

Follow the Leader: Student Strikes, School Absenteeism and Long Term Implications for Education Outcomes*

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Abstract

The 2011 Chilean student strikes, led by university students, but promptly joined by hundreds of thousands of secondary school students, triggered a major drop in public secondary school class attendance during that year: a decline of nearly 20% in all four grades. Attendance returned to normal levels in 2012. I show that, for public secondary school students, the strikes led to a persistent negative effect on both results in the high-stakes math exam taken after completing secondary education and university enrollment rates. This result holds even for the cohort that took these exams 4 years after the strikes, that is for the students who were enrolled in the first year of secondary education in 2011. The effect in the math exam fluctuates between 3.2% and 4% standard deviation. Associated university enrollment rates fell between 9.8% to 15.3%. I find no significant effect on the high-stakes language exam. I show that my results are neither driven by the sorting of students across schools or cohorts, nor by other factors such as disruptiveness at the time of the high-stakes exams, school environment, class size or teachers. Finally, using the school type that students attended during the strikes as an instrument for school attendance, IV estimations suggest that 10 percentage point decrease in attendance during secondary school is related to 9.5% standard deviation reduction in the math exam score, and a 3.2 percentage point reduction in the associated probability of university enrollment.

JEL codes: I20, I21.

Keywords: Student Strikes, School Absenteeism, Secondary School, Educational Attainment.

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1 Introduction

During the first semester of 2011, a conflict between students and the Chilean authorities about changes to the education system escalated into massive student-led protests across the country, the largest national strikes in Chile's history.¹ University students led the strikes, but they were promptly joined by secondary school students. This situation endured for several months until the year ended, and schools resumed as normal in 2012.² However, the student strikes had relevant implications: Hundreds of thousands of secondary school students skipped classes to join the protests, leading to extended periods of absenteeism during the 2011 school year.

This paper examines the long-term consequences of the Chilean student movement in 2011, taking advantage of the fact that this transitory shock affected students in each of the four grades of secondary education during 2011. By doing so, this paper sheds light on the effect of prolonged school absenteeism on educational outcomes.

There are three types of schools in the Chilean education system: public, voucher and private. In 2010, these schools accounted for 42.1%, 50.8% and 7.1% of student enrollment respectively (MINEDUC (2015)). During the strikes, there was a substantial drop in public secondary school students' attendance. A stable average attendance rate over the 2007-2010 period of about 90% for public school students in every secondary school grade dropped sharply to 71% in 2011, but then returned immediately to pre-protest levels in 2012. This drop in attendance rate was mainly driven by the absences during July, August and September, a period in which the average attendance rate of students in public schools fell below 55%. This evidence highlights the fact that public school students from every secondary grade skipped classes for long and continuous periods during this school year. There were much less significant reductions in attendance for students enrolled in voucher and private schools. This indicates that public school students were much more likely to be affected by the strikes than voucher and private school students.

The Chilean education system uses high-stakes testing to rank students for admission to selective universities,³ as is the practice in many other countries (including the United States and the United Kingdom). In Chile, these exams cover the whole secondary education curriculum and are sat shortly after the completion of secondary school. By exploiting microdata containing individual information for all secondary students in Chile over the period 2003 to 2014, I study the long-term implications of this disruptive transitory shock for secondary students' performance in high-stakes exams and university enrollment rates.

This paper uses a differences-in-differences design for identifying the effect of the strikes on students' education outcomes. I compare students attending public and voucher schools, before and after the strikes took place. Moreover, while this transitory shock affected students in all four grades of secondary school during 2011, normal attendance resumed in the 2012 school year. This combination of the broad impact of the strikes on public secondary school students only in 2011, and the fact that high-stakes exams are sat after the completion of secondary education,

¹The students' main demand was to change the current market-oriented education system for a public education system that provides free and high-quality education at every level (Simonsen (2012)).

²In Chile, the academic year starts in early March and ends in early December.

³A more detailed description of the Chilean post-secondary education system is presented in Section 2.2.

allows me to study the persistence of the effect over time.

I show that the strikes had a negative effect on public school students' results in the high-stakes math exam, as well as on their university enrollment rates. A key finding is that this negative impact persists, even four years later, when the last of the four cohorts of secondary school students affected by the student strikes in 2011 sit the high-stakes exams. The effect in the math exam fluctuates between 3.2% and 4% standard deviation (σ), while university enrollment in selective universities fell by between approximately 1 percentage point and 1.5 percentage points. This is a sizeable effect: The previous enrollment rate of public school students in selective universities was around 9.8%, so this is a decline of between 9.8% and 15.3%. I do not find any significant effect on the high-stakes language exam. It is possible that the student strikes may have also affected voucher school students, which would introduce a bias in my results. Nevertheless, in this case, my estimations are a lower bound of the true effect of the student strikes on public school students' performance.

Robustness analysis shows that results are not driven by the sorting of students across schools following the strikes. I also provide evidence that results are not driven by the sorting of students across cohorts, induced by an increase in grade repetition rates in 2011. Furthermore, the student strikes might have affected schools in many ways, and the resulting impacts on the math exam and university enrollment rates may have occurred through various channels. I provide evidence suggesting that these results were not driven by inputs to the education production function that might have been affected by the student strikes, such as disruptiveness at the time of the high-stakes exams, school environment, class size or teachers.

The strikes introduced large variation in school attendance across the different types of schools during 2011, and evidence suggests that it was the change in school attendance, rather than any other channel, that affected students' academic outcomes. Given this, I conduct a tentative instrumental variable (IV) analysis to identify the causal effect of school attendance on educational outcomes. In particular, I use the school type that students attended during the student strikes as an instrument for school attendance. Instrumental variables estimates suggest that a 10 percentage points decrease in school attendance rate during secondary school is related to a 9.5% σ decline in the high-stakes math exam score and a 3.2 percentage points reduction in the probability of enrolling in a selective university. Furthermore, IV estimations highlight the long-term implications of school absenteeism: attendance during each grade of secondary school matters in terms of academic performance.

My study is connected to several strands of the literature. Prior work has used student strikes as a source of exogenous variation. [González \(2016\)](#) uses the Chilean student movement of 2011 to investigate the role of networks in collective action. His main finding suggests that individual participation in the strikes follows a threshold model of collective behavior: students were influenced by their networks to skip classes only when more than 40% of their network's members also skipped classes. This paper also investigates the effect of the student strikes on some students' academic achievement. In particular, this paper studies the impact of the strikes on school GPA and repetition rates, by comparing students in primary and secondary school. His findings suggest that repetition rates increased by around 3.5 percentage points and school GPA decreased by 0.1 σ in year 2011 among secondary school students. However, in contrast to national-level standardized tests, school GPA might not be the most accurate measure for

studying the effect on students' academic performance. School GPA is a composite measure of the grades obtained by the students in the different courses during the school year, and teachers of each course issue a grade. Even though this paper uses within-school variation, primary and secondary school teachers might have different incentives for grading students. This concern about incentives is particularly relevant given that secondary school GPA is one of the factors considered for university admission. In contrast, high-stakes exams are national-level tests, which are centralized marked by an external institution, and therefore free of this concern.⁴

[Maurin and McNally \(2008\)](#) studied the 1968 student riots in France, establishing exogenous variation that increased the likelihood of spending a greater number of years in higher education. Because of the conflict between students and university authorities, normal examination procedures were abandoned during that year, considerably increasing the pass rate for several qualifications. Using date of birth as an instrument, the authors find that additional years of higher education increase future wages and occupational levels. They also find a transmission of the effect across generations, reflected in children's educational attainment.

My paper is also linked to studies of transitory shocks that disrupt the accumulation of human capital for secondary school students during extended periods. [Aizer and Doyle \(2015\)](#) analyze the effect of juvenile incarceration on crime and the formation of social and human capital among a population of juvenile offenders in Chicago, using the incarceration tendency of randomly assigned judges. They show that incarceration decreases high school graduation by 13 percentage points. The strongest results are for those aged 15 and 16, a similar age to the students in my sample. Although the periods of incarceration are short (one to two months), the impact on teenagers is very disruptive.

[Pischke \(2007\)](#) studies the effect of drastically shortening the school year while keeping the education curriculum fixed. The author exploits variation introduced by a policy intervention in West Germany in 1966-67, which exposed some students to a total of about two thirds of a year less of school while enrolled. His findings suggest an increase in grade repetition in primary school and fewer students attending higher secondary school tracks among those students in schools with a short school year.

My study also connects with papers that investigate the causal effect of school absenteeism on students' academic attainments. A general finding is that school absenteeism is more relevant for students' performance in math tests than language or reading tests, which is in line with my results. [Gottfried \(2010\)](#) implements an instrumental variable strategy, in which the distance that students live from school is used as an instrument for school absenteeism. [Goodman \(2014\)](#) uses snowfall variation in Massachusetts as an instrument for identifying the effect of the time spent at school on achievement test scores. [Aucejo and Romano \(2016\)](#) jointly estimate the effect of absences and length of the school year on test results of primary public school students in North Carolina, by exploiting a state policy that varies the number of school days prior the tests. The authors also use flu data at the county level to instrument for school absences.

The remainder of the paper is organized as follows. Section 2 describes the Chilean education system. Section 3 provides background to the student movement in 2011. Section 4 describes the data sources and Section 5 outlines the strategy for identifying the effect of the student strikes.

⁴A more detailed description of the high-stakes exam testing system is presented in Section.2.2.

Results addressing the impact of the strikes are discussed in Section 6. Section 7 discusses the effect of school absenteeism on students' academic outcomes. Section 8 concludes.

2 Brief Overview of the Chilean Education System

2.1 Primary and secondary education

The Chilean school system is divided in eight years of primary school (1st grade to 8th grade) and four years of secondary school (9th grade to 12th grade). Moreover, there are three types of schools: public, voucher, and private. Public schools are publicly administered and free of charge, voucher schools are privately owned and receive public funding per student enrolled via a voucher system, and private schools are privately owned and do not receive public funding. The current system evolved out of a reform passed in 1980, changing the school funding system by introducing a voucher per student. This voucher is directly paid to public and voucher schools, based on students' attendance.

2.2 Post-Secondary Education

Admission to post-secondary education is partly centralized. There are two types of institutions: *selective institutions*, the most prestigious universities;⁵ and *non-selective institutions*, which includes some universities and technical and professional institutions. To apply to a selective institution, students must take high-stakes exams after finishing secondary education, in which math and language are mandatory and there are optional exams depending on the degree. Admission is based on these high-stakes exams and students' secondary school GPA. These exams are called *Prueba de Selección Universitaria (PSU)* and they cover the whole secondary education curriculum. The examinations take place simultaneously across the country shortly after the end of the school year. These exams take place only once a year, and can be taken multiple times, for a fee.⁶ The high-stakes exams contain 80 multiple choice questions and are marked electronically by an external institution.

The post-secondary education system has been widely criticized. The public debate has included excessive tuition fees, quality issues related to its rapid expansion and serious problems of information asymmetry, among other issues (Reyes et al. (2013)). Chile currently has the second most expensive private university system of any OECD country, after the United States. It is estimated that Chilean families pay directly more than 75% of the costs associated with higher education, compared to 40% in the United States and just 5% on average in Scandinavian countries. This was the background to the student movement in 2011.

⁵There are 25 universities in the Council of Chancellors of Chilean Universities (*Consejo de Rectores de las Universidades Chilenas (CRUCH)*), popularly known in Chile as "*universidades tradicionales*") which historically represent the largest fraction of the Chilean university enrollment.

⁶The fee in 2016 is CLP 28.790 (about US\$43.5) and is waived for students from public and voucher schools who apply for this benefit.

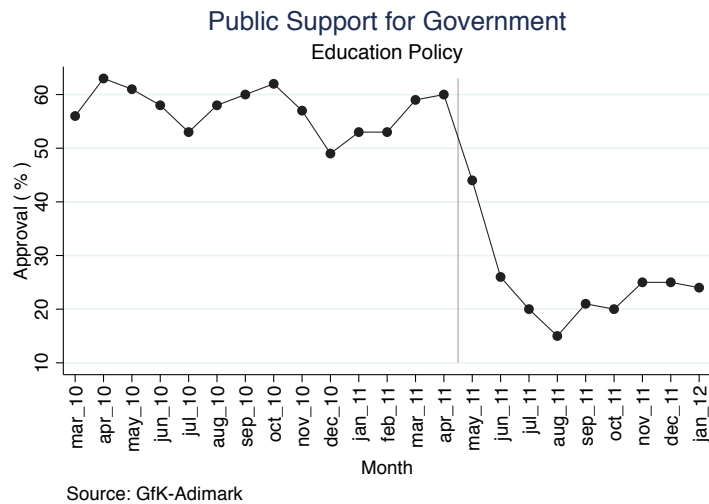
3 The Chilean Student Movement in 2011

The Chilean student movement was a wave of student protests across Chile in 2011, peaking between June and October. The movement was a reaction to the market-oriented education system established in the early 80's, which has produced large profits for private supplier institutions and chronic indebtedness for thousands of post-secondary students (González and Montealegre (2012), Simonsen (2012)).

The movement was initiated in late April 2011, when more than 6,000 students occupied a private university in protest after it was taken over by a private investment fund. On the 28th of April, the association of university students *Confederación de estudiantes de Chile* (CONFECH)⁷ convened the first protest of the year, which brought together more than 15,000 students in the streets of downtown Santiago. At this time, secondary school students started to raise their own demands relating to the deterioration of the public school education system. This first protest was followed by more than 75 others across the country over the school year.

On the 12th of May, a new protest was again organized by the CONFECH, under the slogan "*national strike for saving public education*". Again, thousands of students marched in the streets of Santiago. At this point, the movement started to gain followers other than students, while the government suffered a drop in public support (see Figure 1). A primary demand of the movement emerged: a public education system that provides free and high-quality education at every level (Simonsen (2012)).

Figure 1: Public support for Government's education policy



Notes: This information is captured in a monthly survey by GfK - Adimark, one of the largest Chilean firms dedicated to collect public perceptions.

⁷This confederation brings together students from the Council of Chancellors of Chilean Universities, whose students are organized in democratically elected federations.

In June, the situation climaxed: Universities were occupied, dozens of schools were on strike or shut down, and protesters flooded streets throughout the country, with more than 400,000 people demonstrating. During this period, hundreds of thousands of secondary school students skipped classes to join the strikes. Around October the movement started to decay, as the end of the school year drew closer. Finally, the year ended without a clear agreement between the Government and the students.

4 Data

The data used in this paper includes administrative records for individual-level secondary school enrollment, high-stakes exams test scores and university enrollment for the period 2003 to 2014, obtained from different sources. The first data source is the Chilean Students' Registry, which covers the complete population of students and is administered by the Ministry of Education. It provides information about basic demographic characteristics for each student, their annual average attendance, GPA⁸ and the schools in which each student was enrolled. From year 2011 onwards, it also includes students' monthly average attendance.

The second source of information corresponds to the registry of students who enroll for the PSU test. This is census data provided by the DEMRE (Department of Educational Evaluation, Measurement and Recording), which depends on the Council of Chancellors of Chilean Universities. The variables I use in my analysis are individual data on PSU scores,⁹ as well as the outcomes of the applications for post-secondary placement. The third data source is the Chilean Teachers' Registry, which contains the complete population of teachers in the school education system. This data is administered by the Ministry of Education and provides information about basic demographic characteristics for each teacher and their qualifications. The last source corresponds to teachers' 8th grade SIMCE questionnaires,¹⁰ that provides information regarding a variety of school environment measures over the years 2009, 2011, 2013 and 2014. This data is administrated by the Quality Assurance Agency for Education.

The information from these sources is merged using individual national identification numbers provided for students, teachers and schools.

Table 1 presents descriptive statistics for 12th grade students nationwide from 2007 to 2010, organized by type of school administration. It is worth noting that public school students have a slightly lower average attendance rate, a lower average take-up rate of high-stakes exams, perform worse in those exams, and fewer of them enroll in selective universities.

Over the period in question, private schools account for 8.14%, voucher schools account for 45.26%, and public schools account for 46.6% of enrollment of 12th grade students.

⁸GPA is a continuous variable that goes from 1 to 7.

⁹PSU scores are normalized to a distribution with mean of 500 and a standard deviation of 110 to enable comparison between years. The scores range from 150 to 850 points.

¹⁰SIMCE (*Sistema de Medición de la Calidad de la Educación*) is a battery of standardized tests taken some years by students in specific grades and it is used to measure certain aspects of the school curriculum. In addition to the tests, questionnaires are provided to students, parents and teachers, to collect information regarding specific subjects.

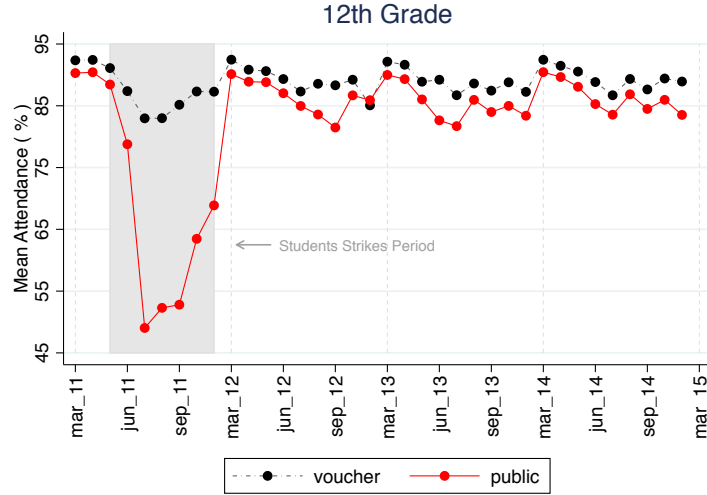
Table 1: Descriptive statistics for 12th grade students over the period 2007-2010

	Private		Voucher		Public	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Students Characteristics						
Female (%)	49.10	49.99	52.90	49.91	51.92	49.96
Yearly attendance rate	92.99	6.91	91.82	7.78	89.97	8.62
12 th grade GPA	6.01	0.52	5.53	0.56	5.48	0.56
Repetition rate (%)	0.27	5.25	1.87	13.53	2.68	16.16
PSU: take-up rate (%)	97.45	15.75	76.77	42.23	64.16	47.95
PSU: math test score (standardized)	1.26	0.82	0.08	0.89	-0.23	0.90
PSU: language test score (standardized)	1.17	0.81	0.10	0.89	-0.24	0.93
Enrollment rate in selective universities (%)	35.63	47.89	15.28	35.98	9.73	29.64
Size of the cohort	16,549.46	124.5	92,025.25	1,570.67	94,735.75	2,729.92
Schools Characteristics						
Class Size	24.58	7.32	31.88	10.30	31.60	11.18
Rural (%)	2.91	16.83	6.38	24.46	9.96	29.96

5 Identification of the Effect of the Student Strikes

In this section I identify the effect of the strikes on the education outcomes of secondary school students. In particular, I investigate the impact on students' attendance, performance in high-stakes exams and enrollment in selective universities.

Figure 2: Average monthly attendance rates in 12th grade



Notes: The figure plots the average monthly attendance rates in 12th grade during the academic years 2011-2014.

Figure 2 shows the monthly attendance rates of 12th grade students over time. Appendix Figure A.1 provides the monthly attendance rates for 9th, 10th and 11th grade students. The pattern is the same: attendance of public secondary school students in all four grades sharply dropped during the period of the strikes, but immediately recovered by 2012, once the strikes were over. During the peak of the strikes (July, August and October of 2011), attendance of public secondary school students fell below 55%. On the other hand, there was hardly any drop in attendance at voucher schools. This shows that public secondary school students were much more likely to participate in the strikes than voucher secondary school students. This combination of the broad impact of the strikes on public secondary school students only in 2011, and the fact that high-stakes exams are sat after the completion of secondary education, allows me to investigate the long-term implications of this disruptive shock on students' academic achievements. Given this, I study the impact of the student strikes on secondary school students using the following baseline regression:

$$outcome_{isrt} = \alpha_s + \gamma_{rt} + \rho(Post_t \times Public_s) + x'_{irst}\varphi + \epsilon_{isrt} \quad (1)$$

Here the subscript i refers to student, s refers to the school, r refers to the region, and t refers to the year. Outcomes of interest are students' attendance, high-stakes exams scores in math and language, and university enrollment. Students' attendance is measured in percentage points, high-stakes exams results are standardized within each year and university enrollment is measured with an indicator variable that takes the value of 1 if the student was enrolled in a selective university right after school graduation.¹¹

As a control group, I use students attending voucher secondary schools.¹² As was discussed before, student strikes could also have impacted voucher secondary school students, which would bias my results. Nevertheless, in this case my estimates are a lower bound of the true effect of the strikes on public school students' performance.

The analysis focuses on ρ , which indicates the average effect of the strikes in all four cohorts of public school students enrolled in secondary school during the year 2011. This is the coefficient associated with the interaction between $Post_t$, an indicator variable that takes the value of 1 from year 2011 onwards; and $Public_s$, another indicator variable that becomes 1 if the student attends a public school. To quantify the relative drop in the yearly attendance rate of public secondary school students in comparison to voucher secondary school students during 2011 due to the strikes, $Post_t$ is replaced by an indicator variable that takes the value of 1 if the year corresponds to 2011.

During the last 25 years, there has been a considerable flow of students from public to voucher schools.¹³ My identification strategy relies on comparing the evolution of outcomes in public and voucher schools, and therefore this endogenous sorting could bias my estimates. To ensure that results are not driven by this sorting, I control for measures of students' ability using their rank position in their class 4 years before 12th grade.¹⁴ As the last cohort of 12th grade students I use in the analysis is the 2014 cohort, this measure was fixed before the strike for all cohorts included in the analysis. The other student-level control used is a gender dummy. I also control for time-invariant unobserved heterogeneity across schools by including school fixed effects. In addition, to account for potential heterogeneous regional responses to temporal shocks, I also include region \times time fixed effects. Standard errors are clustered at the school level.

The key assumption in a differences-in-differences strategy is that the evolution of outcomes in public and voucher schools did not follow differential trends before the strikes took place. I test this assumption following Granger (1969) and Autor (2003), using Equation (2):

¹¹As discussed in Section 2.2, students are allowed to sit high-stakes exams more than once, and to apply to a major degree as many times as they wish.

¹²I decided to exclude private secondary school students from the sample. There are two main reasons for this decision: (i) Private school students represent a very small proportion of the total of secondary school students and; (ii) family backgrounds of private school students are very different from the rest of the students' population. In fact, their families are able to pay very expensive fees for private education. Thus, strikes might have differently affected these unobserved characteristics in comparison to the rest of secondary school students.

¹³Since the introduction of the initial reform in 1980, students have moved from the public system to voucher schools. In the early 90's, 60% of the students were enrolled in public schools, 33% attended voucher schools and the remaining 7% attended private schools (Simonsen (2012)). In 2012, only 39.7% of the students were enrolled in public schools, 53.1% attended voucher schools and the remaining 7.2% attended private schools.

¹⁴This measure of students' past performance is a continuous variable that goes from 0 to 100.

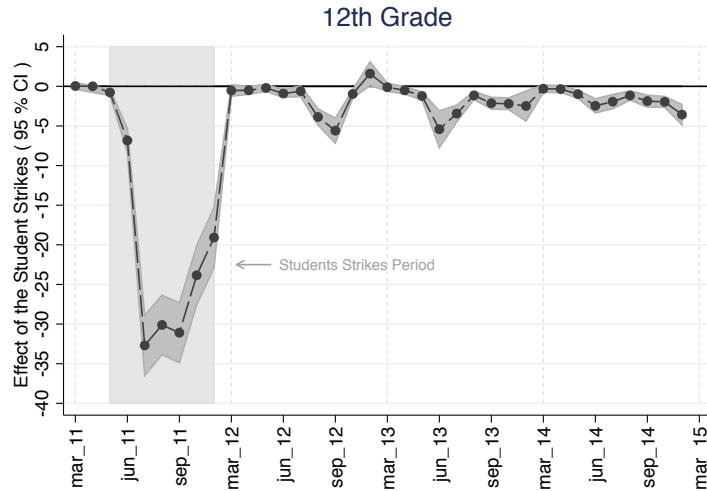
$$\begin{aligned}
outcome_{isrt} = & \alpha_s + \gamma_{rt} + \sum_{m=2006}^{2009} \beta_m (Year_t \times Public_s) + \\
& \sum_{n=2011}^{2013} \rho_n (Year_t \times Public_s) + x'_{irst} \varphi + \epsilon_{isrt}
\end{aligned} \tag{2}$$

If the common trend assumption is satisfied, it is expected that coefficients β_m are not statistically different from zero. In addition, Equation (2) offers a more flexible estimation of the strikes' impact on secondary school students' outcomes. Indeed, it decomposes the effect, making it possible to study its evolution over time. These yearly effects are captured by coefficients ρ_n .

6 The Effect of the Student Strikes

6.1 The Effect on Students' Attendance

Figure 3: Effect of the student strikes on public school students' monthly attendance in 12th grade



Notes: The figure plots parameter estimates of Equation (2), using the monthly attendance rate of 12th grade students as a dependent variable. In the regression, I use monthly repeated cross-section data at student level during the academic years 2011-2014. I include school fixed effects and region \times time fixed effects. At student level, I control for pre-strikes measures of individual students' past performance. I also include a gender dummy.

I begin the empirical analysis by studying the dynamic effect of the strikes on students' monthly attendance presented in Figure 2 and appendix Figure A.1. The regression results are presented in Figure 3 and appendix Figure A.2, on which school fixed effects, region \times time fixed

effects and student-level controls were included. The main conclusion is that, after controlling for this set of different fixed effects and student-level characteristics, the drop in the attendance rate of public secondary school students in all four grades is very large and significant in comparison to voucher secondary school students. At the peak of the strikes (July, August and September), the fall in the monthly attendance was more than 30 percentage points.

However, high-stakes exams and university enrollment are processes that happen once a year, at the end of the school year. Appendix Figure A.3 presents the yearly attendance rates of secondary school students by grade. Again, attendance rates follow a similar pattern across the different grades of secondary school. The average yearly attendance rate of students in public secondary schools dropped by almost 20 percentage points in 2011, but immediately returned to normal levels in 2012, the point at which schools resumed standard practices. To estimate the effect of the student strikes on the yearly attendance of public secondary school students during 2011 in comparison to voucher secondary school students, I use Equation (1).

Table 2: Effect of the student strikes on public school students' yearly attendance in 2011

	(1)	(2)	(3)	(4)
	9 th Grade	10 th Grade	11 th Grade	12 th Grade
public × 2011	-14.87*** (0.888)	-14.91*** (0.914)	-15.35*** (0.957)	-14.34*** (0.899)
Observations	1,965,085	1,774,719	1,613,636	1,436,384
R-squared	0.311	0.305	0.304	0.301
Student Level Controls	YES	YES	YES	YES
School FE	YES	YES	YES	YES
Region × Year FE	YES	YES	YES	YES

Notes: ***, **, * Denote statistical significance at 1%, 5% and 10% level respectively. All standard errors are clustered at school level and reported in parenthesis. This table only shows estimates of interest. The data contains repeated cross-section information at students level during the academic years 2007-2014. Outcome variables are yearly attendance rates of students in 9th grade, 10th grade, 11th grade and 12th grade, respectively. These variables are measured in percentage points and goes from 0 to 100. *Public* is a dummy variable that takes the value of 1 if the student attends to a public school, 0 otherwise. *2011* is a dummy variable that takes the value of 1 if the observation corresponds to year 2011, 0 otherwise. Student-level controls include a measure of students' ability unaffected by the strikes (the rank position of the students within their class 4 years before 12th grade, which is a continuous variable that goes between 0 and 100) and a gender dummy. All regressions include school fixed effects and time × region fixed effects.

Regression results of Equation (1) are presented in Table 2. Column 1 shows the effect of the student strikes on the yearly attendance rate of 9th grade public school students, Column 2 shows the results for 10th grade public school students, Column 3 shows the results for 11th grade public school students, while Column 4 shows the results for 12th grade public school students. Differences-in-differences estimates reveal a significant reduction in the yearly attendance rate

of public secondary school students in all grades in comparison to students in voucher schools. This average reduction is very similar across grades, with point estimates fluctuating between 14.3 percentage points and 15.3 percentage points. These results imply that on average different cohorts of students in each of the four grades of secondary education were exposed to the same large and negative transitory shock to their attendance in 2011.

6.2 The Effect on Academic Outcomes

I start the empirical analysis with a graphical comparison of 12th grade students' academic outcomes in public and voucher schools. Figure 4 presents the evolution of the three main academic outcomes of interest in both types of schools. To make the comparison easier, levels in the year 2007 are set to 0.

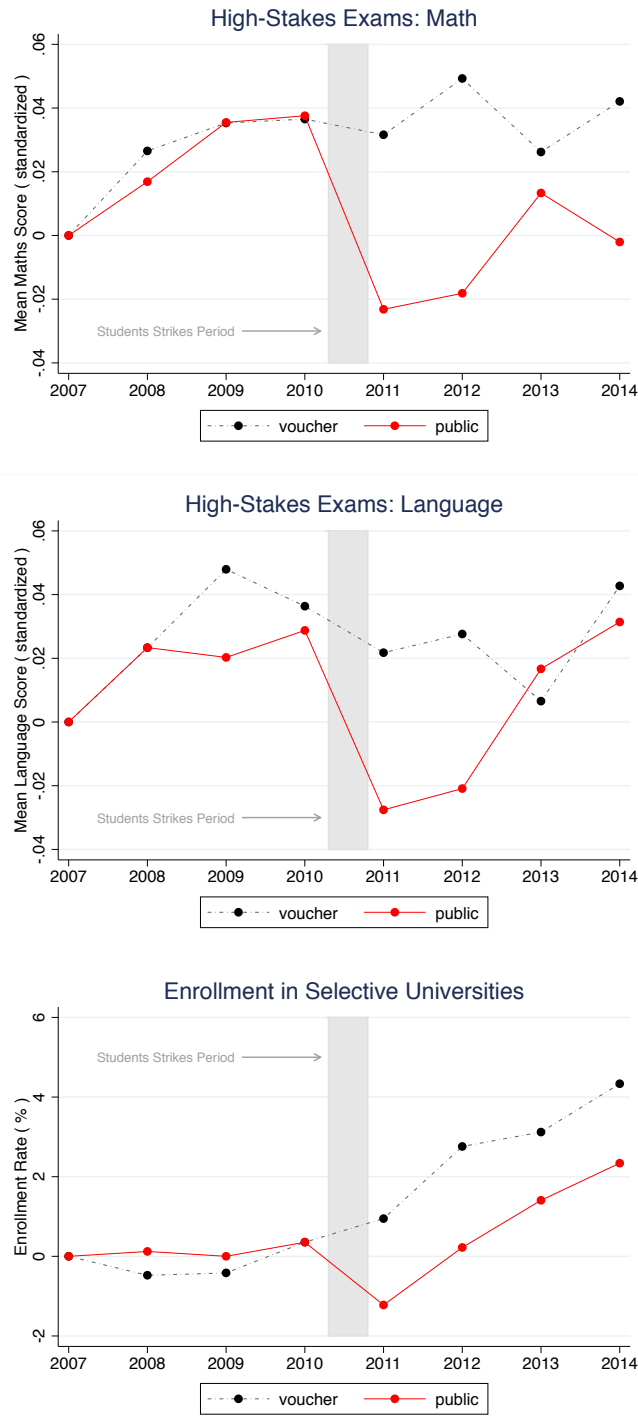
At first glance, it is possible to highlight two features: (i) In all outcomes, the common trend assumption seems to be satisfied; (ii) and in math test and university enrollment, there is a negative effect of the student strikes on public school students that persists over the whole post-strike period. This second feature is interesting. It is reasonable to expect that the strikes could have an immediate negative effect on students' performance, however, the impact also lasts well beyond 2011, when schools resumed standard practices. Public school students who were in 11th grade at the time of the strikes still seem negatively affected one year later when they sat their high-stakes examinations at the end of 12th grade in 2012. Similarly, students who were in 10th and 9th grade in 2011 also still seem negatively affected in 12th grade; 2 and 3 years after the strikes, respectively.

The top panel of Figure 4 shows the standardized results of 12th grade students in public and voucher schools in the high-stakes math exam. Trends of math results are notably parallel from 2007 up to the year of the student strikes, when public school students' results drop sharply. From 2012 onwards, students in public schools catch up but they do not fully recover.

Results in the high-stakes language exam are presented in the middle panel of Figure 4. Here, data is a bit more noisy and trends do not coincide just before the protests take place. Again, even though results for both public and voucher school students go down after the strikes, the decline in public schools students' language scores in 2011 is more pronounced. In 2012, students in public schools start to catch up, and they have fully recovered by 2013.

The bottom panel of Figure 4 shows enrollment rates of 12th grade students in selective universities. As could be seen in the high-stakes exams, enrollment rates of public school students in selective universities drop immediately after the strikes. However, compared to voucher school students, they do not catch up in the post-strike period.

Figure 4: Academic outcomes of 12th grade students



Notes: Top panel plots the average standardized score in the high-stakes math exam during the academic years 2007-2014. Middle panel plots the average standardized score in the high-stakes language exam during the academic years 2007-2014. Bottom panel plots the average enrollment rates in selective universities during the academic years 2007-2014. In order to facilitate the interpretation, levels in year 2007 are set to 0.

Results for the baseline specification, contained in Equation (1), are presented in Table 3. This regression analysis provides the average effect of the strikes on all four cohorts of public school students enrolled in secondary education during the year 2011. Column 1 shows the result in math, Column 2 shows the result in language, and Column 3 shows the result for enrollment in selective universities. Differences-in-differences estimates reveal a significant reduction in the math test and enrollment rate in a selective university for public school students after the strikes, as was shown in Figure 4. This average reduction corresponds to 3.7% σ in math and 1.3 percentage points in university enrollment, which is a sizeable effect considering that the average enrollment rate of public school students in selective universities was around 9.7% between 2007 and 2010. This means a drop of approximately 13.4%. By contrast, although the point estimate of the language test is negative, it is not statistically significant.

Table 3: Baseline results for the effect of the student strikes on students' academic outcomes

	(1)	(2)	(3)
	Math	Language	Enrollment
public \times post	-0.0373*** (0.00720)	-0.00511 (0.00702)	-0.0126*** (0.00231)
Observations	1,033,409	1,033,409	1,429,263
R-squared	0.475	0.430	0.248
Student Level Controls	YES	YES	YES
School FE	YES	YES	YES
Region \times Year FE	YES	YES	YES

Notes: ***, **, * Denote statistical significance at 1%, 5% and 10% level respectively. All standard errors are clustered at school level and reported in parenthesis. This table only shows estimates of interest. The data contains repeated cross-section information at students level during the academic years 2007-2014. Outcome variables are the standardized score in the high-stakes math exam, the standardized score in the high-stakes language exam and enrollment in a selective university, respectively. High-stakes exams scores are standardized within each year. Enrollment is a dummy variable that takes the value of 1 if the student was enrolled in a selective university right after finishing 12th grade. *Public* is a dummy variable that takes the value of 1 if the student attends to a public school, 0 otherwise. *Post* is a dummy variable that takes the value of 1 if the observation corresponds between years 2011 and 2014, 0 otherwise. Student-level controls include a measure of students' ability unaffected by the strikes (the rank position of the students within their class 4 years before 12th grade, which is a continuous variable that goes between 0 and 100) and a gender dummy. All regressions include school fixed effects and time \times region fixed effects.

Appendix Table A.1 provides the regression results of Equation (2), while Figure 5 graphs the coefficients separately for each year. They show that the effect of the strikes persists over time, even though the situation in schools is back to normal in 2012. This shows the long-run implications of the transitory shock on students' performance. In the high-stakes math exam just after the strikes, the impact is around 3.6% σ . The immediate impact of the strikes on university

enrollment rates is 1.4 percentage points and remains significant at the one percent level during the whole period. The fact that the effect on enrollment rate in selective universities has a similar pattern to the one on high-stakes exams makes sense, given that university enrollment depends on the students' performance in those exams.

6.3 Heterogeneous Effects

On average, the student strikes have a negative impact on students' academic outcomes. However, these effects might differ depending on students' characteristics. In this section, I study heterogeneous responses to the strikes according to students' previous performance. I divide the sample into two groups: students above and below the median of the distribution of students' previous performance, which is the proxy used for students' ability. The top-left panel of appendix Figure A.4 provides the public school students' yearly attendance rate in 12th grade by ability, showing a similar drop in the attendance rate of public school students among both these groups during the year of the strikes.

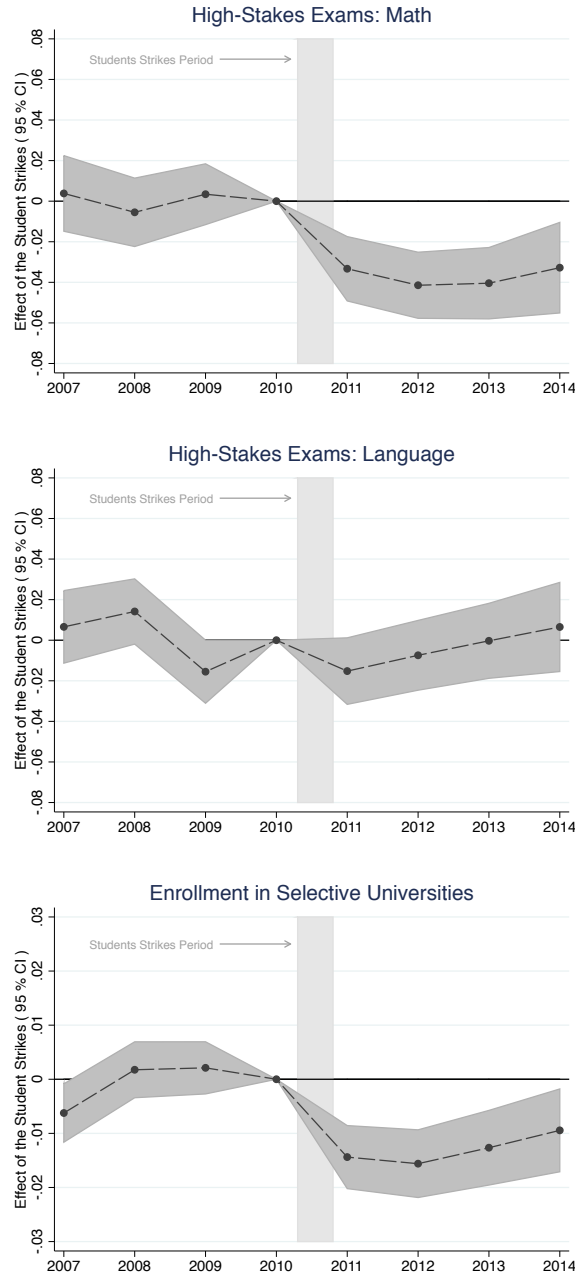
To investigate these potential effects, I use a triple differences-in-differences design:

$$\begin{aligned} outcome_{isrt} = & \alpha_s + \gamma_{rt} + \beta High_i + \theta_1(Public_s \times Post_t) + \\ & + \theta_2(Public_s \times High_i) + \theta_3(High_i \times Post_t) + \\ & \rho(Public_s \times High_i \times Post_t) + x'_{isrt}\varphi + \epsilon_{isrt} \end{aligned} \quad (3)$$

In Equation (3), $High_i$ is a dummy variable that takes the value of 1 if the student is above the median of the students' ability distribution. The analysis focuses on ρ , which is the difference in the average effect of the strikes on all four cohorts of public school students enrolled in secondary education during the year 2011 between the two groups of students' ability.

The results are in appendix Table A.2. Column 1 shows the difference in the decline of 12th grade students' attendance rate in 2011 by students' ability. The point estimate of the triple interaction coefficient is negative and significant at the 1% level, indicating that the fall in the attendance rate in 2011 was 2.2 percentage points larger among the high-achieving students of public schools. Columns 2 to 4 show the differences in the effect of the strikes on the academic outcomes by students' ability. The point estimates of ρ for all academic outcomes are also negative and significant at the 1% level, indicating that public school students in the upper part of the ability distribution were more affected by the strikes. Appendix Figure A.4 presents the evolution of these outcomes divided by students' ability. To make the comparison easier, levels in year 2007 are set to 0. Appendix Figure A.4 shows that the larger impacts of the student strikes on public school students in the upper part of the ability distribution are not driven by the effect in a specific year.

Figure 5: Effect of the student strikes on 12th grade public school students' academic outcomes



Notes: Top panel plots parameter estimates of Equation (2), using the standardized score in the high-stakes math exam of 12th grade students as a dependent variable. Middle panel plots parameter estimates of Equation (2), using the standardized score in the high-stakes language exam of 12th grade students as a dependent variable. Bottom panel plots parameter estimates of Equation (2), using the enrollment status in a selective university of 12th grade students right after finishing secondary school as a dependent variable. In the regressions, I use yearly repeated cross-section data at student level during the academic years 2007-2014. I include school fixed effects and region \times time fixed effects. At student level, I control for pre-strikes measures of individual students' past performance. I also include a gender dummy.

The average effect of the strikes on low-performing public school students is captured by θ_1 , which is the coefficient related to the interaction between $Post_t$ and $Public_s$. Interestingly, strikes don't seem to have affected the high-stakes exams' performance of public school students in the lower part of the ability distribution. The largest point estimate corresponds to the math test ($-1\% \sigma$), and is only significant at 10% level. In contrast, there is a negative impact of around 0.4 percentage points on enrollment in selective universities. This small effect is likely explained by the drop in the high-stakes exams' take-up rate in year 2011. This situation is discussed more in detail in Section 6.4.

6.4 Robustness Checks

A potential driver of the education outcomes after 2011 may have been that good students moved from public schools more involved in the strikes to less affected voucher schools. Following Waldinger (2010), I address this by assigning students who switched schools in 2012, 2013 and 2014 to their 2011 school. Appendix Figure A.5 shows the results I obtain re-estimating Equation (2) after this modification. These results are qualitatively the same as those provided by the main specification presented in Figure 5, and point estimates barely change.

Another concern is that repetition rates increased in public schools in 2011 because of the sharp decline in attendance rates (top and middle panels in appendix Figure A.6).¹⁵ Accordingly, the take-up rates of the high-stakes exams in public schools went down in 2011 (bottom-left panel in appendix Figure A.6). This raises the concern that the 2010 and 2011 cohorts taking the PSU exam in public schools are not comparable, thus invalidating my differences-in-differences estimation strategy for the PSU results in 2011. Moreover, this situation could have induced self-selection of students across cohorts, which also threatens my identification. For instance, this potential self-selection issue might have occurred if the probability of repeating a grade due to school absenteeism in 2011 was larger for low-ability students in comparison to high-ability students. I already partly addressed this problem in my specification by controlling for pre-strikes measures of students' ability. Top-left and top-right panels of appendix Figure A.7 provide the measure of students' past performance over time for non-repeaters and students that took the high-stakes exams, showing that the trends of these measures didn't seem to be affected by the strikes. This first descriptive evidence suggests that the strikes did not impact the students' composition across students' cohorts in terms of students' ability. Furthermore, I conduct two robustness checks: (i) I put students that repeated after 2011 back in their original cohorts, (ii) and I use an estimation strategy inspired from Abadie (2003)¹⁶ to characterize the students that were *induced* to repeat by the strikes in terms of their academic past performance. Appendix Figure A.8 lays out the results of the first exercise, which are qualitatively the same as those obtained in the main specification presented in Figure 5. The result of the second exercise is provided in Appendix B. Equation (B.4) shows that the mean ability of the students that repeated grade *induced* by the strikes in 2011 is similar to the mean ability of non-repeaters,

¹⁵In Chile, students' attendance rates are a potential cause for repeating the academic year. If the annual attendance rate of a student is lower than 85%, she might repeat the academic year. Nevertheless, the principal of the school has the option to apply this criteria on a case by case basis

¹⁶Abadie (2003) proposes an estimation method to describe compliers in instrumental variable models.

allaying the potential concern regarding self-selection across cohorts in terms of students' ability.

6.5 Mechanisms

Sorting of teachers across schools is a first potential mechanism through which the student strikes might have affected students' performance. Good teachers from more affected public schools may have moved to voucher schools less involved in the strikes. I study the turnover of secondary school teachers across schools during the period using Equation (2) and individual-level data of the complete population of teachers in the secondary school system. In particular, I analyse the proportion of teachers that leave the school during every year in the sample, as well as the proportion of teachers that hold an academic degree, as a measure for capturing teachers' quality. Results are presented in appendix Figure A.9, showing that neither the turnover of teachers across the schools nor teachers' qualifications seem to be affected by the student strikes.

In 2011, students sat the high-stakes exams between the 11th and the 13th of December. Even though the student movement started to decay in October, a disruptive environment on the days of the exams might affect students' academic outcomes. However, if this channel had been the main driver we wouldn't have observed an effect in 2012, 2013 and 2014.

Changes in the school environment due to the student strikes might explain my findings. To explore this alternative, I use information regarding school environment reported by teachers in the 8th grade SIMCE tests in years 2009, 2011, 2013 and 2014. 8th grade is the last grade of primary education, and therefore I use information about schools that provide both primary and secondary education. This is a non-random sample of secondary education schools. In fact, this set only contains about 25% of the public schools and 56% of the voucher schools in the whole sample. Appendix Figure A.10 lays out the students' monthly attendance rate in this sub-sample of schools for each grade of secondary education, showing qualitatively the same pattern as the whole population. This suggests that the sub-sample of schools was affected by the student strikes in a similar manner as the whole population. The information regarding school environment is reported by specific-subject teachers (math, language, social science and natural science, which are the subjects taken in the 8th grade SIMCE test), who often teach in both primary and secondary education. In particular, I have school-level information regarding three aspects: (i) How difficult it is to teach in the school due to student discipline, (ii) the degree to which rules are respected by the students at the school, (iii) and the level of violence at the school. Appendix Figure A.11 presents the results of the regression analysis. There are no statistical differences in any outcome and point estimates are close to zero. This evidence suggests that changes in the school environment are not driving the results relating to students' academic performance.

Finally, class size could also have been affected by the student strikes. One mechanism is a decrease in the effective class size in 2011 due to high rates of absenteeism. A potentially second mechanism is a reduction in class size in public schools after 2011 if enrollment rates declined due to the student strikes. The latter may have occurred if the student strikes accelerated the trend of students moving from public to voucher schools. Therefore, the effects I present might be attributable to a change in class size rather than the strikes. Appendix Figure A.12 shows

changes in class size in each grade of secondary school education in public and voucher schools. Class size in public schools started to fall before the strikes of 2011, and continued after that. As the literature on class size suggests a positive effect of smaller classes on student achievement (Angrist and Lavy (1999), Krueger (2003), among others), this reduction in class size should once again go against my results. In addition, and being aware of the potential bias induced by a *bad control problem* (Angrist and Pischke (2008)), as an indicative exercise I re-estimate my main specification using Equation (2), adding class size as a control. Results are presented in appendix Figure A.13: they remain unchanged in comparison to the results in Figure 5.

7 The Effect of School Absenteeism on Academic Outcomes

7.1 Aggregate School Absenteeism during Secondary School

The student strikes introduced large variation in school attendance across the different types of schools during 2011. In the previous section I showed that my findings on students' educational outcomes are not driven by the sorting of students across schools or cohorts nor by key inputs of the education production function that might have been affected by the student strikes, like disruptiveness at the moment to take the high-stakes exams, school environment, class size and teachers. This evidence suggests that it was the change in school attendance, rather than any other channel, that affected students' academic outcomes. Thus, even though there may have been unobservable variables affected by the strikes that also affected students' educational attainments, I conduct a tentative instrumental variable analysis to identify the causal effect of school absenteeism on students' education outcomes.

$$outcome_{is2011r2011t} = \alpha_{s2011} + \gamma_{r2011t} + \rho Absenteeism_{is2011r2011t} + x'_{is2011r2011t} \varphi + \zeta_{is2011r2011t} \quad (4)$$

In Equation (4), I regress students' academic outcomes on students' school absenteeism rate during secondary school. I include the same student-level controls used in Equations (1), (2) and (3), as well as school fixed effects and region \times time fixed effects. For each student in cohorts after 2011, I assign the school (and therefore also the region) attended in 2011. For these students, I decided to fix the school they were attended in the year of the strikes given that the choice of the school on which they graduate from 12th grade is an endogenous decision. Nevertheless, estimating Equation (4) using ordinary least squares (OLS) would lead to a biased estimate of ρ . Omitted variables could be a source of bias, for instance, more able and motivated students are more likely to attend school and to perform well on tests. To tackle this problem, I use the school type that students were attending in 2011 to instrument students' school absenteeism during secondary school.

Appendix Figure A.14 shows the students' attendance rates during secondary school, displaying a sharp decline public school students' attendance rates immediately after the strikes, which remains throughout the post-strike period. This is because school attendance for all post-strike

cohorts of 12th grade students was similarly affected by the strikes in 2011, even though in 2011 they were enrolled in different grades of secondary education.

The first-stage regression is:

$$Absenteeism_{is2011r2011t} = \alpha_{s2011} + \gamma_{r2011t} + \phi(Public_s \times 2011_t) + x'_{is2011r2011t}\varphi + \varsigma_{is2011r2011t} \quad (5)$$

In Equation (5), the instrument for school absenteeism during secondary school is $(Public_s \times 2011_t)$, which is a dummy variable that takes the value of 1 if the student attended a public school in 2011, 0 otherwise.

Table 4 contains the results, with the results of the first-stage regressions in Columns 1 and 6 showing a strong and significant effect of the student strikes on absenteeism during secondary school.¹⁷ This was expected from trends shown in appendix Figure A.14. Results regarding academic outcomes are presented in Columns 2 to 5, 7 and 8. Columns 2, 4 and 7 report the OLS results in math, language and enrollment in a selective university, respectively. Columns 3, 5 and 8 contain their counterpart IV estimates. At first glance, it is possible to highlight three features: (i) OLS and IV point estimates show a negative effect of absenteeism during secondary school on all academic outcomes, (ii) OLS and IV estimates show a larger effect in math in comparison to language, (iii) and OLS and IV point estimates are very similar in magnitude regarding the impact of absenteeism on math and university enrollment. Columns 2 and 3 show the effect of absenteeism during secondary school on the high-stakes math exam. The IV estimate suggests that a 10 percentage points decrease in school attendance rate during secondary school is related to 9.5% σ reduction in math exam score. Students' performance in the high-stakes language exam is shown in Columns 4 and 5. The IV point estimate suggests that a 10 percentage points decrease in the attendance rate during secondary school reduces the language exam score by 2.9% σ . This effect is only significant at the 10% level. Finally, Columns 6 and 7 show the estimates of the effect on enrollment in selective universities. Again the IV estimate is negative and highly significant, suggesting that a 10 percentage points decrease in attendance rate during secondary school reduces by 3.2 percentage points the probability of enrolling in a selective university.

It is interesting to compare my results with previous findings in the literature regarding the effect of school absenteeism on education attainment. Firstly, as I already pointed out, my results show a larger effect of school absenteeism on math than language, which is a general finding in the literature (Gottfried (2010), Goodman (2014), Aucejo and Romano (2016)). In particular, my instrumental variable estimates are very similar to those in Aucejo and Romano (2016). In this paper, the authors estimate the effect of absences and length of the school calendar on test score performance of primary public school students in North Carolina. Even though this is a different aged population of students, their findings suggest that 10 days of school absence reduce math scores by 5.5% σ , and 2.9% σ in reading, under their preferred specification. This implies that a 10 percentage points decrease in the yearly attendance (18 days) would reduce math scores by 9.9% σ .

¹⁷First-stage regression reported in Column 1 only contains 12th grade students that sat the high-stake exams, while the first-stage regression reported in Column 6 includes the whole population of 12th grade students.

Table 4: OLS vs IV estimations regarding the effect of secondary school absenteeism on academic outcomes

	Math			Language		Enrollment		
	(1) Absenteeism	(2) OLS	(3) IV	(4) OLS	(5) IV	(6) Absenteeism	(7) OLS	(8) IV
public \times 2011	4.227*** (0.267)					4.041*** (0.232)		
absenteeism in secondary (%)		-0.00891*** (0.000338)	-0.00952*** (0.00157)	-0.00155*** (0.000287)	-0.00293* (0.00158)		-0.00371*** (0.000141)	-0.00318*** (0.000578)
Observations	1,033,404	1,033,404	1,033,404	1,033,404	1,033,404	1,429,263	1,429,263	1,429,263
R-squared	0.389	0.478	0.478	0.431	0.431	0.385	0.250	0.250
Student Level Controls	YES	YES	YES	YES	YES	YES	YES	YES
School FE	YES	YES	YES	YES	YES	YES	YES	YES
Region \times Year FE	YES	YES	YES	YES	YES	YES	YES	YES
F-test on instrument	251.3					303.2		

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Notes: ***, **, * Denote statistical significance at 1%, 5% and 10% level respectively. All standard errors are clustered at school level and reported in parenthesis. This table only shows estimates of interest. The data contains repeated cross-section information at students level during the academic years 2007-2014. Outcome variables are school absenteeism during secondary school education, the standardized score in the high-stakes math exam, the standardized score in the high-stakes language exam and enrollment in a selective university, respectively. Column 1 reports the first-stage estimates considering the whole population of students, while column 6 reports the first-stage estimates only considering the population of students that sat the high-stakes exams. Columns 2, 4, and 7 report the OLS estimates regarding the effect of school absenteeism during secondary school education on academic outcomes, while columns 3, 5, and 8 reports the IV estimates. School absenteeism during secondary school education is measured in percentage points, and therefore it is a continuous variable that can take values from 0 to 100. High-stakes exams scores are standardized within each year. Enrollment is a dummy variable that takes the value of 1 if the student was enrolled in a selective university right after finishing 12th grade. *Public* is a dummy variable that takes the value of 1 if the student attends to a public school, 0 otherwise. *2011* is a dummy variable that takes the value of 1 if the observation corresponds to year 2011, 0 otherwise. Student-level controls include a measure of students' ability unaffected by the strikes (the rank position of the students within their class 4 years before 12th grade, which is a continuous variable that goes between 0 and 100) and a gender dummy. All regressions include school fixed effects and time \times region fixed effects. In addition, for each student in cohorts after 2011, I assign them the school (and therefore, also the region) she attended in 2011.

To put my results in context, I compare them with the effect of other policy interventions. Following my findings, reducing absenteeism during secondary school by 10 percentage points has a relatively similar or slightly smaller effect in math than a 1σ improvement in teacher value added in the context of primary education (Rothstein (2010), Chetty et al. (2014)). Nevertheless, in the context of first-year of post-secondary education (more similar aged students), my estimates are almost double (Scott E. Carrell (2010)). In addition, reducing absenteeism during secondary school by 10 percentage points has more than the double the effect in math than large financial incentives' for secondary school teachers based on their students' test performance (Lavy (2009)).

7.2 School Absenteeism in each Grade of Secondary School

The student strikes similarly affected the attendance rate of public school students in every secondary school grade during 2011. Nevertheless, schools resumed their standard practices in the school year 2012. This means that I can study the effect of absenteeism during each grade of secondary school on high-stakes exams and enrollment in selective universities. To investigate the impact of school absenteeism during 12th grade, I use Equations (4) and (5), only keeping in my sample the pre-strike and 2011 cohorts of 12th grade students. The pre-strike cohorts did not receive any shock to their class attendance in any grade during secondary school, while the 2011 cohort was only affected in 12th grade. Similarly, to study the effect of absenteeism during 11th grade, I only use the pre-strike and the 2012 cohorts of 12th grade students; to investigate the effect of absenteeism during 10th grade, I only use the pre-strike and the 2013 cohorts of 12th grade students, and to study the effect of absenteeism during 9th grade, I only use the pre-strike and the 2014 cohorts of 12th grade students. This is because the attendance rate of the 2012 cohort of 12th grade students was only affected by the strikes when these students were enrolled in 11th grade, the attendance rate of the 2013 cohort of 12th grade students was only affected when these students were enrolled in 10th grade, while the attendance rate of the 2014 cohort of 12th grade students was only affected when these students were enrolled in 9th grade.

First-stage regressions are reported in appendix Table A.3, showing a strong and significant effect of the student strikes on absenteeism in each grade of secondary school. These point estimates are slightly different from those presented in Table 2 for the following three reasons: (i) The low attendance rate of some students that repeated a grade in 2011 was replaced by their new attendance rate after passing that grade later, (ii) some students dropped out of secondary school, (iii) and in the regressions reported in appendix Table A.3 I only use a sub-group of cohorts of students.

Results of the OLS and IV estimations regarding the effect of school absenteeism of each grade on math, language and university enrollment are reported in appendix Figure A.15 and appendix Tables A.4, A.5 and A.6, respectively. A first interesting finding is the long-term implications of school absenteeism, reported in both OLS and IV estimations: attendance during each grade of secondary school matters for academic outcomes. A second interesting result is that OLS point estimates tend to assign more importance to the later grades in students' academic performance, while IV results suggest a more even effect of each grade of secondary school on students' educational attainments. IV estimates suggest that a 10 percentage points decrease in attendance rate in any grade during secondary school reduces the math exam score by around

2.3% σ to 3.2% σ . In addition, IV regressions also suggest that the same decrease in attendance rate in any grade during secondary school is related to a 0.8 percentage points to 1.2 percentage points decline in the probability of enrolling in a selective university.

8 Concluding Remarks

This paper examines the long-term implications for student outcomes of the Chilean student movement in 2011, which affected public secondary school students in all four grades. By doing so, this paper sheds light on the impact of prolonged school absenteeism on students' academic achievements. I show that the student strikes, initially led by university students but spreading to secondary school students, did have a very strong effect on the attendance rate of public secondary school students in 2011. In particular, the yearly attendance rate of public school students in every grade of secondary education dropped by around 15 percentage points, compared to students in voucher schools. Nevertheless, the attendance rate of secondary school students returned to normal levels in 2012, when the protest action abated.

I show that the strikes had a negative impact on public school students' performance in both the high-stakes math exam and on their university enrollment, compared to students in voucher schools. A main finding is the persistence of this negative effect four years after the strikes, as each of the four cohorts of secondary school students affected by the student strikes in 2011 sat their high-stakes examinations after completing secondary education. The yearly impact on the math exam fluctuates between 3.2% and 4% σ , while university enrollment in selective universities dropped between 1 percentage point to 1.5 percentage points. This effect on university enrollment is substantial, given that the pre-strike enrollment rate of public school students in selective universities was approximately 9.8%, so this is a decline between 9.8% and 15.3%. On the other hand, I didn't find any significant effect on the high-stakes language exam.

Student strikes may have also affected secondary school students in voucher schools, which would bias my findings. Nonetheless, if this was the case, my estimations are a lower bound of the true effect of the student strikes on the performance of public school students. Further robustness analysis shows that these previous findings on students' educational outcomes are driven neither by the sorting of students across schools following the strikes nor by the sorting of students across cohorts induced by an increase in grade repetition rates in 2011. Moreover, the student strikes might have affected schools in many ways, and the resulting effects on the math exam and university enrollment rates may have occurred through different channels. I provide evidence suggesting that these results were not driven by inputs to the education production function that might have been affected by the student strikes, such as disruptiveness at the time of the high-stakes exams, school environment, class size or teachers.

Finally, following suggestive evidence that rules out the student strikes affecting students' academic attainments through a mechanism other than school attendance, I do a tentative instrumental variable analysis to identify the causal effect of school attendance on educational outcomes. I use the school type that students attended in 2011 to instrument students' school attendance. Instrumental variables estimations suggest that a 10 percentage points decrease in the attendance rate during secondary school leads to a 9.5% σ reduction in score in high-

stakes math exams and a 3.2 percentage point reduction in the probability of being enrolled in a selective university. Moreover, my estimations also highlight the long-run consequences of absenteeism: attendance during each grade of secondary school is relevant in terms of students' academic performance.

From a policy perspective, my instrumental variable results stress the attention that policy-makers should pay to school absenteeism, due to its short- and long-term impacts on students' academic achievements. Furthermore, reducing absenteeism could be a cost-effective instrument for increasing students' instruction time, given that it does not involve the allocation of additional resources to schools.

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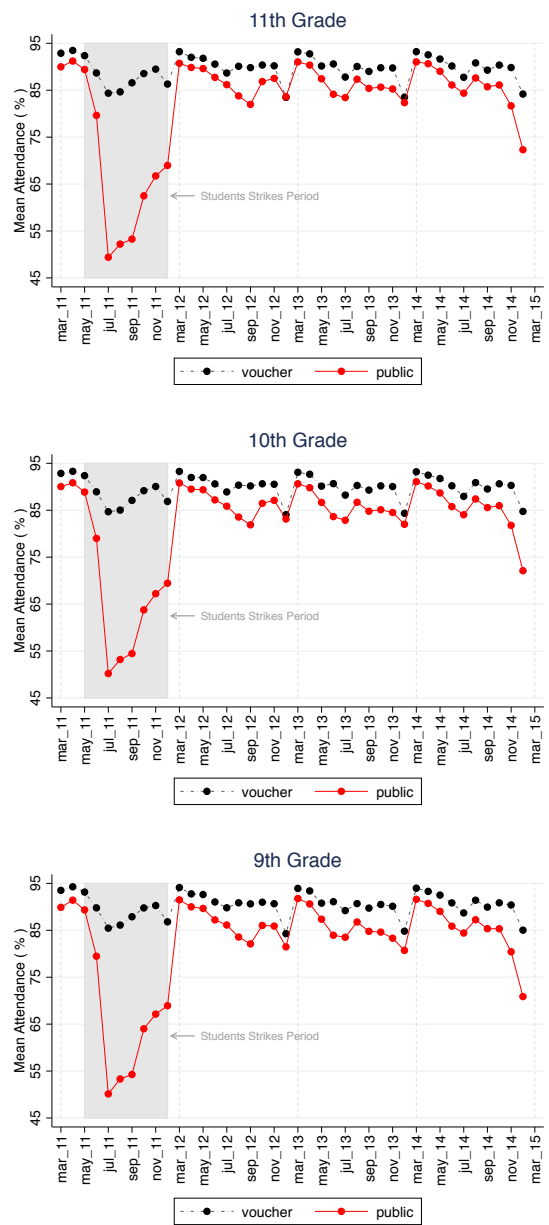
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A Appendix Figures and Tables

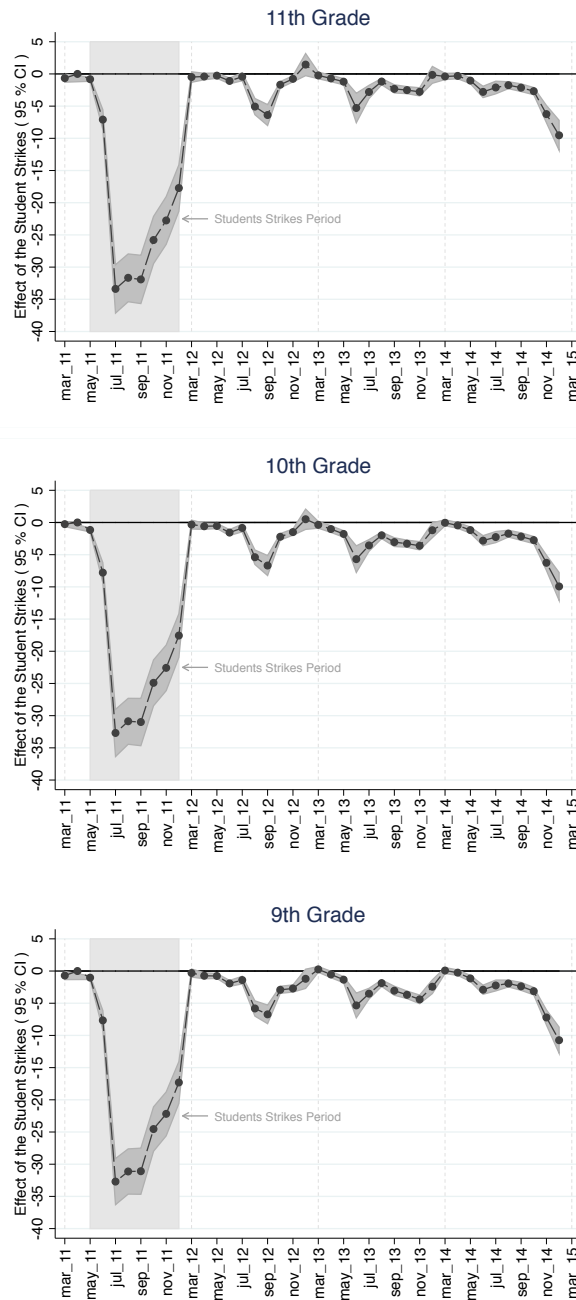
A.1 Figures

Figure A.1: Average monthly attendance rates in grades 9th to 11th



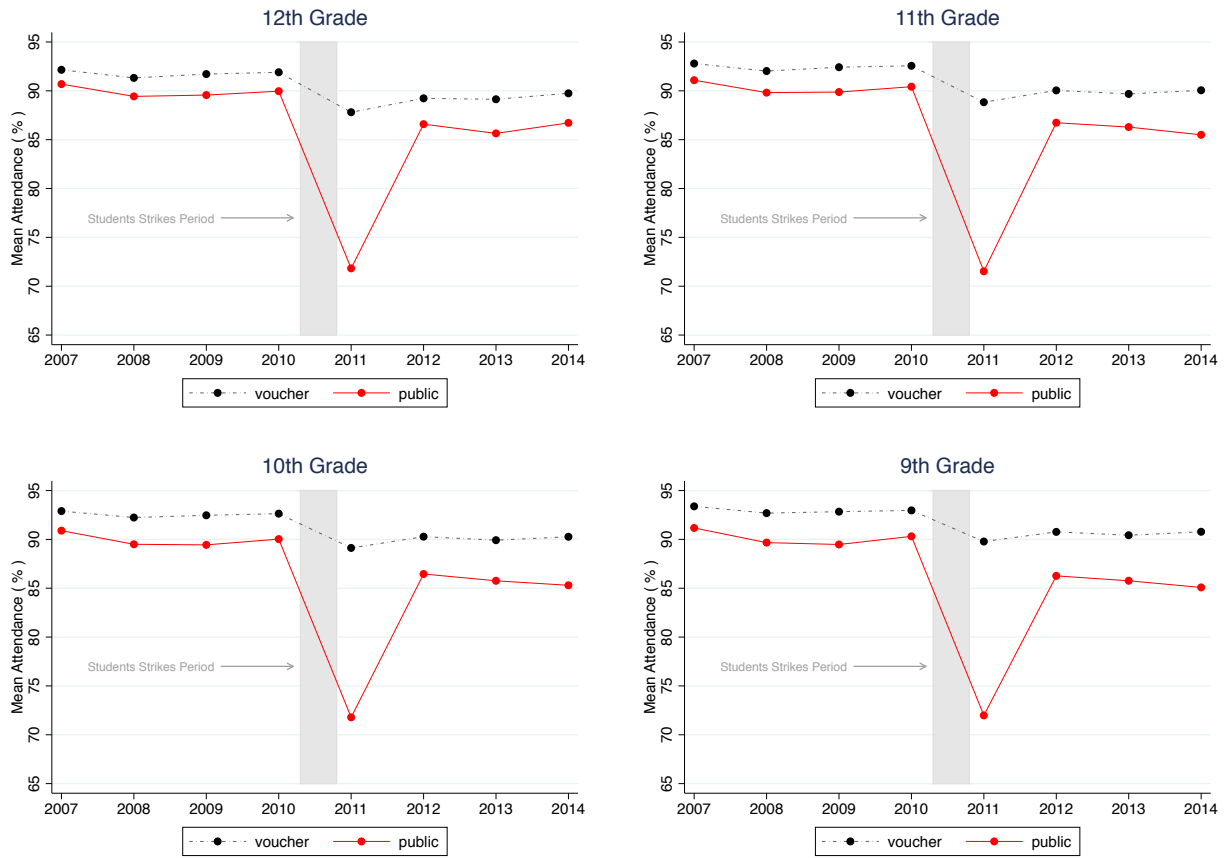
Notes: Top panel plots the average monthly attendance rates in 11th grade during the academic years 2011-2014. Middle panel plots the average monthly attendance rates in 10th grade during the academic years 2011-2014. Bottom panel plots the average monthly attendance rates in 9th grade during the academic years 2011-2014.

Figure A.2: Effect of the student strikes on public school students' monthly attendance in grades 9th to 11th



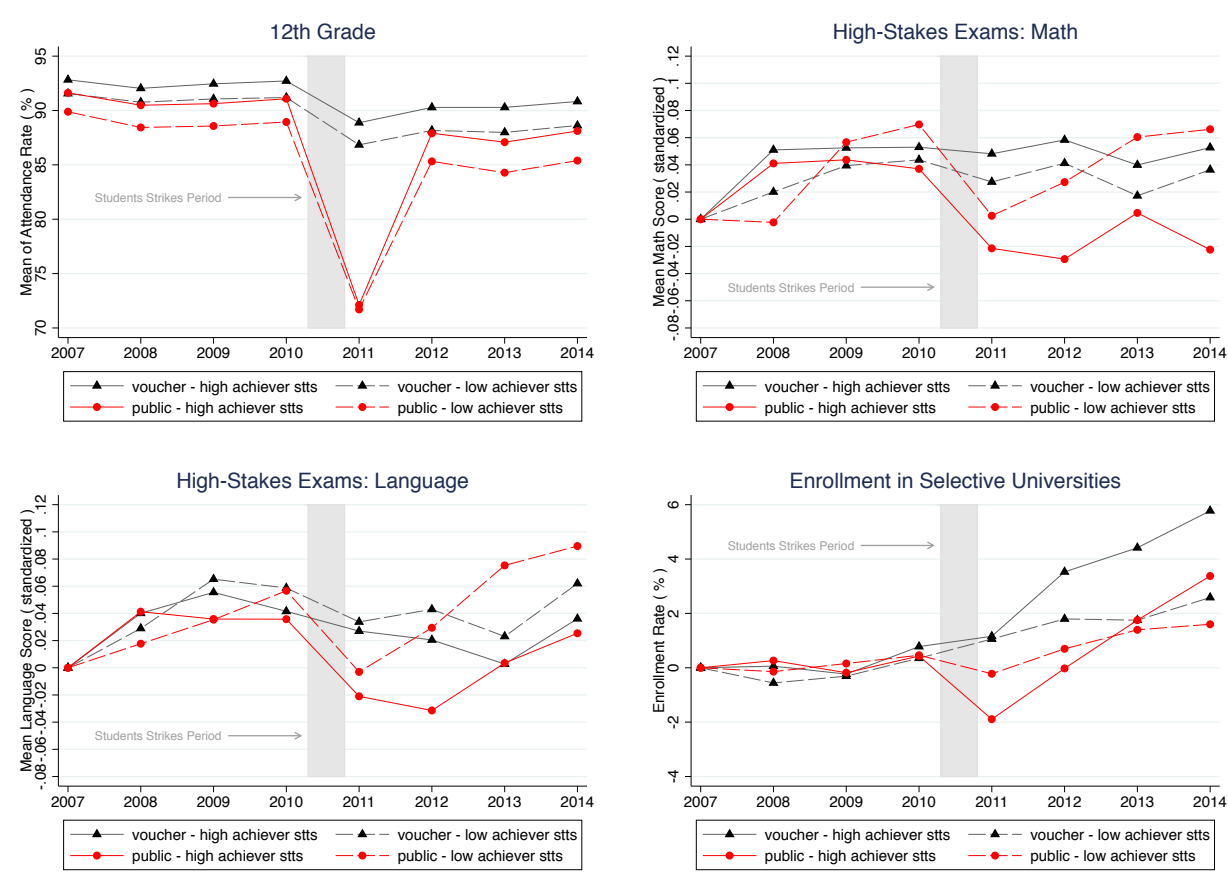
Notes: Top panel plots parameter estimates of Equation (2), using the monthly attendance rate of 11th grade students as a dependent variable. Middle panel plots parameter estimates of Equation (2), using the monthly attendance rate of 10th grade students as a dependent variable. Bottom panel plots parameter estimates of Equation (2), using the monthly attendance rate of 9th grade students as a dependent variable. In the regressions, I use monthly repeated cross-section data at student level during the academic years 2011-2014. I include school fixed effects and region \times time fixed effects. At student level, I control for pre-strikes measures of individual students' past performance. I also include a gender dummy.

Figure A.3: Average yearly attendance rates in grades 9th to 12th



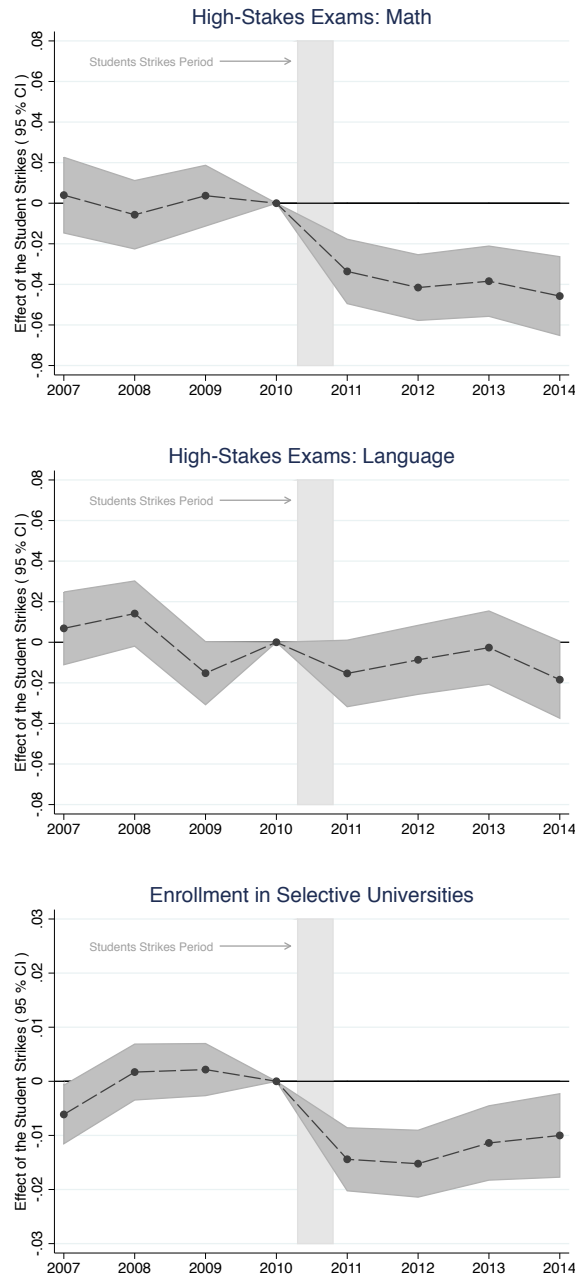
Notes: Top panel plots the average yearly attendance rates in 11th grade during the academic years 2007-2014. Middle panel plots the average yearly attendance rates in 10th grade during the academic years 2007-2014. Bottom panel plots the average yearly attendance rates in 9th grade during the academic years 2007-2014.

Figure A.4: Yearly attendance rates and academic outcomes of 12th grade students by students' past performance



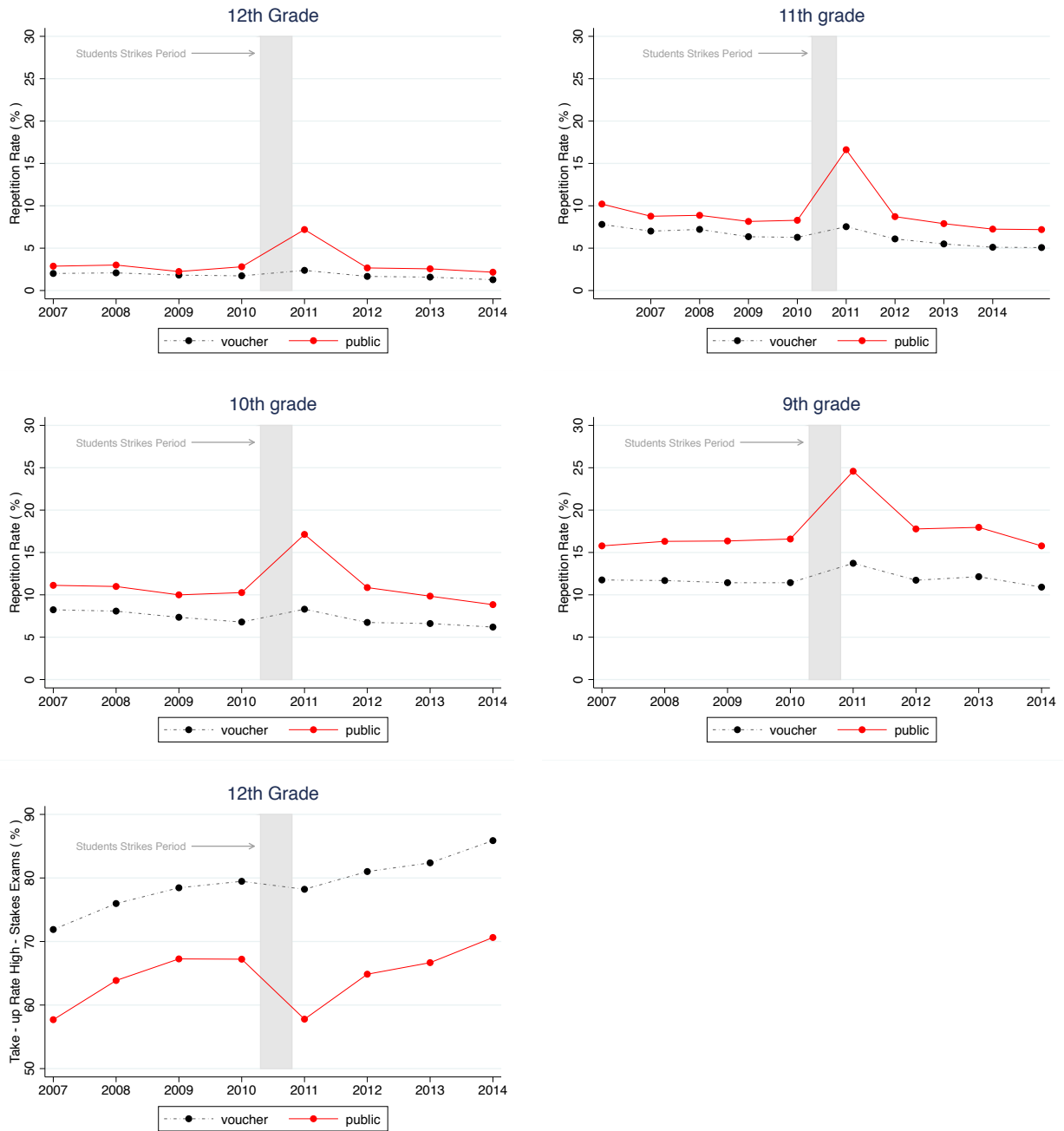
Notes: Top-left panel plots the average monthly attendance rates in 12th grade during the academic years 2007-2014. Top-right panel plots the average standardized score in the high-stakes math exam during the academic years 2007-2014. Bottom-left panel shows the average standardized score in the high-stakes language exam during the academic years 2007-2014. Bottom-right panel shows the average enrollment rates in selective universities during the academic years 2007-2014. In order to facilitate the interpretation, levels in year 2007 are set to 0.

Figure A.5: Effect of the student strikes on 12th grade public school students' academic outcomes (Intention to Treat (ITT))



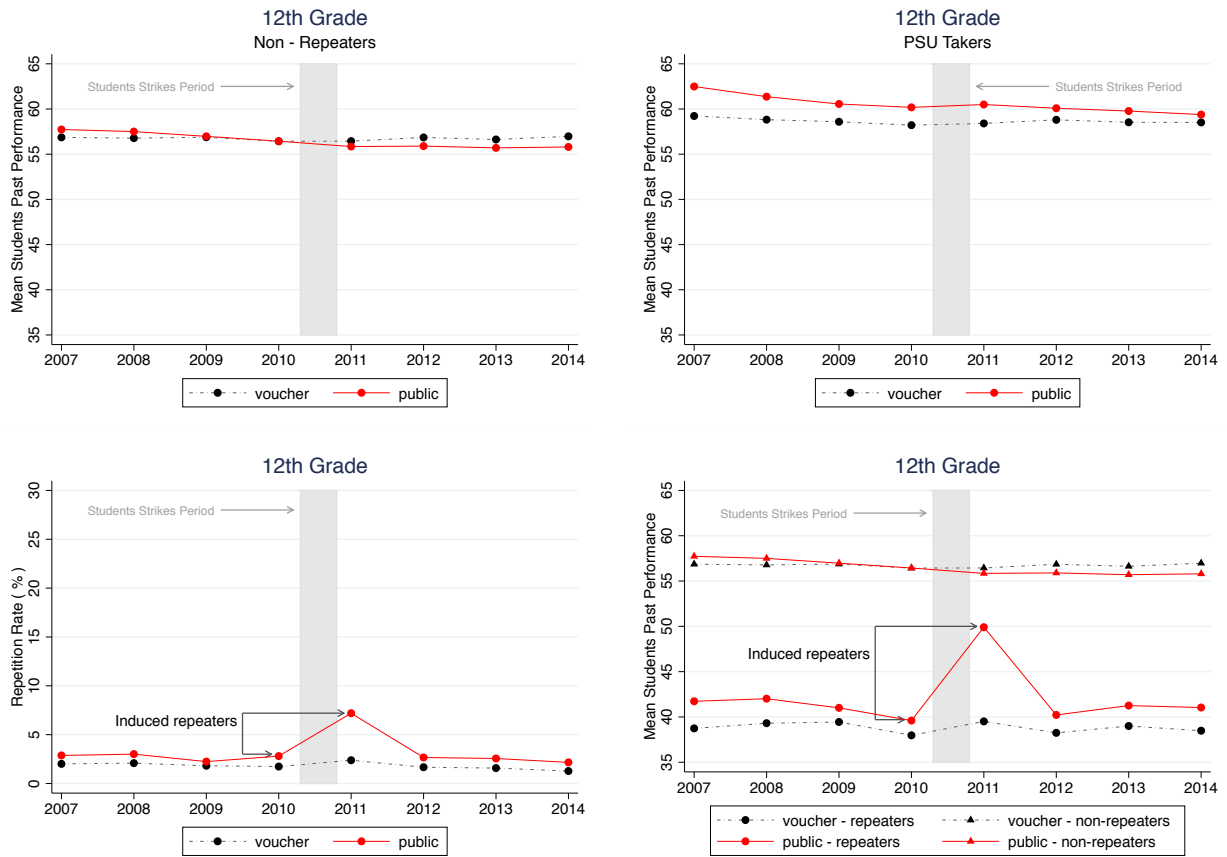
Notes: Top panel plots parameter estimates of Equation (2), using the standardized score in the high-stakes math exam of 12th grade students as a dependent variable. Middle panel plots parameter estimates of Equation (2), using the standardized score in the high-stakes language exam of 12th grade students as a dependent variable. Bottom panel plots parameter estimates of Equation (2), using the enrollment status in a selective university of 12th grade students right after finishing secondary school as a dependent variable. In the regressions, I use yearly repeated cross-section data at student level during the academic years 2007-2014. I include school fixed effects and region \times time fixed effects. At student level, I control for pre-strikes measures of individual students' past performance. I also include a gender dummy. In addition, I assign to students who switched schools in 2012, 2013 and 2014; their 2011 school.

Figure A.6: Repetition rates in grades 9th to 12th and high-stakes exams take-up rates



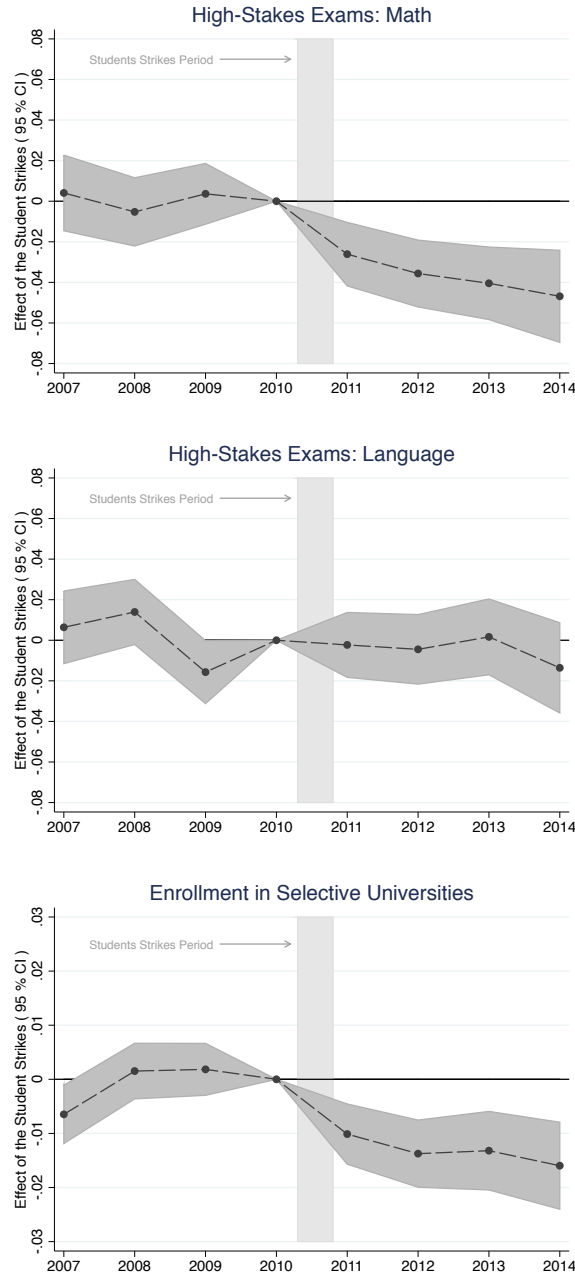
Notes: Top-left panel plots the average repetition rates in 12th grade during the academic years 2007-2014. Top-right panel plots the average repetition rates in 11th grade during the academic years 2007-2014. Middle-left panel shows the average repetition rates in 10th grade during the academic years 2007-2014. Middle-right panel shows the average repetition rates in 9th grade during the academic years 2007-2014. Bottom plots the average high-stakes exams' take-up rates during the academic years 2007-2014.

Figure A.7: Past performance of 12th grade students and repetition rates



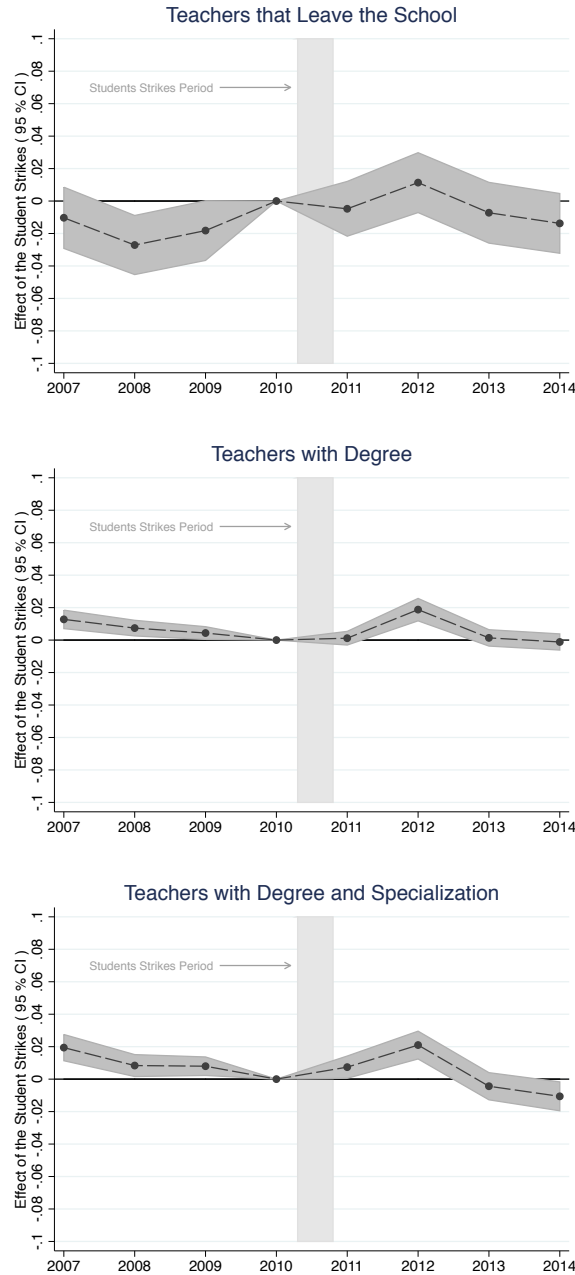
Notes: Top-left panel plots the average past performance of 12th grade non-repeater students during the academic years 2007-2014, while the top-right panel plots the average past performance of 12th grade non-repeater students that took the high-stakes exams in the same period. Bottom-left panel plots the average repetition rates in 12th grade during the academic years 2007-2014. Bottom-right panel compares the past performance of 12th grade students that repeated grade and those students that did not repeat grade during the academic years 2007-2014.

Figure A.8: Effect of the student strikes on 12th grade public school students' academic outcomes (placing post-strikes repeaters back to their original cohorts)



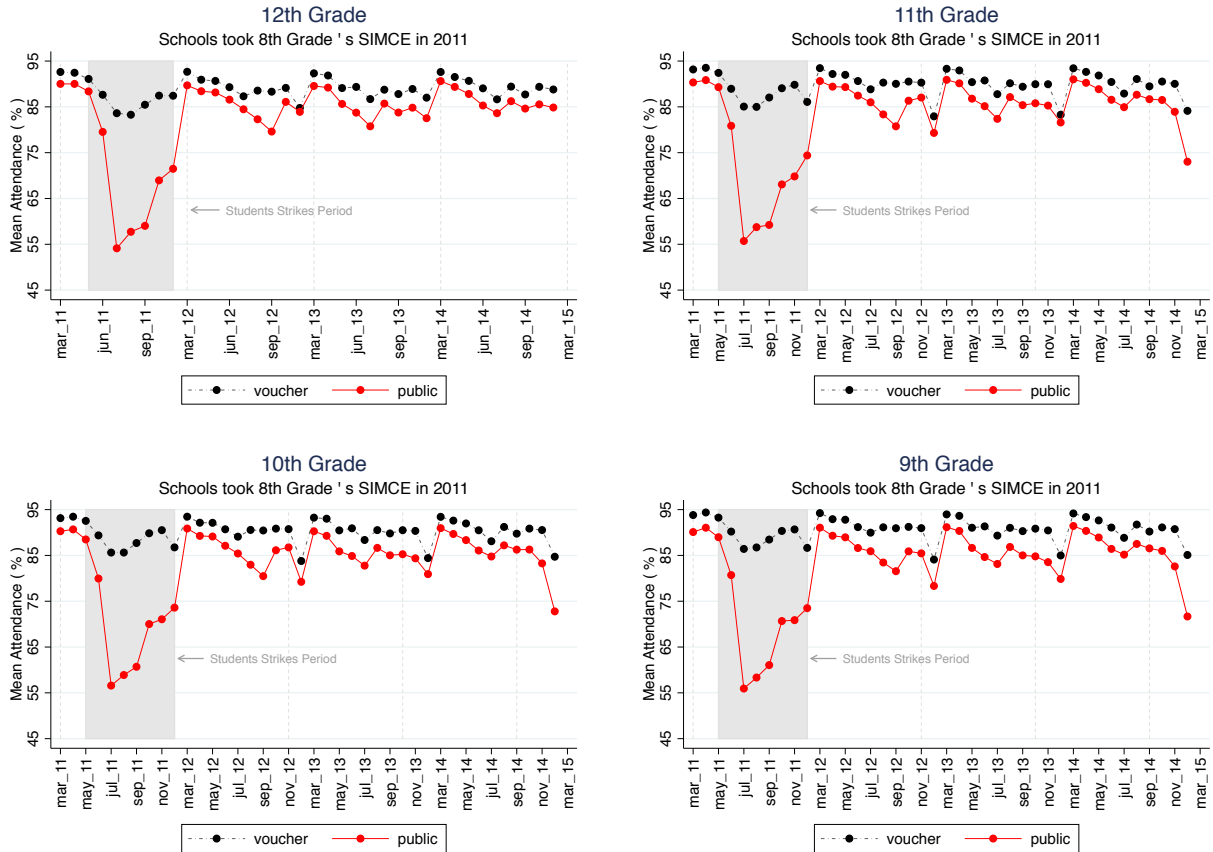
Notes: Top panel plots parameter estimates of Equation (2), using the standardized score in the high-stakes math exam of 12th grade students as a dependent variable. Middle panel plots parameter estimates of Equation (2), using the standardized score in the high-stakes language exam of 12th grade students as a dependent variable. Bottom panel plots parameter estimates of Equation (2), using the enrollment status in a selective university of 12th grade students right after finishing secondary school as a dependent variable. In the regressions, I use yearly repeated cross-section data at student level during the academic years 2007-2014. I include school fixed effects and region \times time fixed effects. At student level, I control for pre-strikes measures of individual students' past performance. I also include a gender dummy. In addition, I place post-strikes repeaters back to their original cohorts.

Figure A.9: Effect of the student strikes on secondary school teachers



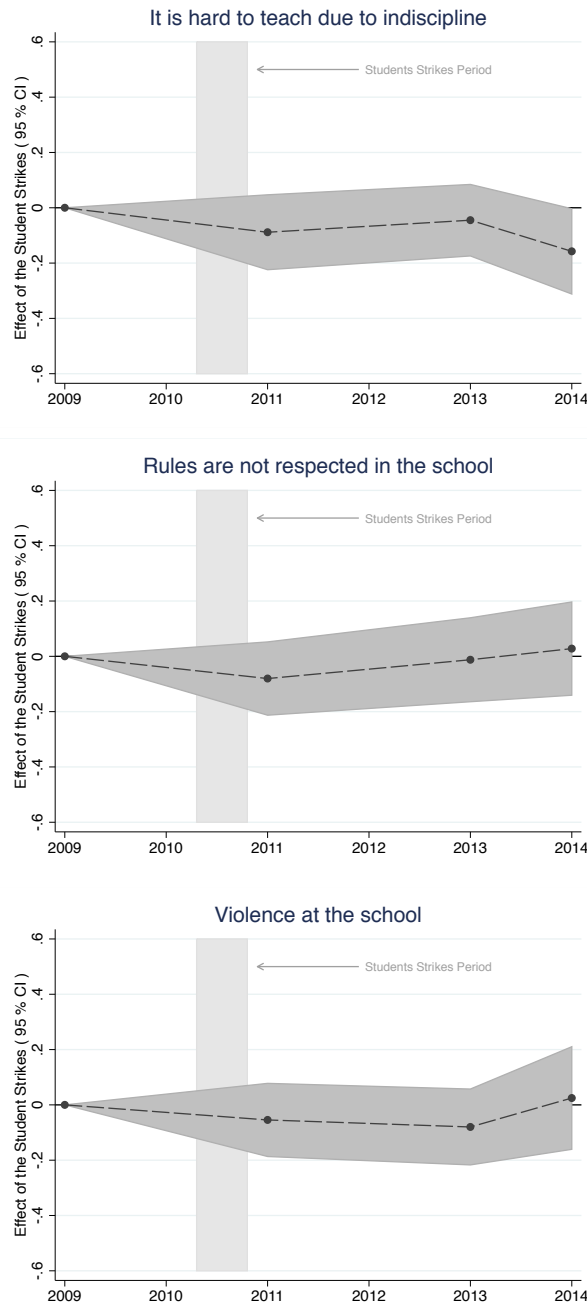
Notes: Top panel plots parameter estimates of Equation (2), using as a dependent variable an indicator variable that takes the value of 1 if the teacher leaves the school. Middle panel plots parameter estimates of Equation (2), using as a dependent variable an indicator variable that takes the value of 1 if the teacher holds a degree. Bottom panel plots parameter estimates of Equation (2), using as a dependent variable an indicator variable that takes the value of 1 if the teacher holds a degree and a specialization. In the regressions, I use yearly data at teacher level during the academic years 2007-2014. I include school fixed effects and region \times time fixed effects. At teacher level, I control for teachers' age and a gender dummy.

Figure A.10: Monthly attendance rates in grades 9th to 12th among the schools that offer both primary and secondary education and took the 8th grade SIMCE test in 2011



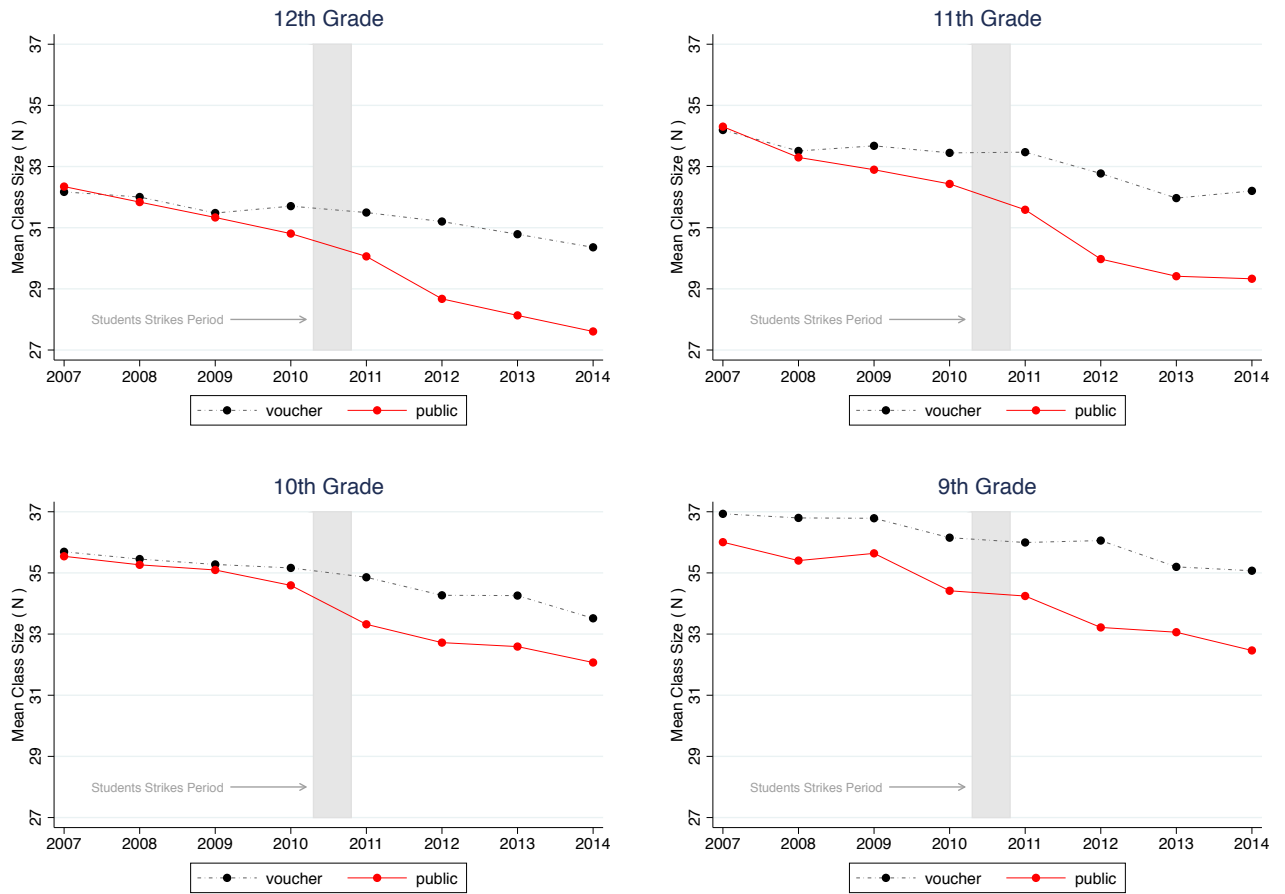
Notes: Top-left panel plots the average monthly attendance rates in 12th grade during the academic years 2011-2014 among the schools that offer both primary and secondary education and took the 8th grade SIMCE test in 2011. Top-right panel plots the average monthly attendance rates in 11th grade during the academic years 2011-2014 among the schools that offer both primary and secondary education and took the 8th grade SIMCE test in 2011. Bottom-left panel shows the average monthly attendance rates in 10th grade during the academic years 2011-2014 among the schools that offer both primary and secondary education and took the 8th grade SIMCE test in 2011. Bottom-right panel shows the average monthly attendance rates in 9th grade during the academic years 2011-2014 among the schools that offer both primary and secondary education and took the 8th grade SIMCE test in 2011.

Figure A.11: Effect of the student strikes on school environment



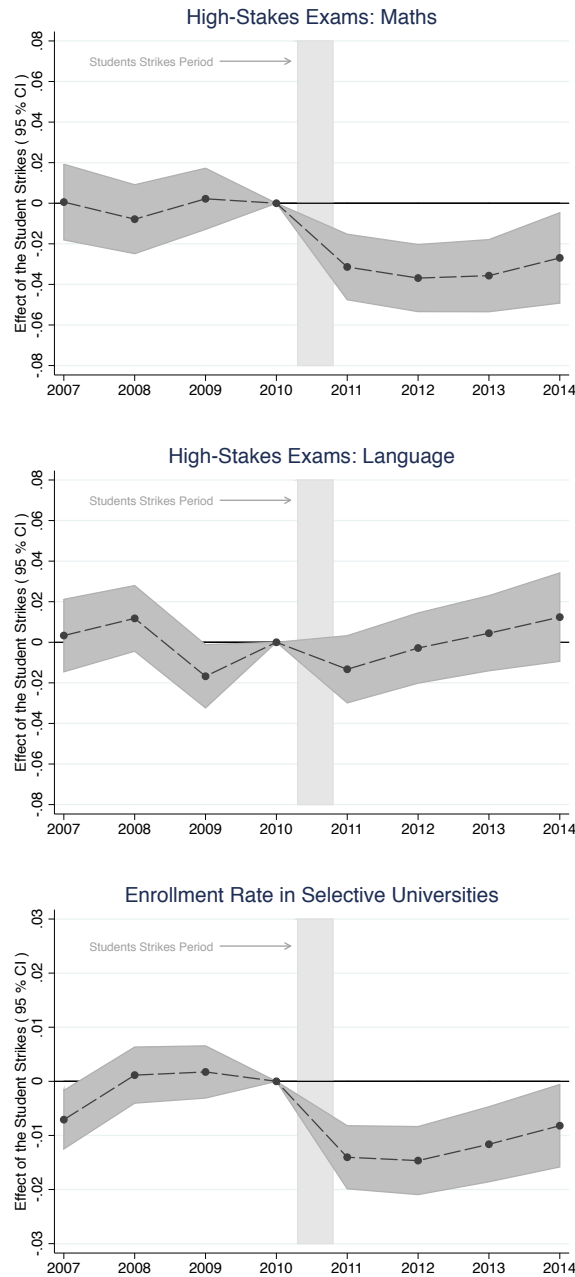
Notes: Top panel plots parameter estimates of Equation (2), using as a dependent variable the standardized score regarding the difficulty to teach in the school due to students' indiscipline behavior. Middle panel plots parameter estimates of Equation (2), using as a dependent variable the standardized score regarding the degree on which the rules in the school are respected by the students. Bottom panel plots parameter estimates of Equation (2), using as a dependent variable the standardized score regarding the degree of violence at the school. In the regressions, I use teacher-level data for years 2009, 2011, 2013 and 2014. I include school fixed effects and region \times time fixed effects. At teacher level, I control for dummy variables regarding the subject taught by each teacher. I also include a gender dummy. All outcome variables are questions answered by the teachers regarding different situations at school level and these outcomes are standardized at year level.

Figure A.12: Class size in grades 9th to 12th



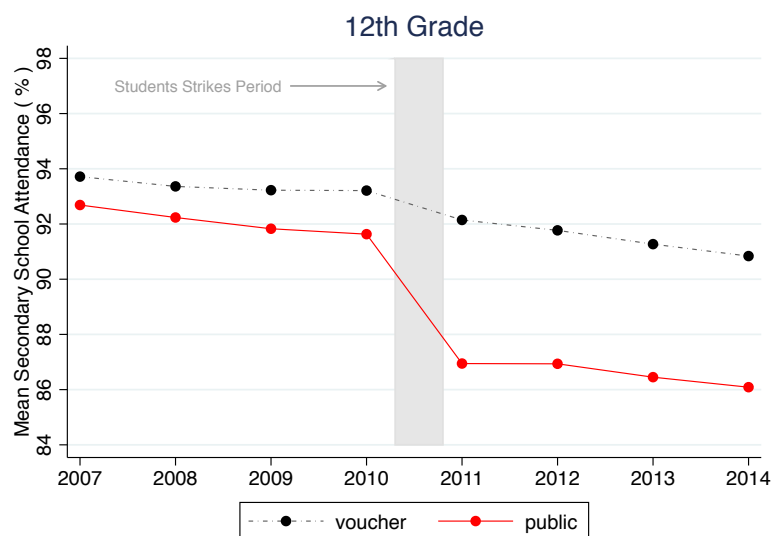
Notes: Top-left panel plots the average class size in 12th grade during the academic years 2007-2014. Top-right panel plots the average class size in 11th grade during the academic years 2007-2014. Bottom-left panel shows the average class size in 10th grade during the academic years 2007-2014. Bottom-right panel plots the average class size in 9th grade during the academic years 2007-2014.

Figure A.13: Effect of the student strikes on 12th grade public school students' academic outcomes (controlling for class size)



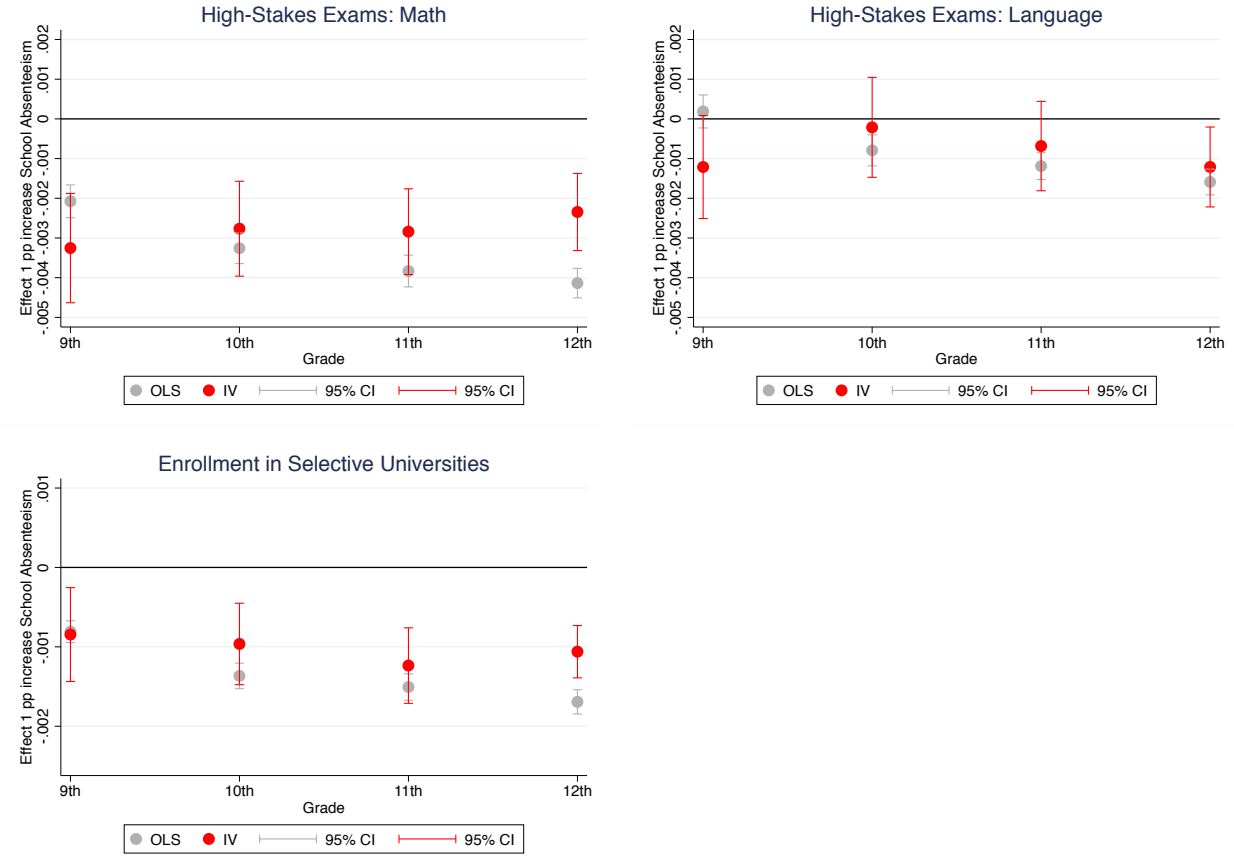
Notes: Top panel plots parameter estimates of Equation (2), using the standardized score in the high-stakes math exam of 12th grade students as a dependent variable. Middle panel plots parameter estimates of Equation (2), using the standardized score in the high-stakes language exam of 12th grade students as a dependent variable. Bottom panel plots parameter estimates of Equation (2), using the enrollment status in a selective university of 12th grade students right after finishing secondary school as a dependent variable. In the regressions, I use yearly repeated cross-section data at student level during the academic years 2007-2014. I include school fixed effects and region \times time fixed effects. At student level, I control for pre-strikes measures of individual students' past performance. I also include a gender dummy. In addition, I control for class size.

Figure A.14: Secondary school attendance rates of 12th grade students



Notes: The figure plots the average attendance rate during the whole secondary school of 12th grade students over the academic years 2007-2014.

Figure A.15: Effect of school absenteeism in each secondary school’s grade on students academic outcomes



Notes: Top-left panel plots OLS and IV estimates regarding the effect of school absenteeism during each secondary school’s grade on the high-stakes math exam. Top-right panel plots OLS and IV estimates regarding the effect of school absenteeism during each grade of secondary school’s grade on the high-stakes language exam. Bottom-left panel plots OLS and IV estimates regarding the effect of school absenteeism during each secondary’s school grade on enrollment in selective universities. In the regressions, I use yearly repeated cross-section data at student level during the academic years 2007-2010. For estimations regarding the effect of school absenteeism in 9th grade, 10th grade, 11th grade and 12th grade, I also include the cohort of 12th grade students corresponding to the academic year 2014, 2013, 2012 and 2011, respectively. The previous procedure is discussed more in detail in Section 7.2. High-stakes exams scores are standardized within each year, and enrollment in a selective university is a dummy variable that takes the value of 1 if the student was enrolled in a selective university right after finishing 12th grade. Attendance rate on each grade is measured in percentage points and goes from 0 to 100. The instrument for school absenteeism is $(Public_s \times 2011_t)$, which is a dummy variable that takes the value of 1 if the student was attended a public school in 2011, 0 otherwise. Student-level controls include a measure of students’ ability unaffected by the strikes and a gender dummy. All regressions include school fixed effects and time \times region fixed effects.

A.2 Tables

Table A.1: Yearly effect of the student strikes on students' academic outcomes

	(1)	(2)	(3)
	Math	Language	Enrollment
public × 2007	0.00381 (0.00952)	0.00657 (0.00913)	-0.00624** (0.00275)
public × 2008	-0.00550 (0.00860)	0.0142* (0.00820)	0.00175 (0.00264)
public × 2009	0.00342 (0.00765)	-0.0155* (0.00794)	0.00211 (0.00246)
public × 2011	-0.0333*** (0.00809)	-0.0152* (0.00837)	-0.0144*** (0.00297)
public × 2012	-0.0414*** (0.00831)	-0.00744 (0.00878)	-0.0156*** (0.00319)
public × 2013	-0.0404*** (0.00897)	-0.000298 (0.00943)	-0.0127*** (0.00352)
public × 2014	-0.0328*** (0.0114)	0.00652 (0.0112)	-0.00945** (0.00391)
Observations	1,033,409	1,033,409	1,429,263
R-squared	0.475	0.430	0.248
Student Level Controls	YES	YES	YES
School FE	YES	YES	YES
Region × Year FE	YES	YES	YES

Notes: ***, **, * Denote statistical significance at 1%, 5% and 10% level respectively. All standard errors are clustered at school level and reported in parenthesis. This table only shows estimates of interest. The data contains repeated cross-section information at students level during the academic years 2007-2014. Outcome variables are the standardized score in the high-stakes math exam, the standardized score in the high-stakes language exam and enrollment in a selective university, respectively. High-stakes exams scores are standardized within each year and enrollment is a dummy variable that takes the value of 1 if the student was enrolled in a selective university right after finishing 12th grade. *Public* is a dummy variable that takes the value of 1 if the student attends to a public school, 0 otherwise. Year dummy variables are interacted with *Public* and they take the value of 1 if the observation corresponds to that specific year, 0 otherwise. Student-level controls include a measure of students' ability unaffected by the strikes (the rank position of the students within their class 4 years before 12th grade, which is a continuous variable that goes between 0 and 100) and a gender dummy. All regressions include school fixed effects and time × region fixed effects. *Public* × 2010 is used as base category.

Table A.2: Triple differences-in-differences estimations by students' past performance

	(1) Attendance	(2) Math	(3) Language	(4) Enrollment
public \times high \times 2011	-2.215*** (0.590)			
public \times 2011	-13.23*** (0.810)			
public \times high \times post		-0.0388*** (0.00736)	-0.0189*** (0.00727)	-0.0164*** (0.00308)
public \times post		-0.0131* (0.00786)	0.00768 (0.00811)	-0.00473** (0.00208)
Observations	1,429,263	1,033,409	1,033,409	1,429,263
R-squared	0.315	0.478	0.432	0.249
Student Level Controls	YES	YES	YES	YES
School FE	YES	YES	YES	YES
Region \times Year FE	YES	YES	YES	YES

Notes: ***, **, * Denote statistical significance at 1%, 5% and 10% level respectively. All standard errors are clustered at school level and reported in parenthesis. This table only shows estimates of interest. The data contains repeated cross-section information at students level during the academic years 2007-2014. Outcome variables are students' yearly attendance rate, the standardized score in the high-stakes math exam, the standardized score in the high-stakes language exam and enrollment in a selective university, respectively. Yearly attendance rate is measured in percentage points and goes from 0 to 100. High-stakes exams scores are standardized within each year. Enrollment is a dummy variable that takes the value of 1 if the student was enrolled in a selective university right after finishing 12th grade. *Public* is a dummy variable that takes the value of 1 if the student attends to a public school, 0 otherwise. *High* is a dummy variable that takes the value of 1 if the student is above the median of the students' past performance distribution, 0 otherwise. *2011* is a dummy variable that takes the value of 1 if the observation corresponds to year 2011, 0 otherwise. *Post* is a dummy variable that takes the value of 1 if the observation corresponds to the academic years 2011-2014, 0 otherwise. Student-level controls include a measure of students' ability unaffected by the strikes (the rank position of the students within their class 4 years before 12th grade, which is a continuous variable that goes between 0 and 100) and a gender dummy. All regressions include school fixed effects and time \times region fixed effects.

Table A.3: First-stage regressions for each grade of secondary school

	(1) 9 th Grade	(2) 10 th Grade	(3) 11 th Grade	(4) 12 th Grade
public × 2011	12.46*** (0.789)	12.55*** (0.770)	13.27*** (0.849)	14.85*** (0.903)
Observations	908,511	910,836	914,123	922,582
R-squared	0.356	0.363	0.390	0.399
Student Level Controls	YES	YES	YES	YES
School FE	YES	YES	YES	YES
Region × Year FE	YES	YES	YES	YES
F-test instrument	249.6	266	244.1	270.1

Notes: ***, **, * Denote statistical significance at 1%, 5% and 10% level respectively. All standard errors are clustered at school level and reported in parenthesis. This table only shows estimates of interest. The data contains repeated cross-section information at students level during the academic years 2007-2010. For estimations regarding 9th grade, 10th grade, 11th grade and 12th grade, I also include the cohort of 12th grade students corresponding to the academic year 2014, 2013, 2012 and 2011, respectively. The previous procedure is discussed more in detail in Section 7.2. Outcome variables are school absenteesim in 9th grade, 10th grade, 11th grade and 12th grade, respectively. *Public* is a dummy variable that takes the value of 1 if the student attends to a public school, 0 otherwise. *2011* is a dummy variable that takes the value of 1 if the observation corresponds to year 2011, 0 otherwise. Student-level controls include a measure of students' ability unaffected by the strikes (the rank position of the students within their class 4 years before 12th grade, which is a continuous variable that goes between 0 and 100) and a gender dummy. All regressions include school fixed effects and time × region fixed effects.

Table A.4: OLS vs IV estimations regarding the effect of school absenteeism in each secondary school's grade on math

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
absenteeism in 9 th (%)	-0.00208*** (0.000211)	-0.00325*** (0.000702)						
absenteeism in 10 th (%)			-0.00326*** (0.000197)	-0.00277*** (0.000610)				
absenteeism in 11 th (%)					-0.00383*** (0.000204)	-0.00284*** (0.000551)		
absenteeism in 12 th (%)							-0.00414*** (0.000190)	-0.00234*** (0.000496)
Observations	654,737	654,737	650,149	650,149	649,956	649,956	646,906	646,906
R-squared	0.474	0.474	0.484	0.484	0.483	0.483	0.486	0.485
Student Level Controls	YES	YES	YES	YES	YES	YES	YES	YES
School FE	YES	YES	YES	YES	YES	YES	YES	YES
Region × Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: ***, **, * Denote statistical significance at 1%, 5% and 10% level respectively. All standard errors are clustered at school level and reported in parenthesis. This table only shows estimates of interest. The data contains repeated cross-section information at students level during the academic years 2007-2010. For estimations regarding 9th grade, 10th grade, 11th grade and 12th grade, I also include the cohort of 12th grade students corresponding to the academic year 2014, 2013, 2012 and 2011, respectively. The previous procedure is discussed more in detail in Section 7.2. Outcome variable is the standardized score in the high-stakes math exam. High-stakes math exam's score is standardized within each year. Attendance rate on each grade is measured in percentage points and goes from 0 to 100. The instrument for school absenteeism is $(Public_s \times 2011_t)$, which is a dummy variable that takes the value of 1 if the student was attended a public school in 2011, 0 otherwise. Odd columns report the OLS estimates for 9th grade, 10th grade, 11th grade and 12th grade, respectively. Even columns report their counterpart IV estimates. Student-level controls include a measure of students' ability unaffected by the strikes (the rank position of the students within their class 4 years before 12th grade, which is a continuous variable that goes between 0 and 100) and a gender dummy. All regressions include school fixed effects and time × region fixed effects.

Table A.5: OLS vs IV estimations regarding the effect of school absenteeism in each secondary school's grade on language

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
absenteeism in 9 th (%)	0.000187 (0.000212)	-0.00121* (0.000662)						
absenteeism in 10 th (%)			-0.000792*** (0.000199)	-0.000213 (0.000642)				
absenteeism in 11 th (%)					-0.00119*** (0.000172)	-0.000684 (0.000574)		
absenteeism in 12 th (%)							-0.00159*** (0.000165)	-0.00121** (0.000513)
Observations	654,737	654,737	650,149	650,149	649,956	649,956	646,906	646,906
R-squared	0.435	0.435	0.436	0.436	0.441	0.441	0.443	0.443
Student Level Controls	YES	YES	YES	YES	YES	YES	YES	YES
School FE	YES	YES	YES	YES	YES	YES	YES	YES
Region × Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: ***, **, * Denote statistical significance at 1%, 5% and 10% level respectively. All standard errors are clustered at school level and reported in parenthesis. This table only shows estimates of interest. The data contains repeated cross-section information at students level during the academic years 2007-2010. For estimations regarding 9th grade, 10th grade, 11th grade and 12th grade, I also include the cohort of 12th grade students corresponding to the academic year 2014, 2013, 2012 and 2011, respectively. The previous procedure is discussed more in detail in Section 7.2. Outcome variable is the standardized score in the high-stakes language exam. High-stakes language exam's score is standardized within each year. Attendance rate on each grade is measured in percentage points and goes from 0 to 100. The instrument for school absenteeism is $(Public_s \times 2011_t)$, which is a dummy variable that takes the value of 1 if the student was attended a public school in 2011, 0 otherwise. Odd columns report the OLS estimates for 9th grade, 10th grade, 11th grade and 12th grade, respectively. Even columns report their counterpart IV estimates. Student-level controls include a measure of students' ability unaffected by the strikes (the rank position of the students within their class 4 years before 12th grade, which is a continuous variable that goes between 0 and 100) and a gender dummy. All regressions include school fixed effects and time × region fixed effects.

Table A.6: OLS vs IV estimations regarding the effect of school absenteeism in each secondary school's grade on university enrollment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
absenteeism in 9 th (%)	-0.000809*** (0.000070)	-0.000845*** (0.000302)						
absenteeism in 10 th (%)			-0.00137*** (0.000082)	-0.000964*** (0.000262)				
absenteeism in 11 th (%)					-0.00151*** (0.000085)	-0.00124*** (0.000242)		
absenteeism in 12 th (%)							-0.00169*** (0.000078)	-0.00106*** (0.000168)
Observations	908,511	908,511	910,836	910,836	914,123	914,123	922,582	922,582
R-squared	0.250	0.250	0.251	0.251	0.254	0.254	0.253	0.253
Student Level Controls	YES	YES	YES	YES	YES	YES	YES	YES
School FE	YES	YES	YES	YES	YES	YES	YES	YES
Region × Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: ***, **, * Denote statistical significance at 1%, 5% and 10% level respectively. All standard errors are clustered at school level and reported in parenthesis. This table only shows estimates of interest. The data contains repeated cross-section information at students level during the academic years 2007-2010. For estimations regarding 9th grade, 10th grade, 11th grade and 12th grade, I also include the cohort of 12th grade students corresponding to the academic year 2014, 2013, 2012 and 2011, respectively. The previous procedure is discussed more in detail in Section 7.2. Outcome variable is enrollment in a selective university, which is an indicator variable that takes the value of 1 if the student was enrolled in a selective university right after finishing 12th grade. Attendance rate on each grade is measured in percentage points and goes from 0 to 100. The instrument for school absenteeism is $(Public_s \times 2011_t)$, which is a dummy variable that takes the value of 1 if the student was attended a public school in 2011, 0 otherwise. Odd columns report the OLS estimates for 9th grade, 10th grade, 11th grade and 12th grade, respectively. Even columns report their counterpart IV estimates. Student-level controls include a measure of students' ability unaffected by the strikes (the rank position of the students within their class 4 years before 12th grade, which is a continuous variable that goes between 0 and 100) and a gender dummy. All regressions include school fixed effects and time × region fixed effects.

B Characterizing students that were *induced* to repeat by the student strikes

Let me define:

A_i as the measure of student i past performance.

Y_i as a dummy variable that takes the value of 1 if student i is observed in year 2011.

I_i as a dummy variable that takes the value of 1 if student i was *induced* to repeat by the student strikes.

R_i as a dummy variable that takes the value of 1 if student i repeated the grade.

S_i as a dummy variable that takes the value of 1 if student i attended a public school.

By conditional expectations:

$$\begin{aligned}
 \underbrace{\mathbb{E}[A_i | R_i = 1, Y_i = 1, S_i = 1]}_{\text{mean students' past performance of repeaters in 2011}} &= \underbrace{\mathbb{E}[A_i | I_i = 0, R_i = 1, Y_i = 1, S_i = 1]}_{\text{mean students' past performance of always repeaters in 2011}} \times \\
 &\quad \underbrace{Pr(I_i = 0 | R_i = 1, Y_i = 1, S_i = 1)}_{\text{proportion of always repeaters in 2011}} + \\
 &\quad \underbrace{\mathbb{E}[A_i | I_i = 1, R_i = 1, Y_i = 1, S_i = 1]}_{\text{mean students' past performance of induced repeaters in 2011}} \times \\
 &\quad \underbrace{Pr(I_i = 1 | R_i = 1, Y_i = 1, S_i = 1)}_{\text{proportion of induced repeaters in 2011}}
 \end{aligned} \tag{B.1}$$

Where,

$$Pr(I_i = 1 | R_i = 1, Y_i = 1, S_i = 1) = 1 - Pr(I_i = 0 | R_i = 1, Y_i = 1, S_i = 1) \tag{B.2}$$

By conditional probability:

$$Pr(I_i = 0 | R_i = 1, Y_i = 1, S_i = 1) = \frac{Pr(I_i = 0 \cap R_i = 1 | Y_i = 1, S_i = 1)}{Pr(R_i = 1 | Y_i = 1, S_i = 1)} \tag{B.3}$$

Consider the following assumptions:

A1. Timing of the strikes

Strikes only affected the behaviour of public school students in 2011:

$$Pr(I_i = 1 | Y_i = 0, S_i = 1) = \mathbb{E}[I_i | Y_i = 0, S_i = 1] = 0$$

A2. Proportion of repeaters

The proportion of always repeaters in public schools is stable over time:

$$Pr(I_i = 0 \cap R_i = 1 | Y_i = 1, S_i = 1) \approx$$

$$Pr(R_i = 1 | Y_i = 0, S_i = 1) = \mathbb{E}[R_i | Y_i = 0, S_i = 1]$$

A3. Past performance of repeaters

The mean past performance of always repeaters in public schools is stable over time:

$$\mathbb{E}[A_i | I_i = 0, R_i = 1, Y_i = 1, S_i = 1] \approx \mathbb{E}[A_i | R_i = 1, Y_i = 0, S_i = 1]$$

Assumption (1) comes from the fact that the student strikes only took place during 2011. Assumptions (2) and (3) are based on the trends presented in the top-left and the bottom-left panel of appendix Figure A.7.

From the data,

$$\mathbb{E}[A_i | R_i = 1, Y_i = 0, S_i = 1] = 41.01$$

$$\mathbb{E}[R_i | Y_i = 0, S_i = 1] = 0.0263$$

$$Pr(R_i = 1 | Y_i = 1, S_i = 1) = \mathbb{E}[R_i | Y_i = 1, S_i = 1] = 0.0719$$

$$\mathbb{E}[A_i | R_i = 1, Y_i = 1, S_i = 1] = 49.9$$

$$\mathbb{E}[A_i | R_i = 0, Y_i = 1, S_i = 1] = 58.84$$

Combining Equations (B.1), (B.2) and (B.3), using Assumptions (1), (2) and (3), and the data; implies that for students in public schools:

$$\underbrace{41.01}_{\text{mean students' past performance of always repeaters in 2011}} \times \underbrace{\frac{0.0263}{0.0719}}_{\text{proportion of always repeaters in 2011}} + \underbrace{y}_{\text{mean students' past performance of induced repeaters in 2011}} \times \underbrace{\frac{(0.0719 - 0.0263)}{0.0719}}_{\text{proportion of induced repeaters in 2011}} \approx \underbrace{49.9}_{\text{mean students' past performance of repeaters in 2011}}$$

(B.4)

$$\Rightarrow y \approx 55.03 \approx \underbrace{55.84}_{\text{mean students' past performance of non-repeaters in 2011}}$$