Closing Schools to Improve Education

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Abstract

Brazil closed more than 40,000 schools managed by municipal authorities between 2007 and 2023. School closures affect the lives of displaced students and also impact the schools that receive these students. This paper investigates the impact of school closures on the educational performance of the remaining schools using a difference-in-difference approach based on Callaway and Sant'Anna (2021) model. The results show that municipalities that closed schools experienced better educational outcomes, such as lower dropout rates, lower failure rates, and higher promotion rates. This positive impact can be partially explained by increased spending per student, improved infrastructure, and better teacher quality. These results are robust across different model specifications and apply to all municipalities, with stronger effects observed in those that closed a higher percentage of schools.

JEL Classification: H4, I2, I38

Keywords: school closure, education, school dropout, grade retention

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1 Introduction

In many countries around the world, the process of urbanization and demographic changes have reduced the demand for schools, particularly in rural areas. Permanent school closures can be a strategy for local governments to improve educational resources by leveraging economies of scale. By concentrating resources in fewer schools, they aim to improve school quality. Additionally, when closed schools have lower achievement levels than the receiving schools, displaced students can benefit from the transition after an adaptation period (Engberg et al. 2012; Brummet 2014).

On the other hand, displaced students who live far from the receiving schools may spend more hours commuting or face challenges adapting to a new social context. These challenges can negatively impact attendance and increase dropout rates. Furthermore, school closures can adversely affect students at the receiving schools, and there is evidence suggesting that when school buildings are left empty, crime rates can rise (Steinberg and MacDonald 2019; Borbely et al. 2023).

This paper presents evidence of the educational impacts of permanent school closures on the educational outcomes of the schools that remain open. The literature provides ample evidence of what happens to students after a school closure, with results varying according to the social context and the difference in educational performance between closed and receiving schools (De la Torre and Gwynne 2009; Grau, Hojman, and Mizala 2018). To my knowledge, this is the first paper to focus on municipal results instead of individual schooling outcomes. In my approach, I analyze what happens to schools that remain open when a municipality closes a school. Focusing on municipalities allows for a discussion of other dimensions of school closure, such as public management decisions.

I apply a difference-in-differences approach to municipal data from Brazilian schools under municipal administration. Brazil is an ideal country for this kind of experiment since there are more than 5,500 municipal school systems, and municipalities have the authority to reallocate students, create incentives, and manage the education budget. As municipalities can decide about school closure at different points in time (the treatment is staggered) and the impacts could change over time, I apply Callaway and Sant'Anna (2021) estimator. I analyze data from 2007 to 2023 for 5,568 municipalities for elementary education. For this, I run the analysis using as control municipalities that never closed a school during the period. In the period of analysis, 1,428 municipalities did not close any schools.

Results show that municipalities which close schools improve educational outcomes such as failure rate, dropout rate, attrition rate, and school promotion rate. Event study analysis suggest that the impact seems to increase over the years. Despite an increase in the student-class ratio, the pupil-teacher ratio decreases, which could be more relevant for student performance. I find evidence that school resources improve, such as the percentage of schools with libraries, the percentage of teachers with higher education, and the percentage of schools with science and computer labs. I also find that treated municipalities increase spending per student, but there is no evidence of a change in the overall budget for education. This could mean a reduction in the number of students, which is a downside of school closure. The model shows that the number of enrollments in elementary education decreases, but this is not statistically significant at 5% level.

Results are robust to changing the control group to municipalities not yet treated and with covariates using the double robust estimation as in Sant'Anna and Zhao (2020) in multi-period treatment contexts. I also discuss the relevance of treatment dosage by re-estimating the model for sub-samples of municipalities according to the percentage of schools closed. I find that school closure positively affects educational outcomes regardless of the treatment dosage, but the effects are higher for municipalities that closed a higher percentage of schools.

The paper is organized as follows. Section 2 presents a discussion about school closures and the Brazilian institutional framework, analyzing the evolution of school closures in Brazil and their relevance. Section 3 describes the data used in the paper. Section 4 details the empirical strategy to estimate the causal effect of closing schools. Section 5 presents the results, validity tests, transmission mechanisms, robustness tests, and some heterogeneities. Section 6 concludes.

2 Background

2.1 School closure

School closure is an issue and a political strategy for most countries in the western civilization. There are many reasons to justify school closure, ranging from demographic shifts to educational policy strategies aimed at increasing efficiency.

Demography has played an important role in the process of school closure worldwide. As birth rates have dropped, countries have closed schools due to low demand. With the process of urbanization, countries have also closed schools in rural areas, even when they increased expenditure on education. Proponents of this strategy claim that it would reduce costs, such as those related to building maintenance, infrastructure supply, opportunity cost of the building (renting), and others. In particular, when educational authorities close schools in rural areas, the logistics of supplies distribution become less costly as schools are more concentrated geographically. On the other hand, students from closed schools in rural areas or localities far from more populated areas will need public transportation to attend school, potentially increasing municipal expenditure in this area.

Another reason for school closure is an attempt to raise school achievement as part of an accountability system. In this view, schools are closed due to low performance, providing students from closed schools the opportunity to migrate to better schools. At the same time, school principals and teachers from closed schools are, in a sense, punished, sending a signal to open schools to put more effort into their activities.

Economic constraints often force governments to consolidate resources by closing underutilized schools, especially in regions experiencing declining populations. For example, the consolidation of school systems in rural China was driven by the need to manage limited educational resources more efficiently amidst declining fertility rates and rural out-migration Hannum, Liu, and Wang (2021). Similarly, in Denmark, rural school closures were a response to local population decline, where the simultaneous closure of eight village schools led to significant demographic shifts Sørensen et al. (2021).

Performance-related closures are another common rationale, particularly in urban areas with multiple schooling options. Low-performing schools are often targeted for closure to improve overall educational quality and reallocate students to better-performing institutions. This approach has been observed in the United States, where school districts with declining enrollments closed low-achieving schools to consolidate resources and improve student outcomes Engberg et al. (2012) and Brummet (2014).

The impact of school closures on educational outcomes has been widely studied, revealing both positive and negative effects. School closures can disrupt students' learning environments, leading to initial declines in academic performance. In Chicago, De la Torre and Gwynne (2009) found that students displaced by school closures experienced a temporary negative effect on their test scores, although this effect diminished once students adjusted to their new schools. In Philadelphia, however, Steinberg and MacDonald (2019) reported that displaced students did not experience significant declines in test scores, and those who moved to higher-performing schools even showed academic improvements. In Chile, Grau, Hojman, and Mizala (2018) found that school closures led to an increase in dropout rates and grade retention, particularly for students in the fifth grade. The unplanned nature of these closures exacerbated the negative impacts, highlighting the importance of strategic planning in mitigating adverse effects.

School closures also have significant behavioral and social consequences. Kim (2024) found that school closures in Texas led to persistent behavioral issues among students, which continued to affect their educational and labor market outcomes in later years. Increased absenteeism and suspension rates were also noted among displaced students in Philadelphia, particularly those who had to travel longer distances to their new schools Steinberg and MacDonald (2019). Moreover, the receiving schools can be affected by an influx of displaced students. Steinberg and MacDonald (2019) observed that the academic performance of students in receiving schools declined when a significant number of displaced students were enrolled. This spillover effect underscores the broader community impact of school closures.

An often-overlooked consequence of school closures is their impact on crime and safety within affected neighborhoods. Borbely et al. (2023) examined the effects of permanent school closures on crime in Scotland, finding that neighborhoods experiencing school closures saw a reduction in crime by about 9% of a standard deviation compared to areas where schools remained open. This reduction was primarily driven by decreases in violent and property crimes. The study suggests several mechanisms behind this effect, including changes in neighborhood composition and reductions in school-level segregation.

Long-term studies have shown that school closures can have enduring socioeconomic impacts. Hannum et al. Hannum, Liu, and Wang (2021) reported that girls exposed to school closures in rural China during their primary school years had significantly lower educational attainment by age 17. In Denmark, the closure of rural schools contributed to local population declines, reflecting the deep social roots and economic consequences of such policies Sørensen et al. (2021). Similarly, in the United States, Kim (2024) found that school closures negatively affected post-secondary education attainment, employment, and earnings, particularly among students from low-performing schools and economically disadvantaged backgrounds.

The literature highlights the multifaceted impacts of school closures on educational outcomes, emphasizing the need for careful planning and consideration of local contexts. While closures can lead to resource optimization and potential academic benefits for some students, they often result in significant disruptions and long-term negative effects, particularly for vulnerable populations. These findings underscore the importance of developing comprehensive strategies to support displaced students and minimize adverse outcomes in the wake of school closures.

2.2 Brazilian Educational System and school closure

In Brazil, there were 43.7 million students enrolled in basic education in 2023. This paper focuses on elementary schools since this is the educational step mostly managed by municipalities. In elementary education, there were 14.4 million students in Brazil, with 8.7% enrolled in schools managed by state authorities, 0.03% in schools managed by the federal administration, 68.3% in schools managed by municipal administrations, and 23% in private schools. In other words, in elementary education, there were around 10 million students enrolled in 70,886 schools managed by municipal authorities, which are the focus of my analysis.

There are 5,563 Brazilian municipalities with schools under their authority.[1] The participation of municipalities in educational administration increased in the 1990s with the creation of Fundef, a program that increased financial resources for municipalities to invest in the basic educational system. At the same time, a profound program of school decentralization was implemented, transferring the management of thousands of schools from state governments to municipal administrations. The aim of the school decentralization process was to bring school management closer to local demands, encompassing cultural heterogeneities and local needs.

In Brazil, the Federal Ministry of Education promotes educational programs and invests resources in these policies, but these programs are partnerships with local school authorities. Municipalities have autonomy and authority to manage schools under their administration. More specifically, municipalities can decide about the pedagogical curriculum, teacher training programs, school supplies, infrastructure, and are responsible for hiring teachers and designing their contracts.

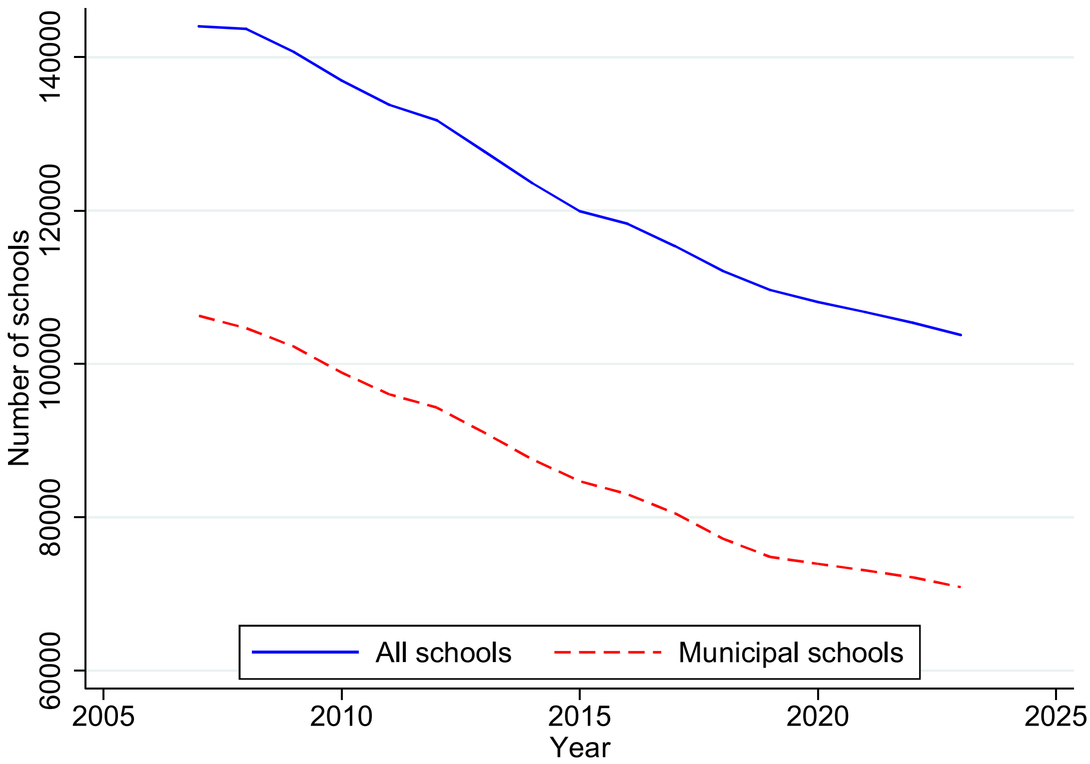
Municipalities in Brazil receive federal transfers targeted to education and have minimum spending targets. However, the allocation of educational resources is exclusively decided by the municipal Secretary of Education. Additionally, the allocation of students among schools is a decision of the municipal Secretary of Education, usually based on the distance from the student's

[1] There are currently 5,568 municipalities in Brazil.

home to school. Therefore, if a student is displaced from a closed school, the municipal authority has to reallocate this student to a new school.

Municipalities can decide about closing or creating new schools. In 2007, there were 106,279 elementary schools under municipal administration. In 2023, there were 70,886, representing a 33% decrease in the period. In Brazil, 43,964 elementary schools under municipal administration closed from 2007 to 2023, with 94.35% of closed schools located in rural areas.

Figure 1: Number of active schools by year



Despite the relevance of school closures for municipal administration, it is not only a matter for municipalities. Figure 1 shows the decline in the number of schools that offer elementary education between 2007 and 2023. During this period, 71.4% of closed schools were run by municipal authorities. That is why I focus on this paper on municipal schools for analyzing the impact of school closures.

To date, rural schools constitute the majority of municipal schools offering elementary education. In 2023, 56.9% of municipal active schools were located in rural areas. As discussed in subsection 2.1, there are many reasons why municipal administrations might close schools. However, in the case of Brazil, one of the reasons is certainly the decrease in demand for education in rural areas. Between 2007 and 2023, enrollments in municipal elementary schools decreased by 46.7% in rural schools, while there was a reduction of only 6.7% in enrollments in urban schools. Therefore, we can state that school closure in Brazil is essentially about closing schools in rural areas.

Table 1: Closed and remaining schools characteristics at 2007

Variables	Closed	Remaining	Difference
Schools at rural areas	0.94	0.71	-0.24***
	(0.23)	(0.46)	(0.01)
Enrollments on elementary education	24.07	117.35	93.28***
	(49.37)	(166.33)	(3.03)
Library	0.04	0.20	0.16***
	(0.19)	(0.40)	(0.01)
Science lab	0.00	0.02	0.01***
	(0.06)	(0.13)	(0.00)
Computer lab	0.01	0.10	0.09***
	(0.08)	(0.30)	(0.01)
Number of classrooms	1.58	4.44	2.86***
	(1.66)	(5.25)	(0.10)
Number of teacher of elementary education	0.87	4.49	3.62***
	(2.03)	(6.35)	(0.12)
Approval rate - elementary education	77.52	79.25	1.73***
	(23.00)	(17.41)	(0.33)
Failure rate - elementary education	14.30	15.51	1.21***
	(16.92)	(13.91)	(0.27)
Dropout rate - elementary education	8.18	5.24	-2.93***
	(15.97)	(8.88)	(0.17)

1) Standard deviations (errors) in parentheses under means (differences)

2) * p¡0.10, ** p¡0.05, *** p¡0.01

3) At 2007 the number of schools that closed was 3014 and the schools that remained open was 103265

4) This analyzes is constrained to schools managed by municipal authority that have students enrolled at elementary education

Closing schools in rural areas also means closing schools that face the biggest challenges regarding infrastructure and learning conditions. Table 1 compares schools that were closed and those that stayed open in 2007. The mean test difference in the third column shows that schools closed had a higher probability of being rural and had an average of 24 students enrolled in elementary education compared to 117 average students for the remaining schools. Additionally, only 4% of closed schools had a library, 1% had a computer lab, and the average number of classrooms and teachers was just a fraction of the remaining schools. The worse infrastructure and resources led to worse outcomes. Consequently, closed schools had worse approval rates and dropout rates.

It is not clear whether schools in rural areas were closed because of their low demand or their performance. However, as presented in subsection 5.3, the fact that low-performance schools were closed will be one of the explanations for the positive impacts of closing schools in Brazil.

3 Data

I use two sources of data in this paper: the School Census of Education released by the Brazilian Ministry of Education bureau responsible for educational statistics (INEP 2023) and the 2000 Demographic Census released by the Brazilian Bureau of Geography and Statistics (IBGE 2000).

The School Census releases annual information on school characteristics and enrollment. Based on school data, INEP calculates the outcomes used in this paper, such as failure rate, school dropout rate, school promotion rate, repetition rate, school attrition rate, and the percentage of students who migrate to Youth and Adult Education.

I opt for using data starting from 2007 despite INEP releasing the School Census since 1995. This is because there was a major methodological change in the 2007 School Census, which created challenges in harmonizing educational outcomes.[2] Consequently, I assume that all decisions about closing schools before 2007 did not affect future outcomes or at least did not affect outcomes differently between treated and control municipalities.

A school is considered closed in year t if it had enrolled students in year t but not afterward. Thus, in t+1, there are no more students enrolled in that school. There is no information about the exact month the school closes, so I assume that schools close at the end of the year, allowing students time to migrate to new schools for the next school year.

I constrain the sample to schools under municipal administration that offer elementary education. All analyzed variables focus on students and teachers in elementary education. It is possible that some schools also offer education in other stages of the educational system, such as middle or high school. I do not distinguish here between schools that only offer elementary education and others. Data is aggregated at the municipal level.

[2]INEP itself releases educational indicators and aggregate data only starting in 2007.

4 Empirical Strategy

In this paper, I aim to estimate the impact of a municipality closing schools on the educational performance of the remaining schools. This differs from most of the existing literature, which analyzes the effect of school closures on displaced students.

A naive comparison between municipalities that closed schools and those that kept the same number of schools would be biased by municipalities' characteristics such as population, economy, and demographic aspects. Even controlling for observable characteristics, selection bias could remain since the municipality's decision to close a school is not random.

Table 2: Descriptive statistics for pre-treatment covariates

Variables	Control	Treated	Difference
Illiteracy rate	14.93	24.32	9.39***
	(7.98)	(12.90)	(0.36)
Municipality Geographical area	640.16	1887.46	1247.30***
	(1512.46)	(6603.11)	(177.35)
Percent. Households with energy	95.39	83.25	-12.14***
	(8.27)	(18.24)	(0.50)
Schooling years	4.67	3.80	-0.87***
	(1.00)	(1.30)	(0.04)
Percent. Households with sewage	44.23	30.20	-14.03***
	(34.98)	(28.61)	(0.94)
Percent. Population in rural areas	33.00	45.05	12.05***
	(21.77)	(22.70)	(0.70)
Population	22454.64	33807.88	11353.24**
	(80832.96)	(211072.01)	(5760.64)
Percent. population between 10 and 14 yo	0.10	0.11	0.01***
	(0.01)	(0.02)	(0.00)

1) Standard deviations (errors) in parentheses under means (differences)

2) * p¡0.10, ** p¡0.05, *** p¡0.01

3) The number of treated municipalities is 4049 and the number of control municipalities (never treated) is 1428.

4) Covariates are from 2000 Brazilian Demographic Census released by IBGE

Table 2 compares pre-treatment demographic characteristics of municipalities that did not close any schools between 2007 and 2023 (control group) and municipalities that closed at least one school (treated group). In my sample, 1,428 municipalities are in the control group and 4,049 municipalities are treated. The table shows that treated municipalities have a less educated population, larger cities, and more houses located in rural areas with worse infrastructure.

To avoid the bias of naive comparisons between treated and control municipalities, I adopt a Difference-in-Difference approach to estimate the causal impact of closing schools. A standard strategy would be to run a Two-Way Fixed Effects estimator (TWFE) as follows:

$$Y_{it} = \theta_i + \theta_t + D_{it}\delta + \eta_{it} \tag{1}$$

where my outcome is the average municipality educational performance rate (failure rate, school dropout rate, school promotion rate, repetition rate, school attrition rate and percentage of students who migrate to Youth and Adult Education) for elementary education of municipality i at year t, θ_i and θ_t are unit and year fixed effects, respectively, while D_{it} is a treatment indicator for municipality i first close a school at time t. The coefficient of interest is δ which measures the effect of closures on educational outcomes.

Callaway and Sant'Anna (2021) propose an alternative strategy to recover the ATT (Average Treatment Effects on Treated) in a difference-in-difference approach in contexts of multi-period treatment.[3] In staggered treatment frameworks like this paper, Sant'Anna and Zhao (2020) shows that the TWFE estimator generates biased estimations and gives negative weights to treated units.

Callaway and Sant'Anna (2021) rely on two hypotheses: no anticipation and parallel trends.[4] No anticipation requires that students and educational workers from displaced schools did not change their behavior or move to another school because of the expectation of future school closures. In the Brazilian context, school migration depends on the local secretary of education's authorization, and municipalities warn students and teachers about school closures just a couple of months before the school year ends.

The parallel trends assumption requires that educational outcomes for treated municipalities would have evolved similarly to control municipalities if they had not closed schools. I test this assumption in two ways: first, by testing if all pre-treatment coefficients estimated by (Callaway and Sant'Anna 2021)'s difference-in-difference model are zero; second, by analyzing the pre-treatment coefficients of event study graphs. In both exercises, I do not refute the assumption for all exercises reported in the paper.

Despite following municipalities over time, I do not have a balanced panel and I report results for the pooled regression version of Callaway and Sant'Anna (2021).[5] The default control group

[3] ATT means Average Treatment Effects on Treated.

[4] Actually, Callaway and Sant'Anna (2021) allows for limited anticipation, but the farther anticipation is from treatment time, the less reliable the hypothesis becomes.

[5] I ran the model for the unbalanced panel data, but some observations were dropped. As missing municipalities could be correlated with school closures, I opt for focusing the paper on the pooled regression version of Callaway and Sant'Anna (2021).

is never-treated municipalities, but I run the model as a robustness check using not-yet-treated municipalities.[6] Additionally, as a robustness test, I replicate Callaway and Sant'Anna (2021) using pre-treatment covariates. In both robustness tests, results are essentially the same.

5 Results

5.1 Main results

Table 3 presents results for the main outcomes. Columns 1 and 2 represent the impact of municipalities that closed any type of school under their administration, whether located in rural or urban areas. Columns 3 and 4 consider treated municipalities that closed rural schools. I make this distinction because most closed schools were located in rural areas. Columns 1 and 3 present results for the static Two-Way Fixed Effects model, while columns 2 and 4 present results for the (Callaway and Sant'Anna 2021) approach (denoted as CS in the table). For (Callaway and Sant'Anna 2021), I report the aggregated estimator as proposed in the paper. Standard errors are clustered by municipalities.

All results indicate improvements in the remaining elementary schools' performance after the municipality decided to close schools. Results for the TWFE and CS differ substantially in magnitude, but for most outcomes, the coefficients' signs are the same. Using column 2 as a reference, the failure rate reduces by 2.1 percentage points for treated municipalities. The effect is also negative and significant for dropout rate, school attrition rate, repetition rate, and the rate of migration to Youth and Adult Education, and it is positive for the school promotion rate. For the TWFE model for schools in rural areas (column 3), the coefficients are smaller than those estimated by CS (column 4) but still statistically significant for all variables except for migration to Youth and Adult Education.

As I focus here on elementary education, school dropout, school attrition, and migration to Youth and Adult Education are not as relevant in this education step as they are for middle and high school. However, promotion rate and repetition rate are significant issues for elementary education in Brazil as they not only hinder students' learning but also increase the likelihood of dropout for students who are not promoted and have to repeat a grade. In this sense, closing schools appears to be part of a successful program to improve the education system.

The fact that coefficients are higher in column 4 than in column 2 suggests that closing schools in rural areas is more relevant than in urban areas. This is justified by the concentration of enrollments in urban areas due to the decline in enrollments in rural areas. Thus, the possible side effects of closing schools on displaced students are offset by the improvement of remaining schools, as shown in subsection 5.3.

Figure 2 presents event study results when the treatment is the municipality closing any type of school under municipal administration, and Figure 3 does the same but for treatment involving

[6] Municipalities that are not treated at some point in time but close schools in the future.

the closure of rural schools. In both figures, it is clear that the impact of closing schools is dynamic and increases over the years, which argues for caution when interpreting TWFE results (Callaway and Sant'Anna 2021). The smaller results in the first years corroborate (Engberg et al. 2012)'s findings about the challenges faced by displaced students in the first year at the new school. As time goes on, displaced students benefit from better infrastructure and teaching, which improves their results.

Table 3: Difference in difference estimation - Main results

	All schools		Rural schools	
	(1) TWFE	(2) CS	(3) TWFE	(4) CS
	Failure rate			
ATT	-0.286**	-2.128***	-0.629***	-2.390***
	(0.091)	(0.169)	(0.098)	(0.172)
N. of obs	8.9e+04	6.7e+04	8.9e+04	6.8e+04
	School dropout rate			
ATT	-0.048	-1.176***	-0.181***	-1.237***
	(0.043)	(0.078)	(0.047)	(0.081)
N. of obs	8.9e+04	6.7e+04	8.9e+04	6.8e+04
	School attrition rate			
ATT	-0.021	-0.949***	-0.119**	-1.006***
	(0.035)	(0.068)	(0.038)	(0.071)
N. of obs	7.8e+04	5.9e+04	7.8e+04	6.0e+04
	School promotion rate			
ATT	0.413***	3.669***	0.892***	4.025***
	(0.114)	(0.250)	(0.122)	(0.256)
N. of obs	7.8e+04	5.9e+04	7.8e+04	6.0e+04
	Repetition rate			
ATT	-0.393***	-2.633***	-0.761***	-2.929***
	(0.093)	(0.198)	(0.099)	(0.202)
N. of obs	7.8e+04	5.9e+04	7.8e+04	6.0e+04
	Migration to Youth and Adult Education			
ATT	0.001	-0.087***	-0.011	-0.090***
	(0.010)	(0.018)	(0.010)	(0.018)
N. of obs	7.8e+04	5.9e+04	7.8e+04	6.0e+04

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 2: Event study - Callaway and Sant'anna estimator - All schools

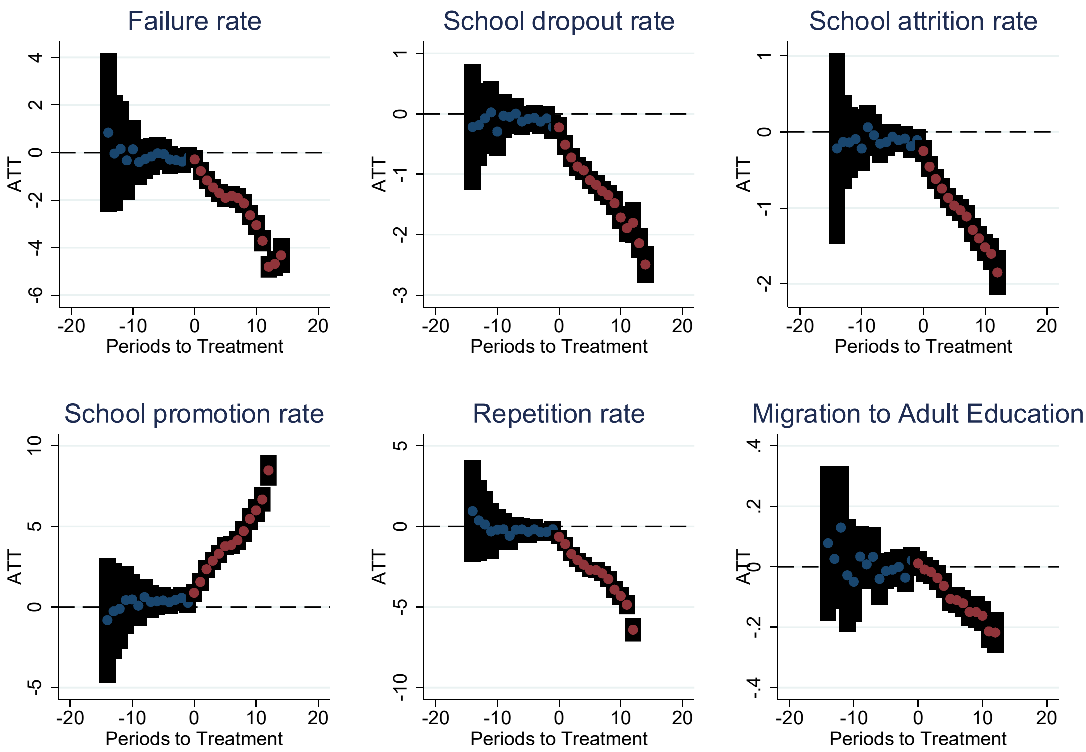
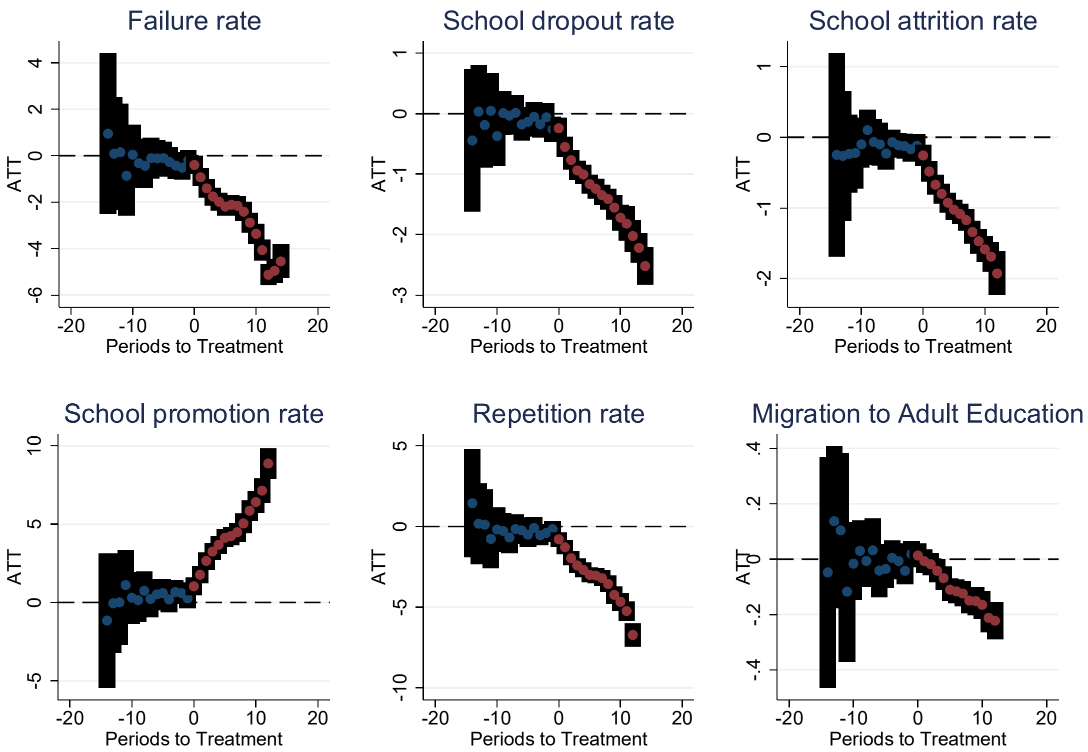


Figure 3: Event study - Callaway and Sant'anna estimator - Rural schools



5.2 Validity tests

Callaway and Sant'Anna (2021)'s difference-in-difference estimator depends on two main assumptions: no anticipation of the treatment and parallel trends. Here, I provide evidence on the parallel trends assumption.

Table 4: Parallel trend tests for main outcomes

	All schools		Rural schools	
	Chi Squared	P-value	Chi Squared	P-value
Percentage of schools with library	49.72	1.00	46.72	1.00
Percentage of schools with science lab	24.98	1.00	30.26	1.00
Percentage of schools with computer lab	85.93	0.91	82.97	0.94
Pupil-teacher ratio	39.26	1.00	39.55	1.00
Log of number of non-white students	21.49	1.00	26.69	1.00
Percentage of non-white students	94.72	0.75	138.46	0.02
Percentage of girls	42.55	1.00	53.50	1.00
Log of number of teachers	10.78	1.00	11.29	1.00
Students per class ratio	27.46	1.00	22.72	1.00
Percentage of teachers with higher education	8.32	1.00	17.39	1.00
Migration to Youth and Adult Education	83.34	0.93	103.00	0.51
Failure rate	117.97	0.18	165.57	0.00
School dropout rate	108.61	0.39	113.66	0.27
School promotion rate	95.25	0.72	113.52	0.25
Repetition rate	96.41	0.69	111.74	0.28
School attrition rate	92.02	0.79	103.15	0.51
Number of class hours per day	32.95	1.00	38.07	1.00
Log of expenditure with education and culture	8.70	1.00	8.65	1.00
Log of expenditure per student	0.65	1.00	32.30	1.00

Table 4 presents the chi-squared statistics and the p-value for a test where the null hypothesis is that all pre-treatment coefficients estimated by (Callaway and Sant'Anna 2021)'s difference-in-difference model are zero. Such results are a valid test for coefficients presented in columns 2 and 4 of Table 3 and for tables in the next section.

Results show that the null hypothesis is not rejected for most variables.[7] So this is evidence for parallel trends despite an actual test being impossible by definition. The event study figures also corroborate the parallel trends assumption since, for all variables analyzed, pre-treatment coefficients are not statistically different from zero.

5.3 Mechanisms

Results show that closing schools is an effective public policy to improve educational outcomes. But why? It is simple to realize that merely closing schools does not improve anything. The impact depends on how the municipality reallocates resources and why municipalities are closing schools. In this section, I discuss the most important transmission mechanisms.

One possible impact of closing schools is a change in class compositions of receiving schools. Table 5 shows that municipalities that closed schools raised the student-to-class ratio. This is an anticipated consequence of closing schools. With a lower number of classes, the migration of students could concentrate students and potentially worsen school quality. Also, there is no impact on the number of students, and Table 3 shows a decrease in the dropout and attrition rate, creating a challenge for each educational system to accommodate displaced students.

However, Table 5 also presents a negative effect on the pupil-to-teacher ratio, which could potentially offset the effects of classes with more students. One possible problem of closing schools is a downside effect on class composition by excluding less socially privileged students. Despite rural schools being located usually in poorer areas, Table 5 presents a positive effect (increase) in the number of non-white students and the percentage of non-white students.

There is extensive literature reporting the positive effects of reducing the pupil-to-teacher ratio and promoting diversity in schools. But Table 6 presents additional mechanisms that can explain the improvement in educational outcomes. As we see, treated municipalities increase the percentage of schools with libraries, science, and computer laboratories. Also, treated schools increase the percentage of teachers with higher education.

The improvement of school resources could be explained by two sources: an increase in educational expenditure and a change in the schools' composition, with schools with fewer resources having a higher probability of being closed. Table 6 shows there is no evidence of a change in the total educational expenditure by municipalities, despite an increase in educational spending per student. This can be explained by the small reduction in the number of students enrolled.[8]

[7] Actually, I do not reject H0 for all variables except for failure rate and the percentage of non-white students in the case of schools in rural areas. But even in these cases, the event study analysis does not present pre-treatment coefficients statistically different from zero.

[8] As Table 5 shows, the negative effect on the number of students is statistically significant only at the 10% level of significance.

With more financial resources per student, municipalities can improve infrastructure and human resources quality.[9]

The second possibility is the change in school composition, with worse schools being closed. As Table 1 shows, closed schools have worse infrastructure and less educated teachers. So even if there was no increase in expenditure per student, the fact that displaced students migrated to better schools helps explain the improvement in the system's results.

[9] Unfortunately, there is no information on the quality of infrastructure or specific programs run by each Secretary of Education, which are relevant for school quality, such as teacher training programs.

Table 5: Difference in difference estimation - Class' composition

	All schools		Rural schools	
	TWFE	CS	TWFE	CS
	Pupil-teacher ratio			
ATT	0.366	-1.214***	0.152	-1.350***
	(0.228)	(0.315)	(0.253)	(0.318)
N. of obs	9.4e+04	7.1e+04	9.4e+04	7.3e+04
	Log of number of students			
ATT	-0.011	-0.058*	-0.031***	-0.069*
	(0.006)	(0.028)	(0.006)	(0.028)
N. of obs	9.4e+04	7.1e+04	9.4e+04	7.3e+04
	Log of number of teachers			
ATT	-0.039***	-0.052*	-0.053***	-0.057*
	(0.007)	(0.025)	(0.007)	(0.025)
N. of obs	9.4e+04	7.1e+04	9.4e+04	7.3e+04
	Students per class ratio			
ATT	0.703***	1.090***	0.737***	1.073***
	(0.065)	(0.125)	(0.070)	(0.128)
N. of obs	9.4e+04	7.1e+04	9.4e+04	7.3e+04
	Log of number of non-white students			
ATT	0.067***	0.236***	0.095***	0.252***
	(0.016)	(0.046)	(0.017)	(0.046)
N. of obs	9.4e+04	7.1e+04	9.4e+04	7.2e+04
	Percentage of non-white students			
ATT	1.289***	7.247***	2.289***	7.794***
	(0.320)	(0.462)	(0.344)	(0.473)
N. of obs	9.4e+04	7.1e+04	9.4e+04	7.3e+04
	Percentage of girls			
ATT	0.009	-0.110*	0.036	-0.077
	(0.045)	(0.049)	(0.048)	(0.049)
N. of obs	9.4e+04	7.1e+04	9.4e+04	7.3e+04

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Difference in difference estimation - Schools resources

	All schools		Rural schools	
	TWFE	CS	TWFE	CS
		Library		
ATT	0.017**	0.071***	0.017**	0.071***
	(0.005)	(0.008)	(0.005)	(0.008)
N. of obs	9.4e+04	7.1e+04	9.4e+04	7.3e+04
		Percentage of schools with science lab		
ATT	0.001	0.012**	0.001	0.012**
	(0.003)	(0.004)	(0.003)	(0.004)
N. of obs	9.4e+04	7.1e+04	9.4e+04	7.3e+04
		Percentage of schools with computer lab		
ATT	0.006	0.042***	0.006	0.041***
	(0.007)	(0.008)	(0.007)	(0.008)
N. of obs	9.4e+04	7.1e+04	9.4e+04	7.3e+04
		Percentage of teachers with higher education		
ATT	-2.263***	3.140***	-2.263***	4.045***
	(0.446)	(0.860)	(0.446)	(0.933)
N. of obs	7.2e+04	3.1e+04	7.2e+04	3.3e+04
		Number of class hours per day		
ATT	-0.035	0.052*	-0.035	0.065**
	(0.019)	(0.022)	(0.019)	(0.022)
N. of obs	7.8e+04	3.6e+04	7.8e+04	3.8e+04
		Log of expenditure per student		
ATT	0.003	0.071***	0.003	0.072***
	(0.005)	(0.012)	(0.005)	(0.012)
N. of obs	8.4e+04	6.4e+04	8.4e+04	6.5e+04
		Log of expenditure with education and culture		
ATT	-0.007	0.047	-0.007	0.051*
	(0.005)	(0.026)	(0.005)	(0.026)
N. of obs	8.4e+04	6.4e+04	8.4e+04	6.5e+04

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.4 Heterogeneities

In this paper, we estimate the causal impact of closing schools on the remaining schools. Despite that closing schools represents a guidance of public policy, the size of the program could be relevant for evaluating results. In this sense, (Callaway and Sant'Anna 2021)'s estimator is exclusively for binary treatment, and to capture the relevance of the dose of treatment, I re-run the difference-in-difference but apply a change in the treatment group. I consider as treated the municipality that closed a percentage of schools above the median.

To construct this measure, I calculate the total number of municipal schools closed between 2007 and 2023 and divide by the number of active municipal schools in 2007 for each municipality. Then I calculate the median of this variable only for municipalities that closed at least one school in the period. Thus, I define two sub-samples of treated municipalities: low school closure, when the municipality is treated if it closed fewer schools than the median (which is 0.44), and high school closure, when the municipality is above the median.[10]

Table 7 presents results for each sub-sample. In both sub-samples, closing schools still impact outcomes in the same way as the overall sample. However, coefficients for the above-median sub-sample seem to be higher. We can conclude that closing schools improve educational performance regardless of the dose of treatment, but higher doses mean a better improvement of remaining schools.

[10] This does not mean that the average treated municipality closed 44% of all schools in the period. Municipalities can build new schools to replace closed ones.

Table 7: Diff in diff estimation according to percentage of schools closed

	Below median	Above median
Failure rate		
ATT	-1.821***	-2.457***
	(0.207)	(0.249)
N. of obs	4.8e+04	4.3e+04
School dropout rate		
ATT	-0.925***	-1.447***
	(0.096)	(0.119)
N. of obs	4.8e+04	4.3e+04
School attrition rate		
ATT	-0.735***	-1.176***
	(0.086)	(0.100)
N. of obs	4.2e+04	3.8e+04
School promotion rate		
ATT	2.836***	4.553***
	(0.310)	(0.369)
N. of obs	4.2e+04	3.8e+04
Repetition rate		
ATT	-1.991***	-3.315***
	(0.243)	(0.293)
N. of obs	4.2e+04	3.8e+04
Migration to Youth and Adult Education		
ATT	-0.109***	-0.063**
	(0.025)	(0.024)
N. of obs	4.2e+04	3.8e+04

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.5 Robustness

I run two robustness exercises for results in Table 3. In the first exercise, I change the control group to be the not-yet-treated group instead of using the never-treated group as in Table 3. Not-yet-treated municipalities can be used as a control group for the periods before they first decide to close a school. Using such a strategy is relevant in contexts where all units are expected to be treated at some point during the period. However, it faces some methodological challenges with negative weighting of treated units when estimated by a standard Two-Way Fixed Effects model.[11]

Table 8 presents results. Except for migration to Youth and Adult Education, all coefficients are statistically significant and have the same sign as in Table 3. However, the magnitude of coefficients seems to be smaller with not-yet-treated municipalities as the control group.

[11] See Callaway and Sant'Anna (2021) for a discussion about TWFE limitations.

Table 8: Difference in difference estimation - Not yet treated as control

	All schools	Rural schools
Failure rate		
ATT	-1.965***	-2.225***
	(0.168)	(0.172)
N. of obs	6.7e+04	6.8e+04
School dropout rate		
ATT	-1.108***	-1.174***
	(0.078)	(0.081)
N. of obs	6.7e+04	6.8e+04
School attrition rate		
ATT	-0.880***	-0.940***
	(0.068)	(0.071)
N. of obs	5.9e+04	6.0e+04
School promotion rate		
ATT	3.378***	3.731***
	(0.250)	(0.257)
N. of obs	5.9e+04	6.0e+04
Repetition rate		
ATT	-2.417***	-2.708***
	(0.197)	(0.203)
N. of obs	5.9e+04	6.0e+04
Migration to Youth and Adult Education		
ATT	-0.082***	-0.082***
	(0.018)	(0.018)
N. of obs	5.9e+04	6.0e+04

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The other exercise is to include pre-treatment covariates in the model using never-treated municipalities as the control group. For this, I re-run Callaway and Sant'Anna (2021)'s model, including the following variables from the 2000 demographic census: illiteracy rate, municipality geographical area, percentage of households with electricity, years of schooling, percentage of households with sewage, percentage of the population in rural areas, population, and percentage of the population aged 10 to 14 years old.

Including pre-treatment covariates weakens the parallel trends assumption. Now, the evolution of outcomes for treated and control groups does not need to be parallel over time, but only conditional on the covariates.

Table 9: Diff in diff estimation - Main results - with covariates

	All schools	Rural schools
Failure rate		
ATT	-1.444***	-1.425***
	(0.388)	(0.295)
N. of obs	6.5e+04	6.6e+04
School dropout rate		
ATT	-0.725***	-0.722***
	(0.124)	(0.121)
N. of obs	6.5e+04	6.6e+04
School attrition rate		
ATT	-0.320**	-0.445**
	(0.123)	(0.156)
N. of obs	5.7e+04	5.8e+04
Repetition rate		
ATT	-1.371***	-1.492***
	(0.411)	(0.362)
N. of obs	5.7e+04	5.8e+04
Migration to Youth and Adult Education		
ATT	-0.010	-0.006
	(0.030)	(0.036)
N. of obs	5.7e+04	5.8e+04

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 9 shows that except for migration to Youth and Adult Education, closing schools impacts all outcomes with the same sign as in Table 3. Additionally, all coefficients are statistically significant. However, including covariates reduces the magnitude of the coefficients. In other words, both robustness exercises presented corroborate the improvements in remaining schools' performance caused by closing schools.

6 Conclusions

This paper investigates the impact of permanent school closures on the educational outcomes of schools that remain open in Brazil. Utilizing a difference-in-differences approach, specifically the Callaway and Sant'Anna (2021) estimator, the analysis provides robust evidence on the positive effects of school closures on educational performance at the municipal level.

The results indicate that municipalities which close schools experience significant improvements in key educational outcomes, including reduced dropout and failure rates and increased promotion rates. These improvements appear to be sustained over time, as evidenced by the event study analysis showing that the positive impact of school closures grows in the years following the closure. This suggests that the initial disruption caused by school closures is outweighed by the long-term benefits of resource concentration and improved educational environments.

One of the critical mechanisms driving these positive outcomes is the enhancement of school resources. Municipalities that close schools are able to increase spending per student, which in turn leads to better infrastructure and higher-quality teaching staff. Specifically, the analysis shows an increase in the percentage of schools with libraries, science labs, and computer labs, as well as a higher proportion of teachers with advanced educational qualifications. These improvements in educational inputs are crucial for fostering better learning environments and outcomes.

Moreover, the study finds that the benefits of school closures are more pronounced in municipalities that close a higher percentage of their schools. This indicates that more extensive consolidation efforts may yield greater efficiency gains and educational improvements. The positive effects are consistent across various robustness checks, including different control groups and the inclusion of pre-treatment covariates, further validating the findings.

However, it is important to acknowledge the potential downsides of school closures. The analysis shows that the number of enrollments in elementary education decreases slightly, which, although not statistically significant at the 5% level, suggests a need to monitor the potential displacement and exclusion of students. Additionally, while the pupil-teacher ratio decreases, indicating more personalized attention to students, the increased student-class ratio poses challenges that need to be managed to prevent overcrowding and ensure effective teaching.

The findings of this study have important policy implications. They suggest that while school closures can be an effective strategy for improving educational outcomes, the success of such policies depends on careful planning and implementation. Policymakers should focus on ensuring that the savings from school closures are reinvested into the remaining schools to enhance educational quality. Additionally, strategies to mitigate the potential negative impacts on displaced students, such as providing transportation and support services, are crucial for maximizing the benefits of school closures.

In conclusion, this paper contributes to the literature by providing comprehensive evidence on the impacts of school closures at the municipal level, highlighting the importance of resource reallocation and infrastructure improvements in driving educational success. The results underscore the need for thoughtful and well-executed school closure policies that prioritize the educational needs of students and the efficient use of resources. Future research could further explore the long-term impacts on labor market outcomes and the broader social implications of school closures, providing a more holistic understanding of this complex issue.

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Appendices

A Event study graphs

Figure 4: Event study - Classes' composition

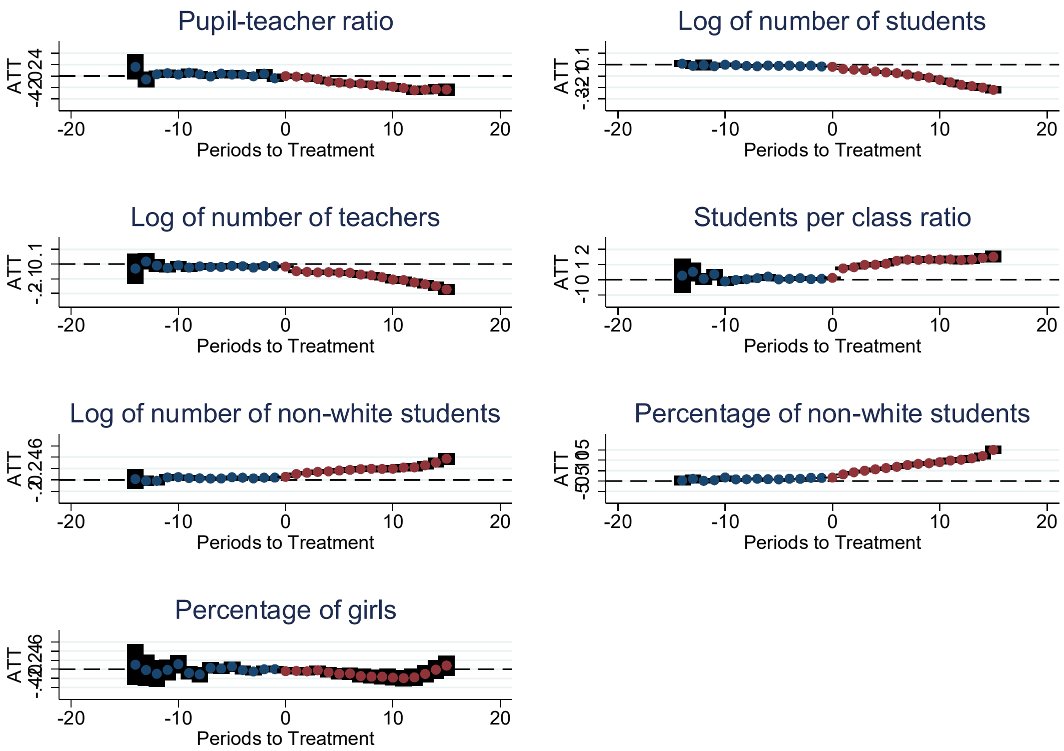


Figure 5: Event study - School resources

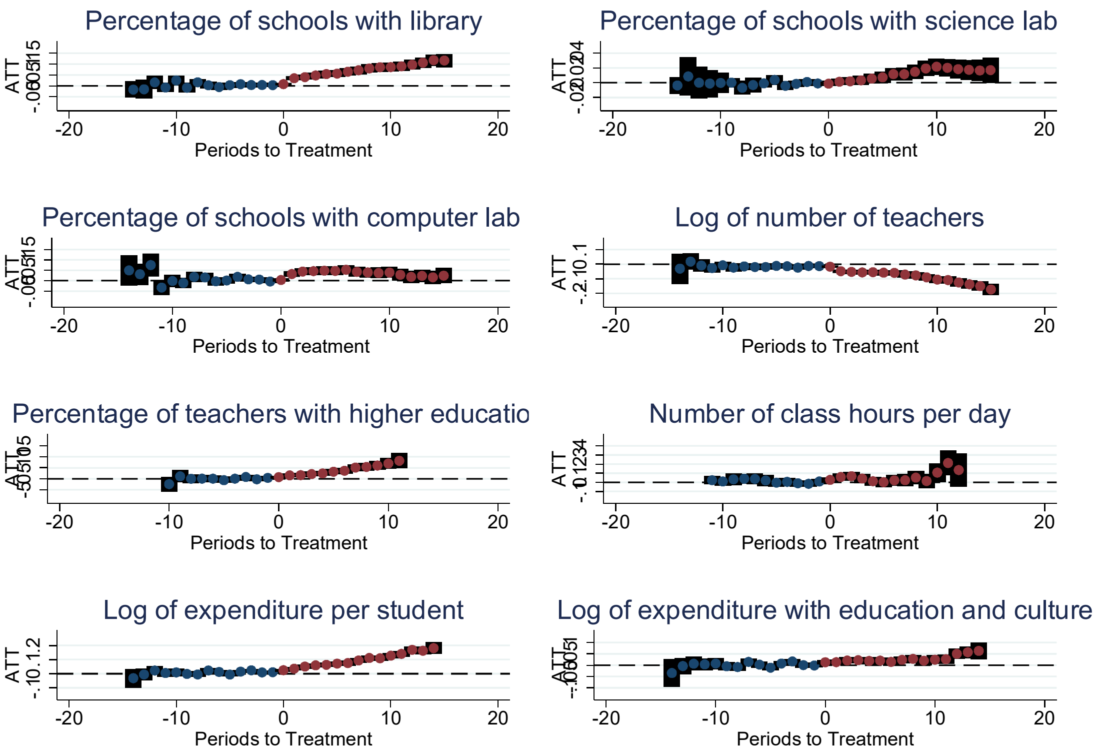


Figure 6: Event study - Municipalities that closed less schools

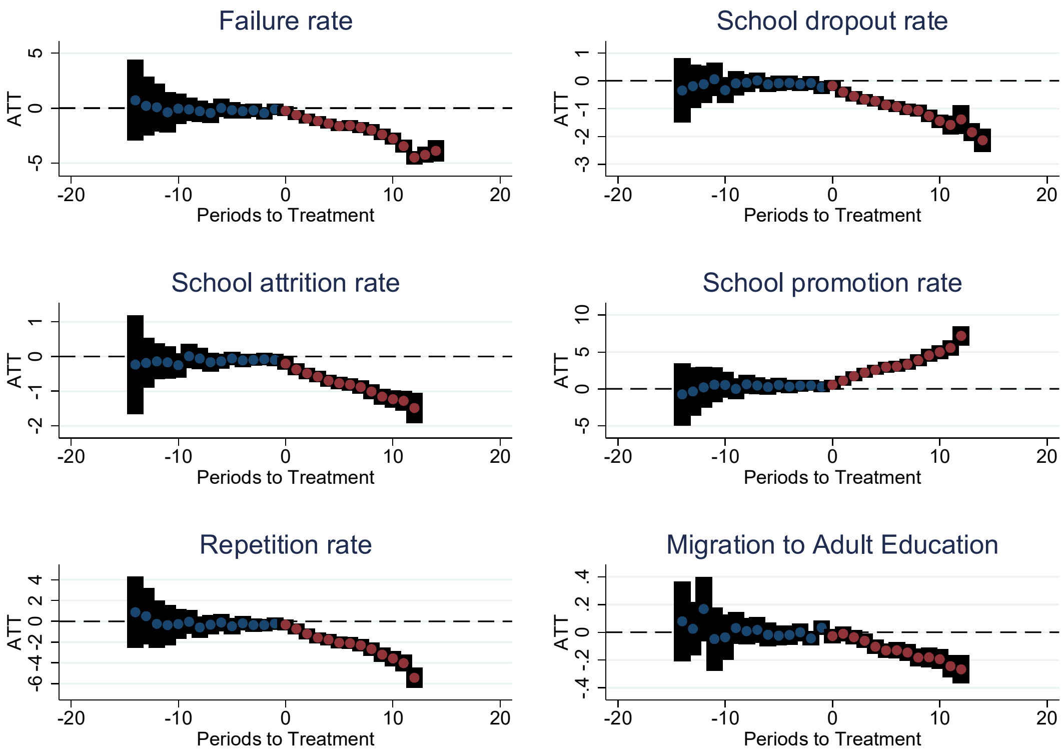


Figure 7: Event study - Municipalities that closed more schools

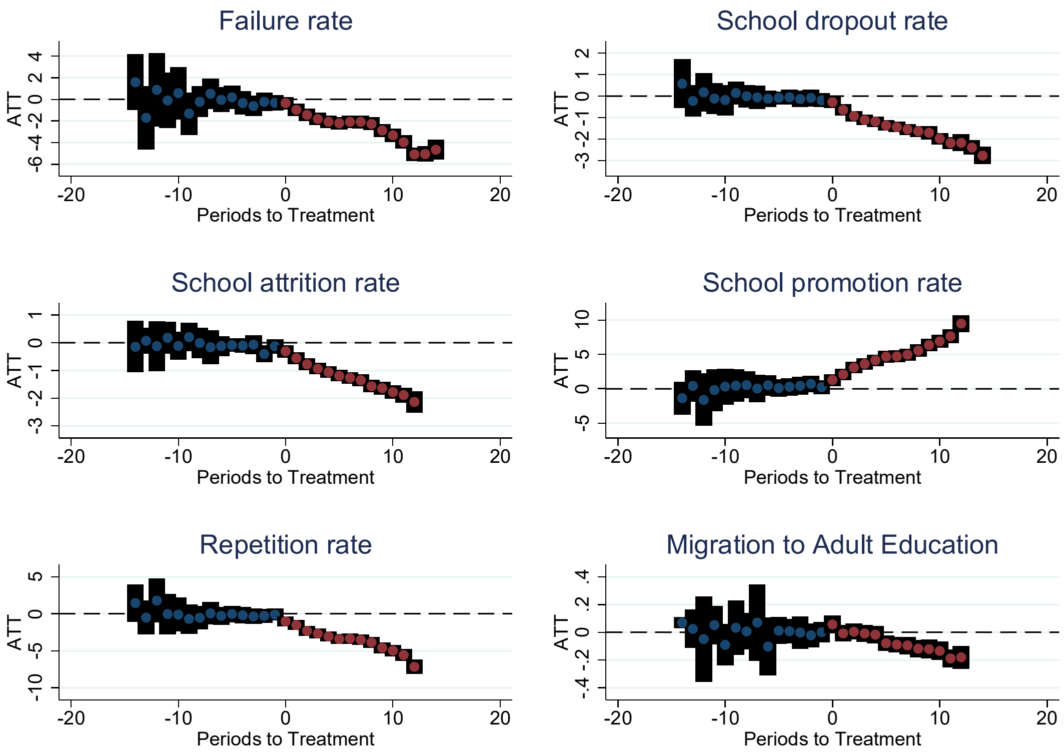


Figure 8: Event study - Main results with covariates - All schools

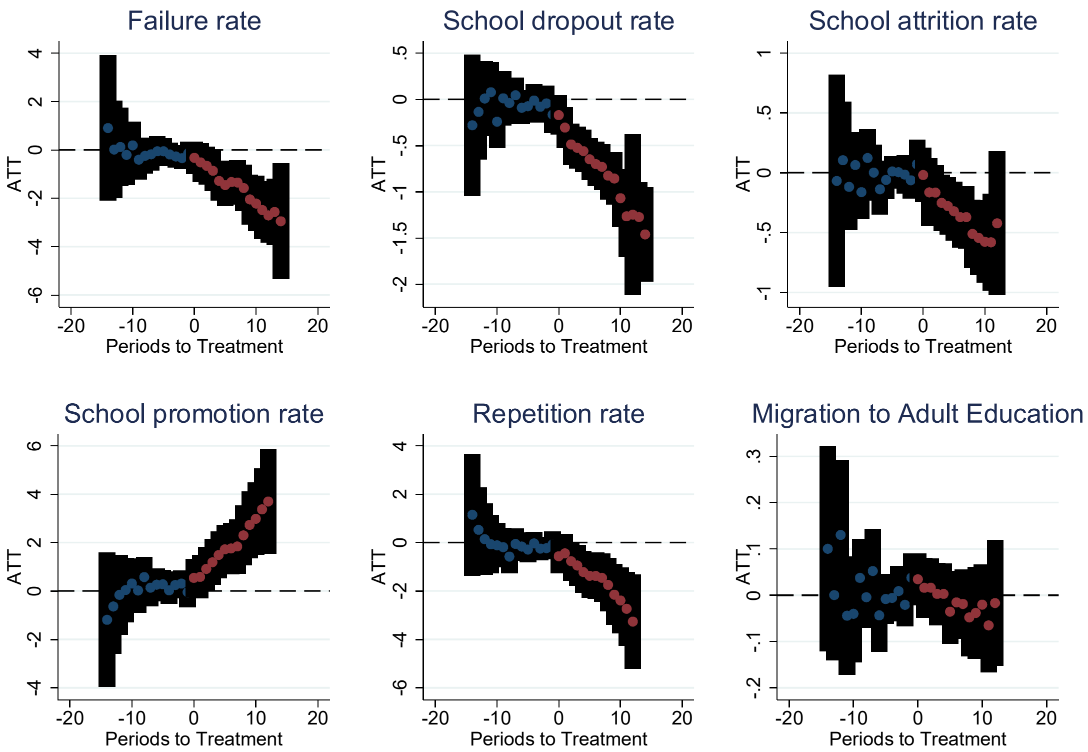


Figure 9: Event study - Not yet treatead as control - All schools

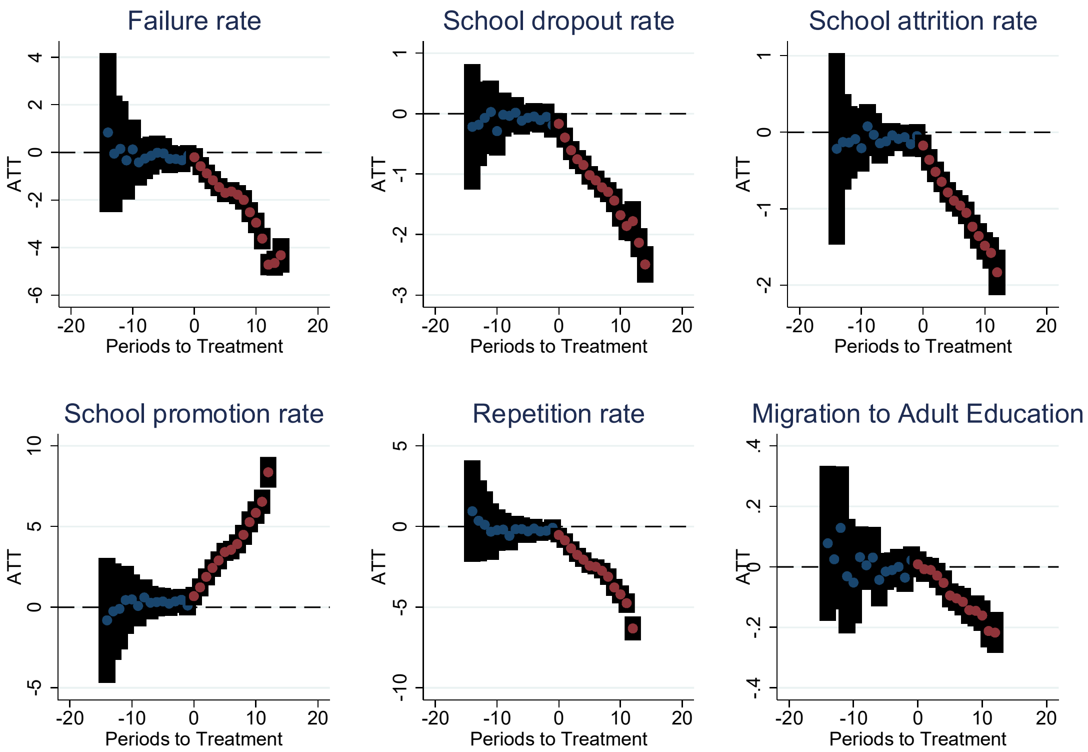
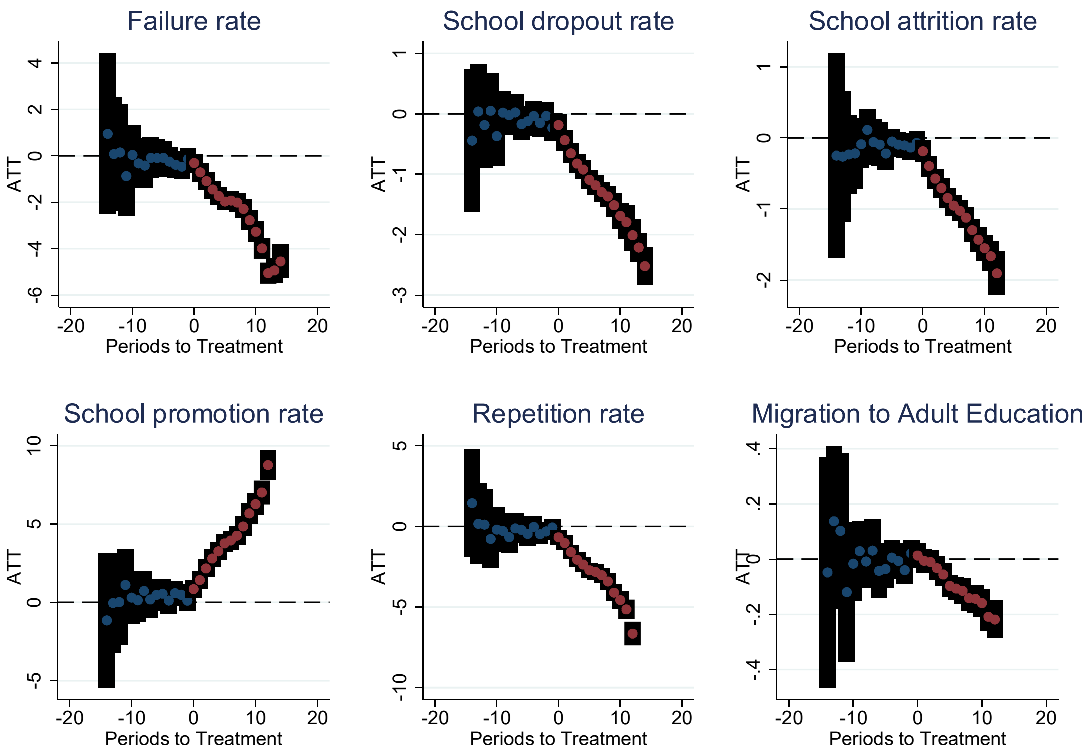


Figure 10: Event study - Not yet treatead as control - Rural schools



B Parallel trends tests

Table 10: Parallel trends for regressions with covariates

	All schools		Rural schools	
	Chi Squared	P-value	Chi Squared	P-value
Migration to Youth and Adult Education	79.83	0.96	101.44	0.55
Failure rate	62.24	1.00	92.51	0.80
School dropout rate	70.27	1.00	72.93	0.99
School promotion rate	58.13	1.00	63.88	1.00
Repetition rate	59.37	1.00	65.29	1.00
School attrition rate	72.87	0.99	84.66	0.92
Percentage of schools with library	41.01	1.00	33.26	1.00
Percentage of schools with science lab	27.82	1.00	67.45	1.00
Percentage of schools with computer lab	74.26	0.99	12.33	1.00
Percentage of teachers with higher education	9.20	1.00	37.92	1.00
Number of class hours per day	34.03	1.00	14.98	1.00
Log of expenditure with education and culture	11.87	1.00	44.62	1.00
Log of expenditure per student	29.35	1.00	43.28	1.00
Pupil-teacher ratio	45.53	1.00	40.14	1.00
Students per class ratio	19.84	1.00	35.70	1.00
Log of number of non-white students	19.25	1.00	34.31	1.00
Percentage of non-white students	37.19	1.00	33.93	1.00
Percentage of girls	6.81	1.00	45.97	1.00
Log of number of students	23.75	1.00	6.63	1.00
Log of number of teachers	48.82	1.00	31.76	1.00

Table 11: Parallel trend tests for regressions with not yet treated as control

	All schools		Rural schools	
	Chi Squared	P-value	Chi Squared	P-value
Migration to Youth and Adult Education	83.25	0.9332	102.9069	0.5119
Failure rate	117.3471	0.1932	164.7562	0.0002
School dropout rate	107.8722	0.4043	112.8525	0.2828
School promotion rate	94.4596	0.7377	112.4041	0.2697
Repetition rate	95.7879	0.7049	110.7967	0.3059
School attrition rate	91.2783	0.809	102.3316	0.5279