When Nature Strikes Repeatedly: Are Municipalities Fiscally Resilient?*

Carla Morvan†

Abstract

Natural disasters impose significant and recurring fiscal challenges on local governments, with increasing frequency under climate change. This paper analyzes the causal impact of flood exposure on municipal budgets in France over the period 2000–2024. I employ the non-binary staggered difference-in-differences estimator of de Chaisemartin and D'Haultfoeuille (2024), which simultaneously accommodates the sporadic timing of disaster shocks and their cumulative intensity. The results document a pattern of apparent fiscal resilience: municipalities increase investment expenditures without crowding out local public services, relying on intergovernmental grants and property tax adjustments rather than debt. However, this resilience conceals important heterogeneity across disaster frequency, financial health, and household income, with disproportionate fiscal costs falling on the most vulnerable communes and their residents.

Keywords : Natural disasters, Fiscal resilience, Local public finance, Municipal taxation, Difference-in-differences, Intergovernmental transfers

JEL Codes : H71, H72, Q54

*I would like to thank Sonia Paty, Frédéric Jouneau, Raphaël Soubeyran, Jérôme Héricourt, Sophie Legras, and Lionel Ragot, as well as all those who provided helpful comments and suggestions on this project, notably participants at the GATE Lyon–Saint-Étienne and CEE-M seminars, the EAERE conference, the 60th ERSA Congress, the 38th Applied Microeconomics Days, and the 8th AFSE–DG Trésor EPP Conference.

†Center of Environmental Economics - Montpellier, Univ. Montpellier, CNRS, INRAe, Institut Agro, 34960 Montpellier, France. carla.morvan@umontpellier.fr

1 Introduction

Lightning never strikes the same place twice, an adage that is losing its relevance. While natural disasters were once associated with rare, century-long intervals, floods and storms are becoming increasingly frequent. The autumn 2022 floods in northern France exemplify this shift: five successive floods devastated the region within a few months, where the previous disaster had occurred years earlier. As the frequency of extreme weather events accelerates under climate change (Barrage 2025), understanding how local governments absorb repeated fiscal shocks has become a pressing policy question.

Local governments are on the front line in managing these major climatic events. As the level of government closest to citizens, municipalities play a crucial role during crises, requiring immediate action to protect residents, maintain public services, and restore normalcy, followed by reconstruction efforts and preventive measures against future risks.

The literature on local public economics has documented how natural disasters affect local budgets across a variety of institutional contexts. Studies have shown that municipalities often increase expenditures and rely on intergovernmental transfers following a disaster (Jerch et al. 2023; Masiero & Santarossa 2020; Miao, Chen, et al. 2020; Panwar & Sen 2020; Miao, Hou, et al. 2018; Lodi et al. 2023; Marin et al. 2025; Ouattara & Strobl 2013). However, findings on long-term effects remain inconsistent. While some studies report sustained increases in expenditures and investment (Masiero & Santarossa 2020; Lodi et al. 2023), others document a deterioration of public goods provision and a decline in tax revenues. Jerch et al. (2023) find that municipalities in the southeastern United States reduced both expenditures and revenues within ten years of a hurricane, with more pronounced effects in poorer and less-educated communities. These findings align with broader evidence on fiscal shocks showing that European municipalities rely heavily on grants to rebalance budgets, while US municipalities primarily adjust their own revenues (Buettner & Wildasin 2006; Buettner 2009; Solé-Ollé & Sorribas-Navarro 2012).

Building on this literature, this paper investigates the causal impact of natural disasters on the budgets of French municipalities, with particular attention to the repetition of these events. Using a comprehensive database of municipal accounts from 2000 to 2024 and a record of natural disasters since 1982, I analyze the dynamic relationship between flood exposure and local budget accounts. To do so, I employ the non-binary staggered difference-in-differences estimator of Chaisemartin & D'Haultfœuille (2024), which simultaneously accommodates the sporadic timing of disaster shocks and their cumulative intensity. To my knowledge, this methodology has not previously been applied to the study of natural disasters, and represents the main methodological contribution of this paper.

The results document a pattern of apparent fiscal resilience: municipalities increase investment expenditures without crowding out local public services, relying on intergovernmental grants and property tax adjustments rather than debt. The decomposition of tax responses reveals deliberate fiscal strategies on both the property and business tax sides. I further explore heterogeneity across municipalities, showing that this apparent resilience conceals important differences related to disaster frequency, financial health, and household income, with disproportionate fiscal costs falling on the most vulnerable communes and their residents.

The remainder of this paper is structured as follows. Section 2 describes the data. Section 3 details the empirical strategy. Section 4 presents the main results and heterogeneity analysis. Section 5 discusses the findings and their implications. The final section concludes.

2 Data

A particularity of France is its approximately 35,000 municipalities, more than half of which have fewer than 500 inhabitants, and over 80% have fewer than 2,000 inhabitants. These small jurisdictions create a unique institutional context, especially in relation to politics. For this study, the database includes 34,627 municipalities between 2000 and 2022.

France is a decentralized country with multiple levels of government: the central government, regions, departments (counties), inter-municipal cooperation entities (EPCI), and municipalities. Each level has specific responsibilities. Municipalities are in charge of local roads, schools, sports and cultural facilities, parks and gardens, sewage system maintenance, and waste treatment. Moreover, part of the public assets, such as buildings, are insured. These insured assets benefit from the natural disaster clause under the French Insurance Code[1], provided a relevant decree has been published. However, some municipal assets, such as roads, engineering structures, parks, and water distribution networks, are typically not insured.

The distinction between the roles of each level of government is crucial because, during natural disasters, the management of infrastructure falls under the authority of the level of government responsible for it. Mayors are accountable for ensuring public safety during crises, including preparation and coordination of rescue operations. In practice, the roles of various local authorities may overlap during a disaster, leading to potential challenges. Nonetheless, the mayors of the affected municipalities remain ultimately responsible for the safety of their population.

Municipal Accounts

The primary dataset used in this analysis is the database of French municipal accounts from 2000 to 2024, provided by the Ministry of Public Accounts. These individual municipal accounts provide detailed

[1] Article L.125-1 of the Code des Assurances

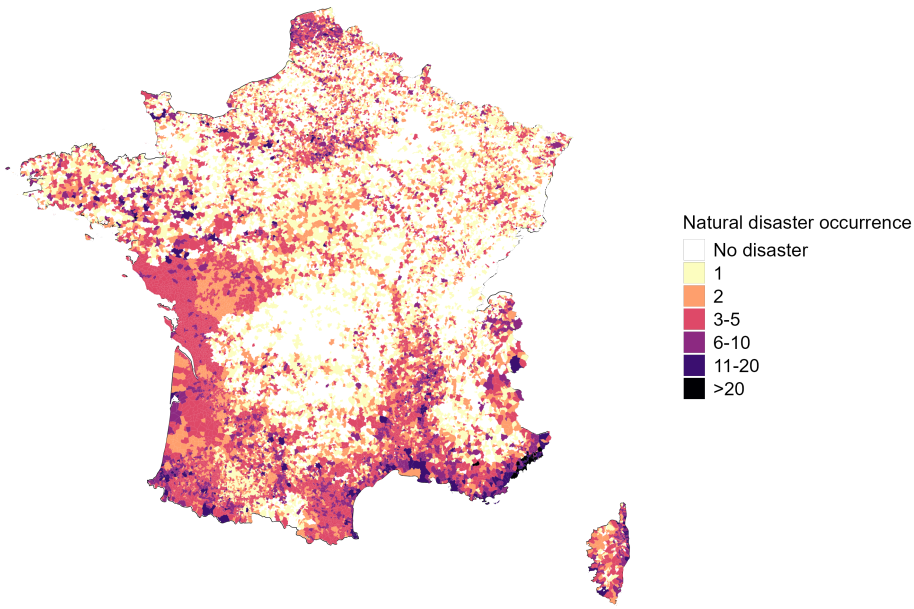
information on major expenditure and revenue categories, though they do not allow identification of specific functions or purposes. For instance, whether a given expense relates to repair, reconstruction, or prevention, which may be recorded under either current or investment accounts depending on their nature.

The analysis focuses on six key variables drawn from these accounts: current expenditures, investment expenditures, grants received from higher levels of government, two local tax revenues — the property tax (*taxe foncière*) and the business tax (*taxe professionnelle* until 2010, replaced by the *cotisation foncière des entreprises* thereafter) — and the total outstanding debt stock at December 31st of each year.

On the financing side, current expenditures are predominantly funded through tax revenues and operating grants from higher levels of government. Investment expenditures rely more heavily on capital grants and borrowing, though the boundary between the two sections is not rigid: municipalities that generate a surplus on their current account can transfer it as self-financing (*capacité d'autofinancement*) to fund investment, reducing their dependence on debt.

Natural disasters

Figure 1: Distribution of natural disasters in France (2000-2024)

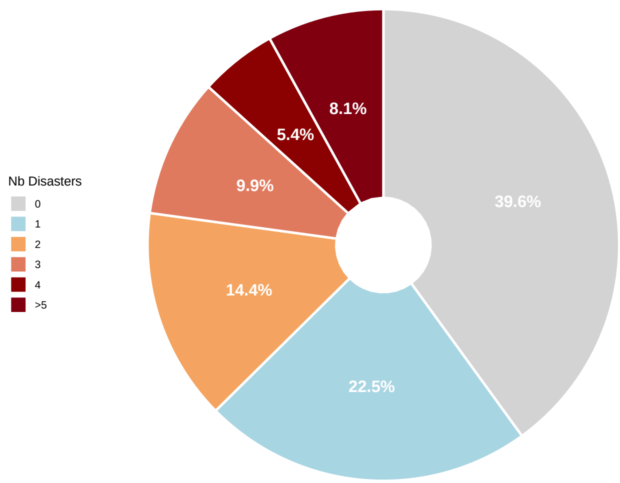


Note: Map displays the cumulative number of recognized natural disasters per municipality over the 2000–2024 period. White municipalities experienced no natural disaster over the period. Disaster data from the GASPAR database (Ministry of Environment). Cartographic data from OpenStreetMap.

In France, the designation of a climatic event as a “natural disaster” follows a specific legal and administrative process. The status applies to meteorological events of abnormal intensity that are exceptional in nature, including floods, mudflows, droughts, land movements, earthquakes, and storms. Crucially, this designation is not automatic: it is granted by ministerial decree, following a formal request from the mayor of the affected municipality. This institutional framework is particularly important in the French context, as both private insurance compensation and public reinsurance mechanisms are contingent upon the prior recognition of the natural disaster status (Nachbar 2017). This makes France atypical relative to many neighboring countries, where insurance payouts are not subordinated to such an administrative recognition.

Natural disaster data come from the GASPAR database (*Gestion ASsistée des Procédures Administratives relatives aux Risques*), made available by the Ministry of Environment. This database records all ministerial decrees recognizing natural disasters since 1982, and provides precise information on the date, location, and type of each event at the municipal level. As shown in Figure 1, disaster exposure displays substantial spatial heterogeneity, with neighboring municipalities sometimes exhibiting strikingly different levels of exposure. Data prior to 2000 are used to construct a historical exposure index, which captures each municipality’s disaster experience before the analysis period begins.[2] A key limitation of this database is that it contains no information on the intensity of events or the extent of damages caused.

Figure 2: Municipal Exposure to Floods and Storms 2000-2024



Note: Figure displays the distribution of municipalities by number of natural disasters experienced over the 2000–2024 period. Data from the GASPAR database (Ministry of Environment).

[2]Historical natural disaster experience is measured by an index: $HE_{i,2000} = \sum_{t=1982}^{1999}(Shock_{i,t}/(2000-t))$. This is the sum of disasters occurred before 2000, weighted by the inverse of the number of years elapsed since each occurrence, following Masiero & Santarossa (2020).

Figure 2 illustrates the distribution of natural disaster exposure across French municipalities over the 2000–2024 period. Approximately 40% of municipalities experienced no natural disaster over the 25-year period, while 23% experienced one, 15% two, 10% three, and 12% four or more. This distribution highlights both the prevalence of zero-exposure municipalities and the existence of substantial cross-sectional variation, which is necessary for identification. Among municipalities that experienced at least two shocks, the average time elapsed between consecutive events is approximately seven years, suggesting that repeated exposure is not concentrated over short periods but rather spread across the analysis window.

3 Methodology

3.1 The 1999 Storm

Accounting for municipalities' prior disaster history is a key challenge in this analysis. All territories carry some legacy of past natural shocks, and heterogeneous pre-treatment exposure across municipalities could bias a difference-in-differences strategy by undermining the comparability of treatment and control groups before the study period begins.

In late December 1999, two rapidly developing mid-latitude depressions, Lothar and Martin, swept across Western Europe on the 26th, 27th, and 28th of December. These exceptionally powerful extra-tropical cyclones caused the death of 140 people and nearly $19.2 billion in material damages, making them among the most destructive storms ever recorded in France. According to our data, nearly 80% of mainland French municipalities experienced this event, reflecting its extraordinary geographic reach.

Restricting the sample to municipalities whose last recorded disaster before 2000 was the 1999 storms therefore serves two purposes. First, it ensures that all units enter the analysis with a common disaster baseline, so that identifying variation comes entirely from differences in natural disaster exposure after 2000. Second, this starting point is institutionally motivated: the 1999 storms prompted significant reforms to the French natural disaster compensation regime, making earlier episodes less comparable to those occurring afterward.

3.2 Empirical strategy

Identifying the causal effect of natural disasters on municipal budgets raises two distinct challenges. First, natural disasters occur sporadically and at different points in time across municipalities, which calls for a staggered treatment framework. Second, some municipalities experience repeated shocks, making the treatment inherently non-binary. We address each challenge in turn.

Staggered Treatment. The sporadic nature of natural disasters means that municipalities enter the treatment at different points in time. In such settings, standard two-way fixed effects estimators are known to produce biased estimates in the presence of heterogeneous treatment effects (Chaisemartin & D'Haultfœuille 2020). A natural alternative is the staggered difference-in-differences framework of Callaway & Sant'Anna (2021), in which a municipality is considered treated from the year it first experiences a natural disaster, and remains in the control group as long as it has not yet been treated. However, this binary framework is insufficient in our setting, as many municipalities experience repeated shocks over the study period.

Non-Binary Treatment. In our sample, 45% of municipalities experience no disaster after 1999, 24% experience exactly one, and 31% at least two, a distribution that a binary treatment variable cannot adequately capture. To our knowledge, this paper is among the first to apply the non-binary staggered difference-in-differences estimator of Chaisemartin & D'Haultfœuille (2024) (hereafter dCDMH) to the study of natural disasters. This estimator simultaneously accommodates the staggered timing of shocks and their cumulative intensity, treating the number of disasters experienced as a continuous dose of treatment that increases with each additional event.

The baseline specification takes the following form:

$$Y_{i,t} = \alpha_i + \gamma_t + \sum_g \sum_\ell \beta_\ell \cdot Shocks_{i,g,\ell} \cdot Post_{g,t-\ell} + \varepsilon_{i,t} \tag{1}$$

where $Y_{i,t}$ is a per capita municipal account (total expenditures, revenues, grants, debt, or taxes) for municipality i in year t, transformed using the inverse hyperbolic sine to limit data loss.[3] α_i and γ_t denote municipality and year fixed effects respectively. $Shocks_{i,g,\ell}$ is the number of natural disasters experienced by municipality i belonging to group g, ℓ periods after the group's first treatment change. $Post_{g,t-\ell}$ is an indicator equal to one if period t is ℓ periods after group g entered treatment. The coefficient β_ℓ captures the effect of treatment intensity ℓ periods after the initial shock.

To allow for heterogeneous trends across municipalities with different disaster histories, we include group-specific time trends via the `trends_nonparam` option, where groups are defined by municipalities' historical exposure index constructed from pre-2000 disaster records. Under this specification, identification requires parallel trends only within groups sharing the same historical exposure, rather than across the full sample.[4]

Finally, following the dCDMH handbook (Chaisemartin & D'Haultfoeuille 2026), municipalities that

[3]The inverse hyperbolic sine transformation $\log(y + \sqrt{y^2 + 1})$ approximates a log transformation while accommodating zero values.

[4]See Section 1.4 of the Web Appendix of Chaisemartin & D'Haultfœuille (2024) for further details.

experienced more than one disaster shock in 2000 are excluded from the sample. When groups receive heterogeneous treatment doses at period one, this may indicate unobserved treatment changes before the start of the study period whose dynamic effects could bias the estimators. Restricting the sample to groups with a stable treatment at period one mitigates this concern, at the cost of a reduced sample size.[5]

Identifying Assumptions. Two assumptions are required for the estimates to have a causal interpretation. The *No Anticipation Assumption* states that a municipality's current outcomes are not influenced by future disaster shocks — a condition that is naturally supported by the unpredictable nature of meteorological events. The *Parallel Trends Assumption* requires that, conditional on sharing the same historical exposure, municipalities that have not yet been treated would have followed the same outcome trajectory as treated municipalities in the absence of treatment. The sample restriction to municipalities whose last pre-2000 shock was the 1999 storm provides a common baseline that supports this assumption. Both assumptions are formally tested through the placebo analysis of Chaisemartin & D'Haultfœuille (2024).

4 Results

This section presents the main results of the analysis. We examine successively the effect of natural disasters on municipal expenditures, financing, and tax revenues. Throughout, the estimated coefficients are obtained from the non-binary staggered difference-in-differences estimator of Chaisemartin & D'Haultfœuille (2024) and capture the effect of an additional natural disaster shock relative to municipalities not yet treated. Given the inverse hyperbolic sine transformation of the outcome variables, coefficients can be interpreted as approximate percentage effects.

Table 1: Main Results – Average total Effect of Natural Disasters on Municipal Budgets

	Investment exp.	**Current exp.**	**Grants**	**Debt**
	0.019***	0.001	0.020***	0.003
	(0.007)	(0.002)	(0.003)	(0.011)
Placebo F-test (p-val.)	0.291	0.848	0.708	0.348
N	353,073	353,074	353,073	353,072
Switchers	112,390	112,390	112,390	112,390

Note: * p<0.05, ** p<0.01, *** p<0.001. Clustered standard errors at municipal level in parentheses. Placebo F-test reports the p-value of a joint test that all pre-trend coefficients are equal to zero.

Figure 3 presents the event-study estimates for investment and current expenditures. Pre-trend tests are satisfied in both specifications, supporting the validity of the parallel trends assumption. Follow-

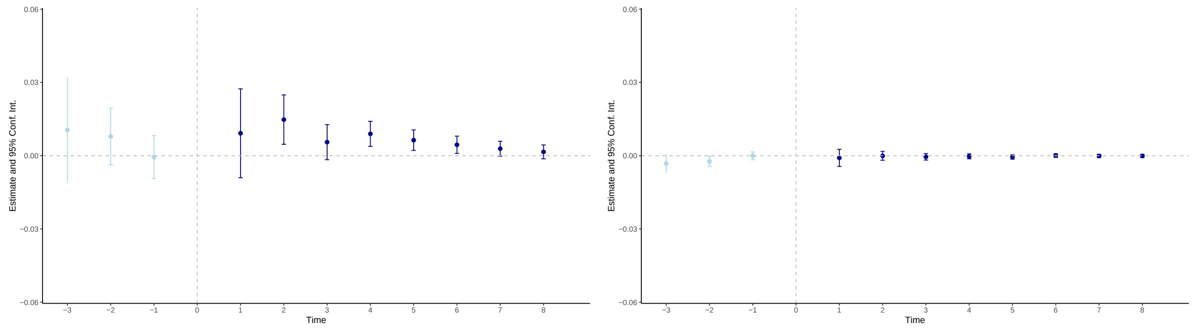
[5] See Section 8.3.4.7 of the dCDMH handbook on the initial-conditions problem.

ing a natural disaster, investment expenditures increase significantly and persistently, with an average total effect of 1.9%. The event-study estimates reveal that this effect materializes from the year of the shock and remains significant up to five years after, suggesting that reconstruction and repair efforts unfold gradually over several years rather than concentrating in the immediate aftermath. Current expenditures, by contrast, remain entirely unaffected at every horizon, with precisely estimated coefficients indistinguishable from zero ($ATE = 0.00075$). This suggests that municipalities absorb the shock without degrading the provision of local public services — a result that stands in contrast with the evidence from the United States documented by Jerch et al. (2023), where hurricanes are shown to reduce total public expenditures in the decade following a strike.

Figure 4 turns to the financing side of the shock. Total grants increase significantly in the aftermath of the disaster, with an average total effect of 2.0%. The event-study estimates reveal that this response

Figure 3: Effect of Natural Disasters on Municipal Expenditures

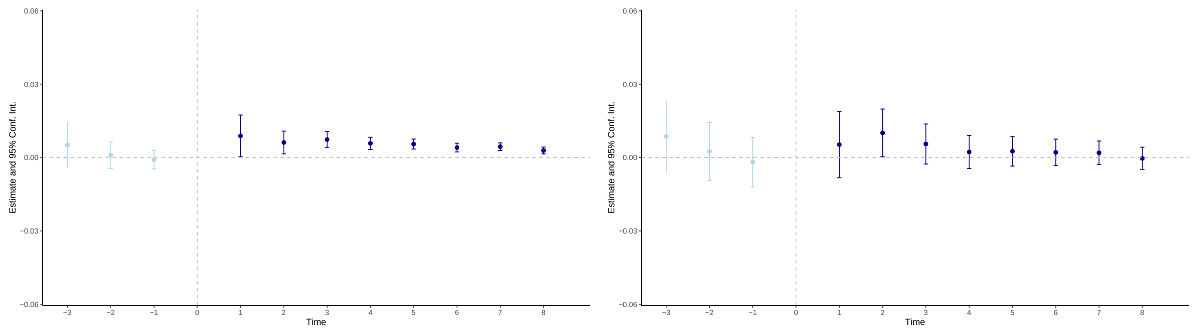
(a) Investment expenditures (b) Current expenditures



Note: Figures display event-study estimates from the non-binary staggered difference-in-differences estimator of Chaisemartin & D'Haultfœuille (2024). The x-axis represents years relative to the first disaster shock. Negative periods correspond to placebo estimates. Dark blue dots indicate post-shock periods, light blue dots indicate pre-shock periods. Bars represent 95% confidence intervals with standard errors clustered at the municipal level.

Figure 4: Effect of Natural Disasters on Municipal Financing

(a) Total grants (b) Debt



Note: Figures display event-study estimates from the non-binary staggered difference-in-differences estimator of Chaisemartin & D'Haultfœuille (2024). The x-axis represents years relative to the first disaster shock. Negative periods correspond to placebo estimates. Dark blue dots indicate post-shock periods, light blue dots indicate pre-shock periods. Bars represent 95% confidence intervals with standard errors clustered at the municipal level.

is strongest in the first year following the shock and then declines gradually, yet remains significant up to eight years after, suggesting a sustained commitment from higher levels of government in supporting affected municipalities through targeted transfers. Crucially, the outstanding debt stock shows no significant response at any horizon, with a precisely estimated null effect ($ATE = 0.003$). Municipalities thus finance post-disaster investment without resorting to borrowing, relying instead on intergovernmental transfers. This capacity to absorb a fiscal shock without increasing indebtedness is a key dimension of municipal fiscal resilience.

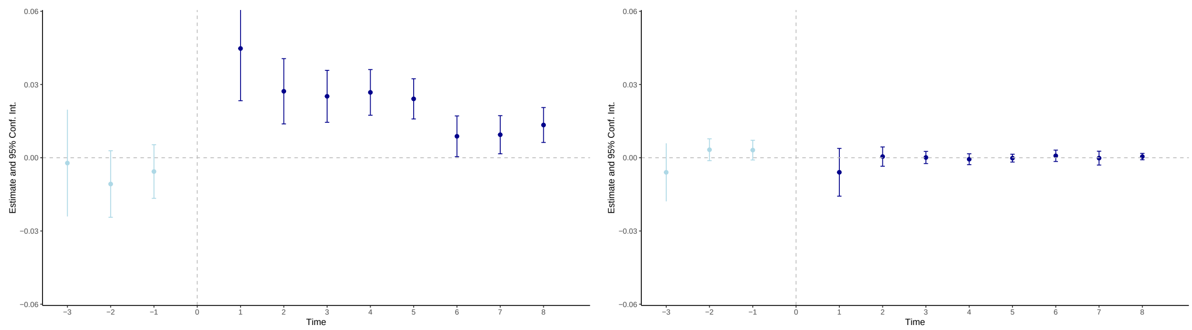
Table 2: Effect of Natural Disasters on Local Tax Revenues

	Property tax		**Business tax**	
	Tax Rate	**Tax Base**	**Tax Rate**	**Tax Base**
	0.070***	0.000	-0.096**	-0.031
	(0.016)	(0.003)	(0.042)	(0.024)
Placebo F-test (p-val.)	0.859	0.191	0.456	0.192
N	353,115	129,379	353,115	129,379
Switchers	112,390	40,844	112,390	40,844

Note: * p<0.05, ** p<0.01, *** p<0.001. Clustered standard errors at municipal level in parentheses. Placebo F-test reports the p-value of a joint test that all pre-trend coefficients are equal to zero. The lower number of observations for tax base regressions reflects the availability of assessed value data starting in 2009.

Figure 5: Effect of Natural Disasters on Property Tax

(a) Tax rate (b) Tax base

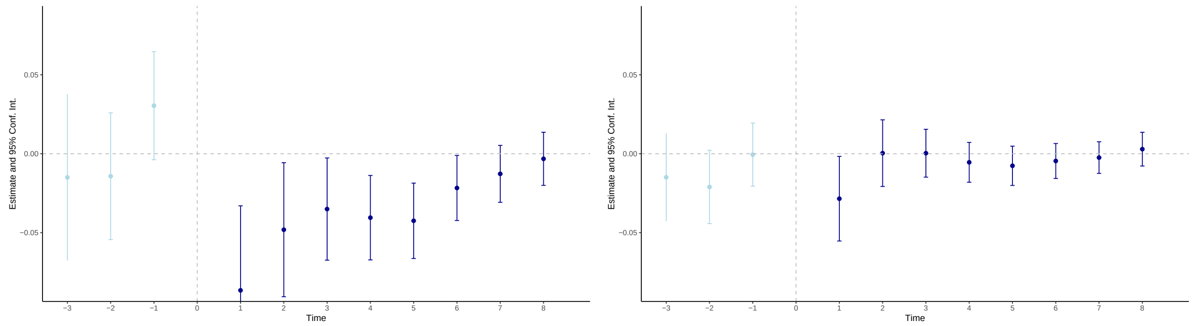


Note: Figures display event-study estimates from the non-binary staggered difference-in-differences estimator of Chaisemartin & D'Haultfœuille (2024). The x-axis represents years relative to the first disaster shock. Negative periods correspond to placebo estimates. Dark blue dots indicate post-shock periods, light blue dots indicate pre-shock periods. Bars represent 95% confidence intervals with standard errors clustered at the municipal level.

Figure 5 examines the response of the property tax (*taxe foncière*). The tax rate increases sharply and persistently following the shock, with an average total effect of 7.0%, and remains significant up to seven years after the disaster. The tax base, by contrast, remains entirely unchanged, with a precisely estimated null effect ($ATE = 0.0002$). This decomposition confirms that the increase in property tax revenues is driven entirely by a deliberate upward adjustment of the voted rate, consistent with municipalities actively mobilizing their fiscal resources in response to the shock. Property owners thus bear part

Figure 6: Effect of Natural Disasters on Business Tax

(a) Tax rate (b) Tax base



Note: Figures display event-study estimates from the non-binary staggered difference-in-differences estimator of Chaisemartin & D'Haultfœuille (2024). The x-axis represents years relative to the first disaster shock. Negative periods correspond to placebo estimates. Dark blue dots indicate post-shock periods, light blue dots indicate pre-shock periods. Bars represent 95% confidence intervals with standard errors clustered at the municipal level.

of the fiscal cost of the disaster through higher tax rates, which may contribute to explaining the well-documented electoral punishment of incumbent mayors following natural disasters (Morvan & Paty 2024; Healy & Malhotra 2009; Bovan et al. 2018).

Figure 6 presents the results for the business tax. In contrast to the property tax, both the tax rate and the tax base decline following the shock. The rate falls significantly and persistently, with an average total effect of -9.6%. The tax base also declines significantly in the year of the shock, but this effect does not persist in subsequent periods. Together, these results suggest that natural disasters damage the local economic fabric, with firms potentially exiting the affected municipality. The observed reduction in the tax rate may reflect a deliberate municipal strategy to retain economic activity in the wake of the disaster, though this interpretation remains speculative in the absence of direct evidence on municipal tax-setting decisions.

4.1 Heterogeneous Fiscal Resilience

Heterogeneous Effects by Disaster Frequency. Table 3 presents the heterogeneous effects of natural disasters by number of cumulative shocks experienced since 2000. Each subsample is constructed by restricting the data to municipalities that have experienced at most n disasters at the time of treatment. The control group for the n-th disaster thus comprises municipalities transitioning from $n-1$ to n shocks, isolating the marginal effect of each additional disaster. This design ensures that estimated effects are not confounded by the cumulative history of prior exposures.

Investment expenditures increase significantly following a first disaster (3.7%), but this effect disappears entirely for municipalities experiencing a second or third shock. Current expenditures remain broadly unaffected across all levels of exposure, though point estimates tend to turn negative after the

Table 3: Heterogeneous Effects by Number of Disasters

	1st Flood	**2nd Flood**	**3rd Flood**
Investment expenditures			
	0.037***	0.013	0.009
	(0.011)	(0.019)	(0.015)
Placebo F-test (p-val.)	0.348	0.405	0.748
N	286,651	60,945	41,724
Switchers	75,120	23,871	17,665
Current expenditures			
	0.002	-0.003	0.000
	(0.002)	(0.004)	(0.003)
Placebo F-test (p-val.)	0.582	0.719	0.413
N	286,652	60,945	41,724
Switchers	75,120	23,871	17,665
Grants			
	0.028***	0.025**	-0.011
	(0.005)	(0.010)	(0.009)
Placebo F-test (p-val.)	0.387	0.917	0.255
N	286,651	60,945	41,724
Switchers	75,120	23,871	17,665
Debt			
	0.005	-0.018	0.029
	(0.018)	(0.028)	(0.022)
Placebo F-test (p-val.)	0.254	0.570	0.021*
N	286,650	60,945	41,724
Switchers	75,120	23,871	17,665

Note: * p<0.05, ** p<0.01, *** p<0.001. Clustered standard errors at municipal level in parentheses. Placebo F-test reports the p-value of a joint test that all pre-trend coefficients are equal to zero. Complete event-study results are reported in Appendix A.1.

second and third shock (Appendix A.1). The grant response is strong and significant for first-time affected municipalities (2.8%), remains significant for those hit a second time (2.5%), but vanishes for municipalities experiencing a third shock. Debt shows no systematic pattern across exposure levels, though the placebo F-test indicates a marginally significant pre-trend for the third-shock subsample (p=0.021), limiting the credibility of estimates for this group. Taken together, these results suggest that fiscal resilience erodes as disaster exposure accumulates — investment responses fade, public service provision comes under pressure, and state support dwindles.

Heterogeneous Effects by Financial Health. Table 4 examines heterogeneous effects by municipal financial health, measured through the financial health score — a composite banking-style indicator computed from 2000 budget data, ranging from 1 (excellent) to 7 (poor).[6] Municipalities are split at the

[6] This score is based on a formula developed by the AFL (*Agence France Locale*), the French local government bank, combining several financial ratios to assess the fiscal soundness of municipalities.

2000 median (1.37) into financially healthy and distressed groups.

The results reveal a striking asymmetry in fiscal adjustment. Distressed municipalities invest significantly more following a disaster (3.1%), while healthy municipalities show no significant investment response. This divergence in investment behavior is mirrored on the financing side: distressed municipalities significantly increase their outstanding debt stock (4.0%), whereas healthy municipalities show no recourse to borrowing. Both groups benefit equally from intergovernmental grants (2.2% and 2.5% respectively), suggesting that state support is allocated on the basis of disaster exposure rather than fiscal capacity. Current expenditures remain unaffected for both groups, indicating that local public service provision is preserved regardless of financial health. Finally, both groups increase their property tax rate by a comparable magnitude (7.9% and 7.4%), suggesting that the fiscal effort borne by property owners is independent of municipal financial conditions. These results paint a nuanced picture of fiscal resilience. Financially healthy municipalities absorb disaster shocks silently — without significant investment responses or debt accumulation — while distressed municipalities are compelled to invest more aggressively and finance this through borrowing. The equal grant response across groups further suggests that intergovernmental transfers alone are insufficient to prevent debt accumulation among fiscally fragile municipalities.

Heterogeneous Effects by Household Income. Table A.3 presents heterogeneous effects by median household income, splitting municipalities at the 2000 income median. Low-income municipalities exhibit a significant investment response (2.1%), while high-income municipalities show no significant effect. The grant response is significant and comparable across both groups (1.8% and 1.5% respectively). Strikingly, low-income municipalities increase their property tax rate significantly (9.3%), while the effect is not significant for high-income municipalities. Current expenditures and debt remain unaffected for both groups.

Sensitivity Analysis. Table A.4 and Table A.2 assess the robustness of the main results across alternative specifications and disaster definitions. Three sensitivity checks confirm the stability of the baseline estimates. Excluding municipalities with more than 10,000 inhabitants leaves the results virtually unchanged, suggesting that the findings are not driven by larger cities with atypical budget structures. Similarly, excluding coastal municipalities does not materially affect the estimates, indicating that the results are not driven by communes specifically exposed to storm surges or coastal flooding. Finally, using the non-normalized dCDMH estimator yields coefficients that are identical to the baseline to the third decimal place. Regarding disaster type, restricting the analysis to all recognized natural disasters — including droughts, land movements, storms and others — produces results broadly consistent with

Table 4: Heterogeneous Effects by Municipal Financial Health

	Healthy	**Distressed**
Investment expenditures	0.016	0.031***
	(0.013)	(0.009)
Placebo F-test (p-val.)	0.642	0.571
N	128,690	134,326
Switchers	44,794	52,457
Current expenditures	0.000	0.002
	(0.003)	(0.002)
Placebo F-test (p-val.)	0.574	0.636
N	128,691	134,326
Switchers	44,794	52,457
Grants	0.022***	0.025***
	(0.006)	(0.005)
Placebo F-test (p-val.)	0.653	0.712
N	128,690	134,326
Switchers	44,794	52,457
Debt	-0.010	0.040***
	(0.022)	(0.012)
Placebo F-test (p-val.)	0.333	0.908
N	128,690	134,326
Switchers	44,794	52,457
Property tax rate	0.079***	0.074***
	(0.026)	(0.023)
Placebo F-test (p-val.)	0.889	0.597
N	128,691	134,326
Switchers	44,794	52,457
Business tax rate	-0.076	-0.081
	(0.068)	(0.059)
Placebo F-test (p-val.)	0.548	0.937
N	128,691	134,326
Switchers	44,794	52,457

Note: * p<0.05, ** p<0.01, *** p<0.001. Clustered standard errors at municipal level in parentheses. Placebo F-test reports the p-value of a joint test that all pre-trend coefficients are equal to zero. Healthy municipalities have an AFL score below the 2000 median (score < 1.37); Distressed municipalities have a score above the median. The AFL score ranges from 1 (excellent) to 7 (poor financial health). Complete event-study results are reported in Appendix A.4.

the baseline, confirming that floods drive the aggregate pattern. By contrast, analyzing droughts in isolation yields no significant effects on investment expenditures, grants, or tax rates, with pre-trend tests less systematically satisfied. This placebo-type exercise supports the interpretation that the baseline effects reflect physical destruction requiring reconstruction, rather than a mechanical response to the administrative recognition of the natural disaster status.

5 Discussion

Natural disasters impose complex fiscal adjustments on local governments that go beyond the immediate reconstruction costs. The results presented above reveal three interrelated dimensions of this adjustment: the fiscal levers available to municipalities, the erosion of resilience under repeated shocks, and the unequal distribution of fiscal costs across municipalities and their residents.

The decomposition of tax responses into rate and base components sheds light on the fiscal strategies available to municipalities following a disaster. On the property tax side, the significant and persistent increase in the voted rate, in the absence of any change in the tax base, reflects a deliberate upward adjustment by local elected officials. The stability of the property tax base is expected: the physical stock of buildings does not disappear following a flood or storm, and assessed values adjust slowly. The increase in the tax rate thus represents one of the few fiscal levers directly controlled by mayors in the immediate aftermath of a shock. This finding complements Guo et al. (2026), who document that Hurricane Sandy led to increased property tax burdens on homeowners through a different mechanism, i.e., taxable values falling less than market values, highlighting how property tax administration is systematically intertwined with disaster responses regardless of the specific institutional context. Mayors who raise taxes in the aftermath of a disaster also expose themselves to electoral punishment from property owners facing higher bills, consistent with Morvan & Paty (2024), who find that natural disasters negatively affect the electoral outcomes of incumbent mayors in French municipalities.

On the business tax side, the significant and persistent reduction in the voted rate is consistent with a strategy aimed at maintaining the attractiveness of the local economic environment following the shock. The tax base declines significantly in the year of the disaster but subsequently stabilizes, suggesting a temporary disruption of local economic activity, e.g., through business closures, interruptions, or temporary relocations, rather than a permanent destruction of the productive fabric. The persistence of the rate reduction beyond this initial disruption period suggests that municipalities maintain a deliberate policy of fiscal attractiveness even after local economic activity has recovered. This is consistent with evidence that adaptive responses to natural disasters can generate positive local spillovers strong enough to overcompensate for the flood's destructive nature (Magontier & Martinez-Mazza 2024), and points to a broader municipal strategy of using fiscal instruments to support post-disaster recovery and territorial attractiveness.

The heterogeneity analysis by disaster frequency reveals that the average fiscal resilience documented above masks a progressive erosion of adjustment capacity as shocks accumulate. Investment responses are significant and strong following a first disaster but fade entirely for municipalities hit a second or third time. Two competing mechanisms may account for this pattern. Under a resilience channel, first-shock investments reduce structural vulnerability, through infrastructure upgrades, flood defenses, or drainage improvements, lowering both damage intensity and the marginal need for reconstruction in subsequent episodes.

Under a fiscal exhaustion channel, repeated shocks deplete budgetary capacity, preventing municipalities from mounting an adequate investment response even when reconstruction needs remain high. The simultaneous fading of intergovernmental grants for chronically exposed municipalities is consistent with both channels: allocating authorities may perceive lower reconstruction needs in previously treated municipalities, or institutional constraints on re-application may limit access to transfers over time. Discriminating between these mechanisms would require data on damage intensity and infrastructure quality, which remain beyond the scope of this paper. As the frequency of extreme weather events increases with climate change (Barrage 2025), municipalities that today face a first or second disaster will progressively transition into the group of chronically exposed communes, where investment responses fade, grant support diminishes, and fiscal buffers erode. This transition may occur silently, without triggering explicit fiscal distress, but with cumulative consequences for the quality of local public infrastructure and the capacity to absorb future shocks.

Beyond the average pattern, natural disasters interact with pre-existing fiscal and socioeconomic inequalities to produce heterogeneous outcomes. Financially distressed municipalities invest significantly more following a disaster and finance this investment through debt accumulation, while financially healthy municipalities absorb the shock without significant investment responses or borrowing. The equal grant response across both groups suggests that intergovernmental transfers are allocated on the basis of disaster exposure rather than fiscal capacity, leaving distressed municipalities without additional support despite their greater vulnerability. This creates a feedback loop: each disaster episode further weakens the financial position of already fragile municipalities, increasing their debt burden and potentially raising their cost of financing (Auh et al. 2022), thereby reducing their capacity to respond to future shocks. Low-income municipalities compound this picture further: they not only bear a larger investment burden but also finance it through sharper increases in property tax rates, so that the fiscal cost of natural disasters is disproportionately borne by residents of poorer communes, who face both higher tax bills and potentially lower-quality local infrastructure.

This distributional pattern echoes findings from the United States, where Guo et al. (2026) document that Hurricane Sandy imposed uneven tax burdens on homeowners, and where Jerch et al. (2023) show that the fiscal costs of hurricanes fall disproportionately on minority and lower-income communities. The equal grant response across income groups further suggests that the current intergovernmental transfer system is not calibrated to correct for heterogeneous fiscal capacity, a concern amplified by the broader evidence that lower-income and credit-constrained regions are especially poorly insured against growing climatic fiscal risks (Barrage 2025).

Taken together, these results paint a nuanced picture of municipal fiscal resilience in France. Compared with the United States, where Jerch et al. (2023) document that hurricanes reduce both expenditures and tax revenues over the decade following a strike, French municipalities appear remarkably resilient on average, maintaining investment responses, preserving current expenditure levels, and avoiding significant debt accumulation. This contrast likely reflects the specificities of the French institutional framework: the CatNat regime provides automatic access to insurance compensation and intergovernmental transfers, limiting the fiscal shock absorbed by municipalities directly. Similar patterns of increased investment and grant responses have been documented for Italian municipalities following floods (Lodi et al. 2023) and hydrogeological events (Marin et al. 2025), and for Italian municipalities following earthquakes (Masiero & Santarossa 2020), suggesting that European institutional models of disaster compensation may generate more resilient local fiscal responses than the US framework.

Several limitations temper these conclusions. The GASPAR database contains no information on the intensity of disasters or the extent of physical damages, which prevents us from distinguishing between shocks of different severity and from directly testing the resilience versus exhaustion channels. The analysis focuses on aggregate budget categories and cannot identify the specific types of investment undertaken, i.e., reconstruction, prevention, or new infrastructure, which would be necessary to assess the long-run effectiveness of the fiscal response. Finally, while the business tax results suggest a temporary disruption of local economic activity, the available data do not allow us to distinguish between firm closures, temporary interruptions, and actual relocations, nor to assess whether municipal rate reductions are effective in retaining or attracting economic activity.

6 Conclusion

This paper examines the fiscal response of French municipalities to natural disasters over the period 2000–2024, exploiting the non-binary staggered difference-in-differences estimator of Chaisemartin & D'Haultfœuille (2024) to identify the causal effect of cumulative flood exposure on municipal budgets. The results document a pattern of apparent fiscal resilience: investment expenditures increase significantly and persistently following a disaster, current expenditures remain unaffected, and municipalities avoid significant debt accumulation by relying on intergovernmental grants and increases in property tax rates. The decomposition of tax responses reveals that municipalities increase the property tax rate they directly control, while reducing business tax rates in an effort to maintain local economic attractiveness following a temporary disruption of the productive fabric.

This picture of resilience, however, is more fragile than it appears. Three findings temper the optimistic reading. First, fiscal resilience erodes with disaster frequency: investment responses and grant support fade for municipalities experiencing repeated shocks, raising concerns about the long-run capacity of chronically exposed communes to absorb future disasters. Second, financially distressed municipalities are compelled to invest more aggressively and finance this investment through debt accumulation, creating a feedback loop that progressively weakens their fiscal position. Third, the fiscal cost of disasters falls disproportionately on residents of low-income municipalities, who face sharper property tax increases despite benefiting from the same level of intergovernmental support as wealthier communes.

These findings carry clear implications for public policy. The current architecture of intergovernmental transfers, while effective at supporting municipalities following an isolated shock, does not appear to be calibrated to address the specific vulnerabilities of chronically exposed or fiscally fragile communes. A more targeted allocation of disaster relief, directed toward municipalities with the weakest fiscal capacity and the highest exposure, could help break the feedback loop between disaster frequency, debt accumulation, and declining resilience. More broadly, as climate change increases the frequency and intensity of extreme weather events, the sustainability of the current model deserves careful scrutiny: what appears today as resilience may, over time, reveal itself as a slow accumulation of fiscal fragility among the most vulnerable municipalities.

References

Auh, J. K., Choi, J., Deryugina, T., & Park, T. (July 2022). Natural Disasters and Municipal Bonds. Working Paper.

Barrage, L. (Oct. 2025). Climate Change Impacts on Public Finances Around the World. fr. *Annual Review of Resource Economics*, *17*. Publisher: Annual Reviews, 281–300.

Bovan, K., Banai, B., & Banai, I. P. (2018). Do Natural Disasters Affect Voting Behavior? Evidence from Croatian Floods. *PLoS Currents*,

Buettner, T. (2009). The contribution of equalization transfers to fiscal adjustment: Empirical results for German municipalities and a US–German comparison. en. *Journal of Comparative Economics*, *37*, 417–431.

Buettner, T. & Wildasin, D. E. (2006). The dynamics of municipal fiscal adjustment. en. *Journal of Public Economics*, *90*, 1115–1132.

Callaway, B. & Sant'Anna, P. H. C. (2021). Difference-in-Differences with multiple time periods. en. *Journal of Econometrics*, Themed Issue: Treatment Effect 1 *225*, 200–230.

Chaisemartin, C. de & D'Haultfœuille, X. (Sept. 2020). Two-Way Fixed Effects Estimators with Heterogeneous Treatment Effects. en. *American Economic Review*, *110*, 2964–2996.

Chaisemartin, C. de & D'Haultfœuille, X. (Feb. 2024). Difference-in-Differences Estimators of Intertemporal Treatment Effects. *The Review of Economics and Statistics*, 1–45.

Chaisemartin, C. de & D'Haultfoeuille, X. (2026). Causal Inference with Differences-in-Differences: Credible Answers to Hard Questions. Princeton University Press. Forthcoming, December 2026. Princeton, New Jersey.

Guo, W., Miao, Q., Kim, Y., & Hou, Y. (June 2026). Rising waters, falling taxes: The impact of Hurricane Sandy on property tax assessments in New York City. *Journal of Environmental Economics and Management*, *138*, 103313.

Healy, A. & Malhotra, N. (2009). Myopic Voters and Natural Disaster Policy. en. *American Political Science Review*, *103*, 387–406.

Jerch, R., Kahn, M. E., & Lin, G. C. (2023). Local public finance dynamics and hurricane shocks. *Journal of Urban Economics*, *134*, 103516.

Lodi, C., Marin, G., & Modica, M. (Apr. 2023). The public finance response to floods of local governments in Italy. en. *Journal of Environmental Management*, *332*, 117352.

Magontier, P. & Martinez-Mazza, R. (Aug. 2024). Floods & Urban Density. en. SSRN Scholarly Paper. Rochester, NY.

Marin, G., Bellocchi, A., Lodi, C., Travaglini, G., & Zavalloni, M. (Sept. 2025). Floods, Public Budgets and Fiscal Resilience: Evidence from Italian Municipalities. en. SSRN Scholarly Paper. Rochester, NY.

Masiero, G. & Santarossa, M. (June 2020). Earthquakes, grants, and public expenditure: How municipalities respond to natural disasters. *Journal of Regional Science*, *60*. Publisher: Wiley-Blackwell, 481–516.

Miao, Q., Chen, C., Lu, Y., & Abrigo, M. (2020). Natural Disasters and Financial Implications for Subnational Governments: Evidence from China. *Public Finance Review*, *48*, 72–101.

Miao, Q., Hou, Y., & Abrigo, M. (2018). Measuring the financial shocks of natural disasters: a panel study of u.s. states. *National Tax Journal*, *71*, 11–44.

Morvan, C. & Paty, S. (Mar. 2024). Natural disasters and voter gratitude: What is the role of prevention policies? en. *Public Choice*, *198*, 427–465.

Nachbar Sénateur, M. P. (2017). Les systèmes d'indemnisation des catastrophes naturelles. fr. Étude de législation comparée. Sénat, 53.

Ouattara, B. & Strobl, E. (Jan. 2013). The fiscal implications of hurricane strikes in the Caribbean. *Ecological Economics*, New Climate Economics *85*, 105–115.

Panwar, V. & Sen, S. (2020). Fiscal Repercussions of Natural Disasters: Stylized Facts and Panel Data Evidences from India. EN. *Natural Hazards Review*, *21*, 04020011.

Solé-Ollé, A. & Sorribas-Navarro, P. (2012). The dynamic adjustment of local government budgets: does Spain behave differently? en. *Applied Economics*, *44*, 3203–3213.

A Appendix

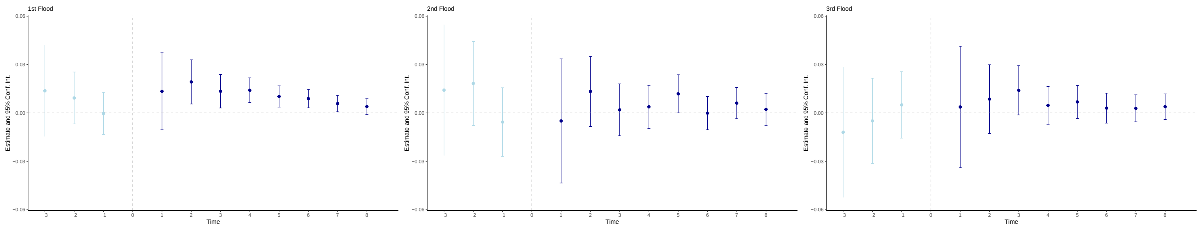
Table A.1: Descriptive Statistics

	Full sample		1999 sample	
	Mean	Std. Dev.	Mean	Std. Dev.
Budget variables (€, nominal)				
Investment expenditures	483	826	431	615
Current expenditures	681	622	633	452
Grants	310	366	280	263
Debt stock	575	1,241	516	696
Property tax				
Tax base (€)	905	1,819	841	1,421
Tax rate (%)	17.0	10.5	17.2	10.7
Business tax				
Tax base (€)	104	1,230	97	1,245
Tax rate (%)	5.4	7.7	5.3	7.5
Socioeconomic characteristics				
Median household income (€)	19,167	4,300	19,243	4,198
Population	1,760	14,687	1,739	13,842
Natural disaster exposure (per year)				
Floods & Storms	0.06	0.29	0.06	0.29
Droughts	0.04	0.20	0.04	0.20
All disasters	0.10	0.40	0.10	0.30
Municipalities	36,589		27,616	
Observations	900,032		690,196	

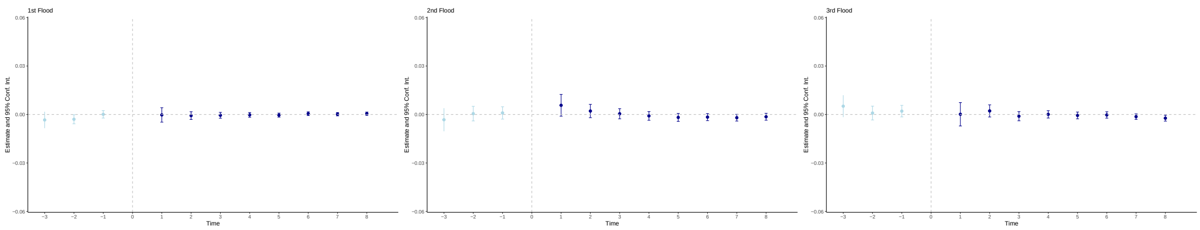
Note: Budget variables are expressed in nominal euros per municipality. The full sample includes all French municipalities over 2000–2024. The 1999 sample restricts to municipalities whose last recorded disaster before 2000 was the 1999 storms Lothar and Martin. Natural disaster exposure is measured as the average annual number of recognized disasters events per municipality.

Figure A.1: Effect of Natural Disasters by Number of Disasters

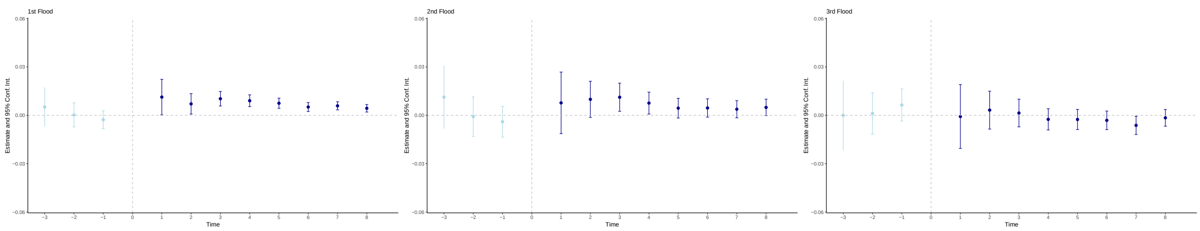
(a) Investment Expenditures



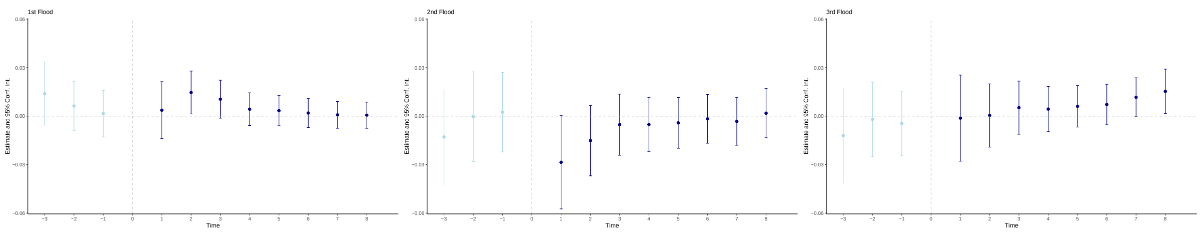
(b) Current Expenditures



(c) Grants



(d) Debt



Note: Figures display event-study estimates from the non-binary staggered difference-in-differences estimator of Chaisemartin & D'Haultfœuille (2024). The x-axis represents years relative to the first disaster shock. Negative periods correspond to placebo estimates. Dark blue dots indicate post-shock periods, light blue dots indicate pre-shock periods. Bars represent 95% confidence intervals with standard errors clustered at the municipal level.

Table A.2: Robustness: Results by Type of Natural Disaster

	Floods	**All disasters**	**Droughts**
Investment expenditures	0.019***	0.016***	0.003
	(0.007)	(0.006)	(0.008)
Placebo F-test (p-val.)	0.291	0.015*	0.415
N	353,073	363,242	269,917
Switchers	112,390	134,546	79,971
Current expenditures	0.001	-0.001	-0.004**
	(0.002)	(0.001)	(0.002)
Placebo F-test (p-val.)	0.848	0.813	0.001***
N	353,074	363,243	269,917
Switchers	112,390	134,546	79,971
Grants	0.020***	0.013***	-0.001
	(0.003)	(0.003)	(0.004)
Placebo F-test (p-val.)	0.708	0.026*	0.094
N	353,073	363,242	269,917
Switchers	112,390	134,546	79,971
Debt	0.003	0.006	-0.006
	(0.011)	(0.010)	(0.012)
Placebo F-test (p-val.)	0.348	0.570	0.350
N	353,072	363,241	269,917
Switchers	112,390	134,546	79,971
Property tax rate	0.070***	0.061***	-0.012
	(0.016)	(0.014)	(0.019)
Placebo F-test (p-val.)	0.859	0.580	0.157
N	353,115	363,301	269,947
Switchers	112,390	134,546	79,971
Business tax rate	-0.096**	-0.115***	-0.062
	(0.042)	(0.036)	(0.051)
Placebo F-test (p-val.)	0.456	0.150	0.064
N	353,115	363,301	269,947
Switchers	112,390	134,546	79,971

Note: * p<0.05, ** p<0.01, *** p<0.001. Clustered standard errors at municipal level in parentheses. Placebo F-test reports the p-value of a joint test that all pre-trend coefficients are equal to zero. Results for floods correspond to the baseline specification. All disasters includes all recognized natural disaster types. Droughts are analyzed separately given their distinct physical nature. Pre-trend tests are less systematically satisfied for the All disasters and Drought specifications, likely reflecting the greater heterogeneity in shock types across municipalities, which makes it harder to identify comparable control groups. These results should therefore be interpreted with caution.

Table A.3: Heterogeneous Effects by Household Income

	Low income	**High income**
Investment expenditures	0.021*	-0.001
	(0.011)	(0.011)
Placebo F-test (p-val.)	0.801	0.549
N	119,849	127,699
Switchers	44,928	46,975
Current expenditures	0.003	0.004
	(0.002)	(0.002)
Placebo F-test (p-val.)	0.943	0.473
N	119,849	127,699
Switchers	44,928	46,975
Grants	0.018***	0.015***
	(0.005)	(0.006)
Placebo F-test (p-val.)	0.923	0.685
N	119,849	127,699
Switchers	44,928	46,975
Debt	0.006	-0.027
	(0.015)	(0.018)
Placebo F-test (p-val.)	0.846	0.076
N	119,849	127,698
Switchers	44,928	46,975
Property tax rate	0.093***	0.040
	(0.026)	(0.025)
Placebo F-test (p-val.)	0.875	0.629
N	119,849	127,699
Switchers	44,928	46,975
Business tax rate	-0.116	0.014
	(0.069)	(0.065)
Placebo F-test (p-val.)	0.549	0.506
N	119,849	127,699
Switchers	44,928	46,975

Note: * $p<0.05$, ** $p<0.01$, *** $p<0.001$. Clustered standard errors at municipal level in parentheses. Placebo F-test reports the p-value of a joint test that all pre-trend coefficients are equal to zero. Low income municipalities have a median household income below the 2000 median; High income municipalities have a median household income above the median. Complete event-study results are reported in Appendix A.5.

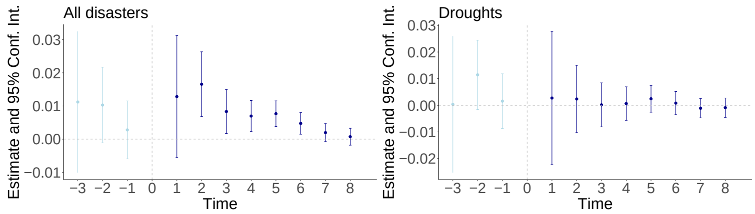
Table A.4: Sensitivity Checks

	Baseline	**Non-normalized**	**Small communes**	**No littoral**
Investment expenditures	0.019***	0.019***	0.021***	0.018**
	(0.007)	(0.007)	(0.007)	(0.007)
Placebo F-test (p-val.)	0.291	0.291	0.266	0.252
N	353,073	353,073	337,746	337,650
Switchers	112,390	112,390	105,933	107,010
Current expenditures	0.001	0.001	0.002	0.001
	(0.002)	(0.002)	(0.002)	(0.002)
Placebo F-test (p-val.)	0.848	0.848	0.782	0.880
N	353,074	353,074	337,747	337,650
Switchers	112,390	112,390	105,933	107,010
Grants	0.020***	0.020***	0.021***	0.020***
	(0.003)	(0.003)	(0.004)	(0.004)
Placebo F-test (p-val.)	0.708	0.708	0.610	0.633
N	353,073	353,073	337,746	337,650
Switchers	112,390	112,390	105,933	107,010
Debt	0.003	0.003	0.004	0.004
	(0.011)	(0.011)	(0.011)	(0.011)
Placebo F-test (p-val.)	0.348	0.348	0.416	0.221
N	353,072	353,072	337,745	337,650
Switchers	112,390	112,390	105,933	107,010
Property tax rate	0.070***	0.070***	0.077***	0.067***
	(0.016)	(0.016)	(0.016)	(0.017)
Placebo F-test (p-val.)	0.859	0.859	0.966	0.767
N	353,115	353,115	337,788	337,691
Switchers	112,390	112,390	105,933	107,010
Business tax rate	-0.096**	-0.096**	-0.099**	-0.081
	(0.042)	(0.042)	(0.044)	(0.044)
Placebo F-test (p-val.)	0.456	0.456	0.112	0.411
N	353,115	353,115	337,788	337,691
Switchers	112,390	112,390	105,933	107,010

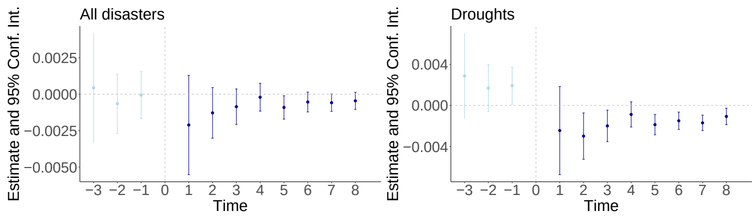
Note: * $p<0.05$, ** $p<0.01$, *** $p<0.001$. Clustered standard errors at municipal level in parentheses. Placebo F-test reports the p-value of a joint test that all pre-trend coefficients are equal to zero. Non-normalized uses the non-normalized dCDMH estimator. Small communes excludes municipalities with more than 10,000 inhabitants. No littoral excludes coastal municipalities. Complete event-study results are reported in Appendix A.3.

Figure A.2: Robustness: Results by Type of Natural Disaster

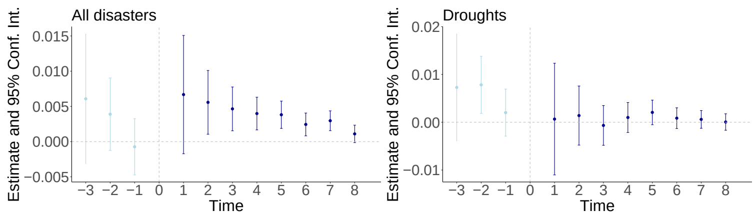
(a) Investment Expenditures



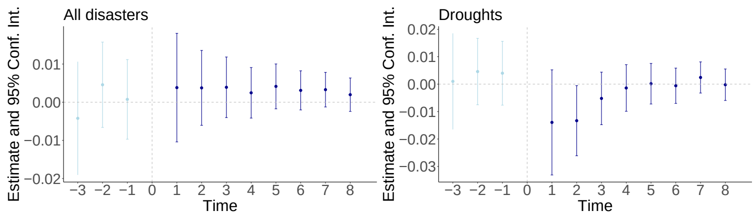
(b) Current Expenditures



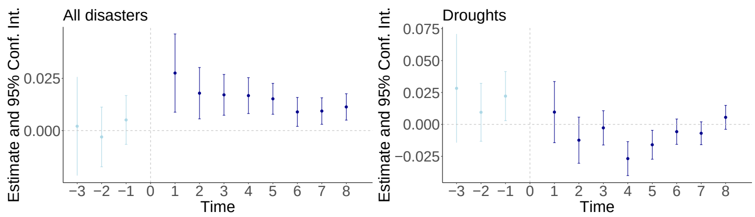
(c) Grants



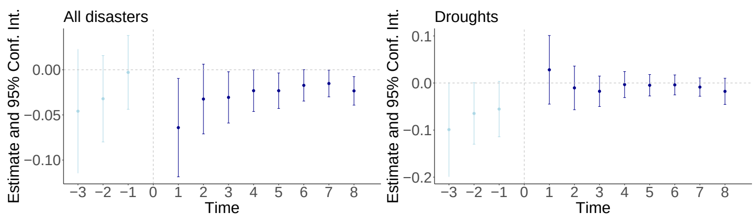
(d) Debt



(e) Property Tax Rate



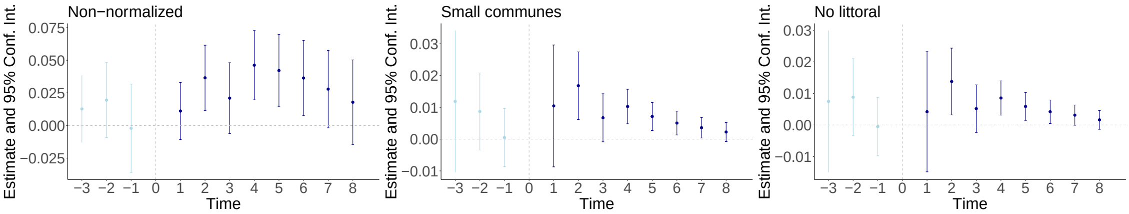
(f) Business Tax Rate



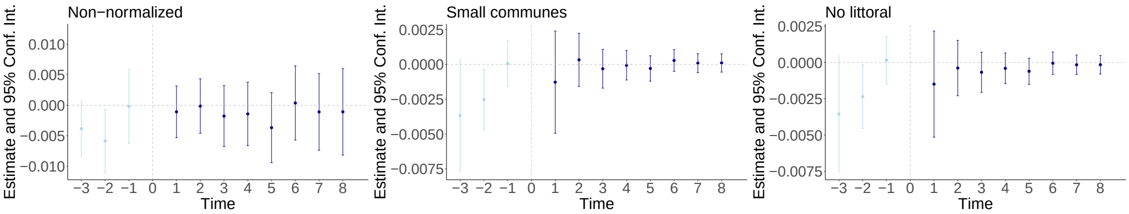
Note: Figures display event-study estimates from the non-binary staggered difference-in-differences estimator of Chaisemartin & D'Haultfœuille (2024). The x-axis represents years relative to the first disaster shock. Negative periods correspond to placebo estimates. Dark blue dots indicate post-shock periods, light blue dots indicate pre-shock periods. Bars represent 95% confidence intervals with standard errors clustered at the municipal level.

Figure A.3: Sensitivity Checks

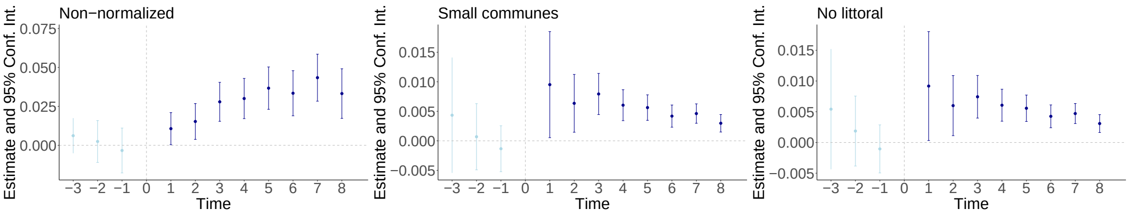
(a) Investment Expenditures



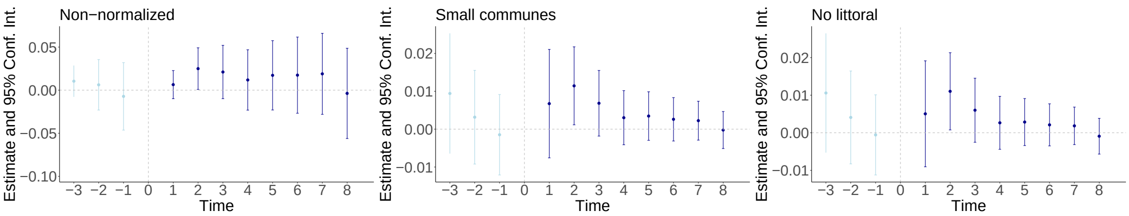
(b) Current Expenditures



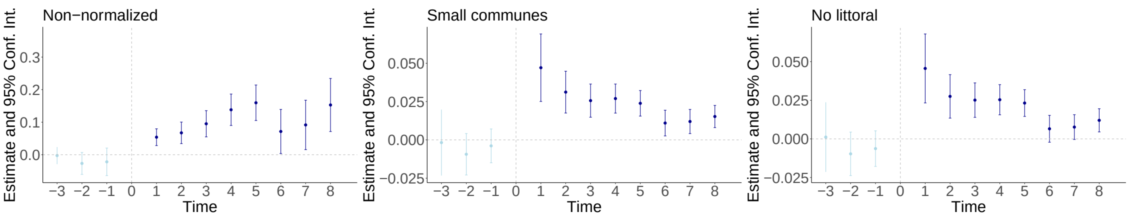
(c) Grants



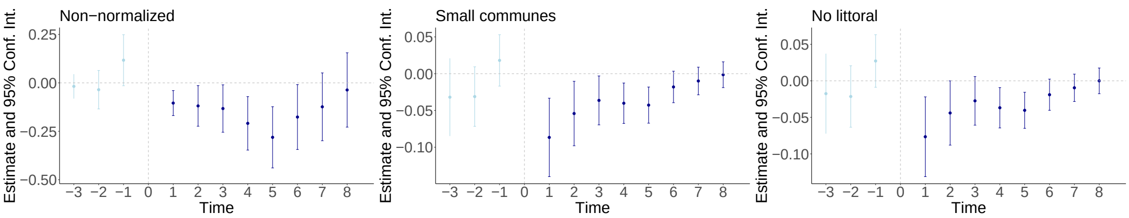
(d) Debt



(e) Property Tax Rate



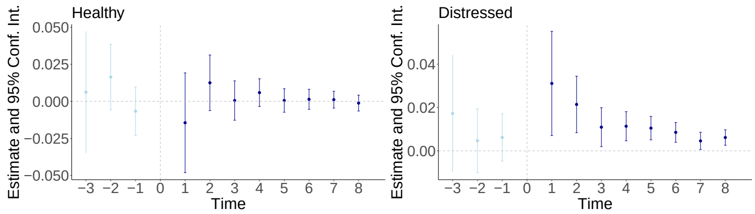
(f) Business Tax Rate



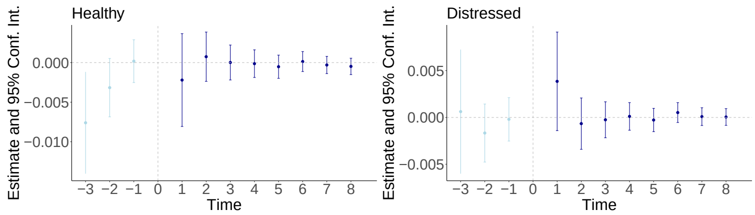
Note: Figures display event-study estimates from the non-binary staggered difference-in-differences estimator of Chaisemartin & D'Haultfœuille (2024). The x-axis represents years relative to the first disaster shock. Negative periods correspond to placebo estimates. Dark blue dots indicate post-shock periods, light blue dots indicate pre-shock periods. Bars represent 95% confidence intervals with standard errors clustered at the municipal level. Non-normalized uses the non-normalized dCDMH estimator. Small communes excludes municipalities with more than 10,000 inhabitants. No littoral excludes coastal municipalities.

Figure A.4: Heterogeneous Effects by Municipal Financial Health

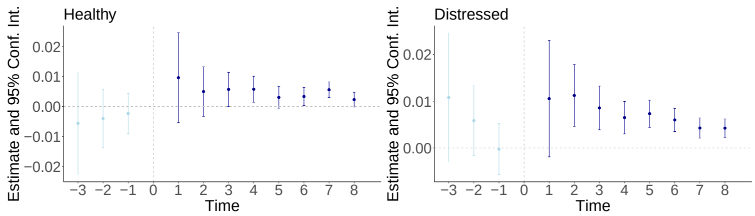
(a) Investment Expenditures



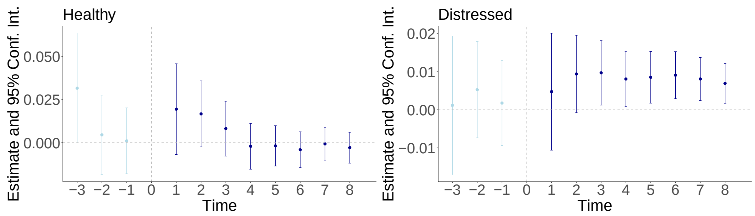
(b) Current Expenditures



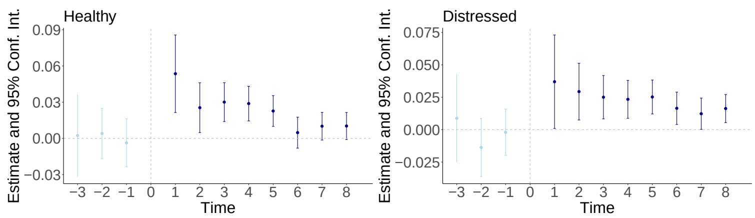
(c) Grants



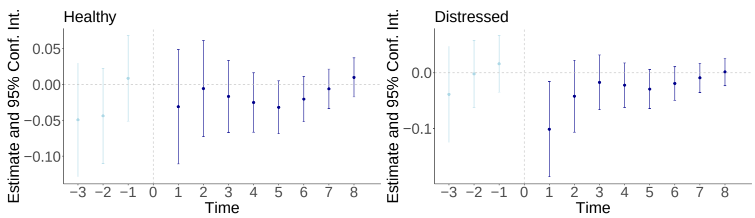
(d) Debt



(e) Property Tax Rate



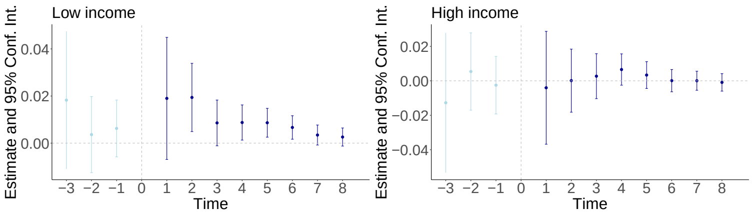
(f) Business Tax Rate



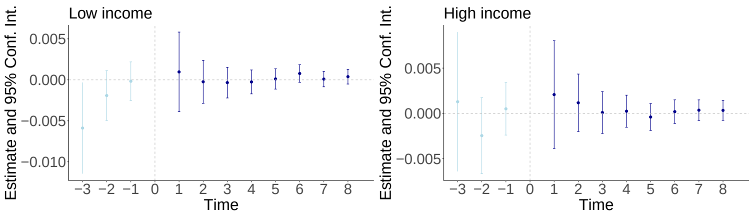
Note: Figures display event-study estimates from the non-binary staggered difference-in-differences estimator of Chaisemartin & D'Haultfœuille (2024). The x-axis represents years relative to the first disaster shock. Negative periods correspond to placebo estimates. Dark blue dots indicate post-shock periods, light blue dots indicate pre-shock periods. Bars represent 95% confidence intervals with standard errors clustered at the municipal level. Healthy municipalities have an AFL score below the 2000 median; Distressed municipalities have a score above the median.

Figure A.5: Heterogeneous Effects by Household Income

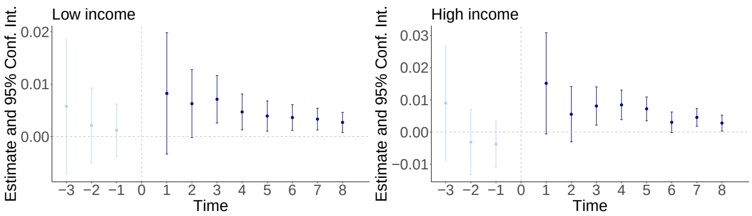
(a) Investment Expenditures



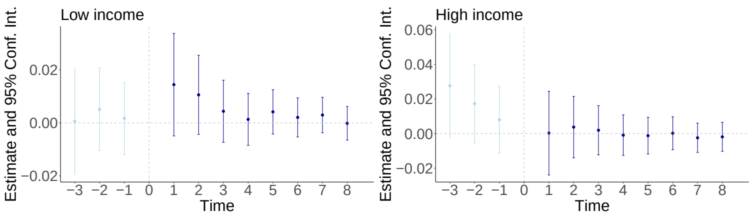
(b) Current Expenditures



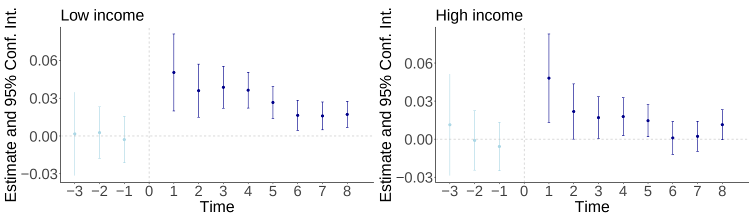
(c) Grants



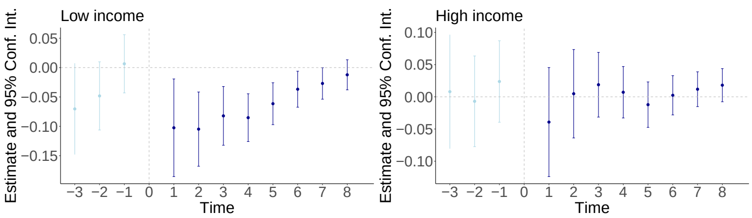
(d) Debt



(e) Property Tax Rate



(f) Business Tax Rate



Note: Figures display event-study estimates from the non-binary staggered difference-in-differences estimator of Chaisemartin & D'Haultfœuille (2024). The x-axis represents years relative to the first disaster shock. Negative periods correspond to placebo estimates. Dark blue dots indicate post-shock periods, light blue dots indicate pre-shock periods. Bars represent 95% confidence intervals with standard errors clustered at the municipal level. Low income municipalities have a median household income below the 2000 median; High income municipalities have a median household income above the median.