) = E(Y_2|Sch \in G_2)P(Sch \in G_2) + \underbrace{E(Y_2|Sch \notin G_2)}_{not-identified}P(Sch \notin G_2)$$

$$E(Y_2|Sch \notin G_2) = E(Y_2|Sch \notin G_1)P(Sch \notin G_1) + E(Y_2|Sch \in G_1 \wedge \notin G_2)P(Sch \in G_1 \wedge \notin G_2)$$

Using *MTS.3* I can replace the lower bound of  $E(Y_2|Sch \notin G_1)$  by  $E(Y_2|Sch \in G_2)$  instead of  $K_0$ . For  $E(Y_2|Sch \in G_1 \wedge \notin G_2)$  I have not made any assumption, so I bound it using the fact that  $\in [K_0, K_1]$ .

A similar procedure can be applied to bound  $E(Y_3)$ .

(c) **Monotone treatment response assumption (Manski (1997))**

$$s > s' \Rightarrow E(Y_s|Sch = i) \geq E(Y_{s'}|Sch = i) \quad (\text{MTR})$$

The MTR implies that the SIMCE score is non-decreasing in the numbers of years the school has had SEP. This may be an assumption that the reader is not willing to make because it states that choosing SEP cannot have a negative impact on test scores. However, since SEP vouchers imply simply extra monetary resources, a school would have to do a very poor job with these extra resources to flip the sign of the inequality of MTR. On the other hand, it could be that having more years of SEP changes the sorting of students year over year, but there is not any evidence for this (Nielsen, 2013).

Using the MTR assumption I can increase the lower bound of  $E(Y_2)$  and  $E(Y_3)$ . For example,  $E(Y_2|Sch \in G_1 \wedge \notin G_2)$  must be greater or equal than  $E(Y_1|Sch \in G_1 \wedge \notin G_2)$  which is observed.

Also, because MTR is satisfied for each school, it implies that:

$$E(Y_0) \leq E(Y_1) \leq E(Y_2) \leq E(Y_3)$$

For this second treatment I study how *iid.3 + iid.4*, *iid.3+ iid.4+ MTS.3*, and *iid.3 + iid.4 + MTS.3 + MTR* affect our estimates of the bounds.

### 3. Inference

In each case I use sample means and empirical probabilities to get estimators for the lower and upper bound  $[\hat{L}_s, \hat{U}_s]$  of the ATE. The results are presented in the next section.

To infer I use the method proposed by Imbens & Manski (2004) as presented in De Haan (2015). I calculate a 95% confidence interval (CI) for the ATE adjusted to ensure uniform coverage:

$$\bar{CI}_{0.95} = (\hat{L}_s - C \times \hat{\sigma}_l, \hat{U}_s - C \times \hat{\sigma}_U)$$

Where  $\hat{\sigma}_l$  and  $\hat{\sigma}_U$  are the estimated standard errors of  $\hat{L}_s$  and  $\hat{U}_s$  respectively and  $C$  satisfies the following equation:

$$\Phi\left(C + \frac{\hat{U}_s - \hat{L}_s}{\max(\hat{\sigma}_l, \hat{\sigma}_u)}\right) - \Phi(-C) = 0.95$$

I use a bootstrap method with 1,000 bootstrapped samples to obtain the standard error.

## 2.6 Results

In this section I present the bounds for the two treatment specifications of interest: 1) the impact of getting SEP vouchers in the year prior to the evaluation (versus not accepting SEP vouchers that year), and 2) the impact of getting SEP for one, two, or three years prior to the evaluation (versus not accepting SEP, or in other words, having it for 0 years prior to the evaluation). In both cases, the outcome of interest is the average SIMCE score of a private subsidized school. All bounds and confidence intervals are in Tables ?? and ?? (in the Appendix H).

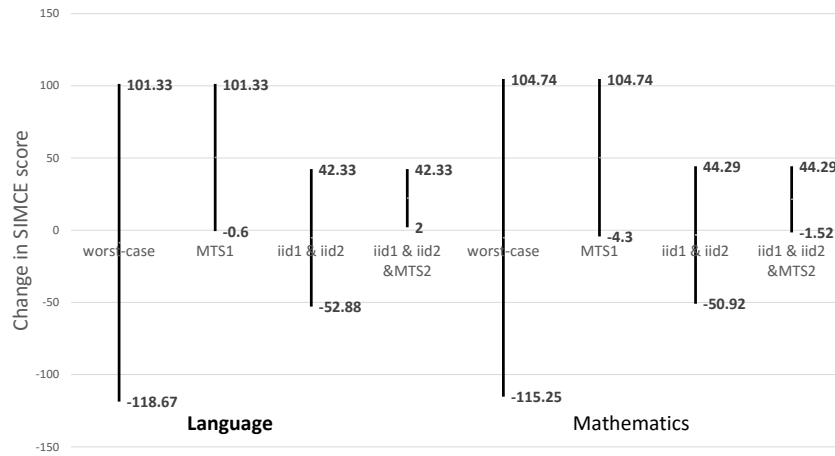
Figure 2.8 shows the bounds for the first treatment. The worst case scenario bounds use quantities that are readily calculated from the data, and leveraged the fact that SIMCE scores can only take values between 140 and 360 to substitute for the unobserved potential outcomes. These bounds are uninformative. Then, I apply MTS.1 assumption (schools that did not receive SEP had non-decreasing SIMCE scores, despite their decision regarding SEP) which substantially increases the lower bound of ATE, but the bounds still include zero<sup>23</sup>. The third case, is when I impose no-trend and policy invariance assumptions (iid.1 & iid.2) which reduce the upper bound and the lower bound, but still the bounds are uninformative. I obtain the tightest bound for this treatment effect when I am willing to assume iid.1, iid.2 and MTS.2 together. Recall that under MTS.2, I assume that schools that never had SEP had greater or equal potential outcomes than other schools. In this case, I find that accepting SEP vouchers in the previous year increases SIMCE scores in language by at least 2 points ( $0.04\sigma$ ), or 1.19 points using the lower confidence interval for the lower bound, although the lower bound for math scores is still negative at -1.52.

Figure 2.9 to Figure 2.11 show the non-parametric bounds on the effect of accepting SEP during X years prior to the evaluation versus never having accepted SEP. Again, the first case is the worst-case scenario bounds, which are not informative. Subsequently, I tighten

---

23. Even though we cannot guarantee that SEP has a positive ATE, we can say that SEP does not have a very negative effect on standardized score

Figure 2.8: Effect of having SEP on the average SIMCE score in language and math

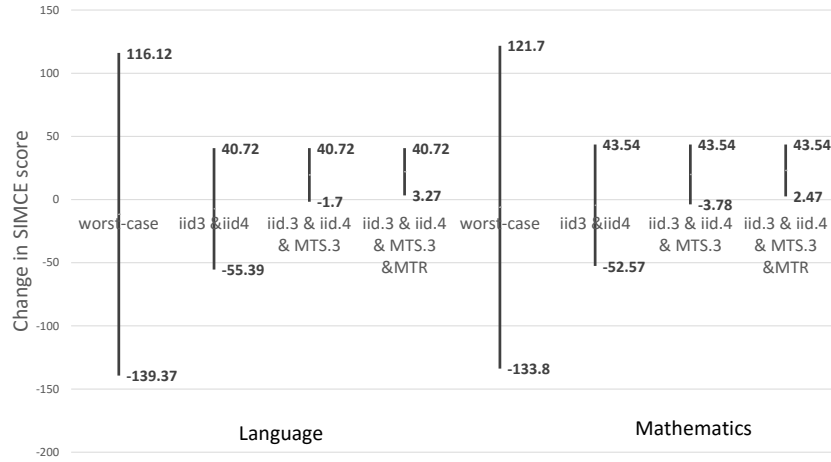


This figure shows the non-parametric bounds on the effect of accepting SEP the year before the SIMCE evaluation take place on the math and language SIMCE scores. Each vertical line represents a bound of ATE under different set of assumptions: no assumptions (the worst-case scenario), MTS.1, iid.1&iid.2, iid.1 & iid.2 & MTS.2. The first four bounds are for language SIMCE scores and the rest are for math scores.

the bounds by imposing iid.3 and iid.4. Then, I report what happens when I add MTS.3 assumption. MTS.3 implies that for schools that never accepted SEP, the mean potential outcome after SEP for  $s$  years is greater or equal than the mean realized outcome of the schools that I observe accepting SEP for  $s$  years. In this case, I found a positive bound in the case of language for the effect of accepting SEP for two years before the evaluation took place rather than not accepting SEP at all. Finally, I impose MTR assumption (SIMCE scores are non-decreasing in the number of years the school has accepted SEP). Assuming iid.3, iid.4, MTS.3 and MTR allows me to obtain positive bounds for all cases. For example, I find that accepting SEP vouchers for one year increases average SIMCE scores by at least 3.27 points in language ( $0.07\sigma$ ) and 2.47 points in mathematics ( $0.05\sigma$ ).

Note that I can say that having the SEP for 1, 2 or 3 years has a positive impact only when I add the MTR assumption. However, it implies that accepting SEP has a non-negative impact on test scores. Therefore, if I can rule out a negative effect of SEP on student test scores and other time-varying factors, I may be able to reliably bound the positive impact

Figure 2.9: Effect of having SEP one year versus never having had it on the average SIMCE scores in language and math



This figure shows the non-parametric bounds on the effect of having SEP for one year before the SIMCE evaluation takes place versus never having SEP on both math and language SIMCE scores. Each vertical line represents a bound of ATE under different a set of assumptions: no assumptions (worst-case scenario), iid.3 & iid.4, iid.3 & iid.4 & MTS.3, iid.3 &iid.4 & MTS.3 & MTR. The first four bounds are for language SIMCE scores and the rest are for math scores.

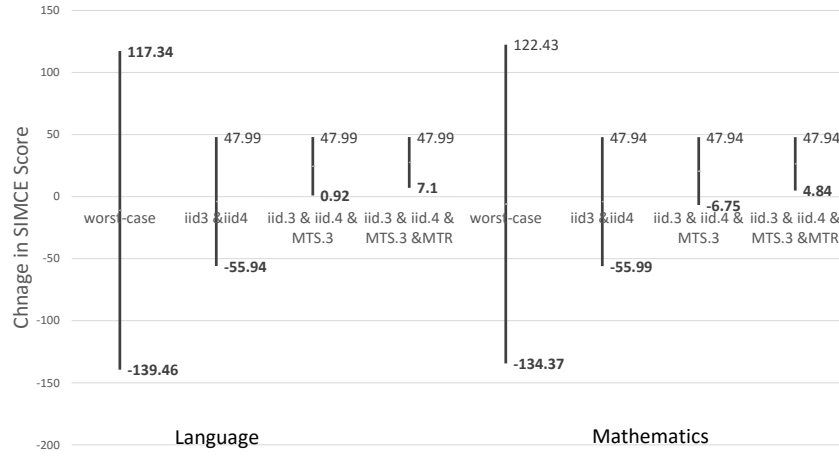
of the program without reliance on parametric assumptions.

If I only assume iid.3 & iid.4 & MTS.3, the estimated bounds for language increase over time until the second year. After the second year, I am not sure that having SEP for an additional year will yield to higher expected scores. This result does not hold for the case of mathematics where over time the bounds are larger and less informative. Figure 2.12 visualizes my findings showing the lower bounds of the  $ATE(0,s)$  under iid.3 & iid.4 & MTS.3 assumptions.

### 2.6.1 Comparison of Results

Now I compare my results with a popular parametric approach that has been used for evaluating SEP. As in Mizala & Torche (2013), I estimate the impact of SEP on school academic performance using fixed effects at the school level to control for unmeasured, time-invariant characteristics of schools that might affect the outcome. This method produce

Figure 2.10: Effect of having SEP for two years versus never having had it on the average SIMCE scores in language and math



This figure shows the non-parametric bounds on the effect of having SEP for two years before the SIMCE evaluation take place versus never having accept SEP on both math and language SIMCE scores. Each vertical line represents a bound of ATE under a different set of assumptions: no assumptions (worst-case scenario), iid.3 & iid.4, iid.3 & iid.4 & MTS.3, iid.3 & iid.4 & MTS.3 & MTR. The first four bounds are for language SIMCE scores and the rest for math scores.

estimators of the ATT and the results show a positive and moderate impact of SEP on academic achievement.

Fixed effects deal with the selection problem in a different way than the non-parametric bound analysis. In fact, in the non-parametric method I imposed several assumptions (some of them very strong: no time trends and policy invariance), each of which were supported by the nature of the policy. On the other hand, fixed effect methodology assumes that everything that explains selection into SEP is unobservable and does not change over time<sup>24</sup>. This assumption implies that over the period of time of this study (6 years), everything that is unobservable and explains the selection into SEP will be capture in the school fixed effect.

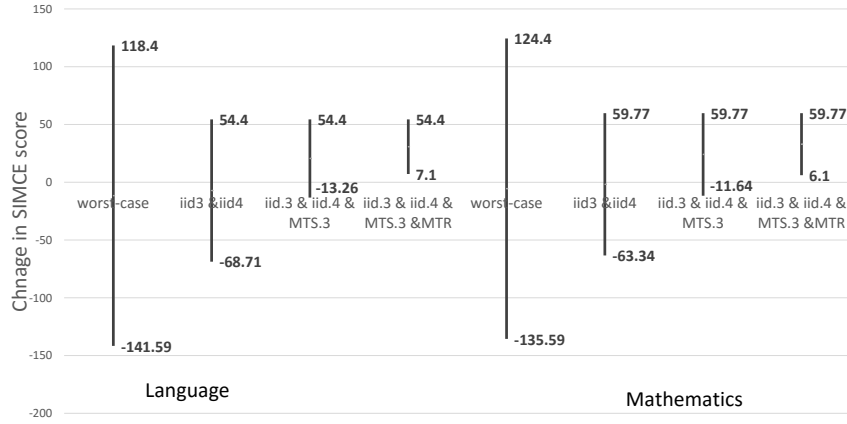
The following specification captures a simple fixed effect approach,

$$Y_{st} = \alpha + \gamma SEP_{st-1} + \phi_t + \mu_s + \varepsilon_{st} \quad (1)$$

---

24. Strong exogeneity assumption

Figure 2.11: Effect of having SEP for three years versus never having had it on the average SIMCE scores in language and math



This figure shows the non-parametric bounds on the effect of having SEP for three years before the SIMCE evaluation take place versus never having SEP on both math and language SIMCE scores. Each vertical line represents a bound of ATE under a different set of assumptions: no assumptions (worst-case scenario), iid.3 & iid.4, iid.3 & iid.4 & MTS.3, iid.3 & iid.4 & MTS.3 & MTR. The first four bounds are for language SIMCE scores and the rest for math scores.

In this model, the SIMCE of school  $s$  in year  $t$  ( $Y_{ist}$ ) is a function of the SEP status of school  $s$  in time  $t - 1$  ( $SEP_{st-1}$ ), a school fixed effect  $\mu_s$  and a year fixed effects  $\phi_t$ <sup>25</sup>.

Specification 1 captures the average SEP effect across all post-SEP years. In order to tease out the effect of SEP over multiple years, I try a second specification that captures the duration of the school's enrollment in SEP. Specifically, I evaluate the impact of having SEP for 1, 2, or 3 years before the SIMCE evaluation takes place.

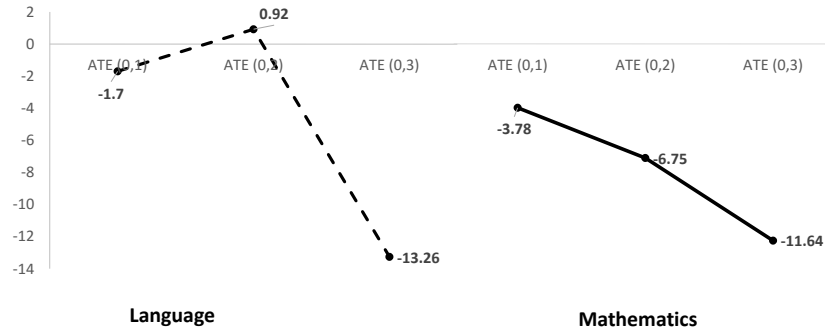
$$Y_{st} = \sum_{e=1}^3 \gamma_e D_{st}^e + \mu_s + \phi_t + \varepsilon_{st} \quad (2)$$

where  $D_{st}^e$  is a dummy variable that takes the value of 1 if school  $s$  has participated in SEP for  $e$  years. This approach estimates three post-SEP effects ( $\gamma_1, \gamma_2, \gamma_3$ ).

Table 2.4 reports the estimators of  $\hat{\gamma}$  of specification 1 and  $\hat{\gamma}_e$  of specification 2. Note

<sup>25</sup>. I control for a year fixed effect to be able to eliminate any time trends that could be changing school performance such as teachers and/or principals becoming more effective over the time period.

Figure 2.12: Lower bounds for ATE(0,s) in language and math



This figure shows the lower bounds on the effect of having SEP for  $s$  years before the SIMCE evaluation takes place versus never having SEP on both math and language SIMCE scores. All of these lower bounds are under iid.3 & iid.4 & MTS.3. The first three lower bounds are for language SIMCE scores and the rest for math scores.

it is very similar to the results of Mizala & Torche (2013).

Columns labeled (1) show the estimator of  $\hat{\gamma}$  from specification 1. The estimated coefficient suggests that having SEP the previous year increases the SIMCE score in language by 3.1 points ( $0.06 \sigma$ )<sup>26</sup> and the math SIMCE score by 4.2 points ( $0.08 \sigma$ )<sup>27</sup>. These point estimators are inside the bounds, which is expected given the width of the estimated intervals. In the case of language if iid.1 & iid.2 & MTS.2 are valid assumptions the bound approach also predicts a certainly positive impact on language (lower bound is positive). In the case of math, the bound analysis was not able to predict positive results with certainty under any set of assumptions, so if one accepts the assumptions of fixed effect it can be argued that the effect of having SEP the previous year is positive for both subjects.

Columns labeled (2) show the results of specification 2. here are three estimators: the impact of having SEP  $X$  years before the SIMCE evaluation where  $X = 1, 2, 3$ . The impact of having SEP the previous year on SIMCE scores is larger when the school has had more

26. The lower bound of the CI is 2.1 points.

27. The lower bound of the CI is 3.1 points.

Table 2.4: Results of fixed effect models

Variable	Language		Mathematics	
	(1)	(2)	(1)	(2)
SEP	3.098*** (0.505)		4.238*** (0.574)	
SEP1		1.477*** (0.585)		1.732*** (0.626)
SEP2		3.722*** (0.632)		4.743*** (0.729)
SEP3		6.195*** (0.801)		9.614*** (0.896)
N	1,703	1,687	1,703	1,687

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

All regressions include year and school fixed effects. Standard errors are clustered at the school level. The number of each of the columns corresponds to the number of the specification. SEP1, SEP2, SEP3 are the post-SEP effects for having SEP for 1, 2, and 3 years before the SIMCE evaluation respectively.

years of SEP. For instance, the impact of having one year of SEP is positive on language (1.48 points), but the impact of having SEP for 2 years is greater in magnitude (3.7 points) and the impact of having SEP for 3 years is even larger (6.2 points). The estimated impacts are even larger in math than in language. These results show evidence that SEP increases school academic performance and that this impact is larger when the school has had more years of SEP, a conclusion not possible when using the non-parametric bound approach. In fact, using that approach and assuming iid.3 & iid.4 & MTS.3 the estimated bounds for language increase until the second year, but the lower bound was still negative. This result did not hold for the case of mathematics where over time the bounds became less informative.

These results depend completely on the fixed effects assumption, which is very strong. It is important to mention that under strong assumptions (policy invariance and no time trend) I fully identify ATT (in the bound analysis). In math the point estimator is 6.36 points (bigger than the FE estimator). The same happens in language. One might be tempted to think that these numbers are evidence of the SEP having a positive impact on the treated, but one should be careful. The results of each of the method are robust only if the assumptions are as well.

## 2.7 Conclusion

Like many important public policy reforms, SEP is difficult to evaluate because of its wide national implementation and voluntary nature. This paper addresses the selection problem by using a nonparametric analysis to estimate the bounds of the causal effect of SEP on fourth grade standardized test scores (SIMCE). I analyze the ATE in SIMCE scores as if all private subsidized schools get SEP.

First, I study the impact of having SEP the year before the SIMCE evaluation. I find, under a set of assumptions (Monotone Treatment Selection (MTS), no time trends, and policy invariance), that having SEP increases the SIMCE language scores by at least 2 points ( $0.04\sigma$ ). These results are robust only if the assumptions are accepted. Under a weaker set of assumptions, I cannot guarantee that the ATE on language SIMCE score will be positive. For math SIMCE scores I am not able to say that the ATE is positive in any case. When I consider a different treatment that takes the time that a school has been getting SEP (1,2 or 3 years) into consideration, I find that under similar assumptions the impact of the policy increases over time (i.e. having SEP for more years is better) until the second year. After the second year, it is not sure that having SEP for an additional year will yield to higher scores in expectation. There are many reason why this could be happening: perhaps schools need only 2 years to learn how to effectively use the subsidy, or it may be that this data simply does not have enough schools with 3 years of SEP to allow me to narrow the bounds for  $ATE(0,3)$ . In any case, these results suggest that that it takes time to observe the full effect of the policy and therefore time needs to be taken into consideration when evaluating SEP.

Finally, I compare my results with those that I get using a simple school fixed effect model. This results are not fully comparable, because fixed effects allow us to get an estimator for the ATT. However, under certain assumptions I am able to point identify the ATT at the school level in the non-parametric setting.

Parametric and not-parametric approaches deal with the selection problem in different

ways, applying different set of assumptions. I leave the final decision about which set of assumptions is stronger to the reader. However, since in the non-parametric approach a positive but moderate impact of SEP arises only when we have strong assumptions (as policy invariance and no time trends), I am tempted to argue that SEP does not have a strong effect on SIMCE scores. Also, I am tempted to say that in the worst case if SEP is a harmful policy the negative impact is almost zero (because applying only MTS the lower bound is almost zero). On the other hand, increasing the amount of time a school has SEP seems to have an effect on SIMCE scores. One reason why we do not observe better results might simply be because schools do not know how to manage the extra resources. If that is true, the policy should increase its focus on resource management to increase SEP's effectiveness.

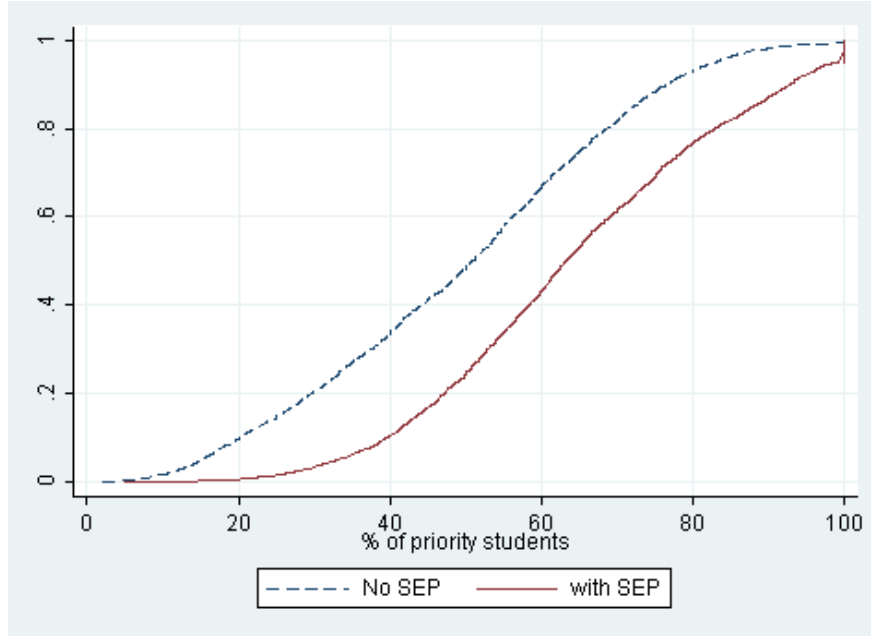
## 2.8 Appendix H: Additional Tables and Figures of Chapter 2

Table H.1: Percentage of priority students as a function of the total enrollment in the school, by type of school and year

Year	Municipal Schools (N)	Mean	Sd	p25	p50	p75
2008	5,172	35.46	19.94	21.35	31.67	47.06
2009	5,217	51.30	22.22	36.87	48.48	66.67
2010	4,988	58.91	23.91	41.67	53.98	77.27
2011	5,082	57.71	23.83	44.56	57.14	73.33
2012	5,497	66.46	18.35	54.27	66.04	79.35
2013	5,412	76.35	16.90	66.07	77.15	89.53
2014	5,313	73.57	16.91	63.20	74.10	85.71
Year	PS Schools (N)	Mean	Sd	p25	p50	p75
2008	3,895	17.19	19.62	2.74	8.90	25.28
2009	4,562	28.79	24.32	8.44	22.86	42.76
2010	4,024	36.02	26.44	15.23	29.79	50.52
2011	4,827	32.17	26.34	9.09	27.12	49.31
2012	5,927	48.48	22.08	32.35	46.92	62.45
2013	5,997	57.51	22.77	41.18	57.69	73.81
2014	6,044	56.85	21.61	41.78	57.14	72.15

This table shows the number schools by sector each year since 2008 and some statistics of the distribution of the percentage of priority students in the school.

Figure H.1: Cumulatives: percentage of priority students in private subsidized schools with versus without SEP in 2014



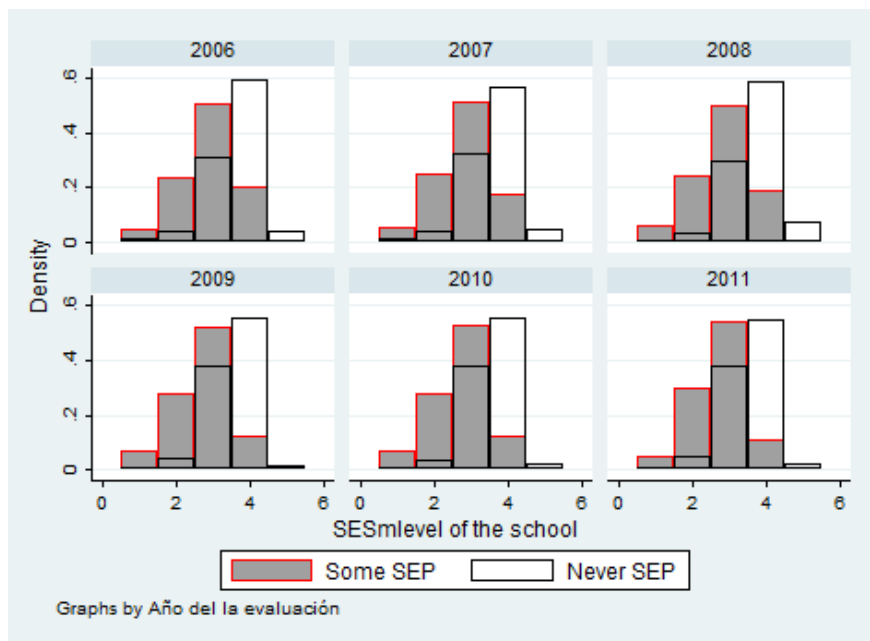
This graph shows the percentage of priority students in private subsidized schools with SEP first order stochastically dominates (FOSD) the percentage of priority students in private subsidized schools with SEP

Table H.2: Summary of results for first classification scheme  $ATE(0, 1)$

		Lower bound	Upper bound	Confidence interval	
Language	Worst-Case	-118.67	101.33	-119.10	101.76
	MTS.1	-0.6	101.33	-1.38	101.76
	iid.1 + iid.2	-52.88	42.33	-55.68	43.92
	iid.1 + iid.2+MTS.2	2	42.33	1.19	43.92
Math	Worst-Case	-115.25	104.74	-115.67	105.16
	MTS.1	-4.3	104.74	-5.20	105.16
	iid.1 + iid.2	-50.92	44.29	-53.55	46.11
	iid.1 + iid.2 + MTS.2	-1.52	44.29	-2.49	46.11

This table shows the non-parametric bounds and the confidence intervals for our estimator of the ATE when the treatment is having SEP. We report the bounds under 4 set of assumptions and for language and math SIMCE score.

Figure H.2: Socioeconomic composition of private subsidized schools by SEP status



Note: This graph shows the distribution of the socioeconomic composition of private subsidized schools in my sample that received SEP at some point after 2008 and those that did not received SEP during that period. The socioeconomic level of the school (SES) goes from 1 to 5, where: 1=low SES, 2=medium-low SES, 3=medium SES, 4=medium-high SES, and 5=high SES

Table H.3: Summary of results for second classification scheme  $ATE(0, s)$

		Lower bound	Upper bound	Confidence interval	
ATE(0,1) Language	Worst-Case	-139.37	116.12	-140.07	116.95
	iid.3 + iid.4	-55.39	40.72	-58.19	42.41
	iid.3 + iid.4 + MTS.3	-1.7	40.72	-2.71	42.41
	iid.3 + iid.4 + MTS.3+ MTR	3.27	40.72	2.81	42.41
ATE(0,1) Math	Worst-Case	-133.80	121.70	-134.53	122.51
	iid.3 + iid.4	-52.57	43.54	-55.21	45.44
	iid.3 + iid.4 + MTS.3	-3.78	43.54	-4.93	45.44
	iid.3 + iid.4 + MTS.3+ MTR	2.47	43.54	1.98	45.44
ATE(0,2) Language	Worst-Case	-139.37	117.34	-140.16	118.18
	iid.3 + iid.4	-55.94	47.99	-58.87	49.55
	iid.3 + iid.4 + MTS.3	0.92	47.99	-0.41	49.55
	iid.3 + iid.4 + MTS.3+ MTR	7.1	47.99	6.58	49.55
ATE(0,2) Math	Worst-Case	-134.37	122.43	-135.09	123.25
	iid.3 + iid.4	-55.99	47.94	-58.63	49.87
	iid.3 + iid.4 + MTS.3	-6.75	47.94	-8.10	49.87
	iid.3 + iid.4 + MTS.3+ MTR	4.84	47.94	3.87	49.87
ATE(0,3) Language	Worst-Case	-141.59	118.40	-142.26	119.23
	iid.3 + iid.4	-68.71	54.40	-71.53	56.08
	iid.3 + iid.4 + MTS.3	-13.26	54.4	-15.07	56.08
	iid.3 + iid.4 + MTS.3+ MTR	7.1	54.44	6.58	56.08
ATE(0,3) Math	Worst-Case	-135.59	124.4	-136.30	125.21
	iid.3 + iid.4	-63.34	59.77	-66.05	61.63
	iid.3 + iid.4 + MTS.3	-11.64	59.77	-13.46	61.63
	iid.3 + iid.4 + MTS.3+ MTR	6.1	59.77	5.20	61.63

This table shows the non-parametric bounds and the confidence intervals for our estimator of the ATE when the treatment is having the SEP for 1,2 or 3 years versus never having had it. We report the bounds under 4 set of assumptions and for language and math SIMCE score.

# CHAPTER 3

## THE IMPACT OF TARGETED VOUCHERS ON TEACHER TURNOVER: THE CASE OF CHILE

### 3.1 Introduction

In this paper, I study the impact of giving extra money to disadvantaged schools on teacher turnover. Schools that serve students with low socioeconomic backgrounds are known as disadvantaged schools<sup>1</sup> (OECD, 2012). It is well documented that these schools have lower academic performance than advantaged schools (Reschovsky and Imazeki, 2001), and face challenges attracting and retaining effective teachers (Lankford et al., 2002). A common policy to address these issues is giving more funds to disadvantaged schools<sup>2</sup>. In general, this type of policy is evaluated in terms of its impact on student academic achievement. However, in reality, policies like this may affect many other outcomes. An important outcome that can be affected by increased funds is the teacher/school separation rate or teacher turnover (the rate at which teachers separates from schools from one school year to another). This may happen because additional resources could affect working conditions<sup>3</sup>. Studying how these policies affect teacher/school separation is very important as it allows us to deeply understand how teacher labor markets function and thereby suggest future directions for research and policy innovations.

To evaluate how extra monetary resources impact teacher/school separation, I exploit a change in the Chilean educational system. In 2008 the “Subvención Escolar Preferencial” (from here on SEP) was introduced. This subsidy provides schools that serve the most

---

1. Schools where the average socioeconomic background of students is below the national average.

2. There are many countries that have been increasing school resources with the goal of improving pupil achievement. For example, the Netherlands with the Learning Support policy (De Haan, 2015), France with its priority zones (Bénabou et al., 2009), and US with the introduction of Title I in 1965 (Van der Klaauw, 2007) and the No Child Left Behind Act in 2001 (Springer, 2008).

3. Previous research has shown that working conditions are one of the most important factors that determine if a teacher stays or leaves a school (Balu et al., 2010).

disadvantaged students with extra resources (around 50% additional funds per disadvantaged student). Specifically, the SEP is an extra subsidy available for each student identified as a priority in terms of her socioeconomic status. In order to receive these extra funds, a school must: i) propose an educational improvement plan, ii) accept higher levels of supervision, and iii) ensure that all students who wish to attend the school are permitted to do so<sup>4</sup>. Schools have the choice of whether or not to accept the additional benefits.

If schools accept SEP (SEP schools), they can use the extra money in any way as long they spend it on items that will improve pedagogical practices and, by extension, boost academic performance. Everything must be specified and justified in the improvement plan that is presented annually and checked by the government. Schools can buy didactic materials, hire new staff, provide training courses for teachers, hire external management consultants, and/or support recreational activities that improve the school's sense of community<sup>5</sup>. In practice, it has been shown than SEP schools spend money on items that make teachers' work easier: learning resources, hiring new staff or hiring current staff for more hours (Peticara et al., 2013)<sup>6</sup>.

In addition, in order to reduce discrimination, SEP schools cannot select their students and it is difficult for them to end the enrollment due to academic performance. Because this restriction may change the composition of the students differently in different schools, participation in the voluntary SEP program is much higher in schools that serve to a disadvantaged population (see figure 1 in the Appendix I)<sup>7</sup>.

---

4. Specifically: (i) No copayment for priority students. (ii) No selection based on performance or student socioeconomic levels from pre-kindergarten through 6th grade. (iii) The educational establishment's option to end the enrollment of students from pre-kindergarten through 6th grade due to poor academic performance is limited.

5. All the expenses that a school does has to be classified into one of the following categories: goods and services, staff, training and consulting, teaching and educational resources, school equipment, and contingencies

6. Statistics from the Chilean Ministry of Education reveal that in 2013, 51% of the total expenditure was in the "staff" category, mostly in extra hours for current staff.

7. In 2015 65% of the Chilean students were enrolled in one of the 7,951 schools that accepted SEP vouchers (66% of Chilean schools). Of the schools with SEP, 62% were public.

Given the nature of the policy, it is easy to argue that SEP affects both pecuniary and non-pecuniary job characteristics. If teachers value the working environment, working in a SEP school should affect teachers in some way (positively or negatively). Teachers outside SEP schools might also be affected. For example, teachers who were not considering working in a disadvantaged school might change their minds based on the school receiving SEP.

To identify the impact of SEP on teacher turnover I estimate the probability that a school and a teacher end their job relationship in the next year using a linear probability model. I control for year and school fixed effects and observables characteristics of both, the teacher and the school. I also evaluate the impact of having SEP for one, two, or three or more years and test if the impact is larger for teachers in their first year of teaching.

I use administrative public data about teachers and their schools. Specifically, I follow individuals who entered into the educational system between 2005-2010 who were less than 42 years old when they started working. I follow them until 2013, and I am able to observe how much time they spend in each school and when (if) they leave the system. I restrict the sample to private subsidized schools<sup>8</sup> that did not close during the period, that have at least 10 teachers, that have at least one measure of standardized test scores (language or math) for 4th grade students, and that have not changed the SEP status over the time period.

The impact of SEP on the teacher/school separation rate it is no obvious. For instance, for schools with a large number of priority students, that have never been able to discriminate when selecting their students, and that face a lot of supervision from the government SEP is in reality simply additional funding without substantial changes. However, for schools that are able to discriminate students by their socioeconomic status (by asking for a tuition co-payment) SEP could be less appealing given the introduction of real constraints. In the first group of schools, SEP may improve working conditions and prevent teachers from leaving. However, the final retention outcome is still unclear because teachers may want to stay, but

---

8. Chile has three types of schools, which vary in how they are funded. Public schools are financed by the Chilean government while subsidized private schools are financed by the Chilean government and possibly with parental co-payments. Private are privately funded

SEP could attract more applicants to the school, allowing the principal to replace current teachers<sup>9</sup>. On the other hand, for schools where SEP restrictions actually constrain, working conditions may worsen. For example, increased governmental supervision might introduce an extra workload that might encourage teachers to leave SEP schools, with those who have better outside options (usually the more effective teachers) the first ones to leave.

I find that SEP increases teacher turnover in private subsidized schools and this impact is larger when the school has had more years of SEP. My results also suggest that having SEP for one year does not affect teachers in their first job at all. However, having SEP for two or more years affects all teachers independently of the years of experience. This might be explained because usually teachers in their first job have a high turnover rate no matter what. Then, to affect that in a significant way, the school would have to make a substantive differences that it can only be achieve with more than one year of SEP.

It is important to note that a high teacher/school separation rate is not necessary desirable or undesirable. High turnover can be seen as a negative outcome because it can destabilize the learning process of students (Balu et al., 2010). For example, it can be hard for schools to invest in teacher training if they cannot ensure the return of it because of high teacher rotation rate. Also, teacher turnover can be a bad outcome if the teachers that leave are replaced with new (inexperienced) teachers<sup>10</sup>. On the other hand, high turnover could be a desirable outcome if this implies that schools are replacing low-quality teachers with high quality ones (assuming that the principal can identify an ineffective/effective teacher). In this case, schools may be better off with a high rate of turnover.

The paper proceeds as follows. In Section 3.2, I present a background about teacher mobility. In Section 3.3, I describe the Chilean educational system and the SEP policy.

---

9. These new applicants could come from either outside or inside the educational system, changing the sorting of talent across more versus less disadvantaged schools.

10. This is because teacher experience can be related to students' higher academic performance (Lankford et al., 2002; Clotfelter et al., 2006; Clotfelter et al., 2008). However, this may not be true in Latin American countries, since new teachers might be better educated. Not enough research has been done to determine how this works in Chile.

Section 3.4 describes the data used in this study. Section 3.5 presents the methodology while Section 3.6 discusses the results. Finally, Section 3.7 concludes.

Previous research has shown that sorting and retention of teachers is affected by many factors. First, there is some evidence that teachers respond to salaries. Specifically, the higher the opportunity wages outside teaching, the more likely teachers are to leave for an alternative career (Dolton and Van der Klaauw, 1999)<sup>11</sup> and differences in salaries inside the educational system are important when trying to understand shifts between schools (Imazequi, 2005)<sup>12</sup>.

However, pecuniary characteristics of the school are not the only important ones. Non-pecuniary characteristics, such as facilities, multi-track classrooms, and lack of textbooks, are strong and significant factors that predict high turnover rates (Loeb et al., 2005)<sup>13</sup> Schools' geographic location is important because teachers tend to work in the area where they attended high school (Boyd et al., 2005<sup>14</sup>, 2013<sup>15</sup>). The characteristics of the school student body characteristics also play an important role. For instance, teachers are more likely to leave schools that serve low-achievement students (Boyd et al., 2005; Hanushek et al. 2004<sup>16</sup>), they may prefer to have a smaller proportion of impoverished students, and in the case of white teachers, to have a smaller proportion of minority students (Lankford et al., 2002<sup>17</sup>; Scafidi et al., 2007<sup>18</sup>; Boyd et al., 2013).

There are other underlying characteristics that might affect sorting and retention. For example, effective teachers are less likely to transfer or even to leave the educational system

---

11. Using data from individuals who graduated from British universities.

12. Using data for new teachers in Wisconsin.

13. Using data from California.

14. Using data from New York State public schools.

15. First-through sixth-grade teachers across schools in the Albany-Schenectady-Troy, Buffalo, Rochester, Syracuse, and Utica-Rome metropolitan areas for school years 1994-95 through 1999-2000.

16. Texas public school data.

17. New York State Data

18. Data from Georgia.

(Boyd et al., 2008<sup>19</sup>; Goldhaber et al. 2007<sup>20</sup>), but puzzling, teachers with better pre-service qualifications, such as certification exam scores and college competitiveness, are more likely to apply for transfers (Boyd et al., 2005, 2010<sup>21</sup>).

Finally, school practices are likely to play an important role as well. Not surprisingly, schools prefer to hire higher quality teachers (Boyd et al., 2010, 2013), teachers living in closer proximity to the school (Boyd et al., 2013), and more effective schools seem to recruit and retain better teachers (Loeb et al., 2012)<sup>22</sup>.

In the case of Chile, research has shown that private subsidized schools attract better teachers than public schools (Behrman et al., forthcoming)<sup>23</sup> and that teachers with better unobservable skills (e.g., persistence, reliability, and self-discipline) self-select into private schools (Correa et al., 2014)<sup>24</sup>. Chilean teachers tend to move more both inside and outside the educational system during their first years of experience and between schools of the same administrative type. Like in the US, there is a positive correlation between school type of the teacher's initial position and the school type of the teacher's high school (Cabezas et al., 2011)<sup>25</sup>. Teachers who studied at less selective universities are concentrated in vulnerable schools (Ortúzar et al., 2009), and there is a negative correlation between the INICIA test<sup>26</sup> results and the socioeconomic level of the school where the teacher ends up working (Bascopé and Meckes, 2010).

---

19. Data from New York City.

20. Using data from North Carolina.

21. Data from an open-market system for NYC teachers to apply for transfers.

22. Using Californian data.

23. Using two Chilean surveys: Encuesta de Protección Social (EPS) and the Chilean Teaching Longitudinal Survey 2009.

24. Using the Chilean Teaching Longitudinal Survey from 2009. They use a Roy model approach and concentrate the analysis identifying the coefficients that accompany the inverse Mills ratio.

25. Using the Chilean Teaching Longitudinal Survey from 2005 and 2009.

26. The INICIA exam is given during the final year of teacher education programs. It has been administered since 2009, but is optional and few teachers have taken it.

## 3.2 The Chilean education system, the SEP policy

### 3.2.1 *The education system in Chile*

Schooling is mandatory in Chile from kindergarten to 12th grade. The K-12 Chilean school system is divided into primary education (from kindergarten to eighth grade) and secondary education (from ninth to twelfth grade)<sup>27</sup>.

Chile has three types of schools, which vary in how they are funded. Public schools are financed by the Chilean government while subsidized private schools are financed by the Chilean government and possibly with parental co-payments<sup>28</sup>. Private schools are only privately financed. Public schools are non-profit, while subsidized private and private schools can be for profit or non-profit. Families can choose freely between all schools.

In 2015, Chile had 12,001 schools of which 44% were public and 50% were subsidized private schools. There were 3.5 million students, 37% attended public schools and 54% attended subsidized private schools. The rest attended private schools (see figure 2 in the Appendix I).

Municipalities have been responsible for the administration of public schools since 1981 whereas other types of schools are privately administrated. The central government provides a flat per-student subsidy to public schools and subsidized private schools through the voucher system<sup>29</sup>. This flat voucher was approximately 67,007 Chilean pesos (\$102 US per month)<sup>30</sup> per student in 2015. Meanwhile the SEP was introduced in 2008. This subsidy includes an extra component that changes the value of the voucher depending on student characteristics. The total payment received by schools from the government is a function of average monthly student attendance.

---

27. Kindergarten has been mandatory since 2013. Secondary education has been mandatory since 2003

28. Subsidized private schools have been able to request a tuition co-payment since 1993. In fact, approximately 36% of subsidized private schools ask for co-payment.

29. It varies according to educational level and geographic location, as well as other factors not related to the student's socioeconomic characteristics.

30. 1 US dollar = 654.07 Chilean pesos in 2015

Each year, some grades are required to take a standardized test called “Sistema the Medición de la Calidad de la Educación” (SIMCE). It is mandatory for all Chilean students enrolled in the selected grades to sit for the test, regardless of school type<sup>31</sup>. The average SIMCE score of schools is public information and the government provides an analysis of the scores by school so that parents can understand how their children’s school compares to others.

### *3.2.2 Teachers’ labor market*

In 2014, there were in 215,653 school teachers in the system, and 4% of them were new teachers. Among all teachers 44% were working in the municipal sector, 46% in the subsidized private sector and the rest in the private sector. A large majority, 88%, worked in urban schools.

Among the pool of teachers in 2014, 83% were classroom teachers. Most of the teachers were female (73%), 25% had less than 5 years of experience, 36% had 5 to 15, and 23% between 15 and 30 years of experience. The rest had more than 30 years. Teachers in the municipal sector were on average 5 years older than teachers in the subsidized private sector.

Teachers can work in any type of schools and in more than one. Salaries in the public sector are negotiated at the central level, between the “Colegio de Profesores” (teacher’s union) and the Ministry of Education. In general, the salary depends on a very rigid formula that depends on several factors regulated in the Teachers’ Statute (Estatuto Docente)<sup>32</sup>. Subsidized private schools are mostly free to determine salaries, but have to follow some rules from the Teachers’ Statute<sup>33</sup>. Teachers who work in this sector are protected by the private sector Labor Code. Teachers who work in the private sector are fully governed by

---

31. For some reasons, not every school administers the SIMCE. In 2013, 7,630 schools have fourth grade SIMCE scores.

32. The Estatuto Docente was established in 1991

33. Minimum hourly wages, minimum monthly income, working hours, holidays, and some hiring and firing provisions.

the Labor Code. In addition to the differences in the salary scheme, the Teachers' Statute makes more difficult to fire a teacher compared to the private sector Labor Code.

### *3.2.3 Subvención Escolar Preferencial - Preferential School Subsidy (SEP)*

On February 1, 2008, after more than two years of congressional debate, the Preferential School Subsidy Law (SEP) was enacted. This law amended the Chilean education financing system, which was based on a uniform demand subsidy from 1981. The overall purpose of the law was to provide additional monetary resources to those schools that enroll the most disadvantaged students for the purpose of equalizing educational opportunities.

The SEP comprises two parts. The first one is an additional subsidy for students denominated as "Priority Students"<sup>34</sup> by the Ministry of Education. The second part is known as payment for concentration of priority students, which is a payment per each student, whether priority or not, depending on the percentage of priority students enrolled in the SEP school. The subsidy per priority student varies, decreasing by grade level<sup>35</sup>. The subsidy for concentration increases with the percentage of priority students attending the school.

The SEP is a subsidy that all public (municipal) and private subsidized schools in the country can opt into. The school administrator is the one who decides whether she wants to receive an increase in the subsidy in exchange for undertaking a series of commitments linked to specific learning goals and the elimination of general discriminating conditions. The fact that a student qualifies as a priority student does not guarantee that she will receive the additional subsidy. As noted above, the school must be willing to receive SEP.

Should the school decided to adhere to SEP's rules, it must sign the "Equal Opportunities and Educational Excellence Agreement" with the Ministry of Education, which has a four-

---

34. Basically a priority student is a student whose socio-economic situation obstructs the educational process.

35. There are 2 levels: 1) up to 6th grade, 2) 7th to 12th grade. The payment is bigger for the first group than for the second one

year term and may be renewed for the same period of time. During this period the school undertakes an education improvement plan that is presented annually, utilizing the SEP resources solely for this purpose, accounting for the use of the resources at the end of each year and eliminating specific discriminatory policies<sup>36</sup>. Although the law was created to improve the performance of priority students, it only states that the resources should preferably be spent on priority students, the use of SEP is not in any way restricted to this type of students.

Schools that receive the SEP are classified in one of the following categories: i) *Autónomas* (Autonomous, schools which have had systematically good educational achievement); ii) *Emergentes* (Emerging, schools which have not had systematically good educational achievement); iii) *En recuperación* (In recovery, schools which have had systematically deficient educational achievement). It is the school classification that determines the degree of freedom that a school has in spending SEP resources and also the type of goals and accountability that the school must achieve. In 2008, the Ministry of Education only categorized schools in the first two categories. By 2012, 219 schools were classified as “in recovery”<sup>37</sup>.

Many papers (Mizala & Torche (2013), Neilson (2013), Peticara et al, (2013), Valenzuela et al. (2013), and Correa et al. (2014)) have reported a positive and moderate impact of SEP on schools’ academic achievement. However, no paper shows the mechanism through which SEP has increased SIMCE scores. Peticara et al. (2013) analyze correlations between expense type and SIMCE results. They mention that expenses that are more highly correlated with a better academic performance are: learning resources, external consulting, and hiring new staff or paying for more hours of current staff.

On the other hand, Elacqua et al. (2013) study the effects of SEP’s accountability pressures on teacher policies and practices in low-performing schools (those “in recovery”). These schools have pressure to improve performance in four years (measured through fourth

---

36. (i) No copayment for priority students. (ii) No selection based on performance or student socioeconomic levels from pre-kindergarten through 6th grade. (iii) The educational establishment’s option to end the enrollment of students from pre-kindergarten through 6th grade due to poor academic performance is limited.

37. 809 Autonomous schools and 5,837 Emerging schools.

grade SIMCE scores), and the cost of not doing so is, in theory, that the Ministry of Education can close them<sup>38</sup>. The paper finds that “in recovery” schools are more likely to have more hours dedicated to teaching, more likely to use after class tutors, and to put more experienced teachers in fourth grade classrooms.

If schools accept SEP they must spend the extra money on items that are relevant to improving pedagogical practices and therefore academic performance. For example, schools can buy didactic materials, hire new staff, provide training courses to teachers, hire external management consultants, and even to have some recreational activities to improve the sense of community. On the other hand, SEP schools cannot select their students between first and sixth grade, and it is not easy for them to remove students due to academic performance. These restrictions may change the composition of the student body. Additionally, the way that the SEP measures academic achievement, mostly by using SIMCE scores, can change the allocation of resources inside the school.

In 2015, the SEP was equivalent to of between \$19,681 and \$39,693 Chilean pesos per priority student per month (\$30 to \$60 US) between pre-kindergarten and 6th grade, and an additional payment of between \$2,742 and \$7,018 Chilean pesos per student (4.20–10.80), depending on which concentration section the school is classified. Currently the SEP voucher cover up to 12th grade<sup>39</sup>.

In general, SEP has become part of the Chilean school system 8 years after its implementation. In 2015, 66% of the Chilean schools got SEP<sup>40</sup>. Among them, 4,959 are public schools<sup>41</sup> and 3,001 subsidized private schools<sup>42</sup>. Additionally, of a total of 1.6 million priority students, nearly 1.2 million attend schools that adhere to the policy<sup>43</sup>. Finally, almost

---

38. As of 2015 no schools have been close.

39. In 2008 SEP covered up to 4th grade. After that, SEP added an additional grade every year.

40. 99% of Chilean schools have priority students.

41. 86% of public schools.

42. While a stable number of public schools participated over time, the number of subsidized private schools participating in SEP almost doubled between 2008 and 2015 (from 1,642 to 3,001).

43. In practice, this represents more than one third of total national enrollment.

70% teachers work in SEP schools.

### 3.3 Description of the data

I use public administrative data from the Chilean Ministry of Education, specifically data for all new Chilean teachers working in the system from 2005 to 2014. I follow only new teachers who enter the system between 2005 and 2010 to be able to observe their complete labor history until 2014. I also restrict the sample to those new teachers that were younger than 42 years old when they started teaching<sup>44</sup>.

As mentioned, in Chile teachers may work in more than one school. For example, in 2014 we have 215,653 people working in schools, but there are 234,168 teacher positions, thus 7.4% of teachers were working at least 2 schools. Because of this, for each year I use just the main job of each teacher. Table 3.1 shows the sample.

Table 3.1: Number of teachers by cohort.

	2005	2006	2007	2008	2009	2010
New teachers	5,769	5,575	6,181	8,043	8,291	7,126
New teacher < 42 years old	4,893	4,938	5,542	7,150	7,560	6,659

First row is the number of people in the data that indicate that are new in the educational system. Second row is the number of people that are new in the system and have less than 42 years old.

At the teacher level, I observe a variety of background measures, including years of teaching experience, type of degree, hours under contract, role inside the school, grade taught if teaching, gender, age, tenure, etc. At the school level, I have information on standardized test scores (SIMCE) in language and mathematics for fourth grade as well as the school's socioeconomic status, the year it started receiving SEP, number of priority students, location, administrative dependence, and enrollment, among others.

Table 3.2 summarizes some characteristics of the teachers during their first year in the

---

44. 10% of the sample has more than 41 years old

Table 3.2: Descriptive statistics, all cohorts

Variable	Mean	s.d.
Age	27.88	(4.52)
Male	0.28	(0.45)
Has a degree in education	0.76	(0.43)
Works in a Private Subsidized School	0.59	(0.49)
Works in a Public School	0.30	(0.46)
Works in a Rural School	0.11	(0.32)
Teach at Primary level	0.50	(0.50)
School has a low SES	0.35	(0.46)
Has a contract of > 40 hours per week	0.16	(0.37)
N	36,642	

Descriptive statistics for the sample (all cohorts) that summarize some characteristics of their first year teaching.

education system. On average, they started teaching when they were 28 years old. Most of them are female (72%); 76% have a degree in education; 59% started working in a subsidized private school, 30% in a public school and the rest in the private sector. Additionally, 89% work in urban schools, 50% start by teaching at the primary level, and 35% of them start their careers in low socioeconomic schools<sup>45</sup>. Among these teachers, only 16% have a contract for more than 40 hours per week.

Since 2008, I can observe if a teacher started their careers in a SEP school. In 2008, 58% of the new teachers starting in a SEP school and in 2010 this number was 63%.

As for teacher mobility, I define two possible paths of mobility that reflect that the relationship between a teacher and a school is broken. First, a teacher can move to another school. Second, a teacher can leave the education system. Both of these movements mean that we will not observe the teacher in the same school in the following year.

For example, from the 7,150 new teachers in the sample who entered in the system in

---

45. The socioeconomic status at the school level is constructed using the parental years of schooling, household income, and a vulnerability index (computed by the national agency in charge of scholarships in Chile). Averages of these four variables are computed at the school level and then standardized. Then, a cluster analysis is applied, aiming to code school socioeconomic status into five groups, from A (poorest) to E (richest). In 2013, 30% of schools were in group A, 34% of schools in group B, 21% of schools in group C, 10% of schools in group D, and 6% of schools in group E. For these purposes, I group categories A and B as “low” socioeconomic status, category C represents “medium” socioeconomic status, and categories D and E as “high” socioeconomic status.

2008, 4,581 (64%) of them worked in the same school in 2009, 1,268 changed their school, and 1,301 left the system<sup>46</sup>. Among those who changed schools, 456 changed the type of school (160 from the municipal sector and 214 from the subsidized private sector). Finally, 73% of the teachers from the 2008 cohort were still in the system in 2013, and 64% of them changed job at least once<sup>47</sup>.

In order to focus the analysis on private subsidized schools, I restrict the sample<sup>48</sup> to the private subsidized schools that did not close during the period under study, have at least 10 teachers, that have at least one SIMCE scores for 4th grade (language or math), and have not change the SEP status over time. After this, the data consists of a total of 2,395 schools and 19,359 teachers.

Figure 3.1 shows the average probability of teacher/school separation in private subsidized schools for two different groups of schools. In the graph we plot separation rates for two groups of schools, one group received SEP in 2008 and the other group never participated in SEP. The teacher/school separation rate is decreasing for both groups due to the fact that each year new teachers join the system, but a stock of teachers has longer tenure and more experience. The literature has shown that tenure and experience are correlated with lower chances of leaving a position (Boyd et al., 2005). Notice that after 2008 the difference of probabilities decreases. The results might suggest a positive impact of SEP on teacher turnover.

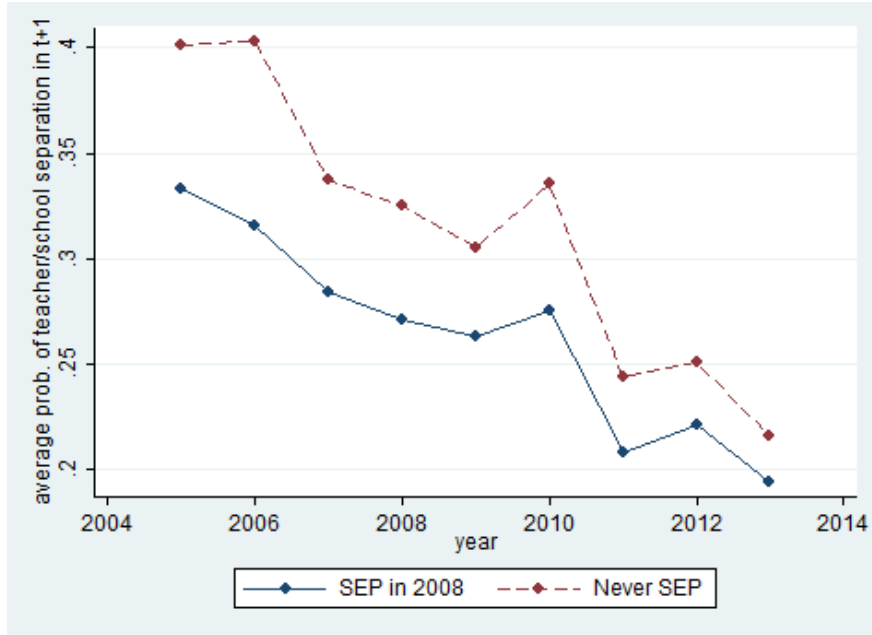
---

46. 741 of them returned to the system at some point.

47. 31% worked in more than two schools.

48. Most of the studies that evaluate SEP focus their analysis on private subsidized schools, since almost all public (municipal) schools got SEP in 2008. Therefore, there are not any temporal variations in the municipal sector.

Figure 3.1: Average probability of teacher/school separation in  $t + 1$  between private subsidized schools that got SEP in 2008 and those who never received SEP



Note: Each year considers new teachers who entered that year and all the previous cohorts of new teacher who entered after 2004.

### 3.4 Methodology

I estimate the likelihood of observing a separation next year as a function of teacher and school-level characteristics. I use fixed effects at school level to control for unmeasured, time-invariant characteristics of schools that might affect teacher turnover<sup>49</sup>.

Let's define the probability of teacher/school separation as:

$$P(y_{ist} = 1|.) = \gamma SEP_{st} + X_{it}\beta_1 + Z_{st}\beta_2 + \phi_t + \mu_s \quad (1)$$

In this model, the probability that a teacher  $i$  separate from school  $s$  in year  $t+1$  (denoted  $y_{ist}$  for notational simplicity) is a function of the SEP status of school  $s$  in time  $t$  ( $SEP_{st}$ ), observed teacher characteristics  $X_{it}$ , observed characteristics of the school  $Z_{st}$ , a school

49. Note that this method is known as multi-period difference in difference (multi-period DD).

fixed effect  $\mu_s$  and a year fixed effects  $\phi_t$  <sup>50</sup>.

The observed teacher characteristics include a set of indicator variables capturing whether the teacher has a degree in education, if she is currently teaching, if her current job is full-time, and if she is in her first job. In some specifications I also include gender, age, experience, tenure, or a combination of these factors. I also sometimes control for teacher cohort fixed effects. The observed characteristics of the school include an indicator variable if the school is located in a rural area and a dummy variable that take the value of one if the school received SEP.

Specification 1 captures the average SEP effect across all post-SEP years. In order to tease out the effect of SEP over multiple years, I try a second specification that captures the duration of the school’s enrollment in SEP. Specifically, I evaluate the impact of having SEP for one, two, or three or more years. The idea behind this is that it can take time for the schools to learn how to best use the extra funds. For robustness, I also estimate a more flexible specification where I separate treatment effects for pre and post SEP years as in an event study:

$$P(y_{ist} = 1|\cdot) = \sum_{e=-2}^3 \gamma_e D_{st}^e + X_{it}\beta_1 + Z_{st}\beta_2 + \mu_s + \phi_t \quad (2)$$

where  $D_{st}^e$  is a dummy variable that takes the value of 1 if school  $s$  has participated in SEP for  $e$  years. If  $e < 0$  and  $D_{st}^e = 1$  it means that the school will participate in SEP in  $-e$  years. Notice that if  $D_{st}^0 = 1$  it means the school participated in SEP in  $t$ .

This approach estimates two pre-SEP effects ( $\gamma_{-2}, \gamma_{-1}$ ) and the four post-SEP effects ( $\gamma_0, \gamma_1, \gamma_2, \gamma_3$ ). The idea behind getting the pre-SEP effects is to check if there is a different pre-SEP year trends in the treatment and control schools<sup>51</sup>.

As shown in the previous section it seems that teachers who are in their first year in the

---

50. Specifically, I control for a year fixed effect to be able to eliminate any time trends that can be changing the likelihood of teacher/school separation, such as more teachers graduating.

51. This allow us to cast doubt on common counterfactual trends, but not to confirm them.

educational system could be more affected by the policy. In order to test if SEP is differentially affecting teachers in their first job I interact the duration of the school’s enrollment in SEP with a dummy that takes the value of one if the teacher has just entered into the system. The following specification captures this:

$$P(y_{ist} = 1|\cdot) = \sum_{e=-2}^3 (\gamma_e D_{st}^e + \delta_e D_{st}^e \times \text{First job}_{it}) + X_{it}\beta_1 + Z_{st}\beta_2 + \mu_s + \phi_t \quad (3)$$

In specification 3  $\delta_e$  is the difference of the impact of having SEP for  $e$  years between teachers in their first year in the system (first job) and those that have been in the system for more than one year.

I estimate these specifications using a linear probability models.

### 3.5 Results

I estimate the likelihood of observing a separation between a teacher and her school in the next year as function of teacher and school-level characteristics. Table 3.3 reports the estimators of  $\hat{\gamma}$  of specification 1,  $\hat{\gamma}_e$  of specification 2 and  $\hat{\gamma}_e$  and  $\hat{\delta}_e$  of specification 3.

I use a common set of controls for all my specification: teacher level controls (gender, age, age squared, experience, experience squared, tenure, a dummy variable that takes the value of one if the teacher has a degree in education, a dummy variable that takes the value of one if the teacher has a contract > 40 hours per week, and an indicator variable for the teacher’s first position), school level controls (an indicator variable for rurality), year and school fixed effects.

Column (1) shows the estimator of  $\hat{\gamma}$  from specification 1. The estimated coefficient suggests that SEP increases teacher turnover in 1.5 percentage points (significant at 5%).

Column (2) shows the results of specification 2. There are 5 estimators: the impact of having SEP in 2 more years, the impact of having SEP in 1 more year, and the impact of

having SEP for  $X$  years, where  $X = 1, 2, 3, 3^+$ . The pre-SEP effects are not significant, and the impact of SEP is larger when the school has had more years of SEP. In fact, the impact of having one year of SEP is positive (1.9 percentage points), significant at 10%, but the impact of having SEP for 2 years is a little greater in magnitude (2.7 percentage points) and significant at 5% and the impact of having SEP for 3 years is even larger, 4.1 percentage points significant at 5%, and very similar to the impact of having more than 3 years of SEP. Figure I.3 in the Appendix I shows these results<sup>52</sup>.

The last column in table 3.3 shows the estimator of  $\hat{\gamma}_e$  and  $\hat{\delta}_e$  of specification 3. The coefficient on SEP1-First Job (0.052) suggests that the effect of SEP on teacher turnover is different for new teachers only when the school has had SEP for just one year. However, the impact of having SEP for one year does not affect new teachers in their first job at all<sup>53</sup>. This last finding can be seen in figure I.4 in the Appendix I .

There are three facts that are important to retain from Table 3.3. First, the pre-SEP effects are not significant. This is evidence that schools did not start making changes before they actually got SEP. Second, SEP increased teacher turnover and this impact is larger when the school has had more years of SEP. This may suggest that schools need time to learn how to use the extra resources. Third, having SEP for one year does not affect teachers in their first position, but it does affect other teachers, and having more than one year of SEP affect all teachers equally. This could be explained by the fact that teachers in their first job have a high separation rate and, when the school has had only one year of SEP, changes are not enough to make a difference for them. However, 2 years of SEP changes in the school might be enough to alter the separation rate for this group.

---

52. I test if these estimated coefficients are significantly different and only find a significant difference between having 1 year of SEP versus having 3 or more years of SEP.

53. This is because the sum of the coefficients on SEP1 and SEP1-First job is not significant.

Table 3.3: Results

Variable	Leave the school next year		
	(1)	(2)	(3)
SEP	0.015** (0.007)		
SEP-2		0.013 (0.010)	0.013 (0.010)
SEP-1		0.013 (0.011)	0.012 (0.011)
SEP1		0.019* (0.011)	0.029** (0.011)
SEP2		0.027** (0.012)	0.023* (0.012)
SEP3		0.041*** (0.013)	0.034** (0.013)
SEP1-First job			-0.052*** (0.014)
SEP2-First job			0.010 (0.015)
SEP3-First Job			0.040** (0.015)
SEP > 3		0.040*** (0.014)	0.038*** (0.014)
N	73,471	73,471	73,471

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

All regressions include teacher level controls (gender, age, age squared, experience, experience squared, tenure, a dummy variable that takes the value of one if the teacher has a degree in education, a dummy variable that takes the value of one if the teacher has a contract > 40 hours per week, and an indicator variable for the teacher's first job), school level controls (an indicator variable for rurality), year and school fixed effects. Standard errors are clustered at the school level

### 3.6 Conclusion

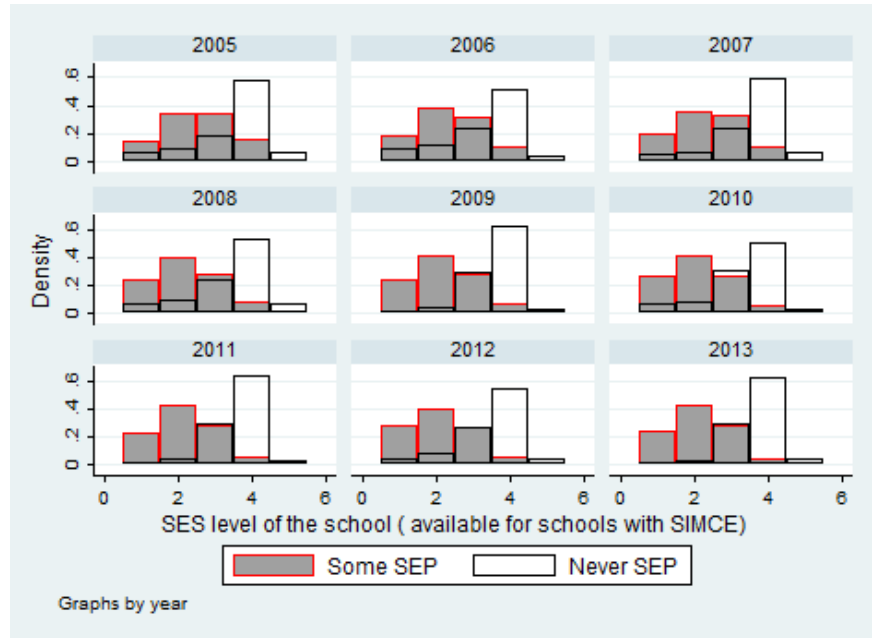
As discussed in this paper, SEP was created with the main goal of improving academic performance of disadvantaged students with the purpose of equalizing educational opportunities for all students. Many scholars have tried to measure the impact of SEP on academic performance, finding a positive and moderate impact of SEP on standardized test scores. However, when policies are implemented, there are other outcomes planned or not. In this paper, I make an effort to measure the impact of SEP on one of those different outcomes: teacher turnover.

My results suggest that SEP increases turnover in private subsidized schools. I am not able to conclude if this is a good or bad result for students, because I do not have information about the quality of the teachers who switch jobs. It could be that SEP makes more teachers willing to work in SEP schools, thus schools would be able to replace low quality teachers with high quality teachers. Or it could be that the costs associated with having SEP provide incentives to teachers to leave the school, and those who have better job opportunities outside (usually, high quality teachers) end up leaving. However, these are speculative thoughts and more research is needed to understand if the impact of SEP on teacher turnover is a desirable outcome.

Also, as mentioned before, there is evidence that shows a positive impact of SEP on academic achievement. However, I am not able to link this paper's results with that finding. In fact, I cannot conclude if higher turnover produced by SEP is one of the factors that might explain the improvement in academic performance of disadvantaged schools or if the impact of SEP on academic achievement can be greater if we are able to reduce the effect of SEP on teacher turnover. For policy makers this is a very important issue. Knowing how the turnover induced by SEP affects academic achievement will allow them to modify SEP accordingly to get better results.

### 3.7 Appendix I: Additional Figures of Chapter 3

Figure I.1: Socioeconomic composition of schools by SEP status



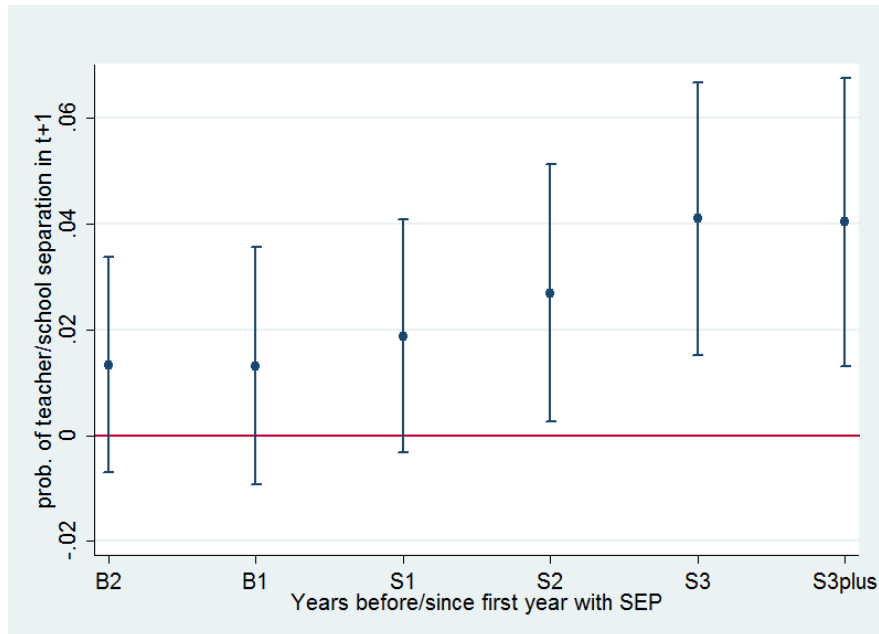
Note: This graph shows the distribution of the socioeconomic composition of private subsidized schools and municipal schools that received SEP at some point after 2008 and those that did not received SEP during that period. The socioeconomic level of the school (SES) goes from 1 to 5, where: 1=low SES, 2=medium-low SES, 3=medium SES, 4=medium-high SES, and 5=high SES

Figure I.2: Number of students by sector and year (in thousands)



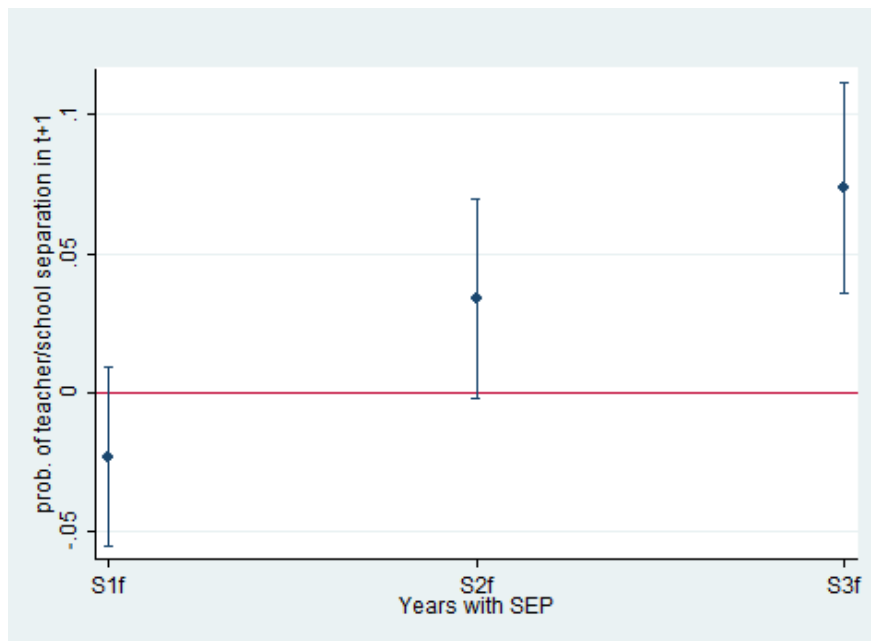
Note: The solid line shows the number of students in municipal (public) schools, the dashed line is the number of students in private subsidized schools, and the dotted line is the number of students in private schools.

Figure I.3: Average Marginal effects with 95% CIs



Note: This graph shows the regression coefficients and their confidence intervals at 95% of specification 2. B2 and B1 are the pre-SEP effects, the impact of having SEP for 1 and 2 years on the probability of teacher/school separation ( $\gamma_{-2}$  and  $\gamma_{-1}$ ). S1, S2, S3 and S3plus are the post-SEP effects ( $\gamma_0, \gamma_1, \gamma_2, \gamma_3$ ), the impact of having SEP for 1, 2, 3 or more 3 years on the probability of teacher/school separation.

Figure I.4: Average Marginal effects with 95% CIs for teachers in their first job



Note: This graph shows the confidence interval at 95% of the post-SEP effects on teachers/school separation for teachers in their first job. S1f, S2f and S3f are the post-SEP effects for having SEP for 1, 2, and 3 years respectively.

## REFERENCES

- Balu, R., Béteille, T., and Loeb, S. (2010). Examining teacher turnover: The role of school leadership. *Politique Americaine*, 15, 5579.
- Bascope, M. & Meckes, L. (2010). Distribución inequitativa de los nuevos profesores mejor preparados: Características de origen y destino laboral de los egresados de pedagogía básica. *Boletín CEPPE*. Santiago: Center for Research on Educational Policy and Practice.
- Behrman, J. R., Tincani, M. M., Todd, P. E., & Wolpin, K. I. (Forthcoming). Teacher quality in public and private schools under a voucher system: The case of Chile. *Journal of Labor Economics*.
- Bénabou, R., Kramarz, F., & Prost, C. (2009). The french zones d'éducation prioritaire: Much ado about nothing? *Economics of Education Review*, 28(3), 345-356.
- Black, D. A., Smith, J. A., Berger, M. A., & Noel, B. J. (2003). Is the threat of reemployment services more effective than the services themselves? *The American Economic Review*, 93(4), 1313-1327.
- Boyd, D., Lankford, H., Loeb, S., & Wyckoff, J. (2013) Analyzing the determinants of the matching of public school teachers to jobs: Disentangling the preferences of teachers and employers. *Journal of Labor Economics*, 31(1), 83-117
- Boyd, D., Grossman, P., Ing, M., Lankford, H., Loeb, S., O'Brien, R., & Wyckoff, J. (2011) The effectiveness and retention of teachers with prior career experience. *Economics of Education Review*, 30, 1229-1241
- Boyd, D., Grossman, P., Ing, M., Lankford, H., Loeb, S., & Wyckoff, J. (2011). The influence of school administrators on teacher retention decisions. *American Education Research Journal*, 48(2), 303-333.
- Boyd, D., Hamilton L., Loeb, S., Ronfeldt, M., and Wyckoff, J. (2010). The role of teacher quality in retention and hiring: Using applications-to transfer to uncover preferences of teachers and schools. *Journal of Policy Analysis and Management*, 30(1), 88-110.
- Boyd, D., Grossman, P., Lankford, H., Loeb, S., & Wyckoff, J (2008). Who leaves? Teacher attrition and student achievement. (NBER Working Paper No. 14022). Cambridge, MA: National Bureau of Economic Research.
- Boyd, D., Lankford, H., Loeb, S., & Wyckoff, J. (2005). Explaining the short careers of high-achieving teachers in schools with low-performing students. *American Economic Review Proceedings*, 95, 166-171
- Boyd, D., Lankford, H., Loeb, S., & Wyckoff, J. (2005). The draw of home: How teachers' preferences for proximity disadvantage urban schools. *Journal of Policy Analysis and Management*, 24(1), 113-132.

- Cabezas, V., Gallego, F., Santelices, V., & Zarhi, M. (2011). Factores correlacionados con las trayectorias laborales de docentes en Chile, con especial énfasis en sus atributos académicos. Santiago: Chilean Ministry of Education.
- Carneiro, P. (2007). Equality of opportunity and educational achievement in Portugal. *Portuguese Economic Journal*, 1, 17-41
- Clotfelter, C. T., Ladd, H. F., & Vigdor, J. L. (2011). Teacher mobility, school segregation, and pay-based policies to level the playing field. *Education*, 6(3), 399-438.
- Clotfelter, C. T., Ladd, H. F., & Vigdor, J. L. (2010). Teacher credentials and student achievement in high school a cross-subject analysis with student fixed effects. *Journal of Human Resources*, 45(3), 655-681.
- Clotfelter, C., Glennie, E., Ladd, H., & Vigdor, J. (2008). Would higher salaries keep teachers in high-poverty schools? Evidence from a policy intervention in North Carolina. *Journal of Public Economics*, 92(5), 1352-1370.
- Clotfelter, C., Ladd, H., & Vigdor, J. (2006). Teacher-student matching and the assessment of teacher effectiveness. *Journal of Human Resources*, 41, 778-820.
- Clotfelter, C. T., Ladd, H. F., & Vigdor, J. (2005). Who teaches whom? Race and the distribution of novice teachers. *Economics of Education Review*, 24(4), 377-392.
- Cohn, E. (1996). Methods of teacher remuneration: Merit pay and career ladders. In W. Becker & W. J. Baumol (Eds.), *Assessing educational practices: The contribution of economics* (209-238). Cambridge, MA: MIT Press.
- Correa, J., Parro, F., & Reyes, L. (2014) The effects of vouchers on school results: Evidence from Chile's targeted voucher program. *Journal of Human Capital*, 4, 351-398
- Correa, J. A., Parro, F., & Reyes, L. (2015). Self-selection in the market of teachers. *Applied Economics*, 47(13), 1331-1349.
- Cunha, F., and Heckman, J. (2007). *The Technology of Skill Formation*. NBER Working Papers 12840, National Bureau of Economic Research, Inc.
- Duflo, E., Rema H., & Ryan, S.P., (2012). Incentives work: Getting teachers to come to school. *American Economic Review*, 102(4), 1241-78.
- De Haan, M. (2015). The effect of additional funds for low-ability pupils: A nonparametric bounds analysis. *The Economic Journal*, SN 1468-0297
- Dolton, P. & Van der Klaauw, W. (1999). The turnover of teachers: A competing risks explanation. *The Review of Economics and Statistics*, 81(3), 543-550
- Elacqua, G., Mosqueira, U., and Santos, H. (2009). La toma de decisiones de un sostenedor: Análisis a partir de la Ley SEP. *Expansiva*, Instituto de Políticas Públicas, Universidad Diego Portales, Serie En foco Educación, 1, pp. 1-36.

- Elacqua, G. (2012). The impact of school choice and public policy on segregation: Evidence from Chile. *International Journal of Education Development*, 32, 444-454
- Elacqua, G., Martinez, M., Santos, H., & Urbina, D. (2013). Escuelas bajo amenaza: Efectos de corto plazo de las presiones de accountability de la ley SEP en las políticas y prácticas docentes. *Documentos de Trabajo*, Universidad Diego Portales, ISSN 0719-4056
- Falch, T. (2010). The elasticity of labor supply at the establishment level. *Journal of Labor Economics*, 28(2), 237-266.
- Falch, T. (2011). Teacher mobility responses to wage changes: Evidence from a quasi-natural experiment. *The American Economic Review*, 101(3), 460-465.
- Feng, L. (2009). Opportunity wages, classroom characteristics, and teacher mobility. *Southern Economic Journal*, 75(4), 1165-1190.
- Feng, L. (2015). The impact of incentives to recruit and retain teachers in “Hard-to-Staff” subjects: An analysis of the Florida Critical Teachers Shortage Program. (Working Paper 141). Washington, DC: National Center for Analysis of Longitudinal Data in Education Research.
- Figlio, D., & Kenny, L. (2007). Individual teacher incentives and student performance. *Journal of Public Economics*, 91 901-914
- Flores Arenas, B. (2015), Estimating the effects of school subsidies targeted at low-income students: Evidence from Chile, Working Paper, University College of London, Department of Economics.
- Fryer R. (2011) Financial incentives and student achievement: Evidence from randomized trials. *Quarterly Journal of Economics*. 126 (4), 1755-1798
- Glazerman, S., & Max, J. (2011). Do low income students have equal access to the highest performing teachers? Washington, DC: Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance.
- Glazerman, S., Protik, A., Teh, B., Bruch, J., & Max, J. (2013). Transfer incentives for high-performing teachers: Final results from a multisite experiment (NCEE 2014-4003). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, US Department of Education.
- Goldhaber, D., Gross, B., & Player, D. (2007). Are public schools really losing their “best”? Assessing the career transitions of teachers and their implications for the quality of the teacher workforce. (CALDER Working Paper No. 12). Urban Institute.
- Hanushek, E. A., Kain, J. F., & Rivkin, S. G. (2004). Why public schools lose teachers. *Journal of Human Resources*, 39(2), 326-354.
- Hanushek, E. (2006) School resources.” In *Handbook of the Economics of Education*, edited by Eric A. Hanushek and Finis Welch. Amsterdam: North Holland: 865-908.

- Heckman, J. (1993). What has been learned about labor supply in the past twenty years? *American Economic Review*, 83(2),116-21
- Heckman, J., Smith, J., & Clements, N. (1997) Making the most out of programme evaluations and social experiments: Accounting for heterogeneity in programme impacts.*Review of Economic Studies* 64 (4), 487-535.
- Heckman, J. (2011), The economics of inequality: The value of early childhood education. *American Educator*, 35(1), 31-35.
- Imazeki, J. (2005). Teacher salaries and teacher attrition. *Economics of Education Review*, 24(4), 431-449.
- Imbens, G. W. & Lemieux, T. (2008). Regression discontinuity designs: A guide to practice, *Journal of Econometrics*, 142(2), 615-635.
- Jackson, C. K. (2009). Student demographics, teacher sorting, and teacher quality: Evidence from the end of school desegregation. *Journal of Labor Economics*, 27(2), 213-256.
- Krueger, A. (2003) Economic considerations and class size. *Economic Journal*, 113(485), F34-F63.
- Lankford, H., Loeb, S., & Wyckoff, J. (2002). Teacher sorting and the plight of urban schools: A descriptive analysis. *Educational Evaluation and Policy Analysis*, 24(1), 37-62.
- Lavy, V. (2003). Paying for performance: The effect of financial incentives on teachers' effort and students' scholastic outcomes. Department of Economics, Hebrew University of Jerusalem, Working Paper.
- Loeb, S., Darling-Hammond, L., & Luczak, J. (2005). How teaching conditions predict teacher turnover in California schools, *Peabody Journal of Education*, 80(3),44-70
- Loeb, S., Béteille, T., & Kalogrides, D. (2012). Effective schools: Teacher hiring, assignment, development, and retention. *Education Finance and Policy*, 7(3), 269-304.
- MaCurdy, T., Green, D. & Paarsch, H. (1990). Assessing empirical approaches for analyzing taxes and labor supply. *The Journal of Human Resources* 25(3) , 415-490
- Machin, S., McNally, S., & Meghir, C. (2010) Resources and standards in urban schools. *Journal of Human Capital*, 4(4),365-393.
- Manski, C. (1989) Anatomy of the selection problem. *Journal of Human Resources*, 24(3), 343-360.
- Manski, C. (1990) Association Nonparametric Bounds on Treatment Effects. *The American Economic Review*, Vol. 80, No. 2:pp. 319-323
- Manski, C. (1997). Monotone treatment response. *Econometrica*, 65(6), 1311-1334

- Manski, C. & Pepper, J. (2000). Monotone instrumental variables: With an application to the returns to schooling. *Econometrica*, 68( 4), 997-1010
- Mizala, A. & Romanguera, P. (2005). Teacher's salary structure and incentives in Chile. In E. Vegas (Ed.), *Incentives to improve teaching* (103-150). Washington, DC: The World Bank.
- Mizala, A., & Torche, F. (2013). Logra la Subvención Escolar Preferencial igualar resultados educativos? *Espacio Público*, Documento de Referencia 9.
- Mroz, T. A. (1987). The sensitivity of an empirical model of married women's hours of work to economic and statistical assumptions. *Econometrica*, 55(4), 765-99.
- Neilsen, C. (2013) Targeted vouchers, competition among schools, and the academic achievement of poor students. *Job Market Paper*.
- Odden, A. (2011). *Strategic management of human capital in education: Improving instructional practice and student learning in schools*. New York, NY: Routledge.
- OECD. (2010). *PISA 2009 Results: Overcoming social background - Equity in learning opportunities and outcomes (Volume II)*. Paris: OECD Publishing.
- OECD. (2012). *Equity and Quality in Education: Supporting Disadvantaged Students and Schools*. Paris, OECD, France: Paris.
- OECD (2013), *Education at a Glance 2013: OECD Indicators*, OECD Publishing. Retrieved from: <http://dx.doi.org/10.1787/9789264091504-en>.
- Ortúzar, M.S., Flores, C., Milesi, C., & Cox, C. (2009). Aspectos de la formación inicial de docentes y su influencia en el rendimiento académico de los alumnos. Santiago: Centro de Políticas Públicas, Universidad Católica
- Papke, L. (2005). The effects of spending on test pass rates: evidence from Michigan. *Journal of Public Economics*, 89(5),. 821-839.
- Pepper, J. (2000). The intergenerational transmission of welfare receipt: A nonparametric bounds analysis. *The Review of Economics and Statistics*, 82(3), 472-488.
- Perticara, M. Román, M. & Selman, J. (2013). Rendimiento escolar y uso de los recursos de la ley SEP. *Documentos de Investigación*, Universidad Alberto Hurtado, Santiago, Chile.
- Peske, H. G., & Haycock, K. (2006). *Teaching Inequality: How poor and minority students are shortchanged on teacher quality: A report and recommendations by the Education Trust*. Education Trust. Retrieved from: <https://edtrust.org/resource/teaching-inequality-how-poor-and-minority-students-are-shortchanged-on-teacher-quality/>
- Podursky, M., & Springer, M. (2007). Teacher performance pay: A review. *Journal of Policy Analysis and Management*, 26(4), 909-949.

- Romaguera, P. & Gallegos, S. (2010). Financiando la educación de grupos vulnerables: La subvención escolar preferencial. in Osvaldo Larrañaga y Dante Contreras (eds.), *Las nuevas políticas de protección social en Chile*, Santiago, Uqbar Editores.
- Romero, A., & Zarate, M. (2013) *Introducción al derecho educacional Chileno*. Editorial Legal Publishing Thomson Reuters. Santiago de Chile.
- Reschovsky, A. & Imazeki, J. (2001). Achieving educational adequacy through school finance reform. *Journal of Education Finance*, 26, 373-396.
- Sass, T. R., Hannaway, J., Xu, Z., Figlio, D. N., & Feng, L. (2012). Value added of teachers in high-poverty schools and lower poverty schools. *Journal of Urban Economics*, 72(2), 104-122.
- Scafidi, B., Sjoquist, D. L., & Stinebrickner, T. R. (2007). Race, poverty, and teacher mobility. *Economics of Education Review*, 26(2), 145-159.
- Springer, Matthew G. (2008). The Influence of an NCLB Accountability Plan on the Distribution of Student Test Score Gains. *Economics of Education Review*, 27(5), 556-563.
- Steele, J. L., Murnane, R. J., & Willett, J. B. (2010). Do financial incentives help low-performing schools attract and keep academically talented teachers? Evidence from California. *Journal of Policy Analysis and Management*, 29(3), 451-478.
- Valenzuela, J., Villarroel, G., & Villalobos, C. (2013). Ley de Subvención Escolar Preferencial (SEP): algunos resultados preliminares de su implementación. *Revista Pensamiento Educativo*, 50(2), 113-131.
- Van der Klaauw, W. (2008). Breaking the link between poverty and low student achievement: An evaluation of Title I. *Journal of Econometrics*, 142(2), 731-756.
- Villarroel, G. (2012). *Mejoramiento en resultados académicos de la educación básica en Chile: Primeros efectos de la ley de Subvención Escolar Preferencial (SEP)? Tesis para optar al grado de Magíster en Economía*, Santiago, Chile: Facultad de Economía y Negocios, Universidad de Chile.
- Zavodny, M. (2000). The effect of the minimum wage on employment and hours. *Labour Economics*, 7, 729-750