When Nature Strikes Repeatedly: Heterogeneous Budgetary Responses of Municipalities to Natural Disasters *

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Abstract

Natural disasters can affect territories not just once but repeatedly, with increasing frequency and intensity. This paper analyzes the causal impact of natural disasters on municipalities' budgetary decisions, accounting for both the sporadic nature and repetition of these extreme events. Using an original dataset covering all French municipalities from 2000 to 2024, I employ a staggered difference-in-differences methodology with a non binary treatment approach. The findings reveal that each disaster triggers an immediate increase in municipal spending, followed by a long-term rise in tax revenues. Additionally, a heterogeneity analysis highlights variations across territories vulnerability and disaster types, shedding light on the specific factors that shape municipal responses.

Keywords : Local public finance, Local expenditure, Natural disasters

JEL Codes : H72, Q54, R50

*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.

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1 Introduction

Lightning never strikes the same place twice, an adage that is losing its relevance. While we once associated natural disasters with rare, century-long or millennial intervals, events like 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.

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

The literature on local public economics further reveals how natural disasters affect local budgets. Studies in various contexts have shown that municipalities often increase expenditures and revenues following a disaster (Jerch et al. 2023; Masiero & Santarossa 2020; Miao, Chen, et al. 2020; Panwar & Sen 2020; Miao, Hou, et al. 2018). However, findings on long-term effects remain inconsistent. While some studies report sustained increases in expenditures (Masiero & Santarossa 2020), others suggest a decline in public goods provision (Jerch et al. 2023). For example, Jerch et al. (2023) found that municipalities in the Southeastern United States reduced both expenditures and revenues within 10 years of a hurricane, with a more pronounced effect in poorer, less-educated communities. These findings align with studies on fiscal shocks, showing that European municipalities rely heavily on grants to rebalance budgets, while U.S. municipalities primarily adjust their own revenues (Buettner & Wildasin 2006; Buettner 2009; Solé-Ollé & Sorribas-Navarro 2012).

Building on this literature, I investigate the impact of natural disasters on the budgets of French municipalities, addressing the issue of the repetition of these events. Using an original database of municipal accounts since 2000 and a comprehensive record of natural disasters since 1982, I analyze the causal relationship between natural shocks and local budget accounts. I explore how municipalities adjust their financial strategies to manage post-shock recovery, assessing their resilience to repeated disasters and their ability to adapt over time. To do so, I employ a staggered difference-in-differences approach with a non-binary treatment, allowing for the analysis of both the sporadic nature of natural disasters and the recurring nature of these events. This research provides new evidence on how natural disasters drive increases in municipal expenditures and revenues.

This study specifically focuses on the financial dimension of local public governments. Local jurisdictions are responsible for providing public goods and infrastructure, supporting their populations, and facilitating recovery after disasters (Morvan 2024). I show that following a natural disaster, municipalities increase their investment expenditures and, over time, their current expenditures. The central government plays a role in supporting municipalities through grants. In fact, municipalities depend heavily on central government decisions; previous studies have highlighted the role of central government support in post-disaster recovery. For instance, Valle et al. (2020) demonstrated that grant funding accelerates economic recovery in Mexico, while Masiero & Santarossa (2020) identified a flypaper effect in Italy, where earthquake-specific grants significantly boosted government spending. However, my results show an increase in tax revenues suggests that grants do not fully cover the costs, leaving municipalities to rely on tax revenues to compensate.

The increasing relevance of understanding the local impacts of natural disasters aligns this research with the literature on territorial adaptation to natural risks. This body of work explores the effects of disasters on urban development (Bakkensen & Ma 2020; Gibson & Mullins 2020; Strobl 2011; Magontier & Martinez-Mazza 2024), local adaptation policies (Aguiar et al. 2018; Morvan & Paty 2024), and the insurance implications of such events (Deryugina 2017; Gallagher 2014).

To gain further insights into territorial adaptation, I propose a heterogeneity analysis based on the municipalities' history of risk. The results show that municipalities previously exposed to risks tend to be more resilient in the future. Although an additional natural disaster impacts municipal budgets, these effects appear to be less persistent as adaptation progresses. These findings offer a positive perspective on the ability of territories to recover from natural disasters.

The remainder of this article is structured as follows: Section 2 describes the data, Section 3 details the econometric approaches, Section 4 presents the main results, and Section 5 explores heterogeneity in responses by disaster type and risk history. 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

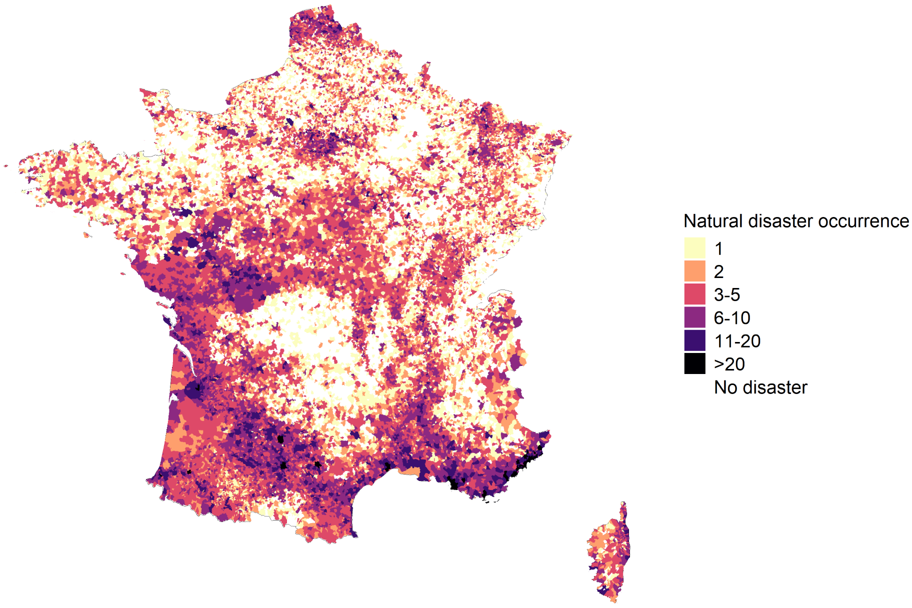
The primary dataset used in this analysis is the database of French municipal accounts from 2000 to 2024, provided by the Ministry of Public Accounts.

The analysis focuses on four key municipal accounts: current expenditures, investment expenditures, grants received from higher levels of government, and tax revenues. Current expenditures primarily include staff costs and operating expenses, while investment expenditures cover equipment spending and can also be used to repay loans when necessary.

Municipalities have two primary means of financing their current expenditures: taxes and

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

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



government grants. In contrast, investments are financed through grants, loans, or their own cash flow. However, it is often difficult to determine which type of expenditure (e.g., security, repair, or prevention) is associated with which type of account (current or investment account).

Natural disasters

Natural disasters are not any type of climatic event, indeed, a major meteorological event can be designated as a "natural disaster" in some particular cases. The status of natural disaster considers exceptional and non-standard meteorological events having an abnormal intensity, it concerns floods, mudflows, droughts, land movement, earthquake, storm, etc.

The status of "natural disaster" is important in the French case since it offers different insurance compensation compared to classic climatic shocks. The "natural disaster" declaration is decided by ministerial decree after a request from the mayor of the municipality concerned. The case of France is atypical since private insurance and public reinsurance mechanisms are subordinated to the prior recognition of the status of natural disaster, which is not the case in many neighboring countries (Nachbar 2017).

Natural disasters data come from the GASPAR database (Gestion ASsistée des Procédures Administratives relatives aux Risques) i.e Assisted Management of Risk Administrative Procedures, available from the Ministry of Environment and it is composed of the decrees of natural disasters since 1982. These data allow us to know exactly when a municipality was affected by a natural disaster and the type of disaster it is (flood, mudslide, land movement, drought, etc.). This database provides information on the dates and types of shocks, but a limitation is the lack of information on the intensity of natural disasters or on the damage caused.

Municipalities have an important role to play during a natural disaster, since the mayor is responsible for safety and crisis management, and must organize the protection and support of the population. The management of the natural disaster can generate additional costs supported by the municipalities. Indeed, the implementation of emergency services is the responsibility of the municipality such as transportation, emergency accommodation, communications (De Choudens 2015).

Control Variables

The third component of the database includes control variables. Demographic and socio-economic characteristics of municipalities are obtained from INSEE (National Institute of Statistics and Economic Studies). I use information on municipal demographics, including total population, the share of the population under 20 years old, and the share of the population over 65 years old. Additionally, I control for the median municipal income. Finally, data on municipal debt levels per capita are sourced from the General Directorate of Public Finance.

3 Empirical strategy

To analyze the impact of natural disasters on municipal budgets, it is essential to account for the sporadic nature of these events. Leveraging a panel of municipal budget data from 2000 to 2024, combined with information on natural disasters, I implement an event study using a difference-in-differences (DiD) framework with multiple time periods, following the methodology of Callaway & Sant'Anna (2021) (CS).

This methodology enables estimation of the effect of a natural disaster shock, while taking account of the unpredictable nature of the shock. A natural disaster can occur at any moment so the treatment includes multiple time periods. A municipality is considered treated from the year when it suffered a natural disaster, and remains in the control group for as long as it remains untreated ("Not yet treated" group). Once a municipality has experienced a natural disaster, it remains in the treatment group, in line with the staggered treatment adoption assumption.

$$Y_{i,t} = \alpha_i + \delta_t + \sum_g \beta_g \cdot Shock_{i,g} \cdot Post_{g,t} + \gamma_{i,t}\mathbf{X}_{i,t} + \varepsilon_{i,t} \quad (1)$$

The outcome variable Y is one municipality's account per capita which can be total expenditures, revenues, grants[2]. The variable $Shock_{i,g}$ represent the natural disaster, which is equal to 1 if the municipality i is first treated in period g, i.e the municipality i belongs to the group g. The variable $Post_{g,t}$ represent the post shock period, equal to 1 when t is subsequent to the period of treatment entry g. I also consider a vector for municipal characteristics $\mathbf{X}_{i,t}$, which includes several time-varying financial, socio-demographic and socio-economic covariates. Specifically, these are the municipality's per capita debt, the municipal population, the share of people aged under 20 years, and the share of people aged over 65 years.

To analyze the effects of a natural disaster on the municipal budget, I use a special aggregation scheme which provides an understanding of how the average treatment effect evolves with the length of time of exposure to the treatment, i.e. event-study-type estimates.

This first methodology takes into account the staggered start of the "treament" as natural disasters occurred sporadicaly. However, sometimes one municipality suffers many natural disasters. Moreover, the frequency of abnormal meteorogical event increase. To take this non binary of the treatment, I use the new method of Chaisemartin & D'Haultfœuille (2024) (dCMDH). In this specification of the model the treatment is non-binary and correspond to the frequency of natural disasters. This means that the intensity of treatment will increase as a municipality is affected by disasters.

$$Y_{i,t} = \alpha_i + \gamma_t + \sum_g \sum_\ell \beta_\ell \cdot Shocks_{i,g,\ell} \cdot Post_{g,t-\ell} + \varepsilon_{i,t} \quad (2)$$

As before, the variables are the same. However, the variable $Shocks_{i,g,\ell}$ represent the number of natural disasters occurred for a municipality i from the group g, ℓ period after the first change in the treatment. The variable $Post_{g,t-\ell}$ represent the post shock period, equal to 1 if t is ℓ periods after the entry of the group g in the treatment.

[2] I use the inverse hyperbolic sine transformation, in order to lose a minimum of data during the transformation.

For this approach to be valid, two identifying assumptions must be satisfied. First, the No Anticipation Assumption states that a group's current outcome is not influenced by its future treatments. Second, the Parallel Trends Assumption requires that, if two groups receive the same treatment in the initial period, their expected outcome trajectories evolve identically.

Furthermore, the implementation of the staggered, non-binary difference-in-differences design is computationally demanding and presents notable limitations—particularly regarding the integration of control variables when the treatment is not binary (Chaisemartin, Ciccia, et al. 2024). To address these challenges, I adopt a matching procedure to pre-process the sample. This approach ensures that the treatment and control groups are balanced ex ante on key observable characteristics. Specifically, municipalities are matched based on total population, the share of residents over 65 years old, median income, local weather conditions (precipitation and temperature), and whether they are covered by a risk prevention plan (PPRN). By doing so, I mitigate the limitations associated with including covariates in a non-binary treatment setting, and strengthen the internal validity of the estimation. (See Appendix for descriptive statistics of the matched sample in table

4 Results

4.1 Average Treatment Effect

Table 1 presents the results for the Average Treatment Effect (ATE) per treatment unit, estimated using different specifications. The aim is to analyze the causal relationship between the occurrence of a shock and municipal financial accounts.

Column (1) uses the Callaway and Sant'Anna (CS) staggered DiD method with a binary treatment, while column (2) applies the de Chaisemartin and d'Haultfœuille (dCMDH) staggered DiD approach, also with a binary treatment. When treatment is defined as a municipality experiencing its first natural disaster, the estimated effect appears positive. In particular, we observe increases in investment expenditures, current expenditures, tax revenues, and grants—although the effects on expenditures are small or not statistically significant.

However, it is important to account for the fact that natural disasters may occur repeatedly. A municipality enters treatment upon its first disaster but may subsequently experience a second, third, or more. Column (3) uses the dCMDH method with a non-binary, discrete treatment variable applied to the full sample, while column (4) replicates this specification on a matched subsample of municipalities. Column (5) presents results using a Two-Way Fixed Effects (TWFE) model.

The main difference between columns (3) and (4) lies in the sample and the ability to include control variables through the matching procedure. In the full-sample specification (3), the treatment variable reflects the cumulative number of disasters experienced over time. This introduces complexity due to the staggered nature of treatment, where both initial entry and subsequent shocks occur at different times. In the most affected municipalities, this cumulative treatment count can reach up to 60 events. The wide variation in treatment intensity complicates the inclusion of control variables.

To address this issue, column (4) restricts the analysis to the matched sample, which allows for the inclusion of controls while maintaining comparability across treated and untreated units.

The results indicate that, when accounting for the possibility of repeated treatments, the cumulative effect per additional treatment unit is slightly smaller than the average treatment effect estimated in the earlier binary-treatment models. However, each additional treatment unit—that is, each additional natural disaster—leads to a statistically significant increase in tax revenues and grants.

Finally, the estimates are very similar to those obtained using the TWFE model.

This initial analysis suggests that an additional natural disaster increases municipal revenues. However, some effects may be obscured by the averaging nature of the estimates, potentially masking heterogeneous responses across time periods.

4.2 Event study analysis

Figure 2 displays the results of the staggered DiD event study model with discrete, non-binary treatment. Each point estimate on these graphs represents the effect of a new natural disaster at different periods following the last occurrence.

The dependent variables analyzed are current expenditures, investment expenditures, grants, and tax revenues, shown in Figures 2a, 2b, 2c, and 2d, respectively.

Figure 2b shows a significant increase in investment expenditures beginning one year after a disaster and lasting for up to three years. This rise likely reflects emergency spending needs,

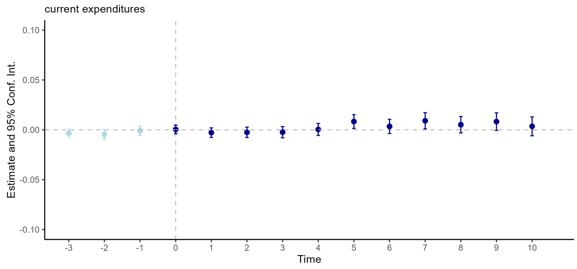
Table 1: Average effect of a natural disaster on local budget accounts

Treatement	Binary		Discret		
	CS	dCMDH	dCMDH		TWFE
	(1)	(2)	(3)	(4)	(5)
Current expenditures	0.025*	0.006*	0.002	0.002	-0.000
	(0.010)	(0.002)	(0.001)	(0.002)	(0.000)
Investment expenditures	0.009	0.011*	0.007	0.005	-0.001
	(0.013)	(0.007)	(0.004)	(0.005)	(0.001)
Tax revenues	0.026*	0.017**	0.010**	0.015*	0.010**
	(0.011)	(0.004)	(0.002)	(0.003)	(0.001)
Grants	0.071**	0.068**	0.035**	0.048**	0.029**
	(0.026)	(0.014)	(0.009)	(0.013)	(0.003)
Observations	30,940	453,663	639,886	481,143	754,375
Fixed effects	Yes	Yes	Yes	Yes	Yes
Demographic control	Yes	Yes			Yes
Budgetary control	Yes				Yes
Matching				Yes	

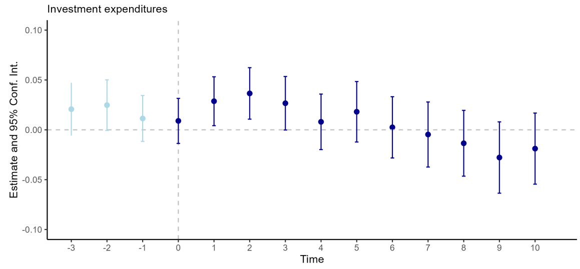
Note: (1) CS staggered DiD with binary treatment, (2) dCMDH staggered DiD with binary treatment, (3) dCMDH staggered DiD with discrete treatment (full sample), (4) dCMDH staggered DiD with discrete treatment (matching sample), and (5) Two-Way Fixed Effects (TWFE). Robust standard errors are reported in parentheses. ** $p < 0.01$, * $p < 0.05$.

Figure 2: Effect of a natural disaster on local budget accounts

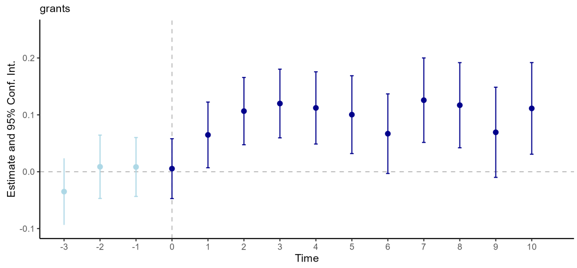
(a) Current expenditures



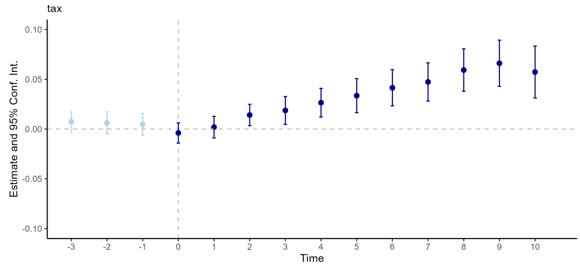
(b) Investment expenditures



(c) Grants



(d) Tax revenues



Notes: These graphs estimate the dynamic effects of a natural disaster on the budgetary accounts of French municipalities using robust standard errors on the matched sample. The methodology is based on a staggered DiD event study with discrete, non-binary treatment.

such as repair and reconstruction. Conversely, Figure 2a indicates a slight but statistically significant increase in current expenditures starting five years after the disaster, likely driven by maintenance needs resulting from earlier investments.

In terms of revenue, Figure 2c illustrates the effect of natural disasters on state grants. Municipalities experience a significant increase in grants beginning in the first year following a disaster, with the effect persisting through the fifth year. Additional significant increases are observed in the seventh, eighth, and tenth years. This pattern likely reflects compensation from higher levels of government to support recovery efforts.

On the other hand, Figure 2d shows a persistent increase in tax revenues beginning in the third year after the disaster. Notably, revenue effects appear to be more persistent than expenditure effects: while investment expenditures tend to decline toward the end of the observation period, tax revenues continue to rise.

The event study analysis provides insights into the average treatment effects, revealing that the effects on current expenditures are generally weak and, on average, insignificant. However, these effects are more pronounced and significant for investment expenditures during specific periods. The next step is to explore the heterogeneity of these effects, examining resilience to shocks, and variations by disaster type.

5 Heterogeneity analysis

Table 2: Descriptive statistics of outcomes by groups

	Current Expenditures	**Investment Expenditures**	**Grants**	**Tax Revenues**	**Obs**
Historical risk					
No Historic Risk	574.92 (419.33)	412.93 (657.71)	93.31 (220.19)	243.4 (468.84)	172064
Historic Risk	666.62 (645.21)	487.02 (859.53)	111.85 (270.37)	280.37 (381.42)	583708
Type of shock					
Drought	618.8 (597.05)	466.23 (838.9)	106.7 (246.84)	253.12 (492.18)	350351
Flood	662.13 (699.99)	493.45 (940.76)	115.13 (301.29)	275.11 (478.99)	493471

Heterogeneity by Exposure to Risks

This analysis divides the sample into two groups based on municipalities' historical exposure to natural disasters. The first group comprises municipalities that experienced at least one disaster before the 1999 storms, while the second group includes those with no prior history of catastrophes before this event.

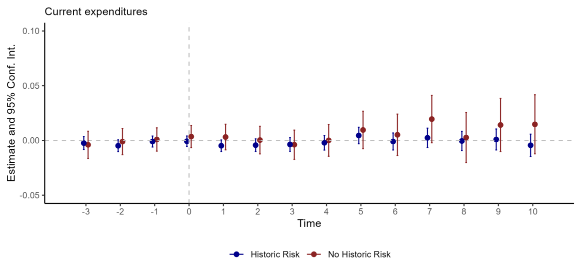
The 1999 storms were a landmark event in France, affecting 27,574 municipalities—nearly 80% of the hexagonal territory. These storms, often remembered as the "storm of the century," remain deeply ingrained in collective memory. They also marked a turning point in how natural disasters were addressed, influencing legislation and the evolution of the "CATNAT" regime (natural disaster declaration).

The goal here is to distinguish between municipalities that had already experienced shocks and were therefore aware of the risks in the decades preceding the study, and those that only became exposed to disasters after this pivotal event.

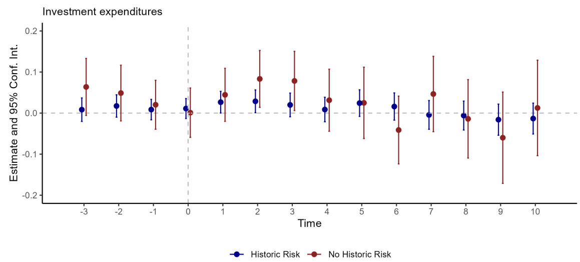
This distinction enables an investigation into whether prior exposure influences municipalities' budgetary responses to subsequent disasters. By differentiating these groups, the analysis aims to shed light on the dynamics of resilience and adaptation developed by municipalities based on their past experiences.

Figure 3: Effect of Natural Disasters on Local Budget Accounts by Historical Risk Exposure

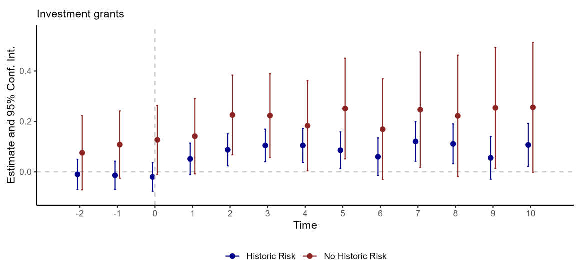
(a) Current expenditures



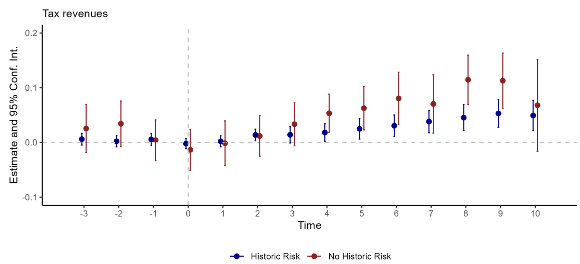
(b) Investment expenditures



(c) Grants



(d) Tax revenues



Notes: Estimation of the dynamic effect of a major natural disaster on the budgetary accounts of French municipalities with robust standard errors, using a dCMDH staggered DiD event study methodology with non binary treatment.

Figures 3 present the event study results for the two samples. In terms of expenditures, municipalities with a history of risk appear to spend less than those without such a history. Municipalities without prior exposure to risks increase their investment expenditures following the disaster and continue to do so for up to three years.Figures 3 present the event study results for the two samples.

In terms of expenditures, municipalities with a history of natural disaster exposure appear to spend less than those without such a history. Municipalities without prior exposure increase their investment expenditures following a disaster and continue to do so for up to three years. In contrast, municipalities with a history of shocks show only a slight, statistically insignificant increase in investment spending and do not significantly raise their current expenditures.

Similarly, municipalities without prior exposure tend to experience greater increases in both grants and tax revenues compared to those with a history of natural disasters.

These patterns may suggest that municipalities previously exposed to shocks undertake fewer new expenditures because they had already made significant investments during earlier events and have since become more resilient to the impact of natural disasters.

Heterogeneity by disaster type

There is reason to suspect that heterogeneity exists based on the type of disaster. Natural disasters encompass various types, with the two most significant being floods and droughts. These disasters are both interconnected and fundamentally different in terms of their impact on local public assets. While floods may result in the direct destruction of certain assets, droughts can have more diffuse effects, often due to the expansion and contraction of clay soils, which can cause longer-term structural damage to buildings.

To analyze the specific effects of floods and droughts, two samples are considered. The first includes municipalities that have experienced floods but never droughts, while the second includes municipalities that have experienced droughts but never floods. The control group consists of municipalities that have not experienced any shocks or have not yet entered treatment.

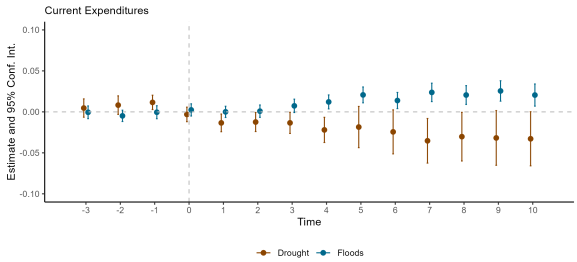
Regarding current expenditures, an increase is observed following floods, while a slight decrease is noted in the case of droughts. The effect of an additional drought appears to reduce current expenditures over the long term. It would be valuable to investigate in more detail which specific components of current expenditures are driving this decline. Notably, operating expenditures are largely composed of staff costs and routine purchases. One possible explanation could be a reduction in municipal staff responsible for maintaining green spaces, as the need for such maintenance diminishes during periods of drought.

Although investment expenditures show an increase in the fifth year after the shock, there is no significant change in the amount of grants received. This raises questions as to whether municipalities affected by droughts face disadvantages in accessing grants, or whether drought-related expenses are simply not eligible for compensation.

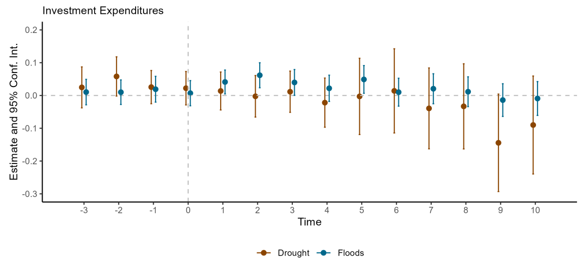
Nonetheless, a long-term increase in tax revenues is observed—reaching levels comparable to, or even exceeding, those seen in the aftermath of floods. This finding is consistent with

Figure 4: Effect of Natural Disasters on Local Budget Accounts by Disaster type: Flood vs. drought

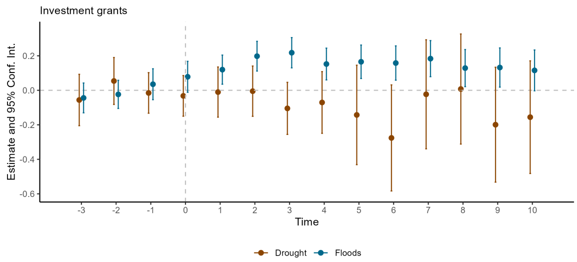
(a) Current expenditures



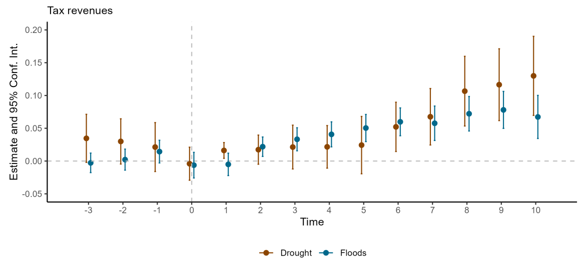
(b) Investment expenditures



(c) Grants



(d) Tax revenues



Notes: Estimation of the dynamic effect of a major natural disaster on the budgetary accounts of French municipalities with robust standard errors, using a dCMDH staggered DiD event study methodology with non binary treatment.

previous results.

6 Discussion and Conclusion

This study investigates how municipalities adjust their budgets in response to natural disasters, focusing on both expenditures and revenues. Natural disasters are significant exogenous climatic events, and their frequency is expected to rise in the coming years. The exogenous nature of these shocks enables an event study approach to identify their causal impact on local government budgets. For this analysis, I use data from French municipal accounts (2000–2022) and records of natural disasters dating back to 1982, examining their effects across various budget categories.

Municipalities, as the level of government closest to citizens, are the first responders in the event of a disaster. They are tasked with ensuring public safety, maintaining essential services, and managing the immediate and long-term consequences of these shocks. When a disaster occurs, municipalities face significant costs: first, they must rescue and protect residents, restore normalcy, and maintain public assets. Subsequently, they undertake reconstruction and repairs, as well as implement measures to mitigate future risks.

The analysis reveals a significant increase in investment expenditures beginning at the time of the shock and persisting for several years. This corresponds to the immediate costs of addressing the disaster and subsequent reconstruction efforts. A few years later, there are smaller increases in current expenditures, reflecting operational needs associated with the new investments.

I also observe an increase in investment grants starting two years after the disaster. This suggests that the central government plays a supportive role in assisting municipalities, as highlighted by studies such as Masiero & Santarossa (2020) and Miao, Hou, et al. (2018). However, grants are not the only tool used by municipalities to offset the rise in expenditures, as there is also an observed increase in tax revenues.

Tax revenues increase for up to ten years following a natural disaster. This rise can be explained in several ways. First, higher tax revenues do not necessarily result from increased tax rates; post-shock investments may stimulate local economic activity and raise the tax base. As Magontier & Martinez-Mazza (2024) explain, floods can lead to immediate and persistent increases in development and urban density in affected areas.

Alternatively, municipalities may seize the opportunity presented by the disaster to raise taxes, as citizens may be more inclined to accept such measures in the aftermath of a crisis. In this context, natural disasters can shift local political preferences or budgetary expectations, temporarily easing resistance to fiscal adjustment.

Another explanation relates to the financial behavior of local governments. Municipalities may seek to rebuild financial buffers in anticipation of future shocks, or to strengthen their fiscal position to meet expected expenditure needs linked to disaster preparedness and recovery. In addition, demonstrating sound financial management—through stable or growing revenues—may help local officials maintain credibility with oversight bodies, constituents, or even higher tiers of government when seeking additional support.

Overall, the sustained increase in tax revenues suggests that natural disasters have long-term fiscal implications beyond immediate recovery, potentially reshaping local financial strategies and priorities.

The average effects observed across all municipalities, however, may conceal important heterogeneity. When grouping municipalities based on their risk history, I find that those with prior exposure to natural disasters are less financially impacted. This suggests that these municipalities may have already made significant investments during earlier shocks, making them more resilient to subsequent disasters.

Similarly, when examining the type of disaster, responses vary. For instance, while the effects of floods are immediate, droughts tend to have more delayed and less persistent effects, likely due to the longer process of disaster recognition and the greater difficulty in accessing grants. This delay highlights the importance of improving support mechanisms for municipalities affected by droughts.

Finally, a key limitation of this study lies in the available data. Natural disasters are represented by a binary indicator, which provides no information on their extent, intensity, or damages. This simplification assumes that all disasters have similar effects, disregarding the diversity in their impacts. By reducing disasters to an indicator variable, I omit key dimensions of their magnitude, which may increase the variance of the estimates and leave endogeneity concerns unresolved. Nevertheless, the use of a difference-in-differences approach with a non-binary treatment represents a significant advancement in understanding the budgetary effects of natural disasters. This method captures the incremental effects of additional disasters, enabling a more nuanced analysis of repeated shocks—an aspect that was not possible with previous approaches.

This study highlights the detrimental effects caused by natural disasters but also underscores the resilience and adaptive capacity of territories. This resilience is a promising indication of the steps local governments are taking to better prepare for and respond to the increasing challenges posed by natural disasters.

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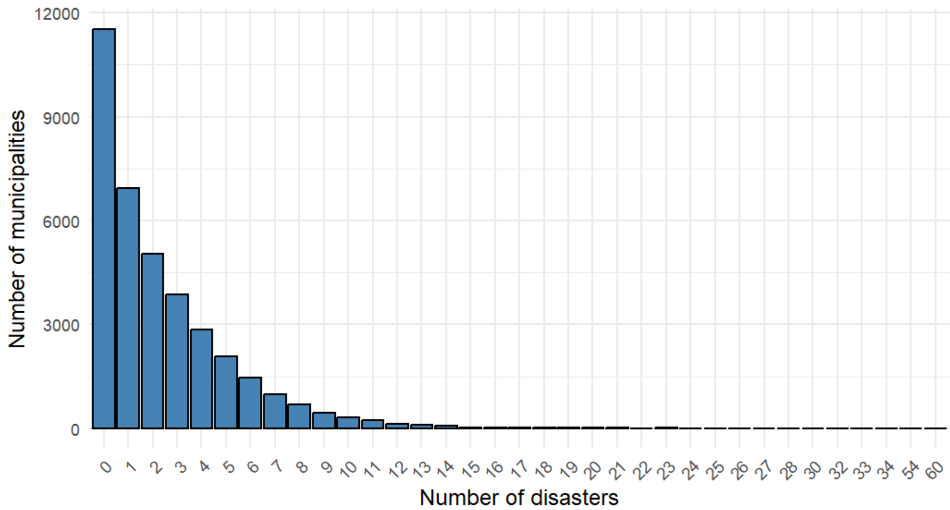
A Appendix

Figure 5: Distribution of the number of disasters per municipality since 2000



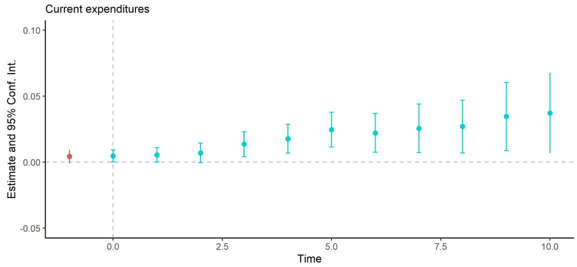
A.1 Additional results

Table 3: Descriptive statistics

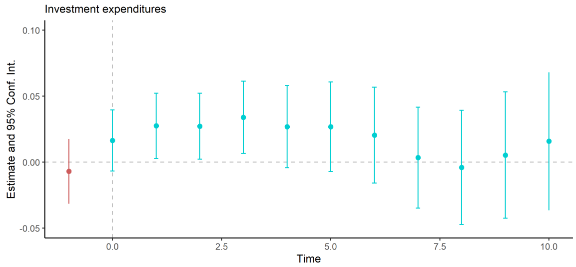
	Full sample		Matched sample		
Variable	**Control**	**Treatment**	**Control**	**Treatment (Pre)**	**Treatment**
Current expenditures	629.11	672.57	594.41	567.31	612.77
	(665.97)	*(569.98)*	*(569.55)*	*(346.82)*	*(366.67)*
Investment expenditures	478.64	464.17	439.40	420.28	422.64
	(929.07)	*(740.03)*	*(780.26)*	*(566.34)*	*(525.35)*
Grants received	109.38	105.63	95.98	94.43	95.72
	(266.71)	*(254.40)*	*(199.26)*	*(175.06)*	*(171.03)*
Tax revenues	255.10	293.24	254.22	239.83	265.47
	(569.56)	*(295.64)*	*(492.14)*	*(202.47)*	*(216.67)*
Total population	569.13	2121.31	661.24	1111.58	1335.75
	(1774.74)	*(10506.01)*	*(1979.57)*	*(3763.49)*	*(4863.67)*
Share of population 65+	0.19	0.19	0.18	0.18	0.19
	(0.10)	*(0.08)*	*(0.08)*	*(0.08)*	*(0.08)*
Median income	18771.61	18849.45	19176.10	16977.10	18701.39
	(4328.77)	*(4150.10)*	*(4164.55)*	*(3854.65)*	*(4050.63)*
Rainfall	593.92	594.98	598.78	611.36	615.27
	(456.36)	*(416.58)*	*(448.40)*	*(420.91)*	*(426.90)*
Maximum temperature	33.05	34.05	33.04	34.65	34.26
	(5.66)	*(5.65)*	*(5.65)*	*(3.19)*	*(5.15)*
PPRN	0.15	0.43	0.19	0.14	0.19
	(0.36)	*(0.50)*	*(0.39)*	*(0.35)*	*(0.39)*
Number of municipalities	11159	25070	7802	7802	7802

Figure 6: Effect of a natural disaster on local budget accounts - CS method

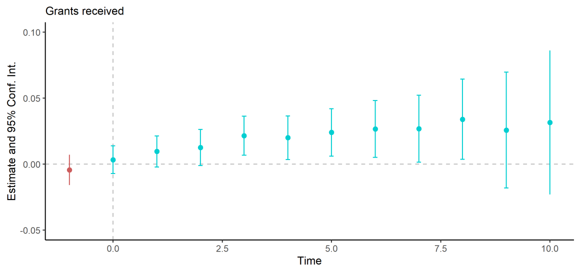
(a) Current expenditures



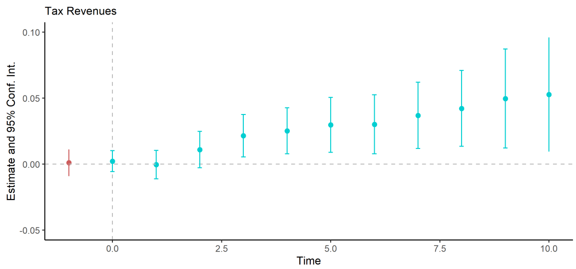
(b) Investment expenditures



(c) Grants



(d) Tax revenues



Notes: These graphs estimate the dynamic effects of a natural disaster on the budgetary accounts of French municipalities using robust standard errors. The methodology is based on a staggered DiD event study with discrete, non-binary treatment.

A.2 Heterogeneity groups

Figure 7: Municipalities by Risk History

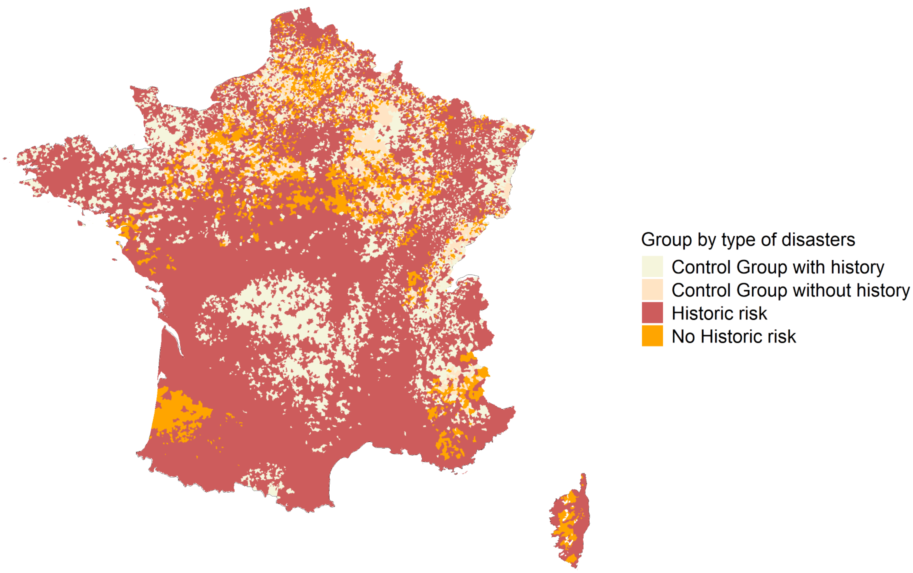


Figure 8: Municipalities by Disaster Types