Politics Matter: How Political Experience Mitigates Learning Losses Caused by Natural Disasters

MANUEL ALCAINO AND PABLO ARGOTE

Growing evidence warns about the detrimental effects of the stress induced by natural disasters on learning outcomes. Yet less is known about how political leadership could mitigate the adverse exposure to these events. Exploiting a natural experiment—the massive 2010 earthquake in Chile—as an exogenous shock and using fine-grained student data, we find that school disruption has a short and long-term impact on students' test scores. Moreover, our results indicate that learning losses were more pronounced in municipalities with a first-term mayor, in contrast to a nonsignificant effect in municipalities with a reelected one. We show that one of the pathways accounting for these effects is the ability of experienced bureaucrats to mobilize educational resources, highlighting the relevance of managerial capacities in times of crisis.

Keywords: natural disasters, 2010 Chilean earthquake, student achievement, political experience

The impact of natural disasters on human development has been extensively studied. Scholars have found that the stress induced by such disruptions negatively affects human capital accumulation (Caruso 2017), income (Pleninger 2022), birth weight (Torche 2011), migration (Drabo and Mbaye 2015), posttraumatic stress (Zubizarreta, Cerdá, and Rosenbaum 2013), employment (Jiménez Martínez, Jiménez Martínez, and Romero-Jarén 2020), productivity (Boustan et al. 2020), and especially educational attainment (Paudel and Ryu 2018; Herrera-Almanza and Cas 2021)—for small children (Gomez and Yoshikawa 2017) and children exposed in-utero (Caruso and Miller 2015; Caruso 2017; Torche 2018; Berthelon, Kruger, and Sanchez 2021).

The United States is by no means exempt from this problem. In the last years, the economic damage and the number of Americans affected by natural disasters have exhibited an upward trend (Ritchie, Rosado, and Roser 2022) partly because of the increasing number of people living in risky zones (Iglesias et al. 2021). In

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addition, scholars have found that natural disasters particularly affect educational outcomes, including test scores (Sacerdote 2012; Fuller 2014), educational attainment (Harris et al. 2024, this issue), and several other emotional and psychological variables (Ward and Shelley 2008; Osofsky et al. 2009; Dogan-Ates 2010).

Natural disasters do not occur in a vacuum (Cohen and Werker 2008). In the aftermath of such events, local governments undertake numerous actions to mitigate its disruption—establishing shelters, enabling critical infrastructure, disbursing aid, and so on—which depends, to a large extent, on institutional factors. Scholars in political science have addressed these institutional variables, finding that state capacity (Lin 2015), regime type (Keefer, Neumayer, and Plümper 2011), and welfare state generosity (Brady, Finnigan, and Hübgen 2017; Cylus, Glymour, and Avendano 2015; Rodriguez, Lasch, and Mead 1997) are key mitigators of these disruptions.

Political variables are not limited to macro-level institutions. Indeed, a prompt and efficient response from local leaders could mitigate the consequences of these disruptions. Hence, from a theoretical and practical point of view, it is essential to explore how political leadership and the characteristic of local governments could mitigate the consequences of such events. Based on the political economy literature, we consider political experience, namely, the number of periods in office of elected officials as a potential mitigating factor of natural disasters. Scholars have argued that later-term incumbents are, on average, more qualified than newcomers, partly given the knowledge acquired in office or because effective politicians are more likely to be reelected, or both (Ashworth and Bueno de Mesquita 2008; Alt, Bueno de Mesquita, and Rose 2011). As a result, an experienced mayor could be better able to navigate the different layers of the bureaucracy to secure extra resources for repairing public infrastructures. Previous studies have shown that the effectiveness of bureaucracy depends highly on the stability of crucial personnel (Akhtari, Moreira, and Trucco 2014; Toral 2021), which in turn may depend on the continuity of political leadership at the top.

This article asks two research questions. What are the short and long-term impacts of an educational disruption caused by a large-scale earthquake on student learning outcomes? Are experienced mayors able to mitigate potential learning losses caused by such events? As these questions suggest, our primary focus is understanding how political leadership mitigates the expected impact of natural disasters, which could give us essential theoretical and practical lessons about this increasingly relevant topic. In addition to these questions, we explore mechanisms explaining a potential mitigating effect by looking at the ability of local bureaucracies to execute educational spending.

Chile is an optimal case to tackle these questions. In 2010, the country suffered a catastrophic earthquake, 8.8 on the moment magnitude scale, which devastated one-third of its territory.[1] Although the epicenter was in the south, the earthquake had an extensive range, covering more than a thousand kilometers on the north-south axis.

The 2010 earthquake can be considered an educational disruption, namely, a sudden change in the schooling experienced by children caused by an unexpected macro-level event (Torche, Fletcher, and Brand 2024, this issue). According to the Chilean Ministry of Social Development, approximately six thousand schools experienced some damage, affecting 1.25 million students (Gobierno de Chile 2010b). The event caused school closures, concentrated in three regions, and 70 percent of students experienced a delay at the beginning of the school year (Sehnbruch et al. 2017).

The Chilean school governance structure allows us to focus on political variables at the local level. Public schools were managed by municipalities whose mayor is elected every four years. The mayor has discretion over several areas of school administration, such as managing personnel and executing educational spending, among others. Thus a mayor's ac-

1. It was the sixth strongest earthquake ever measured (U.S. Geological Survey, Earthquake Hazard Program, 2016).

tions can directly impact students of local public schools.

Using fine-grained administrative data on individual student achievement and exploiting a precise school-level indicator of earthquake intensity using the local ground-shaking level—peak ground acceleration (PGA)—we find that school disruption induced by the earthquake negatively affects student achievement, especially math test scores in the short term. Indeed, among schools with medium and high-intensity exposure to the earthquake, short-term math test scores decreased between 0.04 and 0.05 standard deviations. Second, using electoral data, we include the mayor's tenure in office to explore whether experienced politicians could mitigate such detrimental effects. We observe that learning losses due to school disruption were significantly larger in municipalities with a first-term mayor, both in math and Spanish, in contrast to a null impact in municipalities run by a reelected one (second period in office or more). We provide evidence that differential exposure to the earthquake does not drive this heterogeneous effect. Likewise, our results are robust to restricting the sample to competitive races, which may account for the characteristics of the median voter per municipality, a placebo test using nonmunicipal schools located in the same municipalities, and after adjusting for observables through a nearest neighbor matching model.

What are the mechanisms underpinning these disparate effects? One of the pathways, we claim, is the ability of experienced bureaucrats to mobilize resources and public spending. We find that schools in municipalities with a newly elected official experienced an approximately ten percentage points drop in public spending, in sharp contrast to a short-term increase in educational spending among schools with a reelected mayor. An experienced mayor likely implied more continuity in key personnel, reflected in a more efficient resource disbursement.

These findings indicate that competent political leadership has the potential to alleviate the destructive consequences of a natural disaster. Despite relying on an imperfect measure of managerial ability (time in office), our study reveals that political experience played a significant role in minimizing learning losses. Intuitively, we would expect experienced mayors to be better able to secure or execute public resources for their constituencies. However, it is surprising that they also mitigated learning losses, a variable that strongly predicts the social and economic outcome of individual trajectories.

The main focus of this article—the role of continuity of local leadership as a plausible mitigating factor—has important implications for the United States, where the administration of schools is also decentralized and dependent on local elected officials. Indeed, our results highlight the importance of continuity of effective local personnel—such as superintendents—independent of political cycles, as their knowledge in managing local bureaucracies could make a big difference in learning outcomes. However, we should state the scope conditions for this argument. Even if our findings underline the relevance of leaders, this does not imply that they face the same type of constraints across localities. Indeed, as Douglas Massey and Mary Fischer (2003) show, American society is characterized by high spatial segregation and concentration of affluence, creating inequality in local capacities—which is also the case in Chile (OECD 2017). Research in the United States has shown that states with greater decentralization of natural disaster spending correlate with higher economic losses because decentralization could lead to disparities in resource allocation (Miao, Shi, and Davlasheridze 2021). Consequently, capable politicians may decide to run for office in more affluent zones, which eventually could reinforce inequality after a natural disaster. Alternatively, the few capable leaders in poorer localities may not have enough resources to make a difference, given human and financial constraints.

In sum, the reliance on leaders seems like a double-edged sword; on the one hand, it is encouraging to see that political action can make a difference for victims of catastrophic events. Nonetheless, it is also concerning to note significant disparities based on local leadership, as these may be unevenly distributed across the United States.

CHILEAN EDUCATIONAL SYSTEM

The Chilean educational system has three distinctive characteristics. First, since 1981, public schools have been managed by the 345 local municipalities, which became administrators of state-owned kindergartens, primary, and secondary schools (Raczynski and Serrano 2001). Even if local municipalities make most managerial decisions, the central level still plays an important role. Indeed, the Ministry of Education (MINEDUC) is in charge of defining macro-level policies, and supervising educational institutions.

Second, municipalities are led by a mayor, who is elected every four years in a first-past-the-post electoral system. The mayor has discretion over several administration areas, including school management, personnel hiring, budget planning, execution of ministerial programs, and infrastructure-related tasks. According to the PISA school principal survey of 2018, more than 80 percent of administrative, financial, and staffing decisions in Chile are made locally, ahead of countries such as Colombia (60 percent), Peru (50 percent), Uruguay (10 percent).[2]

In addition, the educational system is strongly market-oriented. Chilean schools—both public and private—are funded by a per-student voucher, delivered from the central level, based on student attendance (Torche 2005). This funding scheme allows private-voucher schools, namely, private schools funded by state subsidies. Thus, in a given locality, private and public options, both funded by the central level, compete to attract students. The prevalence of private-voucher schools has steadily increased in the past forty years.

Regarding funding, two types of vouchers comprise almost 90 percent of the total educational spending: the per-student voucher and a targeted voucher program called Subvención Escolar Preferencial (SEP), which targets poor students, allocating significantly more resources to schools for each eligible student (Mizala and Torche 2017). In addition, municipalities are allowed to allocate some resources from local revenues from other sources on top of these vouchers, which typically happens in affluent local governments (Bellei 2009).

THE 2010 EARTHQUAKE

The 8.8-moment magnitude scale earthquake occurred offshore of southern Chile at 3:34 a.m. local time on February 27, 2010. The epicenter was located in the Biobío region, near the city of Concepcion, the second largest urban area after the capital Santiago. The earthquake caused a damaging tsunami thirty-five minutes later, extending 500 kilometers along the coast with maximum wave heights of up to 10 meters. The earthquake and tsunami caused 521 fatalities, and thousands of people were seriously injured (Gobierno de Chile 2010a). Approximately half a million buildings were severely damaged, and almost 10 percent of the population in the affected areas lost their homes. The event caused nationwide disruptions to public infrastructure such as electric lines, roads, cell phone lines, and other communications networks (Castaños and Lomnitz 2012). The country's critical infrastructure was significantly affected, including airports, railroads, ports, and highways.[3] In the aftermath, the government declared a state of emergency to control the rise of looting and crime. The government and civil society took immediate action prioritizing fulfillment of basic needs, access to basic supplies, and the reconstruction of public infrastructures such as schools, hospitals, and roads.

Regarding school infrastructure, a survey conducted after the earthquake revealed that 24.6 percent of the school children were delayed in starting the school year, concentrated in the six regions most affected by the event. In particular, in the most affected regions—Biobío, Maule, and O'higgins—this number reaches 70 percent (Sehnbruch et al. 2017). Moreover, according to government sources, more than two million students faced damage in their schools; in regions directly affected by the disaster, 74 percent of schools suffered

2. The average for OECD countries (70 percent).

3. It has been estimated that the total economic cost of the earthquake was 18 percent of the country's GDP (Aguirre et al. 2022).

some damage and 48 percent experienced moderate, severe, or disqualifying damage (Gobierno de Chile 2010b).

DATA AND MEASURES

First we describe the relevant measures and data sources in our empirical strategy. We then present a timeline of the relevant events to clarify the temporal gap between the earthquake and the outcomes.

For individual academic performance and student enrollment data, we use individual-level data from the Chilean System for Measuring Educational Quality (SIMCE), including fourth- and eighth-grade math and language test scores for all students in the system from 2008 to 2011. Across models, we use a standardized version of test scores, each year's mean and standard deviation. In some specifications, used to estimate long-term effects, we also included eighth-grade test-takers in 2014. In addition, we use enrollment records from the Ministry of Education (MINEDUC) as pretreatment covariates, including total enrollment, average attendance, whether the student graduated, and grade point average. We also use the SIMCE parent surveys to obtain information on students' socioeconomic backgrounds.

As a proxy for institutional performance, we use a measure of educational spending based on a program called Subvención Escolar Preferencial. This new regulation was implemented in 2008 and created a new voucher for the poorest students, allocating significantly more resources to schools for each eligible student. Through a four-year improvement plan, each school has to spend these new resources on teaching material, hiring educational specialists, contracting external support, or extending teachers' contract hours. The Chilean Superintendency of Education collects this spending data, allowing it to construct a precise measure of the percentage of public spending for each school by year, defined as (SEPspending/total SEPbudget).

We measure earthquake affectation using peak ground acceleration, which accounts for local geological effects. This is a widely used measure in earthquake engineering because, unlike global measures such as Richter, PGA represents the maximum shaking acceleration registered in a specific location. In addition, it accounts for regional propagation effects or local amplifications that other measures, such as the epicentral distance, fail to capture (Aguirre et al. 2022; Zubizarreta, Cerdá, and Rosenbaum 2013). We use peak ground acceleration shapefiles provided by the U.S. Geological Survey (2016), allowing us to precisely construct PGA values using the latitude-longitude plane of the universe of Chilean schools. We then divide our sample into three categories of earthquake intensity by schools: low exposure (PGA<0.092), medium exposure (PGA>0.092 and PGA<0.34), and high exposure (PGA>0.34) to define the treatment and control groups.[4]

As explained, we measure exposure to the earthquake at the school level defined by the school's location. To determine enrollment in a given school, we used the 2009 student registration records, the year preceding the earthquake. Thus a treated (control) student is defined as an individual enrolled in an exposed (nonexposed) school in 2009, regardless of any subsequent school transfers following the 2010 earthquake. Thus we ensure that our results were not influenced by earthquake-induced migration.

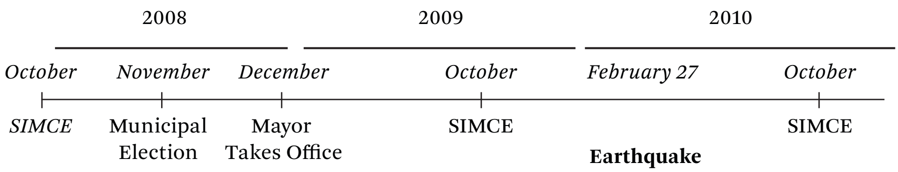
Finally, we use data from the 2008 municipal election from the Chilean Electoral Service (SERVEL) to determine the period in office of each mayor. This measure is an indicator variable equal to one if the mayor were reelected at least once and zero otherwise. Table A.1 displays descriptive statistics of all the described variables.

Timeline

We focus on educational and electoral data around the year of the earthquake. As the timeline in figure 1 shows, the earthquake occurred at the end of February 2010, at the beginning of the school year that starts in March and ends in December. The Chilean System for Measur-

4. These cutoff points are based on the potential damage of earthquake exposure based on the Mercalli scale. In the low-exposure category, the damage ranges from note to light; in medium exposure, it ranges from light to moderate; in the high-exposure category, it ranges from moderate to very heavy (see Zera and Nafian 2018).

Figure 1. Timeline of Election and Education Data



Source: Authors' compilation.

ing Educational Quality is collected annually in October. Therefore, our short-term effects measure the consequences of exposure to the earthquake roughly eight months after. In addition, we compare outcomes by the political experience of the mayor in office. Municipal elections took place in October of 2008 and the mayor took office in December of the same year. Hence the earthquake affected Chile when mayors elected in 2008 had approximately fourteen months in office.

SAMPLE AND DATA STRUCTURE

Our data structure can be best described as repeated cross-sectional, given that it follows schools over time but with different cohorts of students each time. Concretely, we include fourth and eighth-grade students who took the test in 2008, 2009, 2010, 2011, 2012, and 2014. For instance, in 2009—the baseline year—a given cohort of fourth-grade students took the SIMCE test; then, in 2010—the year of the earthquake—a different cohort within schools took these tests, and so on. Thus, we tracked the same schools over time but not the same students.

For our core findings, we restrict the sample to fourth-grade students who met three conditions. First were those who took the SIMCE test during the study period, encompassing 98.9 percent of students from schools recognized by the state. Second were those in a school exposed to the 2010 earthquake. The latter restriction implied that we discarded students that entered the educational system after the earthquake. For the heterogeneous effects using the mayor's tenure in office, we added a third condition, those students enrolled in municipal schools, excluding private and private-voucher schools, because their direct exposure to the mayor's managerial decisions is limited. In 2010, 43.5 percent of students in the fourth-grade cohort were enrolled in public schools.[5]

EMPIRICAL STRATEGY

The study of natural disasters offers excellent potential to researchers in that, by definition, such events are unpredictable and random. Certainly, some geographical areas are more susceptible than others, implying that potentially affected people would differ from subjects in other areas. Therefore, researchers cannot use any nonaffected group as the comparison group. Nonetheless, it is plausible to find variation in exposure within a geographic unit susceptible to these events, allowing researchers to identify a treatment group and counterfactual created through natural circumstances. In other words, natural disasters constitute natural experiments, that is, events in the real world where treatment is "as if" randomly assigned by forces other than a researcher (Dunning 2008).

Even if the intensity of a natural disaster is perfectly random, researchers typically use panel data to study its effects, which allows adjusting for any baseline difference between treated and control units.[6] In other words, panel data allows comparing changes between affected and unaffected units through a difference-in-difference model or a fixed-effect

5. To be precise, for 2010, we retained 104,056 of the 241,332 students.

6. If we assume that the natural disaster is entirely exogenous, we can identify its effect through a simple difference in means or through a comparison of the change over time. In the latter procedure, we could gain efficiency because variation is less in changes than in level differences.

specification. The latter model typically allows for the inclusion of geographic fixed effects, adjusting for heterogeneity across regional variables, such as states, counties, and cities. In our review, we found that this approach is prominent: about 75 percent of the cited papers use a panel or repeated cross-sectional data structure. Moreover, most of these papers show robustness checks satisfying the assumptions of these models, such as parallel trends of the pretreatment outcome or baseline similarities between treatment and control groups.

A second approach considers the natural disaster as a random instrument of some treatment. For instance, earthquake intensity could severely affect public infrastructure. If a researcher is interested in the impact of public infrastructure on other outcomes, they can instrument the treatment with the natural disaster.

A third methodological approach is to create a counterfactual through a weighted average of nonaffected units. This approach allows for comparing similar units based on observable characteristics, restricting the sample to a zone of overlap, that is, a region where treated and control units have a similar probability of treatment.

In our case, along with most of the literature, we estimate a difference-in-difference model, mainly for two reasons. First, the earthquake's exact location is plausibly random, given that the whole Chilean territory is vulnerable to these events. Second, we have six waves of cross-sectional data on student achievement at the individual level, which allows for comparing variation over time, adjusting for school and regional fixed effects. The estimand—the quantity of interest—is the average treatment effect (ATE), given that we are measuring the direct average impact of this macro-level disruption on educational outcomes.

Our first empirical analysis looks at the short-term effect of the earthquake on student achievement through a difference-in-difference model (DID). Here, we estimate a traditional DID regression, which can be described as follows:

$$Scores_{ismrt} = \beta_0 + \sum_{y=2007}^{2012} \beta_y(y)_t + \eta_1(med)_{smr} + \eta_2(high)_{smr} + \sum_{y=2007}^{2012} \tau_y(y) * (med)_{smr} + \sum_{y=2007}^{2012} \lambda_y(y) * (high)_{smr} + \delta_r + \varepsilon \quad (1)$$

The outcome $Scores_{ismrt}$ represent the standardized test scores in math and Spanish of student i, in school s, in municipality m, in macro-region r, in year y. Then, the predictor $\sum_{y=2007}^{2012}$ are indicator variables of the years between 2007 and 2012, using 2009 as the reference category;[7] the parameter δ represents macro-region fixed effects. The variables $(med)_{smr}$ and $(high)_{smr}$ indicate medium and high earthquake intensity, respectively, using PGA—low intensity is omitted. The key parameters are τ_y and λ_y, the interaction terms between the year dummies and the earthquake's intensity indicators, which accounts for the DID estimate. The models include the following pretreatment covariates: Parents' average education, parents' income (log), baseline schools' math and language academic achievement, and school type (municipal, private, or private-voucher).

The identifying assumption is that exposure to earthquake intensity was as-if-randomly assigned across schools.[8] We hypothesize that $\tau < 0$ and $\lambda < 0$ imply a negative effect of both moderate and high intensity on student achievement. Note that the counterfactual scenario is the change in test scores among schools with low exposure to the earthquake.

Our second empirical strategy estimates long-term effects. In these models, we estimate a similar DID, but instead of computing the outcome in 2010, we use outcome data for 2014 obtained from the eighth-grade SIMCE test. Such a model can be described as follows:

7. We included 2007 and 2008 to check for a pre-trend in the model. We expect to find a null effect on those years.

8. We observe evidence in this direction because there are no differences among exposed and nonexposed schools on key student outcomes in the preearthquake period. To this end, we regressed five baseline covariates on our indicator of earthquake intensity, finding, as expected, null results (see table A.2).

$$Scores_{ismrt} = \beta_0 + \beta(2014)_t + \eta_1(med)_{smr} + \eta_2(high)_{smr} + \tau(2014) * (med)_{smr} + \lambda(2014) * (high)_{smr}\, \delta_r + \varepsilon \quad (2)$$

The difference from equation (1) is the inclusion of a dummy variable indicating 2014.

In addition, we estimate an interacted DID model, multiplying earthquake intensity with a variable indicating whether a mayor was reelected.

$$Scores_{ismrt} = \beta_0 + \sum_{y=2007}^{2010} \beta_y(y)_t + \eta_1(med)_{smt} + \eta_2(high)_{smt} + \sum_{y=2007}^{2010} \tau_y(y) * (med)_{smr} + \sum_{y=2007}^{2010} \lambda_y(y) * (high)_{smr} + \omega(re)_{mt} + \sum_{y=2007}^{2010} \alpha_y(y) * (re)_{mt} + \phi_1(re * med)_{smt} + \phi_2(re * high)_{smt} + \sum_{y=2007}^{2010} \theta_y(y) * (re * med)_{smt} + \sum_{y=2007}^{2010} \kappa_y(y) * (re * high)_{smt} + \delta_m + \varepsilon \quad (3)$$

Here, the variable *re* represents a dummy indicator equal to one if the mayor was reelected at least once, zero otherwise. This indicator interacts with all the relevant variables of the model. The parameters of interest are τ, λ, θ and κ. τ and λ represent the effect of moderate and high earthquake intensity for municipalities led by a first-time mayor; meanwhile, θ and κ are the impacts of moderate and high earthquake intensity in places with reelected mayors. We hypothesize that $\tau < 0$, $\lambda < 0$, but $\tau + \theta = 0$ and $\lambda + \kappa = 0$ meaning that an experienced mayor has a mitigating effect.

Finally, we also estimated the long-term model, adding the interaction term of political experience:

$$Scores_{ismrt} = \beta_0 + \beta(2014)_t + \eta_1(med)_{smt} + \eta_2(high)_{smt} + \tau(2014 * med)_{smr} + \lambda(2014 * high)_{smr} + \omega(re)_{mt} + \alpha(2014 * re)_{mt} + \phi_1(re * med)_{smt} + \phi_2(re * high)_{smt} + \theta(2014 * re * med)_{smt} + \kappa(2014 * re * high)_{smt} + \delta_m + \varepsilon \quad (4)$$

As in equation 3, the parameters of interest are τ and θ.

In addition, in the mechanisms section, we estimate identical DID models such as the ones presented in these equations but with a different outcome: the SEP educational expenditure.

Before presenting the results, we discuss the challenges in estimating heterogeneous effects. Although we have an arguably exogenous treatment—which allows identifying the main effect causally—it is always difficult to estimate heterogeneous effects given the typical perils of working with observational data: endogeneity problems, lack of statistical power, and ad hoc selection of any characteristic that may show heterogeneity (Torche, Fletcher, and Brand 2024, this issue). Let us address these points one at a time.

We can discard the problem of ad hoc selection because the inclusion of political experience is based on theoretical grounds. Indeed, the main focus of this article is political experience as a mitigating factor, and we have good theoretical and practical reasons to believe this will be the case. Regarding statistical power, our data set is considerably large, as we have the universe of Chilean students who took the test in the included years. We acknowledge that we may have an endogeneity problem due to the nonrandom selection of mayors. Indeed, because mayors are not randomly assigned, it is plausible that municipalities with reelected mayors differ from the ones with newcomers in variables that may also be related to test scores. To address this problem, we restricted the sample to close races to adjust for the characteristic of the median voter across localities. In addition, we use inverse probability weighting matching in order to better adjust for observable among municipalities with and without a reelected mayor. Our results are practically identical after these adjustments (for a longer explanation of both procedures, see the following section).

RESULTS

We present our results in four stages. First, we explore the consequences of school disruption induced by the earthquake on student achievement. Second, we examine how the political experience of municipal mayors potentially mitigates the effects. Third, we discuss mechanisms, looking at educational spending. Fourth, we present several robustness checks.

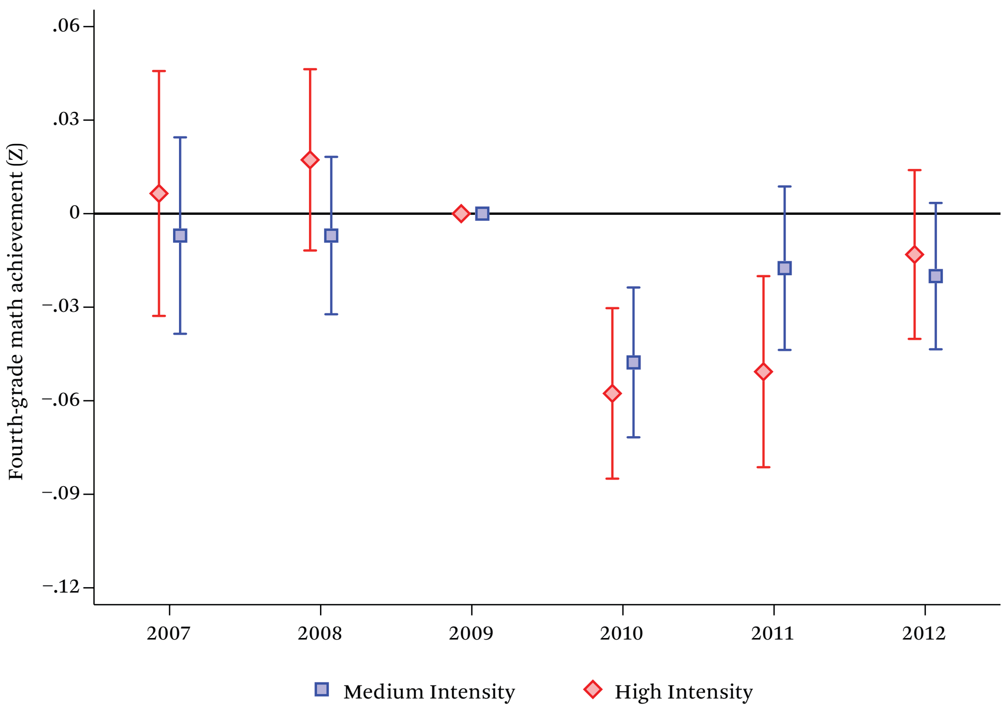
Short- and Long-Term Effects of School Disruption on Student Achievement

In figure 2, we present a coefficient plot with the DID estimates for moderate and high intensity, using math scores at the outcome and 2009 as the reference category. The educational disruption created by the earthquake had a meaningful negative impact on students, both for moderately and severely affected schools, relative to the nonaffected ones (low-intensity). Indeed, medium- and high-intensity exposure to the earthquake decreased math test scores between about 0.04 to 0.05 standard deviation units in 2010; the effect lingers for 2011 among the high-intensity group.

Relative to other benchmarks, the effect on math scores is quite substantial. For example, successful school programs implemented in Chile, such as lengthening the school day (Jornada Escolar Completa) increased test scores between 0.05 to 0.12 standard deviations (Bellei 2009). Nonetheless, when comparing with targeted interventions—such as supporting teachers, which yields a positive impact of around 0.17 and 0.27 standard deviations—our effects look smaller (Muralidharan and Sundararaman 2011).

In table 1, we present the findings of the DID interaction for both short- and long-term outcomes. We display the results for the entire sample in models 1 and 2 and then restrict the analysis to municipal schools in models 3 and 4. In model 2, panel A of table 1, there is no immediate impact on Spanish-language scores, in contrast to math scores. This discrepancy may be attributed to the fact that math performance relies more on school-related factors, whereas reading skills can be influenced, to a greater extent, by family or cultural capital. Indeed, research in the United States demonstrated that a larger variance of math scores, relative to English scores, are explained by teacher effects

Figure 2. Short-Term Effect of 2010 Earthquake on Math Academic Achievement



Source: Authors' tabulation based on SIMCE (2007–2012); MINEDUC (2006–2012).
Note: The coefficients representing the DID estimates using 2009 as the baseline year and low-exposure schools as the reference category. These are equivalent to model 1 in table 1. The models are covariate-adjusted and encompass the entire sample of students from all types of schools. Standard errors are clustered at the school level. Coefficients 95 percent confidence intervals.

Table 1. Short and Long-Term Effect of 2010 Earthquake on Math and Spanish Academic Achievement

	All Students		Municipal Schools	
	Math (Z) (1)	Spanish (Z) (2)	Math (Z) (3)	Spanish (Z) (4)
Panel A. 8 months after fourth-grade test score				
Year 2010 x Med intensity	−0.04***	−0.00	−0.03	0.02
	(0.01)	(0.01)	(0.02)	(0.02)
Year 2010 x High intensity	−0.05***	−0.00	−0.05**	0.02
	(0.01)	(0.01)	(0.02)	(0.02)
Observations	379,037	377,771	157,763	157,151
Clusters	6,772	6,772	3,616	3,616
Controls	Yes	Yes	Yes	Yes
Panel B. 4.6 years after eighth-grade test score				
Year 2014 x medium intensity	0.01	−0.03	−0.01	−0.06***
	(0.02)	(0.02)	(0.01)	(0.01)
Year 2014 x high intensity	0.00	−0.07***	0.02	−0.07***
	(0.02)	(0.02)	(0.02)	(0.02)
Observations	172,365	171,249	395,267	393,196
Clusters	4,782	4,785	8,328	8,334
Controls	Yes	Yes	Yes	Yes

Source: Authors' tabulation based on MINEDUC (2004–2014); SIMCE (2005–2014).
Note: The table presents the interaction term τ as in equation 1 for the entire sample in models 1 and 2, and restricted for students in municipal schools in models 3 and 4. The short-term results in models in panel A include fourth-grade student achievement using 2009 as the baseline year and low-exposure schools as the reference category. The long-term results in panel B include eighth-grade student achievement using 2009 as the baseline year and low-exposure schools as the reference category. Models 1 and 3 include a standardized version of math test scores using, while models 2 and 4 use a standardized version of language test scores. Standard errors are clustered at the school level.
* $p < .1$; ** $p < .05$; *** $p < .01$

(Chetty, Friedman, and Rockoff 2014a, 2014b). Our findings suggest a similar pattern in Chile.

Panel B of table 1 demonstrates that, over the long run, the detrimental effect on math diminishes. We, however, observe a negative long-term impact on Spanish. This persistent effect is primarily concentrated among high-intensity schools. However, in the case of students attending municipal schools, the effect is also noticeable in medium-intensity schools. A plausible explanation is that language development is a cumulative process, relying heavily on early childhood experiences (Austin et al. 2017). If the earthquake occurred during a critical period of language development, it could have had lasting effects on their ability to acquire and use language effectively. Additionally, the earthquake may have created economic instability, in turn affecting the long-term development of language skills.

Finally, table A.3 shows that the negative short- and long-term effects of school disruption were larger among high-performing students, using baseline grade point average relative to the school-grade median, in the short-term (panel A). Most likely, these students were more engaged in school activities, all disrupted after the earthquake.

HETEROGENEOUS EFFECTS BY MAYOR'S TENURE IN OFFICE

Can reelected mayors potentially mitigate the impact of the earthquake on learning outcomes? To address this inquiry, we examine our difference-in-differences estimates in conjunction with a binary variable that indicates whether the mayor was reelected. By interacting with these variables, we can assess whether the reelection of mayors has any moderating effect on the consequences of the earthquake.

In table 2, we display the results of our interacted DID model, both for the short and long-term outcomes (equations 3 and 4). For the sake of simplicity, we include three coefficients: the impact of the earthquake on municipalities with a first-term mayor, the impact on municipalities with a reelected mayor, and the difference between the two.

Columns 1 and 2 show that the learning losses due to school disruption were substantially higher in municipalities with a first-term mayor, both in math and Spanish, among highly exposed schools. Indeed, among schools with a first-term mayor, the earthquake decreased math test scores by 0.13 standard deviations, in contrast with places with an experienced mayor, where the impact is essentially zero. Moreover, the interaction coefficient—indicating the difference between municipalities with a reelected and a first-term mayor among the high-intensity group—is substantial (0.10 standard deviations) and statistically signifi-

Table 2. Short and Long-Term Effect of 2010 Earthquake on Math and Spanish Academic Achievement by Mayor's Reelection Status

	Short-Term Outcomes 8 Months After Fourth grade		Long-Term Outcomes 4.6 Years After Eighth grade	
	Math (Z) (1)	Spanish (Z) (2)	Math (Z) (3)	Spanish (Z) (4)
Medium intensity (not reelected)	−0.07***	−0.01	−0.00	−0.03
	(0.02)	(0.02)	(0.03)	(0.03)
Medium intensity (reelected)	−0.02	−0.00	0.01	−0.04
	(0.03)	(0.03)	(0.02)	(0.03)
Difference	0.05	0.01	0.01	−0.01
	(0.04)	(0.03)	(0.04)	(0.04)
High intensity (not reelected)	−0.13***	−0.06**	−0.04	−0.10***
	(0.04)	(0.03)	(0.03)	(0.03)
High intensity (reelected)	0.03	0.04	0.03	0.06*
	(0.03)	(0.02)	(0.03)	(0.03)
Difference	0.10**	0.10**	0.07	0.04
	(0.05)	(0.04)	(0.04)	(0.04)
Observations	174,161	174,500	172,290	171,175
Clusters	339	339	344	344
Controls	Yes	Yes	Yes	Yes
Macroregion F.E.	Yes	Yes	Yes	Yes

Source: Authors' tabulation based on MINEDUC (2008–2010); SIMCE (2009–2010); SERVEL (2008).
Note: The table presents the results of our DID model, incorporating whether the incumbent mayor was reelected in the previous municipal election (2008). The model includes three parameters: τ, + θ, and θ (as outlined in equation 2). Models 1 and 3 include as outcome a standardized version of math test scores using SIMCE; models 2 and 4 use a standardized version of Language test scores. The short-term results, displayed in models 1 and 2, focus on fourth-grade student achievement with 2009 as the baseline year. The reference category for exposure is low-exposure schools. The long-term results, presented in models 3 and 4, uses eighth-grade student achievement with 2009 as the baseline year. The reference category for exposure is low-exposure schools. The analysis is restricted to students in municipal schools. Standard errors are clustered at the municipal level.
* $p < .1$; ** $p < .05$; *** $p < .01$

cant for both math and Spanish in the short term.

We notice, though, that the heterogeneous effects tend to dissipate over time. Columns 3 and 4 of table 2 show that the achievement gap between students with an experienced mayor (relative to a first-term mayor) narrows significantly, especially for Spanish test scores. Consequently, our results suggest that experienced mayors were particularly relevant in the immediate aftermath of the catastrophic 2010 earthquake.

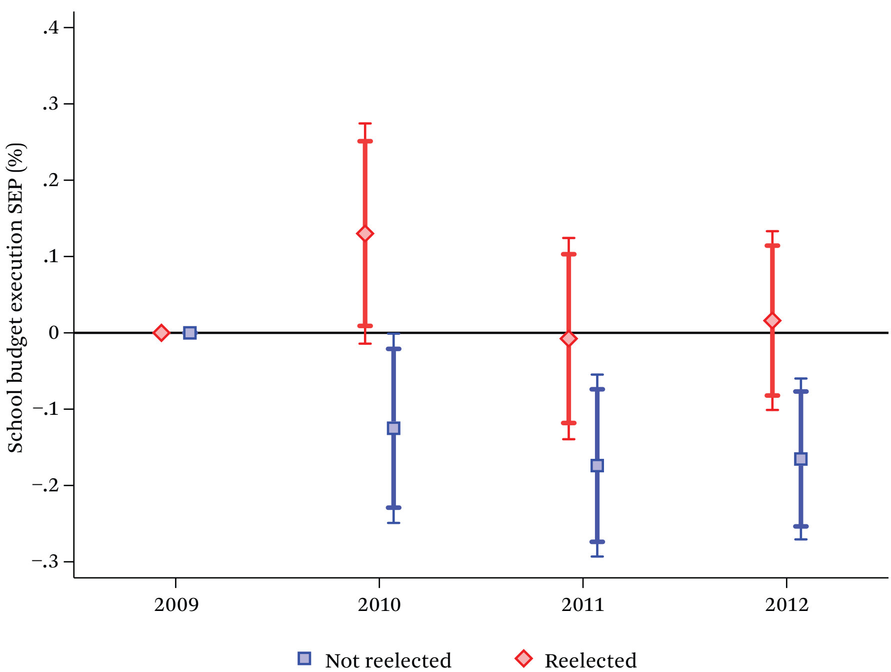
MECHANISMS

What are the mechanisms driving these disparate effects? We argue that one of the pathways is the ability of experienced bureaucrats to mobilize educational resources. To explore this channel, we use administrative data on educational expenditures of the SEP program, the aims of which we defined in previous sections. We observe that SEP spending generally declined due to the earthquake, which is mainly driven by first-term mayors (figure 3). Concretely, exposed first-term mayors spent approximately 10 percentage points (twice the average) fewer SEP resources in 2010 than reelected ones. Thus, we show suggestive evidence that experienced mayors were more effective at executing educational resources after the earthquake.

ROBUSTNESS CHECKS

We focus on five main validity threats: i) whether our results are driven by differential exposure to the earthquake between municipalities with a first-term and reelected mayor; ii) whether contextual factors, other than the

Figure 3. Short and Long-Term Effect of 2010 Earthquake on School Budget Execution



Source: Authors' tabulation based on MINEDUC (2008–2012); SIMCE (2009–2012); SERVEL (2008).
Note: The figure shows the interacted DID model plotting two parameters: τ, $\tau + \theta$ as equation (2) shows. Coefficients represent the effect of high-intensity exposure on school budget execution (as percentage of the total public resources assigned to the school) using 2009 as the baseline year and low-exposure schools as the reference category. The analysis is restricted to students in municipal schools. Coefficients include 90 percent and 95 percent confidence intervals. Standard errors are clustered at the municipal level.

municipal management, explain our heterogeneous effects (we test this threat using non-municipal schools as a placebo); iii) whether our results hold after adjusting by the margin of victory of incumbent mayors; iv) whether our heterogeneous effects hold after adjusting by inverse probability weighting; and v) whether our results are robust when using an alternative measure of earthquake intensity.

(i) Potentially, an earthquake could differentially affect municipalities where incumbents were reelected. To rule this out, we examine whether municipalities with experienced mayors have different levels of exposure to the earthquake than municipalities with a first-term mayor in 2010. To this end, we regress an indicator variable equal to one if the mayor was reelected, zero otherwise, on a set of indicators related to the exposure to the earthquake: PGA, log of distance to the epicenter in kilometers, number of casualties at the municipal level, and the damage induced by the earthquake to the sewer system (as percentage and quantity). As shown in table A.4, we observe no signs that differential exposure to the earthquake could drive our documented heterogeneous effects.

(ii) Our main finding is that political experience mitigates the earthquake's impact on student achievement and budget spending. However, other unobserved variables among municipalities with experienced mayors may be causing the mitigating effect. To discard this possibility, we exploit a special feature of the Chilean educational system, namely, the important presence of private schools funded by a per-student voucher paid by the central state. Our logic is that if political experience and managerial capacities drive the mitigating effect, then such effect should not exist among schools not managed by the municipality. In table A.5, we replicate table 2 but restrict the sample to private-voucher schools. We do not find a mitigating effect on nonmunicipal schools, which gives us more confidence that no other contextual factor other than municipal management explains the heterogeneous effect.

(iii) Moreover, we test if our heterogeneous political effect persists after restricting the sample to municipalities where the mayor won by a smaller electoral margin. Narrowing the sample to competitive electoral races is common practice in the political science literature, in which authors argue that politicians elected by a small margin are "as if random" (Lee, Moretti, and Butler 2004). Consequently, the margin of victory can be used as a running variable for a regression discontinuity design, implying that municipalities where the incumbent mayor barely won are similar to those where they barely lost.[9] Even if the as-if-random assumption may be questionable, restricting the sample to close electoral races allows one to compare municipalities where the median voter is similar, which may account for a variable that could affect both political experience and learning outcomes. In table A.6, we show the results of this exercise, using 25 and 18 percentage points as the margin of victory around the cutoff and restricting the sample to municipalities where the incumbent ran for office in 2008. Furthermore, we apply triangular kernel weights, assigning greater weight to data points closer to the threshold. After narrowing the sample to close races, we observe that our results in schools with high exposure to school disruption are similar for both Spanish and math, although results are statistically significant at a lower confidence level (90 percent), likely due to the sample restrictions.[10]

(iv) In regard to nearest neighbor matching, even if municipalities with and without reelected mayors did not have differential earthquake exposure, reelection status could be capturing something unrelated to managerial capacity, threatening the validity of our heterogeneous effects. We used propensity score matching to better adjust for observable baseline characteristics among municipalities with and without reelected mayors. In particular, we estimate the propensity score of having a re-

9. For an application of this method using mayoral elections in Chile, see Argote 2021.

10. Figure A.1 presents a coefficient plot of the difference between reelected and non-reelected mayors, using a continuous measure of earthquake intensity while employing various bandwidths. These estimates show a significant interaction effect in every bandwidth.

elected mayor using the following individual, school-level, and municipal-level covariates: gender, baseline test scores, school attendance, average school test scores, average family income per school, average family years of education per school, the average number of students per school, average number of students in private-voucher schools, and percentage and number of students in public schools per municipality, average income at the municipal level and math average academic achievement at the municipal level.[11] Then we used the nearest neighbor algorithm to estimate our main DID model. We find similar results (table A.7), suggesting that reelection status did not confound with one of our baseline characteristics.

(v) As an alternative to the main measure of earthquake intensity, we use a continuous measure of exposure based on the Euclidean distance of every school to the epicenter (using the geographical coordinates). We measure earthquake affectation using the following formula: log(max(distances)distances). Inside the parenthesis, we compute the maximum distance in kilometers of any school to the epicenter minus the distance of a given school, which allows assigning higher values to schools closer to the epicenter and smaller values to schools farther away. We then logged this subtraction to normalize the distribution. Table A.8 displays the heterogenous effects by reelection status, using this measure. Again, results are practically identical, especially in the short-term outcomes.

DISCUSSION

Natural disasters do not occur in a vacuum. As Charles Cohen and Eric Werker (2008) claim, "[natural disasters] are not driven by politics, nor are they immune from politics." Do political variables play a role in mitigating adverse exposure to natural disasters? In this article, we argue that experience in office of local leaders can have an important palliative role in the adverse exposure of children to disruptive events.

Exploiting a natural experiment—the 2010 earthquake in Chile—we first show that, in line with previous studies, natural disasters have short and long-term negative consequences on individual-level learning outcomes. We find that school disruption induced by the earthquake detrimentally affects math test scores immediately and in the next few years, although it recovers approximately five years later. In Spanish, though, we find an opposite pattern: negative effects are null in the immediate aftermath of the event and negative later.

There are reasonable explanations for this pattern. As evidence in the United States suggests (Chetty, Friedman, and Rockoff 2014a, 2014b), learning math depends more on school resources, so a shock of this magnitude likely interrupted the learning flow. In turn, given that learning Spanish depends more on household resources and cultural capital, it is normal that these scores would be relatively unaffected at first. But, as school disruption continued over months, and perhaps years, reading and writing problems may manifest years later. Still, this puzzling empirical result could merit further exploration.

Second, we show significant heterogeneous political effects at the local level. Across multiple specifications, we observe that reelected mayors were able to mitigate learning losses caused by the earthquake, for both math and Spanish, especially in the short term. A plausible interpretation of this finding is considering political experience as a proxy of managerial quality. Indeed, as Scott Ashworth and Ethan Bueno de Mesquita (2008) claim, reelected politicians are likely more skilled than those in their first term due to the knowledge acquired in office or because high-quality mayors are more likely to be rewarded with reelection.

What explains this heterogenous effect? We show that a plausible mechanism through which political experience mitigates learning losses is the efficient mobilization of educational resources. This crucial finding suggests that experienced mayors had more capable personnel, in that their resource allocation was not

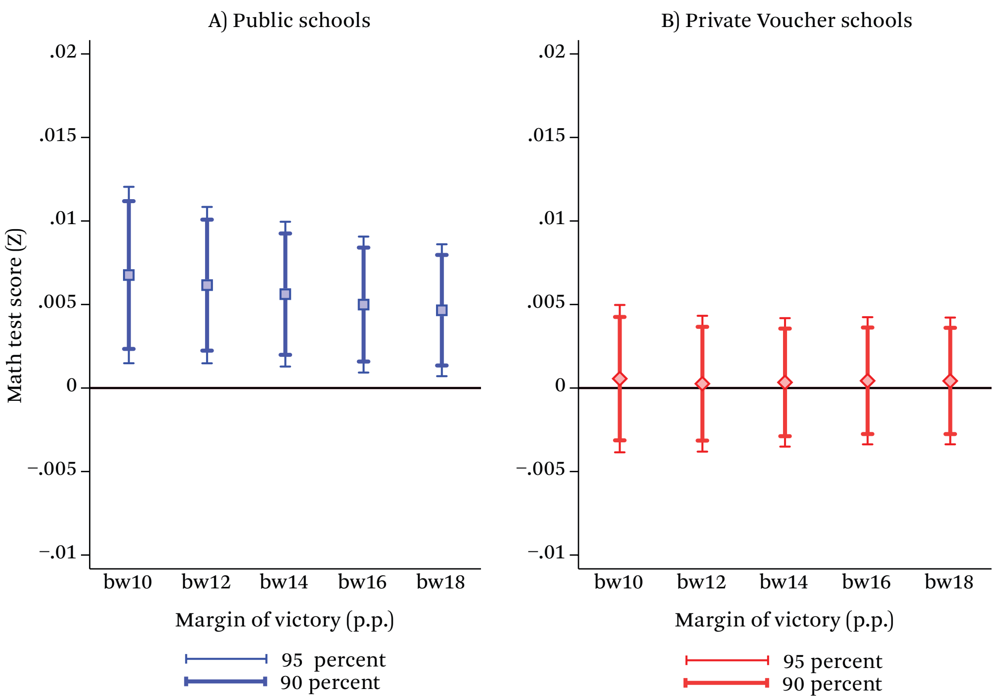
11. We selected these covariates because they could potentially correlate with both having a reelected mayor and student achievement.

affected by the earthquake. Most likely, the years of experience in navigating different layers of the bureaucracy had a positive impact in times of crisis, making a huge difference for students exposed to this disruptive event.

A relevant question that emerges from our findings is what political experience is capturing? Continuity in political leadership could imply stability in bureaucratic personnel, a crucial variable to consider in the aftermath of a natural disaster. Indeed, the evidence related to educational spending strongly suggests better managerial capacities among municipalities with experienced leaders, which probably happened due to bureaucratic stability. This relevance of stability on key personnel is our article's most relevant policy implication because it constitutes an achievable goal, even with turnover in political leadership.

The relevance of local leaders is, in some way, a double-edged sword because it uncovers the pros and cons of a decentralized governance structure, as is the case in Chile and the United States. On the one hand, it is positive to note that leadership matters, even when operating in large bureaucracies. However, in the context of regional inequalities in local capacities, effective leaders may decide not to run for office in poorer localities; or, when they do, they could have too many constraints to do their jobs effectively. In this sense, we may want to celebrate the impact of political leaders. However, we should not assume that these are evenly distributed across the country.

Figure A.1. Differential in Earthquake Effect on Math Scores Between Reelected and Not Reelected Mayors (Different Bandwidths)



Source: Authors' tabulation based on MINEDUC (2008–2010); SIMCE (2009–2010); SERVEL (2008).
Note: Plotted coefficients represent the differential in the earthquake effect on math scores between reelected and not reelected mayors, using a continuous measure of earthquake intensity (described in the robustness checks section). The x-axis represents different bandwidths (margin of victory). Models are weighted using a triangular kernel. Standard errors are clustered at the municipal level. The analysis is restricted to students in municipal schools. Standard errors are clustered at the municipal level.

Table A.1. Descriptive Statistics

	Mean	SD	Min	Max
Municipal level				
Total votes	16,777.88	21,811.41	330.00	135,867.00
Incumbent mayor reelection	0.66	0.47	0.00	1.00
Voucher elementary school enrollment (%)	26.08	22.55	0.00	100.00
Voucher high school enrollment (%)	28.10	27.58	0.00	100.00
Total elementary sch. enrollment	6,205.22	9,238.47	0.00	72,450.00
Total high school enrollment	2,837.30	5,362.67	0.00	56,331.00
Total municipal income (log)	14.98	1.07	9.78	18.33
Total expenditures (log)	14.55	1.76	2.63	18.06
Rural student share	0.04	0.15	0.00	1.00
School level				
Peak ground acceleration (PGA)	0.23	0.13	0.00	0.50
Low exposure (PGA)	0.22	0.42	0.00	1.00
Med exposure (PGA)	0.53	0.50	0.00	1.00
High exposure (PGA)	0.25	0.43	0.00	1.00
Kilometers to earthquake center	432.42	398.03	8.63	2,187.00
Kilometers to earthquake center (log)	2.39	0.70	0.50	6.03
Mean teaching years of experience	17.08	6.08	0.00	52.00
Portfolio teacher evaluation	2.24	0.15	1.20	3.22
Number of teachers	36.01	26.99	1.00	291.00
School spending percentage (SEP)	0.38	0.37	−1.73	10.66
Student level				
Income (log)	5.93	0.81	4.32	8.41
Parents' education	2.75	0.91	1.00	4.00
GPA	5.82	0.59	1.00	7.00
Attendance	93.36	6.24	0.00	100.00
Student graduation	0.98	0.15	0.00	1.00
Student school migration	0.09	0.28	0.00	1.00
Fourth grade math test score	251.19	54.98	101.31	380.55
Fourth grade Spanish test score	262.35	53.29	99.01	382.50
Eighth grade math test score	259.82	48.26	134.61	397.53
Eighth grade Spanish test score	251.28	51.59	107.47	373.24

Source: Authors' tabulation based on MINEDUC (2008–2010); SIMCE (2009–2010); SERVEL (2008).

Table A.2. Balance in Pre-Treatment Outcome and Covariates

	Spanish Test Score (Z)	Math Test Score (Z)	School Failure (%)	GPA	Student Attendance (%)	Student Home Income
Year 2009 x medium intensity	−0.00	−0.00	−0.00	−0.01	0.10	0.62
	(0.01)	(0.01)	(0.00)	(0.01)	(0.08)	(3.81)
Year 2009 x high intensity	−0.02*	−0.02	0.00	−0.01	−0.09	1.28
	(0.01)	(0.01)	(0.00)	(0.01)	(0.16)	(4.19)
Observations	433,236	432,991	483,359	483,355	483,359	473,131
Clusters	7.747	7.752	8.438	8.438	8.438	7.043
Controls	No	No	No	No	No	No
Macroregion F.E.	No	No	No	No	No	No

Source: Authors' tabulation based on MINEDUC (2008–2010); SIMCE (2009–2010).
Note: Coefficients are obtained through a placebo regression of pre-treatment outcomes and covariates on earthquake intensity before the event (2009). Standard errors are clustered at the school level.
p* < .1; ** *p* < .05; * *p* < .01

Table A.3. Short and Long-Term Effect of 2010 Earthquake on Math and Spanish Academic Achievement by Baseline GPA

	All Students		Low GPA		High GPA	
	Math (Z) (1)	Spanish (Z) (2)	Math (Z) (3)	Spanish (Z) (4)	Math (Z) (5)	Spanish (Z) (6)
Panel A. eight months after fourth grade test score						
Year 2010 x medium intensity	−0.04***	−0.00	−0.05***	−0.01	−0.07***	−0.03*
	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
Year 2010 x high intensity	−0.05***	−0.00	−0.06***	−0.00	−0.08***	−0.04**
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Observations	379,037	377,771	177,108	176,396	201,929	201,375
Clusters	6,772	6,772	6,616	6,613	6,418	6,422
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Panel B. 4.6 years after eighth grade test score						
Year 2014 x medium intensity	−0.01	−0.06***	0.02	−0.03**	−0.04**	−0.08***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Year 2014 x high intensity	0.02	−0.07***	0.05**	−0.05***	−0.01	−0.09***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Observations	395,267	393,196	179,981	178,949	215,286	214,247
Clusters	8,328	8,334	7,988	7,999	7,563	7,560
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' tabulation based on MINEDUC (2008–2010); SIMCE (2009–2010).
Note: This table presents a similar specifications as table 1 including term τ as in equation (1). Models 1 and 2 include the full sample. In columns 3 to 6, we analyze differential trends by low and high-performing students using baseline GPA (below and above percentile 25 in the same school). Standard errors are clustered at the school level.
* *p* < .1; ** *p* < .05; *** *p* < .01

Table A.4. Earthquake Exposure by Mayor Reelection Status

	Municipalities (N = 345)	
	Coefficient	S.E.
Mean school distance (km) to the epicenter	−0.49	(1.47)
Mean school distance (log) to the epicenter	−0.06	(0.09)
Mean school peak ground acceleration (PGA)	0.00	(0.01)
Mean school high PGA (ref: low)	0.02	(0.04)
Number of people deceased	−0.75	(0.80)
Population with sewer damaged	−354.5	(311.4)
Population with sewer damaged (%)	−0.01	(0.03)

Source: Authors' tabulation based on US Geological Survey (2010); SERVEL (2008).
Note: Each row expresses a different bivariate regression that includes a dummy of reelection and the earthquake exposure indicators in 2010 as outcomes. We restrict the sample only to municipal schools that are directly controlled by local governments. Rows 1 to 4 are estimated at the school level. Rows 5 to 7 are estimated at the municipal level. Standard errors are clustered at the municipal level.
* $p < .1$; ** $p < .05$; *** $p < .01$

Table A.5. Short-Term Effect of 2010 Earthquake on Nonmunicipal Schools by Mayor Reelection

	Fourth grade Math (Z) (1)	Fourth grade Spanish (Z) (2)	Budget School Spending (%) (3)
Medium intensity (not reelected)	−0.06**	−0.01	−0.03
	(0.03)	(0.02)	(0.04)
Medium intensity (reelected)	−0.03	0.00	−0.02
	(0.02)	(0.02)	(0.04)
Difference	0.04	0.02	0.00
	(0.04)	(0.03)	(0.06)
High intensity (not reelected)	−0.03	−0.01	−0.03
	(0.04)	(0.04)	(0.07)
High intensity (reelected)	−0.06*	−0.01	−0.09
	(0.03)	(0.03)	(0.05)
Difference	−0.03	−0.00	−0.06
	(0.05)	(0.05)	(0.09)
Observations	216,933	216,781	91,551
Clusters	265	265	250
Controls	No	No	No
Macroregion F.E.	Yes	Yes	Yes

Source: Authors' tabulation based on SIMCE (2009–2010); MINEDUC (2008–2010); SERVEL (2008).
Note: The table presents the results of our DID model, where we incorporate an interaction term with a dummy variable indicating whether the incumbent mayor was reelected in the previous municipal election (2008). The model includes three parameters: τ, $\tau + \theta$, and θ, as outlined in equation (2). Models restrict the sample to private schools or private-voucher schools. Standard errors are clustered at the municipal level.
* $p < .1$; ** $p < .05$; *** $p < .01$

Table A.6. Short-Term Effect of 2010 Earthquake on Math and Spanish Academic Achievement in Fourth Grade by Mayor Reelection Using Close Electoral Races

	Math (Z) (1)	Math (Z) (2)	Math (Z) (3)	Spanish (Z) (4)	Spanish (Z) (5)	Spanish (Z) (6)
Medium intensity (not reelected)	−0.07	−0.08	−0.08*	−0.03	−0.01	−0.01
	(0.04)	(0.05)	(0.05)	(0.03)	(0.04)	(0.05)
Medium intensity (reelected)	−0.03	0.02	0.03	−0.00	0.02	0.04
	(0.03)	(0.04)	(0.04)	(0.02)	(0.04)	(0.04)
Difference	0.04	0.09	0.11	0.02	0.03	0.04
	(0.05)	(0.06)	(0.07)	(0.04)	(0.06)	(0.06)
High intensity (not reelected)	−0.15**	−0.14**	−0.15**	−0.11**	−0.08	−0.07
	(0.06)	(0.06)	(0.06)	(0.05)	(0.06)	(0.06)
High intensity (reelected)	−0.03	−0.02	−0.02	0.03	0.03	0.02
	(0.03)	(0.04)	(0.05)	(0.02)	(0.04)	(0.04)
Difference	0.12*	0.13*	0.13*	0.15**	0.11*	0.09
	(0.07)	(0.07)	(0.07)	(0.06)	(0.07)	(0.07)
Electoral margin	All	<=25	<=18	All	<=25	<=18
Observations	123,007	82,352	71,371	123,182	82,524	71,523
Clusters	254	192	165	254	192	165
Controls	No	No	No	No	No	No
Macroregion F.E.	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' tabulation based on MINEDUC (2008–2010); SIMCE (2009–2010); SERVEL (2008).
Note: The table shows three parameters τ, $\tau + \theta$, and θ, as in equation (2). The model is estimated by weighted ordinary least squares, using a triangular kernel around the margin of victory = 0. Models are restricted to students in municipal schools. Standard errors are clustered at the municipal level.
* $p < .1$; ** $p < .05$; *** $p < .01$

Table A.7. Short and Long-Term Effects of 2010 Earthquake on Math and Spanish Academic Achievement by Mayor's Reelection Status (Nearest Neighbor Matching)

	Short-Term Outcomes Eight Months After		Long-Term Outcomes 4.6 Years After	
	Fourth Grade Math (Z) (1)	Fourth Grade Spanish (Z) (2)	Eighth Grade Math (Z) (3)	Eighth Grade Spanish (Z) (4)
Med intensity (not reelected)	−0.05*	−0.01	0.03	−0.02
	(0.03)	(0.03)	(0.03)	(0.03)
Med intensity (reelected)	−0.02	−0.00	−0.00	−0.07*
	(0.03)	(0.03)	(0.03)	(0.04)
Difference	0.03	0.01	−0.04	−0.05
	(0.04)	(0.04)	(0.05)	(0.05)
High intensity (not reelected)	−0.12**	−0.07*	0.01	−0.08**
	(0.05)	(0.04)	(0.04)	(0.04)
High intensity (reelected)	−0.03	0.03	0.01	−0.10***
	(0.03)	(0.02)	(0.03)	(0.04)
Difference	0.10*	0.10**	0.01	0.02
	(0.06)	(0.05)	(0.05)	−(0.05)
Observations	173,781	174,128	150,964	149,624
Clusters	339	339	338	338
Control	Yes	Yes	Yes	Yes
Macroregion F.E.	Yes	Yes	Yes	Yes

Source: Authors' tabulation based on MINEDUC (2004–2014); SIMCE (2005–2014); SERVEL (2008).
Note: The table presents the results of our DID model, where we incorporate an interaction term with a dummy variable indicating whether the incumbent mayor was reelected in the previous municipal election (2008). The model includes three parameters: τ, $\tau + \theta$, and θ, as outlined in equation (2). The propensity score matching includes the following covariates: individual-student level: female (male), baseline GPA, baseline student mean attendance, baseline grade completion. School level: Income, log income, and average parents' education. Municipal level: voucher school total enrollment, voucher school enrollment share, municipalities total enrollment, fourth grade math SIMCE baseline score, mean municipal income as declared by parents in the schools. Standard errors are clustered at the municipal level.
* $p < .1$; ** $p < .05$; *** $p < .01$

Table A.8. Short and Long-Term Effects of 2010 Earthquake by Mayor's Reelection Status Using an Alternative Measure of Earthquake Intensity

	Short-Term Outcomes Eight Months After		Long-Term Outcomes 4.6 Years After	
	Fourth Grade Math (Z) (1)	Fourth Grade Spanish (Z) (2)	Eighth Grade Math (Z) (3)	Eighth Grade Spanish (Z) (4)
Log intensity (not reelected)	−0.06***	−0.03***	0.03	−0.03*
	(0.02)	(0.01)	(0.02)	(0.02)
Log intensity (reelected)	−0.02	−0.00	−0.02	−0.03
	(0.02)	(0.02)	(0.02)	(0.03)
Difference	0.04*	0.03	0.02	0.00
	(0.02)	(0.02)	(0.03)	(0.03)
Observations	160,394	159,767	166,082	164,951
Clusters	345	345	344	344
Controls	Yes	Yes	Yes	Yes
Macroregion F.E.	Yes	Yes	Yes	Yes

Source: Authors' tabulation based on MINEDUC (2008–2010); SIMCE (2009–2010); SERVEL (2008).
Note: The table presents the results of our DID model, where we incorporate an interaction term with a dummy variable indicating whether the incumbent mayor was reelected in the previous municipal election (2008). The model includes three parameters: τ, $\tau + \theta$, and θ, as outlined in equation (2). As exposure to the earthquake, we use a log continuous measure of exposure based on the Euclidean distance of every school to the epicenter log(max(distances)distances). Models 1 and 3 include as an outcome a standardized version of math test scores; models 2 and 4 use a standardized version of language test scores. The short-term results, displayed in models 1 and 2, focus on fourth-grade student achievement with 2009 as the baseline year; the long-term results, presented in models 3 and 4, concentrate on eighth-grade student achievement with 2009 as the baseline year. The analysis is restricted to students in public municipal schools. Standard errors are clustered at the municipal level.
* $p < .1$; ** $p < .05$; *** $p < .01$

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