



**HAL**  
open science

# Natural disasters and voter gratitude: What is the role of prevention policies?

Carla Morvan, Sonia Paty

► **To cite this version:**

Carla Morvan, Sonia Paty. Natural disasters and voter gratitude: What is the role of prevention policies?. 2023. hal-04160167

**HAL Id: hal-04160167**

**<https://hal.science/hal-04160167v1>**

Preprint submitted on 12 Jul 2023

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

WP 2310 – July 2023

## Natural disasters and voter gratitude: What is the role of prevention policies?

Carla Morvan, Sonia Paty

### Abstract:

Natural disasters and related prevention policies can affect voter decisions. In this study, we analyze how the occurrence of natural disasters changes voters' behavior at municipal elections and how prevention policies can mitigate the impact of such catastrophic events on budget accounts and might potentially be rewarded by citizens in upcoming elections. We exploit original data on French municipalities where incumbents sought reelection between 2008 and 2020. To estimate the probability of re-election at the municipal level in the event of a natural disaster we apply a Heckman model based strategy to avoid selection bias. We find that the occurrence of natural disasters significantly decreases the chances of reelection of incumbent mayors. However, although we show that natural hazard prevention plans significantly mitigate the impact of catastrophic events on budget accounts, citizens do not reward such prevention policies in upcoming elections. We confirm the hypothesis of myopia: voters reward incumbents for delivering investment spending or decreasing debt but not for investing in spending on disaster preparedness.

### Keywords:

Elections, natural disasters, prevention policies, natural experiment

### JEL codes:

D72, Q54

# Natural disasters and voter gratitude: What is the role of prevention policies?

Carla Morvan\*      Sonia Paty†

July 10, 2023

## Abstract

Natural disasters and related prevention policies can affect voter decisions. In this study, we analyze how the occurrence of natural disasters changes voters' behavior at municipal elections and how prevention policies can mitigate the impact of such catastrophic events on budget accounts and might potentially be rewarded by citizens in upcoming elections. We exploit original data on French municipalities where incumbents sought reelection between 2008 and 2020. To estimate the probability of re-election at the municipal level in the event of a natural disaster we apply a Heckman model based strategy to avoid selection bias. We find that the occurrence of natural disasters significantly decreases the chances of reelection of incumbent mayors. However, although we show that natural hazard prevention plans significantly mitigate the impact of catastrophic events on budget accounts, citizens do not reward such prevention policies in upcoming elections. We confirm the hypothesis of myopia: voters reward incumbents for delivering investment spending or decreasing debt but not for investing in spending on disaster preparedness.

**Keywords:** Elections, natural disasters, prevention policies, natural experiment. D72, Q54

---

\*Université Lyon 2, CNRS, Université Jean Monnet Saint-Étienne, GATE Lyon Saint-Étienne UMR 5824, F-69130, Ecully, FRANCE. morvan@gate.cnrs.fr

†Université Lyon 2, CNRS, Université Jean Monnet Saint-Étienne, GATE Lyon Saint-Étienne UMR 5824, F-69130, Ecully, FRANCE. sonia.paty@cnrs.fr

# 1 Introduction

Since the 1960s, there has been a tenfold increase in the number of natural disasters across the world (EM-DAT, CRED).<sup>1</sup> The academic literature shows that climatic events can influence voters' perceptions of incumbents in different ways (see contrasting results in e.g. Bechtel and Hainmueller 2011, Ashworth et al. 2018, Gallego 2018, Klomp 2020, Masiero and Santarossa 2021).

On the one hand, there is a large stream of research showing that following a natural disaster citizens punish incumbents at elections (Bovan et al. 2018). Using US data, Achen and Bartels (2012) found that in the 1896-2000 period flood events had a negative effect on electoral support for the incumbent president's party. They explain this effect as the result of egotropic retrospective voting or "blind retrospection", meaning that if voters suffer, incumbents pay at the poll for these bad times, regardless of whether or not they are responsible for the situation. The authors argue that natural disasters often cause resource scarcity which leads to unequal distribution of resources, and therefore low satisfaction with the incumbent. This result has implications for accountability in democracy since it "significantly degrades the efficacy of elections as mechanisms for inducing incumbent leaders to pursue their citizens' subjective well-being" (Achen and Bartels 2016).

However, there is another stream of work showing that in upcoming elections incumbents can take advantage of the occurrence of natural disasters (Masiero and Santarossa 2021). Voters may incorporate elected officials' subsequent relief efforts in their assessment of the candidate (i.e. 'attentive retrospection'). In this case, citizens have an incentive to reward the incumbent who takes action to mitigate the effects of a natural disaster and respond to external shocks to the economy to the benefit of local consumers and business. Also, in developing countries, natural disasters can generate the in-flow of resources in the form of aid which increases the money for buying votes. In Columbia, Gallego (2018) found that such events can favor incumbents since disasters are linked to leader survival through clientelism.

Although there is a large literature which investigates the impact of natural disasters on electoral outcomes, the specific impact of related prevention policies has received less attention. In the context of the United States, Healy and Malhotra (2009) show that voters rewarded the incumbent presidential party for delivering disaster relief spending but not for spending on disaster preparedness. These inconsistencies distort the incentives of public officials, leading governments to under-invest in disaster preparedness, thereby causing substantial public welfare losses.

In this paper, we address the impact of catastrophic events on municipal electoral outcomes controlling for preparedness spending in the form of natural hazard prevention plans. We combine original data from a French natural disasters and prevention policies dataset at the municipal level with data on local public spending and municipal electoral results for 2008 to 2020.

We start by addressing the effect of natural disaster prevention on budget accounts following

---

<sup>1</sup><https://ourworldindata.org/grapher/number-of-natural-disaster-events>

a shock. The empirical literature on natural hazard prevention shows that ex-ante strategies are effective for mitigating damage to households in terms of housing, poverty, and agriculture (Skoufias 2003). However, while some research shows that natural disasters have long-term effects on local government budgets (Morvan 2023, Masiero and Santarossa 2020), few empirical studies have examined the effect of prevention policies on municipal accounts.

We are interested in whether ex-ante disaster prevention policies have an impact on the short-term and long-term budgetary decisions of municipalities, and whether citizens reward incumbents who implement such policies. Using a Heckman model to resolve sample selection bias, we analyze how the reelection probability of incumbent mayors in local elections differs between affected and unaffected municipalities controlling for prevention policies.

Our estimation results show that natural disasters have a negative effect on the reelection of incumbents. However, although we show that natural hazard prevention plans significantly and permanently mitigate the impact of catastrophic events on budget accounts, citizens do not reward prevention policies in upcoming elections. We confirm Sobel and Leeson (2006) hypothesis of myopia: voters reward incumbents for delivering investment spending or decreasing debt before the election year but not for investing in disaster preparedness. Therefore, we confirm the long-term effectiveness of prevention policies when municipalities face natural disasters but show the ineffectiveness of elections as mechanisms to induce incumbent leaders to implement efficient natural disaster prevention.

The remainder of this paper is structured as follows. Section 2 provides an overview of the institutional context in France. Section 3 describes the data and section 4 discusses our identification strategy. Sections 5 and 6 present the results and provide some robustness checks. Section 7 concludes.

## 2 Institutional context

### 2.1 Municipal elections in France

Municipal elections in France allow citizens to elect the city's mayor who chairs the city's council, and the councilors. The usual term of office is six years; the last four municipal elections were held in 2001, 2008, 2014 and 2020.

The election process is related to the size of the municipality. Since a law reform introduced in 2013 which applied to the 2014 municipal council elections the process can take two forms. In municipalities with less than 1,000 inhabitants, the election of municipal councilors involves two voting rounds and is based on majority votes. In the first round, candidates are elected if they receive an absolute majority of the votes cast and the quorum of at least a quarter of the registered voters. In the second round, election is based on a simple majority. In municipalities with more than 1,000 inhabitants election depends on a proportional representation system with a majority premium. The election of councilors involves two rounds and a list system (of candidates) with proportional representation. It should be noted that prior to the 2013 reform, the proportional list system applied only to municipalities with more than 3,500 inhabitants.

Voting is for the most part by municipality with the exceptions of Paris, Marseille, and Lyon (PLM) where voting is by sector (arrondissement).

A particularity of France is that it has around 35,000 municipalities, more than 70% of which include fewer than 1,000 inhabitants. The municipalities are responsible for local roads, schools, sports and cultural facilities, parks and gardens, sewage system maintenance, and waste treatment.

Mayors are responsible for the safety of the local population, and preparation for and organisation of rescue activities in the event of a crisis. Incumbents can be responsible for any damage caused by a natural catastrophe if the appropriate prevention policies were not in place.<sup>2</sup>

## 2.2 Natural disasters

In France, natural disasters refer to a particular type of climatic event. In some specific cases, a major meteorological event may be classed as a natural disaster. Natural disaster status applies to exceptional, high intensity, and non-standard meteorological events such as floods, mudflows, drought, land movements, earthquakes, storms, etc.

The designation of "natural disaster" is decided by ministerial decree following consideration of the arguments proposed by the mayor of the municipality suffering the damage. From the point of view of the citizens, this designation is fundamental since it gives the right to apply for compensation not covered by most insurance policies which exclude most weather damage events. Should the event not be classed as a natural disaster, this might be seen as a failure on the part of the mayor.

The municipality plays an important role during and after a catastrophic event; the mayor is responsible for safety and crisis management, and organising protection and support of the population. The management of a natural disaster can generate additional costs which must be supported by the municipality. For instance, implementation of emergency services is a municipality responsibility and can include transportation, emergency accommodation, and communications.

## 2.3 Natural hazard prevention policies

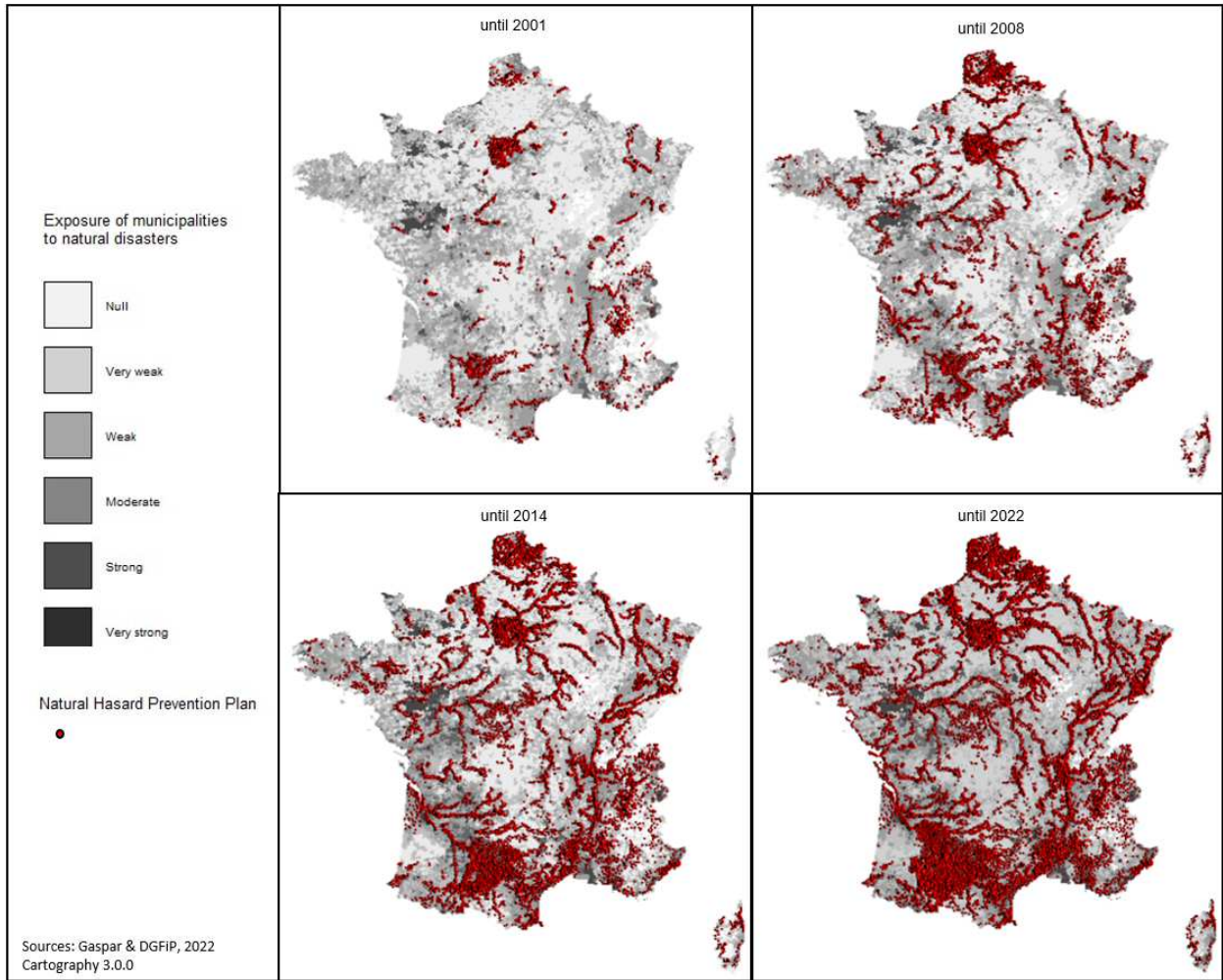
In France, the Plan de Prévention des Risques Naturels or natural hazard prevention plan (NHPP) is aimed at preventing or limiting the impact of a natural disaster (see Morvan 2022). The NHPP defines the rules related to public networks and infrastructures to facilitate evacuation measures or emergency interventions. It also defines the measures related to maintenance of public spaces, and acquisition, management, and maintenance of works and equipment. For example, watercourse development work can be prescribed to prevent flooding.

Thus, the NHPP is an important risk prevention tool in a prevention strategy aimed at delimiting those zones directly exposed to risk and those zones not exposed to direct risk but

---

<sup>2</sup>The mayor of La Faute-sur-Mer in France was sentenced to 2 years in prison after storm Xynthia since he was convicted of manslaughter after the death of 29 inhabitants.

Figure 1: Distribution of natural disasters and prevention plans since 1982



Distribution of natural disasters and prevention plans since 1982. This map shows the total number of approved Natural Hazard Prevention Plan and of natural disaster at the municipal level. This map considers all the natural hazard prevention plans that have been approved since 1982. The dates chosen for the graphic representations are those of the municipal elections. *Source:* Data on Natural Hazard Prevention Plan were provided by the Ministry of Ecology. The cartographic data come from the OpenStreetMap cartographic database constituted from the cadastre made available by the DGFIP (Direction Générale des Finances Publiques).

related to occupations or uses that might aggravate ongoing risks. For instance, the NHHP regulates land uses in areas exposed to hazards.

The overall NHPP is centralized and managed by the prefect ("préfet" in French). Implementation of the NHPP by local authorities is mandatory and must be immediate. The prevention, protection, and safeguarding measures that apply to the zones defined by the NHPP are the responsibility of the local authorities (as part of their general responsibilities) and private individuals.

Implementation of the NHPP measures generates a cost to the municipality. The plan

can require provision of information about natural risks, construction prohibitions, technical requirements related to residential buildings and other specific infrastructures, and investment in risk protection. Municipalities with a NHPP in place can request a specific state grant from the "Barnier" fund (set up to prevent major natural disasters) to cover (up to 50%) of the expenditures related to risk prevention requirements. In extreme cases, the Barnier fund grants compensation for expropriation of property exposed to major risks.

Figure 1 shows the distribution of the Natural Hazard Prevention Plans on the territory between each electoral period. Since 2001, the number of NHPP in place has increased considerably with a third of municipalities subject to a protection plan in 2022 among which 88% implementing a NHPP following experience of a natural disaster. Nevertheless, 60% of municipalities that have suffered a natural disaster do not have a NHPP in place. Most of these municipalities have experienced only a small number of shocks. It can be seen that as the number of shocks to a municipality increases, the proportion of municipalities with no NHPP decreases, and that vice versa the proportion of municipalities with a prevention strategy in place increases with the number of shocks experienced.

Finally, we would emphasize that although the responsibilities related to NHPPs belong to the municipalities, since 2017, several municipalities have joined inter-municipal communities which allows implement of NHPP exploiting a specific tax (GEMAPI or "gestion des milieux aquatiques et prévention des inondations").

### 3 Data

To investigate the impact of a natural disaster on an electoral outcome, we combine several data sets from different institutions.

The first set of data on natural disasters since 1982 and information related to the NHPP were obtained from the GASPARE (Gestion ASsistée des Procédures Administratives relatives aux Risques) or assisted management of risk administrative procedures database, available from the Ecology Ministry. These data provide information on when a municipality was affected by a natural disaster as defined in subsection 2.2. They also provide information on the date and type of shock (drought, floods, seismic events, etc.) but lack information on the intensity of the natural disaster and the damage caused. The GASPARE database provides information on the NHPPs including date of adoption, expertise involved, and types of risk considered.

The data on municipal electoral outcomes were obtained from the Ministry of the Interior and provide demographic information on mayors (e.g. age, gender).

The data include 90,083 observations between 2008 and 2020 of an incumbent mayor running for re-election, among whom 58,535 were re-elected. We create two dummy variables: one for the application to the office of mayor, and one for re-election of the incumbent.

Other data were collected from the following sources. Population data (municipal population and share of people over 65), municipal unemployment rate, and median income are from INSEE (the French national statistic institute). The French municipal accounts database available from the Ministry of Public Accounts (DGFIP) provided information on several variables related to



municipality budget decisions.

To take account of possible integration of the municipality in an inter-municipal union which reduces the power of the mayor, we exploit information on inter-municipal cooperation provided by the Ministry of the Interior. We create a categorical variable that includes three categories: isolated municipalities, i.e. those that do not belong to a group of municipalities, communities of municipalities, i.e. a type of cooperation where municipalities are not very integrated, and integrated groups of municipalities, which include metropolitan areas, urban communities and communities of agglomerations. The reference category will be the communities of municipalities. As already mentioned, the number of inter-municipal communities has increased allowing implementation of NHPP using the GEMAPI tax since 2017. We can control for the existence of a community but unfortunately we do not have information on the possible implementation of a NHPP by inter-municipal unions.

Appendix table 2 presents the descriptive statistics.

## 4 Methodology

### 4.1 The causal impact of natural disasters on municipal budgets

Our first objective is to observe the causal impact of the occurrence of a natural disaster on municipal budgets. Our panel data on municipal budgets (2000-2020) and information on natural disasters allow us to conduct an event study employing a difference-in-differences (DiD) and multiple time periods methodology *à la* Callaway and Sant’Anna (2021).

This methodology enables estimation of the dynamic 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.

To analyze the effects of a natural disaster on the municipal budget, we 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.

The outcome variable is the logarithm<sup>3</sup> of one municipality’s account which could be expenditures, revenues, or grants.

We also consider a vector for municipal characteristics which includes several time-varying financial, socio-demographic and socio-economic covariates. Specifically, these are the logarithms of the municipality’s debts and tax revenues. The socio-economic and socio-demographic variables are population size, share of people aged under 20 years, and the share of people aged over 65 years.

---

<sup>3</sup>The use of the logarithm was chosen according to the literature on econometric models of natural disasters. However, this use led us to perform a transformation on the variables by adding a constant equal to 0.001, in order to lose a minimum of data during the logarithm transformation.

To identify the role of the prevention strategies, we divide the municipalities into two sub-samples according to their prevention strategy. One sub-sample includes municipalities with a prevention plan in place prior to the natural disaster; the other sub-sample includes municipalities with no prevention strategy in place before the shock. Those municipalities with a prevention strategy in place prior to the shock are in the minority, 5,522 versus 28,871.

Our strategy allows us to evaluate the effects of a natural disaster on the budgets of municipalities that had a prevention plan in place and those without a plan which did not anticipate a disaster or its consequences. We also estimate the impact of a natural disaster on the municipal budget using the more conventional two-way fixed effects method.

## 4.2 The causal impact of natural disasters on electoral outcomes

To identify the causal impact of natural disasters on electoral outcomes, we employ a strategy based on a Heckman model. This type of model avoids problems related to selection bias. Before we can investigate whether or not an incumbent mayor will be re-elected, we need to know more about the candidate. The decision of the mayor to run for re-election is likely to be influenced by several factors that will influence his re-election chances. For example, having experienced a natural disaster event while in the position of mayor is likely to influence his or her decision to continue in politics. To estimate this, we use a model *à la* Heckman with two dummy variables where the selection equation considers the incumbent's candidacy and the outcome equation considers re-election.

The selection equation estimates the effect of the covariates on the candidacy of the incumbent mayor,  $candidate_i$  is a dichotomous variable that takes the value 1 if the mayor in municipality  $i$  is seeking re-election and 0 otherwise.

$$Candidate_i = Shock_i\tau_1 + NHPP_i\delta_1 + X_i\beta + \mu_i \quad (1)$$

The outcome equation considers only incumbents standing for re-election. It allows us to estimate the effect on the dichotomous variable  $Reelected_i$  which takes the value 1 if the mayor  $i$  is re-elected.

$$Reelected_i = Shock_i\tau_2 + NHPP_i\delta_2 + X_i\gamma + \nu_i \quad (2)$$

In both stages of the model, the variables of interest are  $Shock_i$  and  $NHPP_i$ . The first is a dummy variable which equals 1 if a natural disaster occurred during the mayor's mandate in municipality  $i$ . The second is a dummy variable for a NHPP and equals 1 if the mayor in municipality  $i$  implemented a NHPP during the term of office. We also consider a vector of the control variables  $X_i$ , which includes several budgetary, political, individual and municipal covariates. We use the mayor's individual characteristics such as age and gender and municipality characteristics such as population, median income, inter-municipal cooperation. We also include budgetary variables such as capital expenditure and debt.

Finally, to enable identification (Wooldridge 2002), in the first equation only we include two additional variables: age squared and the number of candidates. Adding the square of

the variable age allows more accurate modeling of the effect of age which may have a non-linear relationship with being a candidate. We include the number of competitors which might influence the mayor’s choice to run for election again.

Each election is estimated separately and via pooled estimation with a temporal fixed effect for the 2014 election which is the year that the electoral system changed in relation to municipalities with between 3,500 and 1,000 inhabitants.

## 5 Estimation results

### 5.1 Impact of a NHPP on local budget accounts following a natural disaster event

Figure 2: Effect of a natural disaster on expenditure according to the implementation of NHPP

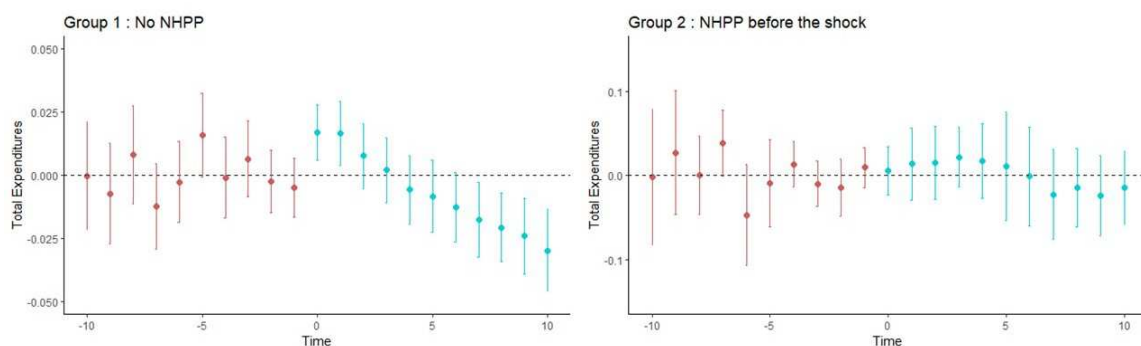
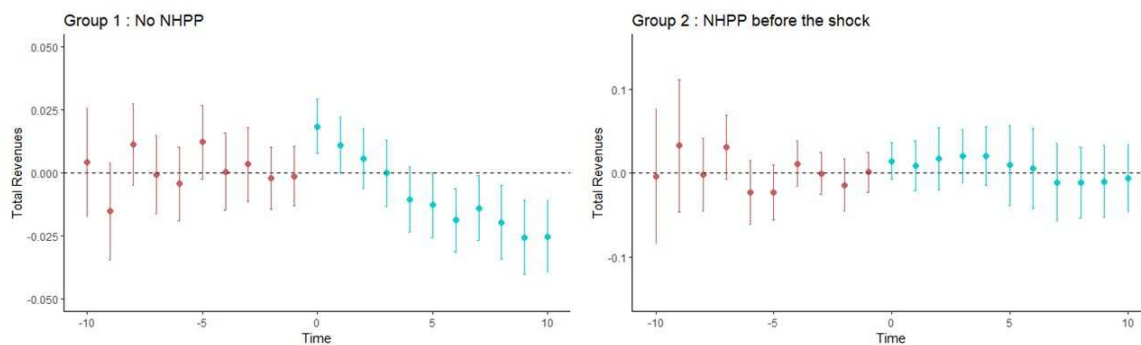
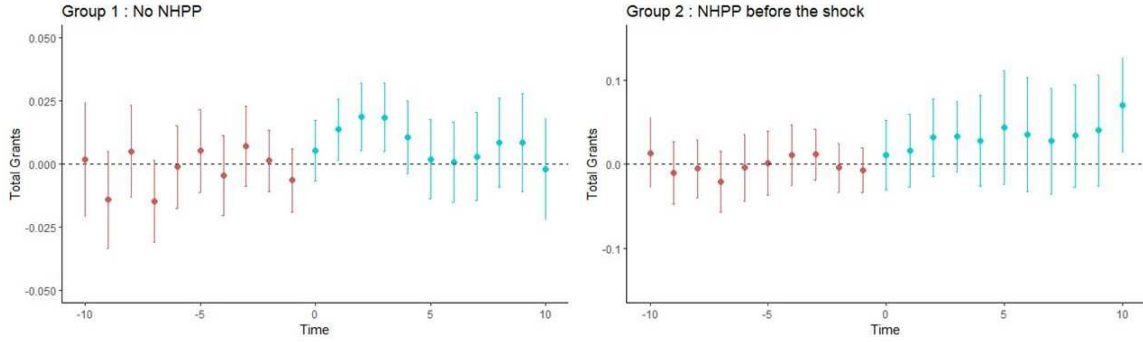


Figure 3: Effect of a natural disaster on revenue according to the implementation of NHPP



Here, we investigate the role of inclusion of a prevention strategy in the municipal budget accounts to respond to a natural disaster (drought, floods, seismic events, etc.) during our period of study (2000-2020). As discussed in Section 2.3, the NHPPs are aimed at encouraging local jurisdictions to invest in risk prevention. They allow for the municipality to access funding to treat territories subject to risks and to provide information for their inhabitants. We assume that municipalities with a NHPP in place are aware of the risks to which they are exposed and that those municipalities with no plan in place or less aware or unaware of such risks. We assume also that being aware of risk could result in a different budgetary situation due to the

Figure 4: Effect of a natural disaster on grants according to the implementation of NHPP



municipality’s better preparedness through prevention and their better ability to mitigate the effects of a catastrophic event by limiting housing construction and by investing in appropriate infrastructures in the most at risk areas.

We analyze the impact of natural disasters on the main budgetary accounts: total expenditure (Figure 2), total revenues (Figure 3), total grants (Figure 4).

Figure 2 shows significant differences between the two groups. Group 1 is composed of 28,871 municipalities with no NHPP in place. Group 2 includes the 5,522 municipalities that have implemented a NHPP. We observe significantly increased expenditures for those municipalities with no pre-disaster prevention strategy although this effect seems to disappear three years after a shock.

However the same shock has no impact on total expenditure in municipalities with a NHPP. These results for total expenditures would indicate that prevention plans have a significant effect on the budgetary decisions related to post-natural disaster management. While municipalities with no prevention strategy experience an increase in their spending in the two or three years after an event, those that anticipated a shock do not suffer the same increase.

Figure 3 focus on total revenues. In municipalities with no NHPP, we observe a significant increase in total revenues in the first two years after a natural disaster event followed by a significant decrease. In contrast, in municipalities with a pre-disaster prevention strategy, we observe no significant change following a disaster event.

These results show that despite the costs related to a prevention strategy, a natural disaster generates a decrease in total revenues likely due to a reduction in tax revenues following a disaster. However, our data do not allow us to disentangle types of revenue.

Figure 4 shows the effects of natural disasters on total grants. We find that municipalities with no pre-disaster prevention plan experience a small but significant increase in the amount of state grants during three years after the shock, likely due to the compensation to fund expenditure on recovery.

In contrast, municipalities with a NHPP in place do not received increased grants. We can conclude that those municipalities that anticipated the shock do not need grant aid in the short term due to their disaster mitigation measures. The increased demand by municipalities that did not anticipate a shock can be explained by the need for finding for new urgent investment

to improve protection strategies.

Appendix table 3 presents the two way fixed effect estimation results. It can be seen that they are consistent with the DiD estimations with multiple treatment periods.

Our results confirm the effectiveness of natural hazard prevention plans for mitigating the impact of natural disasters on municipal budget accounts. Municipalities with no prevention strategy experience significant problems related to recovering from a catastrophic event and absorbing the related shock. Crisis management seems more difficult and requires more budgetary resources.

These results are in line with those of Morvan (2023) for the French case and Masiero and Santarossa (2020) for the Italian case, which show that over the long term municipal budgets are affected. In contrast, municipalities covered by a NHPP do not experience the same impact on their budgetary positions. Prevention has a positive effect on the ability of municipalities to recover from a shock which offers opportunities for public policy.

## 5.2 Evidence on the impact of natural disasters on electoral outcomes

We investigate the impact of natural disasters on electoral outcomes for all incumbent mayors standing for re-election between 2008 and 2020.

The first part of table 1 presents the selection equation estimation results i.e. the probability of standing for election again. The second part of table 1 presents the outcome equation estimates for the probability of being re-elected. The first two columns present the results of the pooled estimates i.e. all mayors across all elections, and the third, fourth, and fifth columns represent the 2020, 2014, 2008 municipal elections.

The first part of table 1 presents the estimation results for a probit model for the probability that the incumbent mayor will run for re-election. We observe no significant effect of a natural disaster event on the decision to run for re-election, and also observe no effect of the existence of a NHPP on any election year.

However, in the case of the pooled data, we find significant results for the interaction of a shock with implementation of a NHPP. The probability of being candidate is higher for incumbents who implemented a prevention plan and have experienced a natural disaster.

In line with the findings in the literature (Cassette et al. 2013), we confirm that the municipal budget position plays a significant role in the willingness of a mayor to stand for re-election. As expected, we found a positive impact of investment spending and a negative effect of debt on the probability of running for mayor. Moreover, the results show that the mayor's characteristics have an influence; it seems that gender and age have an influence on the decision to run for re-election with male mayors and older mayors more keen to be re-elected. Finally, the number of competing candidates seems to have an ambiguous effect which can be positive or negative depending on the election considered.

The second part of table 1 estimates the second step of the Heckman model i.e. the probability of re-election. In the case of re-election, the estimation results show that both experiencing a natural disaster and having prevention plans have significant effects. For each election, we

find that a shock event has a negative effect on the probability of reelection. The electorate tends to punish the incumbent if a natural disaster event occurred during his or her previous term.

We observe also that natural hazard prevention plans have a negative effect on re-election probability. However, the coefficient of the interaction between prevention plan and disaster is not significant which means that citizens penalize mayors who implemented prevention plans whether or not a natural disaster event occurred in their municipality. This result might be due to several mechanisms.

First, prevention policies might be misunderstood by inhabitants; they might consider them ineffective or unimportant or as costly since a NHPP implies some prohibitions on construction, some technical requirements for residential buildings, and specific infrastructures to protect against risk. Housing values are likely to be reduced if a municipality is identified officially as prone to a natural disaster and house buyers are always informed of potential risks during housing transactions.

As in the first part of table 1, the budget variables seem to have an effect on re-election, and especially debt which we observe has a significant negative effect. Investment spending has a positive impact on reelection but only in 2008. Finally, the characteristics of the incumbent mayor have an effect on re-election. Male gender and older age seem to favor re-election.

## 6 Robustness checks

### 6.1 Impact of natural disasters on municipal budget accounts

We conducted several tests to demonstrate the robustness of our results for the impact of natural disasters on municipalities' budgetary responses. First, we conducted a falsification test to check for the presence of a placebo effect. To detect any possible effect, we performed the same regressions as conducted for the baseline results observing the year prior to the shock.

Clearly, there is no significant effect in the pre-shock periods on the graphs 2, 3 and 4. We also perform the TWFE regressions as for the baseline results by observing the year prior to the shock, to detect a possible effect (appendix table 4) The results of this test show that there is no significant effect on municipal accounts in the year before the shock.

Moreover, the common trend hypothesis is verified from Figures 5 and 6 in Appendix. For this purpose, two graphs were made for the two sub-samples: municipalities with a NHPP and municipalities without a NHPP, and we observe the pre-shock trends for the control and treatment groups.

One of the limitations of our research is that we do not control for the intensity of the natural disaster events. It might be argued that large scale disasters will have a different effect from low intensity shocks. However, the data available from GASPAR do not provide information on the intensity of or the damage caused by the disaster.

To try to address this problem, we constructed a restricted sample of municipalities affected by storm Xynthia which was an exceptionally violent European windstorm that occurred in

Table 1: Heckman Model - Occurrence of natural disaster during the electoral cycle

	Pool		2020		2014		2008	
<i>Selection equation : candidate (0 or 1)</i>								
Shock	-0.004 (0.013)	-0.018 (0.014)	-0.011 (0.017)	-0.011 (0.018)	-0.007 (0.029)	-0.019 (0.032)	-0.022 (0.038)	-0.038 (0.041)
NHPP	-0.028 (0.018)	-0.072** (0.025)	-0.039 (0.025)	-0.040 (0.035)	0.022 (0.036)	-0.005 (0.049)	0.005 (0.050)	-0.040 (0.069)
Shock × NHPP		0.090* (0.036)		0.001 (0.049)		0.057 (0.072)		0.098 (0.099)
log(InvExpand)	0.080*** (0.006)	0.080*** (0.006)	0.070*** (0.008)	0.070*** (0.008)	0.103*** (0.015)	0.103*** (0.015)	0.121*** (0.020)	0.121*** (0.020)
log(Debt)	-0.009*** (0.002)	-0.009*** (0.002)	0.002 (0.003)	0.002 (0.003)	-0.016* (0.008)	-0.016* (0.008)	-0.003 (0.007)	-0.003 (0.007)
EPCI (Integrated)	-0.009 (0.015)	-0.009 (0.015)	-0.004 (0.019)	-0.004 (0.019)	0.006 (0.032)	0.006 (0.032)	0.132** (0.051)	0.133** (0.051)
EPCI (Isolated)	-0.064 (0.064)	-0.065 (0.064)			0.516 (0.298)	0.517 (0.298)	0.033 (0.069)	0.033 (0.069)
log(Median Income)	0.005 (0.013)	0.005 (0.013)	-0.012 (0.014)	-0.012 (0.014)	-0.149 (0.102)	-0.150 (0.102)	0.000 (0.098)	-0.001 (0.098)
Inc. gender (M)	0.268*** (0.016)	0.268*** (0.016)	0.279*** (0.021)	0.279*** (0.021)	0.320*** (0.038)	0.320*** (0.038)	0.308*** (0.053)	0.309*** (0.053)
Inc. age	0.011* (0.005)	0.011* (0.005)	0.009 (0.007)	0.009 (0.007)	0.003 (0.013)	0.003 (0.013)	0.019 (0.016)	0.018 (0.016)
Inc. age <sup>2</sup>	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000* (0.000)	0.000* (0.000)	0.000 (0.000)	0.000 (0.000)
Nb. competitors	0.018*** (0.001)	0.018*** (0.001)	-0.003* (0.001)	-0.003* (0.001)	0.220*** (0.004)	0.220*** (0.004)	-0.030*** (0.003)	-0.030*** (0.003)
Control for 2014 election	0.704*** (0.014)	0.704*** (0.014)						
Constant	-1.600*** (0.208)	-1.597*** (0.208)	-1.144*** (0.243)	-1.143*** (0.243)	-0.196 (1.081)	-0.181 (1.081)	-1.699 (1.053)	-1.673 (1.053)
<i>Outcome equation : Reelection (0 or 1)</i>								
Shock	-0.140*** (0.017)	-0.140*** (0.019)	-0.126*** (0.023)	-0.125*** (0.024)	-0.155*** (0.029)	-0.158*** (0.032)	-0.139** (0.047)	-0.127* (0.050)
NHPP	-0.120*** (0.022)	-0.120*** (0.032)	-0.109*** (0.032)	-0.108* (0.046)	-0.163*** (0.035)	-0.170*** (0.050)	0.007 (0.057)	0.053 (0.086)
Shock × NHPP		-0.004 (0.044)		-0.002 (0.063)		0.013 (0.070)		-0.077 (0.117)
log(InvExpand)	0.019* (0.008)	0.019* (0.008)	0.011 (0.012)	0.011 (0.012)	-0.005 (0.016)	-0.005 (0.016)	0.141*** (0.023)	0.142*** (0.023)
log(Debt)	-0.044*** (0.005)	-0.044*** (0.005)	-0.023*** (0.005)	-0.023*** (0.005)	-0.125*** (0.017)	-0.125*** (0.017)	-0.015 (0.009)	-0.015 (0.009)
EPCI (Integrated)	-0.240*** (0.020)	-0.240*** (0.020)	-0.097*** (0.024)	-0.097*** (0.024)	-0.448*** (0.031)	-0.448*** (0.031)	0.000 (0.060)	-0.000 (0.061)
EPCI (Isolated)	-0.058 (0.087)	-0.058 (0.087)			-0.959*** (0.192)	-0.960*** (0.192)	0.048 (0.083)	0.049 (0.083)
log(Median Income)	-0.052* (0.020)	-0.052* (0.020)	-0.026 (0.019)	-0.026 (0.019)	-0.371*** (0.102)	-0.371*** (0.102)	0.147 (0.115)	0.152 (0.116)
Inc. gender (M)	0.158*** (0.022)	0.158*** (0.022)	0.194*** (0.031)	0.194*** (0.031)	0.044 (0.039)	0.044 (0.039)	0.352*** (0.065)	0.350*** (0.065)
Inc. age	0.027*** (0.001)	0.027*** (0.001)	0.024*** (0.002)	0.024*** (0.002)	0.031*** (0.002)	0.031*** (0.002)	0.050*** (0.003)	0.050*** (0.003)
Control for 2014 election	0.033 (0.020)	0.033 (0.020)						
Constant	0.512* (0.220)	0.514* (0.220)	0.270 (0.228)	0.270 (0.228)	4.296*** (1.028)	4.299*** (1.028)	-4.868*** (1.154)	-4.919*** (1.158)
Observations	54920	54920	27724	27724	21406	21406	5790	5790
Log Likelihood	-38549.54	-38546.2	-21741.8	-21741.8	-9599.735	-9599.334	-4821.774	-4820.22
$\rho$	-0.792 (0.092)	-0.794 (0.093)	-0.878 (0.144)	-0.878 (0.144)	-0.857 (0.027)	-0.856 (0.027)	0.905 (0.038)	0.903 (0.038)

Note : \*p<0.05; \*\*p<0.01; \*\*\*p<0.001 ; All control variables are listed in the table above. Heteroskedasticity-consistent Standard errors in parentheses, clustered at the municipal level.

2010. Storm Xynthia crossed Western Europe between February 27th and March 1st 2010. The storm surge combined with high tides and large waves caused flood defenses along western

France to fail. Over 50,000 ha of land were flooded and 47 people died as a result of the storm. Although the French departments of Vendée and Charente-Maritime suffered the most damage, it has been estimated that the damage caused by the flooding cost in excess of €1.2 billion (Lumbroso and Vinet 2011). This event allows us to use a TWFE model without the difficulty of multiple periods. Our estimation results are in line with the previous ones (see appendix table 5).

In addition, we aim to analyze intensity via the EM-DAT database (International Disaster Database, CRED). This database selects disasters of extreme intensity. We then estimate the DiD model by considering only these extreme events, and observe results of a similar magnitude to the baseline (see figures 7, 8 and 9 in Appendix).

Finally, as a last robustness check, we test whether the results would change depending on the nature of natural disaster - flood or drought (table 6). Here, we use the TWFE method for lack of data to apply the multiple-period DiD method. The treatment assignment is based on the type of disaster. We chose to observe flood events and drought events which are the most frequent and contrasting disaster events experienced in France. The results for floods are in line with the basic results, with a slightly more intense effect than if we consider all types of disaster. However, in the case of droughts, the impact on spending is not significant which might be because droughts have a different short-term impact on municipalities compared to floods. For instance, flooding might require evacuation of the population and might cause immediate material damage while a drought affects mainly agriculture and housing over the long-term which does not require the same budget response from the municipality.

## 6.2 Impact of natural disasters on municipal electoral outcomes

To check our results for the effect of natural disasters on electoral results, we analyze their sensitivity. We are first interested in the timing of natural disaster with respect to the election. We assume that the closer the shock to the municipal elections, the greater will be its impact on voters' choices. In this section, our variables of interest are related not only to shocks that occurred during the electoral cycle but also those that occurred one, two, and three years before the election. Table 7 presents the results for these different shock definitions. The estimated results confirm that a disaster has a significant and negative impact on re-election of the mayor and on prevention plans, with a slightly greater intensity if the disaster occurred in the middle of the mayoral term.

We checked the sensitivity of our results to disaster intensity. Again, the data do not allow a measure of shock intensity. However, the EM-DAT (International Disaster Database, CRED) data allow us to identify particularly intense disasters (Xynthia storm, Roya flooding, etc.) Merging our data provides information on the municipalities affected by these major disasters.

Table 8 presents the results for these intense disasters. We observe that these major disaster events have a negative and significant effect on mayor re-election which is of the same magnitude as in the classical case.

To refine our results, we performed the same analysis but focusing only on two types of dis-



asters: flood and drought (appendix table 9). In contrast to the results for budgets, we observe that regardless of the type of disaster, its effect on re-election is negative and significant. We also examined the effects of heterogeneity across municipalities and voting types. We examined municipalities governed by a proportional list system (table 10), and municipalities governed by a multi-member system (table 11), which include the smallest municipalities.

To further refine the analysis, among the largest municipalities, i.e. those with a proportional list system, we analyzed sub-samples based on numbers of inhabitants (more than 10,000 inhabitants, between 10,000 and 3,500, and less than 3,500 inhabitants). Table 10 shows that among the largest communes those with fewer than 3,500 inhabitants experience a positive and significant effect. Those with more than 3,500 inhabitants show no effect of a natural disaster on re-election. However, the budgetary variables and the mayor's characteristics play a role.

We also analyzed the effect of a natural disaster on the smallest municipalities, i.e. those with less than 1,000 inhabitants after 2014 and less than 3,500 inhabitants in 2008. This is a special case since most incumbent mayors run again which rules out use of a two-stage model. We chose a classical probit model. Table 11 shows that the shock has a negative effect on the probability of reelection, while the investment and mayor characteristics are significantly positive.

Finally, we excluded the control variables to avoid possible endogeneity caused by the natural disaster on the other variables. Indeed, a natural disaster affects municipality budgets which might bias the estimated effect of these variables on candidacy and reelection. When we removed the budget variables, the magnitude of the effects of the shock did not change (appendix table 12).

## 7 Conclusion

In this study, we investigated the causal impact of natural disasters on electoral outcomes using French municipal data. We applied a Heckman model based strategy to avoid selection bias and to estimate the probability of re-election at the municipal level in the event of a natural disaster.

We analyzed all French municipalities over three municipal elections, 2008, 2014, and 2020. The advantage of such a model is that it allows us to account for the endogeneity of the individual incumbent mayor's decision to run again or not.

We find that the occurrence of heterogeneous natural disasters significantly reduces the re-election chances of incumbent mayors. This result are in line with those in Gasper and Reeves (2011) and show that French voters are a responsive electorate or (to use Achen and Bartels 2016's terminology) are egotropic retrospective voters, i.e. they react to events without observing the responsibilities of leaders.

Although we show that a NHPP has a very strong and positive effect on local budget accounts citizens do not reward the putting in place of such prevention policies when they vote. Mayors with municipal prevention strategies in place experienced a reduced chance of re-election. This supports the idea of myopia: voters reward incumbents for delivering investment spending or

reducing debt but penalize them for investing in disaster preparedness.

In contrast to Healy and Malhotra (2009), who proposed the myopia hypothesis without seeing any significant effect of preventive spending, here we find a negative effect. Not only voters do not perceive the short-term and long-term benefits of prevention policies on local budgets they also punish decision-makers for implementing costly policies, and construction rules and regulations which might decrease the value of their housing. This last finding needs more investigation using data on housing prices and prevention policies. However, in the context of public policy, we provide evidence of lack of efficacy of elections to persuade incumbent mayors to implement efficient natural disaster prevention measures.

## **8 Acknowledgements**

We are grateful to Frédéric Jouneau, Benjamin Monnery and Benoît Mulkay. We would also like to thank all the participants at seminars and conferences at which this paper was presented for their valuable comments.

## References

- Achen, C. H. and L. M. Bartels (2012). “Blind Retrospection: Why shark attacks are bad for democracy”. In: (*Unpublished manuscript*). *Center for the Study of Democratic Institutions, Vanderbilt University.*, p. 36.
- Achen, C. H. and L. M. Bartels (2016). “Chapter Five. Blind Retrospection: Electoral Responses to Droughts, Floods, and Shark Attacks”. In: Princeton University Press, pp. 116–145.
- Ashworth, S. et al. (2018). “Learning about Voter Rationality”. In: *American Journal of Political Science* 62.1, pp. 37–54.
- Bechtel, M. M. and J. Hainmueller (2011). “How Lasting is Voter Gratitude? An Analysis of the Short- and Long-Term Electoral Returns to Beneficial Policy”. In: *American Journal of Political Science* 55.4, pp. 852–868.
- Bovan, K. et al. (2018). “Do Natural Disasters Affect Voting Behavior? Evidence from Croatian Floods”. In: *PLoS Currents*.
- Callaway, B. and P. H. C. Sant’Anna (2021). “Difference-in-Differences with multiple time periods”. In: *Journal of Econometrics*. Themed Issue: Treatment Effect 1 225.2, pp. 200–230.
- Cassette, A. et al. (2013). “Two-round elections, one-round determinants? Evidence from the French municipal elections”. In: *Public Choice* 156.3, pp. 563–591.
- Gallego, J. (2018). “Natural disasters and clientelism: The case of floods and landslides in Colombia”. In: *Electoral Studies* 55, pp. 73–88.
- Gasper, J. T. and A. Reeves (2011). “Make It Rain? Retrospection and the Attentive Electorate in the Context of Natural Disasters”. In: *American Journal of Political Science* 55.2. Publisher: [Midwest Political Science Association, Wiley], pp. 340–355.
- Healy, A. and N. Malhotra (2009). “Myopic Voters and Natural Disaster Policy”. In: *American Political Science Review* 103.3, pp. 387–406.
- Klomp, J. (2020). “Election or Disaster Support?” In: *The Journal of Development Studies* 56.1, pp. 205–220.
- Lumbroso, D. M. and F. Vinet (2011). “A comparison of the causes, effects and aftermaths of the coastal flooding of England in 1953 and France in 2010”. In: *Natural Hazards and Earth System Sciences* 11.8. Publisher: Copernicus GmbH, pp. 2321–2333.
- Masiero, G. and M. Santarossa (2020). “Earthquakes, grants, and public expenditure: How municipalities respond to natural disasters”. In: *Journal of Regional Science* 60.3, pp. 481–516.
- Masiero, G. and M. Santarossa (2021). “Natural disasters and electoral outcomes”. In: *European Journal of Political Economy* 67, p. 101983.
- Morvan, C. (2022). “Municipalities’ budgetary response to natural disasters”. In: *Working Paper GATE, 2022-06*.
- Morvan, C. (2023). “Les réponses budgétaires des municipalités aux catastrophes naturelles”. In: (*forthcoming*) *Revue Economique*.

- Skoufias, E. (2003). “Economic crises and natural disasters: Coping strategies and policy implications”. In: *in World Development*. Vol. 31, No 7, pp. 1087–1102.
- Sobel, R. S. and P. T. Leeson (2006). “Government’s response to Hurricane Katrina: A public choice analysis”. In: *Public Choice* 127.1, pp. 55–73.
- Wooldridge, J. M. (2002). *Econometric analysis of cross section and panel data*. Cambridge and London: MIT Press.

## 9 Appendices

### 9.1 Descriptive statistics

Table 2: descriptive statistics

FULL SAMPLE	Obs.	Mean	Std Dev	Min	Max
<b>Political variables</b>					
1 if the incumbent is candidate	90,083	0.67	0.47	0	1
1 if the incumbent is reelected	100,282	0.58	0.49	0	1
Incumbent share of votes (at the decisive round)	76,098	75.78	14.43	26.83	99.78
<b>Natural disasters and prevention variables</b>					
1 if a natural disaster occurred during the election cycle	107,158	0.33	0.47	0	1
1 if a natural disaster has occurred in the year preceding the election	107,158	0.12	0.33	0	1
1 if the incumbent has implemented a prevention plan	108,133	0.12	0.33	0	1
<b>Spending variables</b>					
Investment expenditure (per capita)	107,158	448.7	704.98	0	58,888
Debt of the municipality (per capita)	107,158	599.5	1242.37	0	158,577
<b>Incumbent controls</b>					
Mayor's vote share at the previous election	34,987	75.34	15.34	15.79	100
1 if the mayor was elected in the first round of the preceding election	34,988	0.95	0.21	0	1
Number of consecutive mandates	104,202	0.96	1.12	0	6
<b>Mayor's characteristics</b>					
Age of incumbent mayor	85,710	58.45	9.54	20	98
1 if the incumbent is a man	103,045	0.83	0.37	0	1
<b>Municipal characteristics</b>					
Population	107,158	1,729	10,794.87	1	859,367
Median income	98,089	21,628.8	9,329	12.8	354,406
Type of inter-municipal cooperation :	107,156				
• isolated municipality	86,386				
• community of municipalities	2,889				
• highly integrated municipalities	17,512				

### 9.2 Robustness check - Part 1

#### 9.2.1 Two way Fixed Effect model

Table 3: Impact of natural disasters on local government accounts according to their adherence to a Natural Hazard Prevention Plan

	<i>Fixed Effect model - Within Estimator</i>							
	Total Expenditure		Total Revenues		Total grants		Debt	
	NHPP	No NHPP	NHPP	No NHPP	NHPP	No NHPP	NHPP	No NHPP
	<b>Full sample</b>							
Shock <sub>τ</sub>	-0.006 (0.004)	0.010*** (0.002)	-0.007* (0.004)	0.009*** (0.002)	0.008 (0.007)	-0.003 (0.003)	0.007 (0.032)	0.038** (0.015)
Shock <sub>τ-1</sub>	0.002 (0.005)	0.007*** (0.002)	-0.001 (0.004)	0.005** (0.002)	0.012 (0.008)	0.004 (0.003)	0.020 (0.035)	0.042** (0.016)
Shock <sub>τ-2</sub>	0.002 (0.005)	0.006** (0.002)	-0.001 (0.005)	0.004** (0.002)	0.009 (0.008)	0.017*** (0.003)	0.035 (0.038)	0.041** (0.018)
Shock <sub>τ-3</sub>	-0.003 (0.005)	0.006** (0.002)	-0.004 (0.005)	0.004* (0.002)	0.009 (0.009)	0.017*** (0.004)	0.006 (0.040)	0.042** (0.019)
Shock <sub>τ-4</sub>	0.0003 (0.006)	0.003 (0.003)	-0.001 (0.006)	0.001 (0.002)	0.008 (0.011)	0.015*** (0.004)	0.042 (0.042)	0.030 (0.019)
Shock <sub>τ-5</sub>	-0.006 (0.006)	0.004 (0.003)	-0.012** (0.006)	0.002 (0.002)	0.010 (0.011)	0.010*** (0.004)	0.034 (0.047)	0.021 (0.020)
Shock <sub>τ-6</sub>	-0.0004 (0.007)	0.002 (0.003)	-0.011* (0.006)	-0.001 (0.003)	0.003 (0.012)	0.012*** (0.004)	0.007 (0.052)	-0.001 (0.021)
Shock <sub>τ-7</sub>	-0.011 (0.007)	0.003 (0.003)	-0.007 (0.007)	0.004 (0.003)	0.012 (0.012)	0.013*** (0.004)	0.029 (0.055)	-0.005 (0.022)
Shock <sub>τ-8</sub>	-0.001 (0.008)	-0.003 (0.003)	-0.002 (0.008)	0.001 (0.003)	0.018 (0.012)	0.013*** (0.005)	0.0002 (0.058)	-0.025 (0.022)
Shock <sub>τ-9</sub>	-0.013 (0.008)	0.003 (0.003)	-0.006 (0.008)	-0.001 (0.003)	0.036*** (0.013)	0.014*** (0.005)	0.044 (0.061)	-0.039* (0.022)
Shock <sub>τ-10</sub>	-0.001 (0.010)	0.002 (0.004)	-0.005 (0.009)	0.001 (0.003)	0.029* (0.017)	0.009 (0.005)	0.055 (0.062)	-0.005 (0.022)
Observations	103,706	525,538	103,706	525,538	103,706	525,538	103,706	525,538
R <sup>2</sup>	0.158	0.190	0.194	0.242	0.104	0.108	0.010	0.010
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipalities fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Financial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socio-economic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socio-demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Institutional controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*Note* : \*p<0.05; \*\*p<0.01; \*\*\*p<0.001 ; All models control for budgetary time-variant characteristics (revenues from local taxation, from grants and from loans), political (years before elections), institutional (type of inter-municipal cooperation, state fixed effect), socio-economic (median income and percent of unemployment) and socio-demographic factors (population size, percent of young, and percent of old population), and year fixed effects. Heteroskedasticity-consistent Standard errors in parentheses, using White's covariance matrix. The sample of municipalities with a NHPP contains only those municipalities that had a natural hazard prevention plan before the occurrence of a natural disaster. In contrast, the municipalities in the "no NHPP" sample are those that did not have a prevention plan before the disaster occurred. However, some of them have put in place a NHPP after the shock.

## 9.2.2 Placebo test and common trend

Table 4: Placebo test

	Full Sample				Xynthia Sample			
	Total Expenditure		Total Revenues		Total Expenditure		Total Revenues	
	NHPP	No NHPP	NHPP	No NHPP	NHPP	No NHPP	NHPP	No NHPP
Shock <sub><math>\tau+1</math></sub>	-0.0002 (0.005)	0.003 (0.003)	-0.002 (0.005)	0.005 (0.002)	0.054 (0.033)	0.001 (0.009)	0.046 (0.032)	-0.003 (0.008)
Shock <sub><math>\tau</math></sub>	-0.005 (0.004)	0.010*** (0.002)	-0.004 (0.004)	0.009*** (0.002)	0.0001 (0.022)	0.009 (0.007)	-0.015 (0.023)	0.009 (0.006)
Shock <sub><math>\tau-1</math></sub>	0.003 (0.004)	0.007*** (0.002)	0.001 (0.004)	0.005*** (0.002)	0.015 (0.025)	0.016* (0.007)	0.001 (0.024)	0.007 (0.006)
Shock <sub><math>\tau-2</math></sub>	0.004 (0.005)	0.006*** (0.002)	0.001 (0.004)	0.004* (0.002)	0.011 (0.025)	0.028*** (0.007)	-0.001 (0.025)	0.018* (0.007)
Shock <sub><math>\tau-3</math></sub>	-0.002 (0.005)	0.005* (0.002)	-0.002 (0.005)	0.004 (0.002)	-0.004 (0.026)	0.021*** (0.008)	-0.022 (0.023)	0.021*** (0.007)
Shock <sub><math>\tau-4</math></sub>	0.002 (0.005)	0.003 (0.002)	0.001 (0.005)	0.001 (0.002)	0.016 (0.030)	0.030*** (0.008)	0.042 (0.031)	0.025*** (0.007)
Shock <sub><math>\tau-5</math></sub>	-0.004 (0.005)	0.004 (0.002)	-0.010 (0.005)	0.002 (0.002)	-0.019 (0.029)	0.025*** (0.008)	-0.019 (0.033)	0.015 (0.008)
Observations	113,405	515,866	113,405	515,866	39,378	187,680	39,378	187,680
R <sup>2</sup>	0.154	0.191	0.189	0.244	0.032	0.038	0.043	0.047

*Note* : \*p<0.05; \*\*p<0.01; \*\*\*p<0.001; All models control for financial time-variant characteristics (revenues from local taxation, from grants and from loans), political (years before elections), institutional (type of inter-municipal cooperation, state fixed effect), socioeconomic (median income and percent of unemployment) and socio-demographic factors (population size, percent of young, and percent of old population), and year fixed effects. Heteroskedasticity-consistent Standard errors in parentheses, using White's covariance matrix. The sample of municipalities with a NHPP contains only those municipalities that had a natural hazard prevention plan before the occurrence of a natural disaster. In contrast, the municipalities in the "no NHPP" sample are those that did not have a prevention plan before the disaster occurred. However, some of them have put in place a NHPP after the shock.

Figure 5: Common trend before shock - general case without NHPP

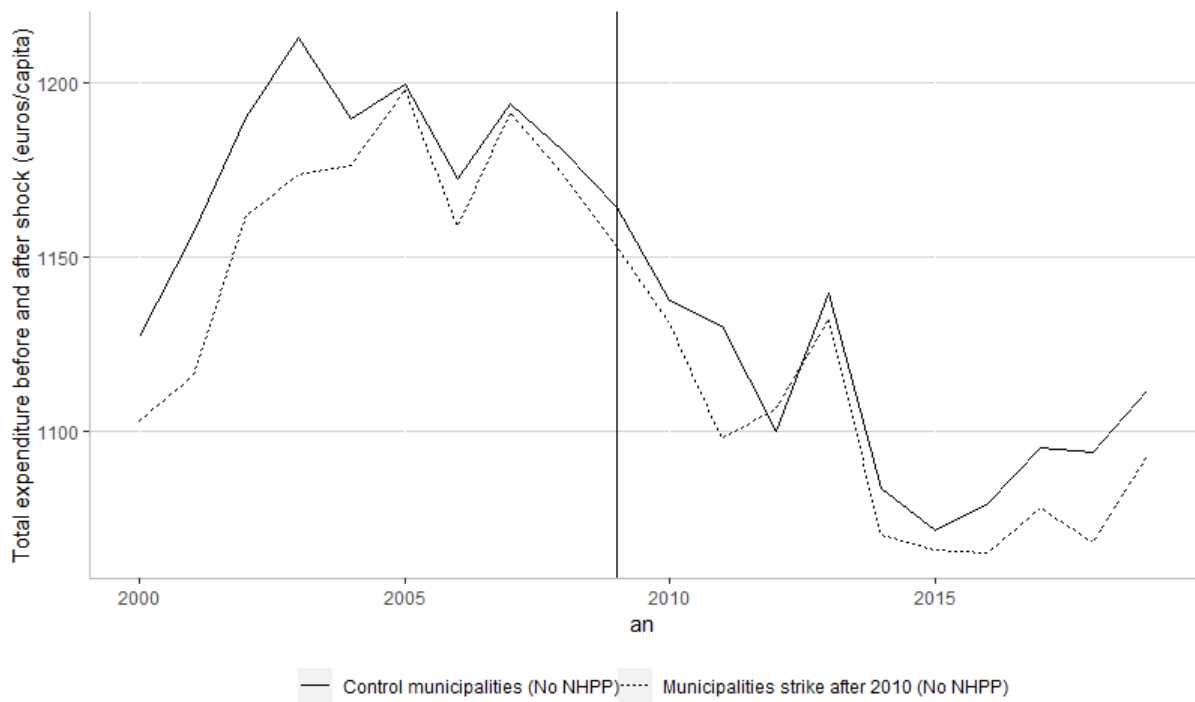
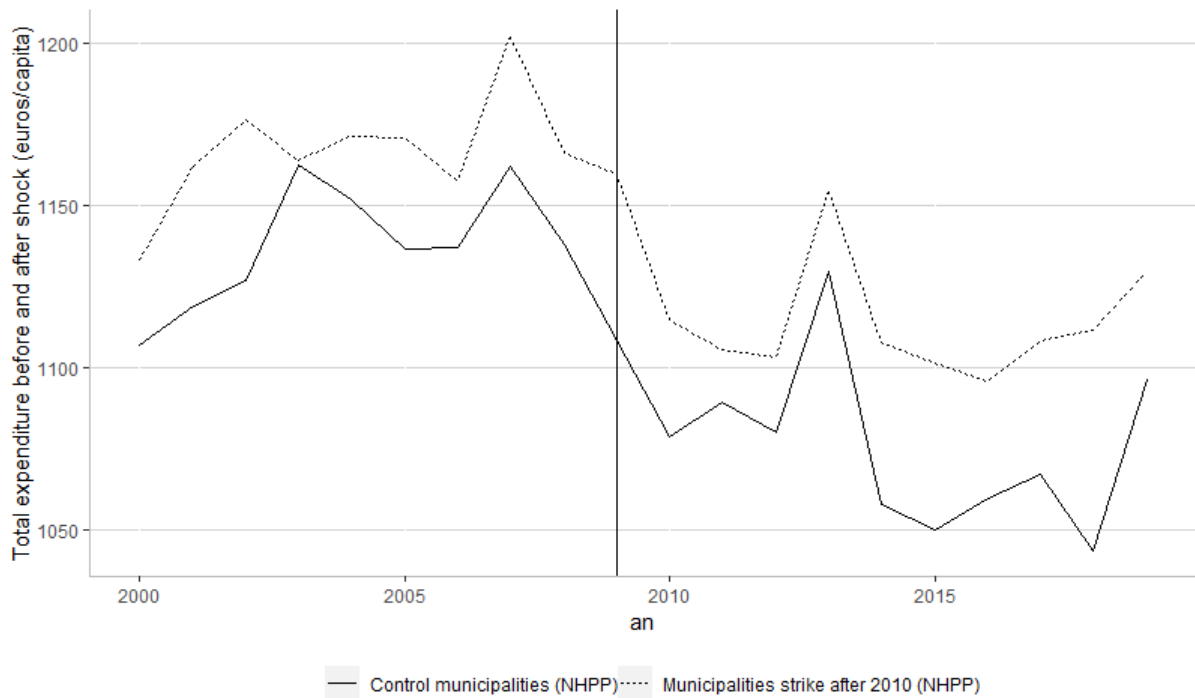


Figure 6: Common trend before shock - general case with NHPP





### 9.2.3 Intensity Analysis

Table 5: Impact of natural disasters on local government accounts according to their adherence to a Natural Hazard Prevention Plan

	<i>Fixed Effect model - Within Estimator</i>							
	Total Expenditure		Total Revenues		Total grants		Debt	
	NHPP	No NHPP	NHPP	No NHPP	NHPP	No NHPP	NHPP	No NHPP
<b>Panel : Xynthia Storm sample</b>								
Xynthia <sub>t</sub>	-0.013 (0.022)	0.021** (0.008)	-0.021 (0.023)	0.025*** (0.007)	-0.005 (0.027)	0.058*** (0.008)	0.006 (0.150)	0.048 (0.042)
Xynthia <sub>t-1</sub>	0.002 (0.027)	0.028*** (0.007)	-0.005 (0.025)	0.023*** (0.007)	0.001 (0.031)	0.061*** (0.009)	0.046 (0.111)	0.015 (0.043)
Xynthia <sub>t-2</sub>	-0.001 (0.026)	0.040*** (0.008)	-0.007 (0.026)	0.034*** (0.008)	-0.0002 (0.032)	0.079*** (0.009)	0.070 (0.122)	0.008 (0.048)
Xynthia <sub>t-3</sub>	-0.017 (0.028)	0.033*** (0.008)	-0.027 (0.026)	0.037*** (0.008)	-0.064 (0.034)	0.071*** (0.010)	0.130 (0.147)	0.004 (0.053)
Xynthia <sub>t-4</sub>	0.004 (0.032)	0.043*** (0.009)	0.036 (0.034)	0.041*** (0.008)	-0.078 (0.049)	0.080*** (0.010)	0.167 (0.192)	0.001 (0.054)
Xynthia <sub>t-5</sub>	-0.032 (0.032)	0.038*** (0.010)	-0.025 (0.035)	0.032*** (0.009)	-0.050 (0.047)	0.062*** (0.012)	-0.092 (0.261)	-0.082 (0.061)
Xynthia <sub>t-6</sub>	-0.057 (0.034)	0.039*** (0.010)	-0.056 (0.033)	0.043*** (0.010)	-0.099 (0.105)	0.099*** (0.013)	0.012 (0.202)	-0.122 (0.064)
Xynthia <sub>t-7</sub>	-0.022 (0.046)	0.035** (0.012)	0.034 (0.049)	0.047*** (0.011)	-0.038 (0.097)	0.079*** (0.016)	-0.085 (0.267)	-0.162* (0.068)
Xynthia <sub>t-8</sub>	-0.015 (0.052)	0.021* (0.012)	0.006 (0.046)	0.045*** (0.011)	-0.010 (0.105)	0.077** (0.024)	-0.055 (0.314)	-0.250** (0.077)
Xynthia <sub>t-9</sub>	-0.008 (0.065)	0.056** (0.015)	0.051 (0.060)	0.058*** (0.014)	0.054 (0.132)	0.114*** (0.021)	-0.091 (0.256)	-0.307*** (0.090)
Observations	39,378	187,680	39,378	187,680	39,379	187,680	39,378	187,680
R <sup>2</sup>	0.032	0.038	0.043	0.047	0.090	0.092	0.005	0.003
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipalities fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Financial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socio-economic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socio-demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Institutional controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*Note* : \*p<0.05; \*\*p<0.01; \*\*\*p<0.001 ; All models control for financial time-variant characteristics (revenues from local taxation, from grants and from loans), political (years before elections), institutional (type of inter-municipal cooperation, state fixed effect), socioeconomic (median income and percent of unemployment) and socio-demographic factors (population size, percent of young, and percent of old population), and year fixed effects. Heteroskedasticity-consistent Standard errors in parentheses, using White's covariance matrix. The sample of municipalities with a NHPP contains only those municipalities that had a natural hazard prevention plan before the occurrence of a natural disaster. In contrast, the municipalities in the "no NHPP" sample are those that did not have a prevention plan before the disaster occurred. However, some of them have put in place a NHPP after the shock.

Figure 7: Effect of a **major** natural disaster

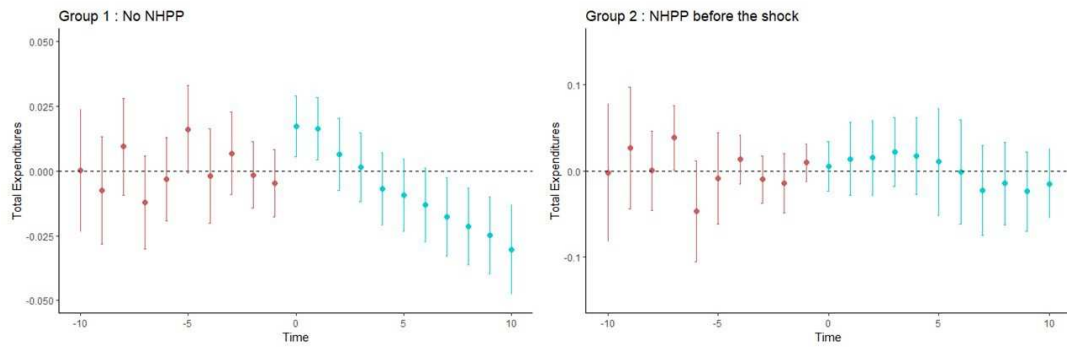


Figure 8: Effect of a **major** natural disaster on revenue

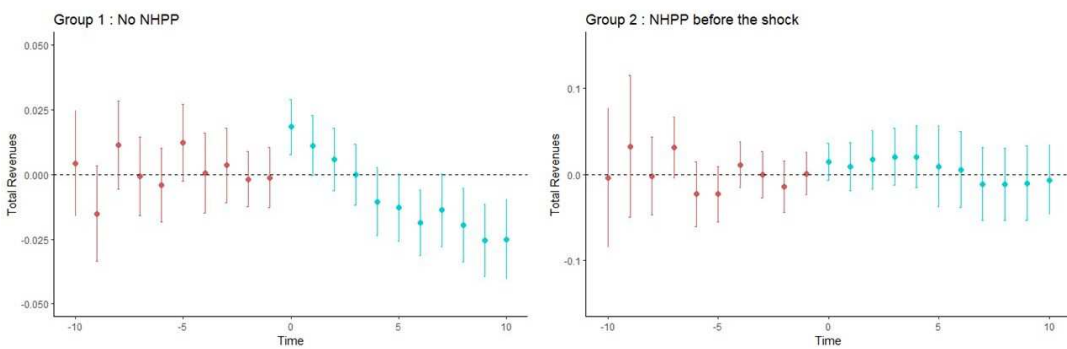
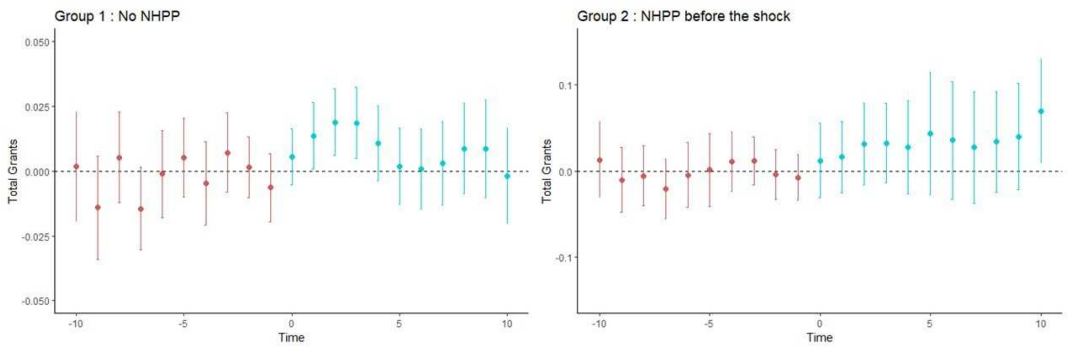


Figure 9: Effect of a **major** natural disaster on grants



## 9.2.4 Types of shock

Table 6: Regression Results according to types of shock

<i>Fixed Effect model - Within Estimator</i>								
	Total Expenditure		Total Revenues		Total grants		Debt	
	NHPP	No NHPP	NHPP	No NHPP	NHPP	No NHPP	NHPP	No NHPP
<b>Floods</b>								
Shock <sub>τ</sub>	-0.003 (0.006)	0.015*** (0.003)	-0.005 (0.006)	0.014*** (0.003)	0.007 (0.012)	-0.002 (0.005)	0.018 (0.049)	0.042 (0.022)
Shock <sub>τ-1</sub>	0.011 (0.007)	0.019*** (0.003)	0.006 (0.006)	0.012*** (0.003)	0.027* (0.012)	0.007 (0.005)	0.017 (0.053)	0.059* (0.023)
Shock <sub>τ-2</sub>	0.007 (0.007)	0.016*** (0.003)	0.003 (0.007)	0.011*** (0.003)	0.012 (0.012)	0.016*** (0.005)	0.049 (0.056)	0.061* (0.026)
Shock <sub>τ-3</sub>	-0.008 (0.007)	0.005 (0.003)	-0.007 (0.007)	0.005 (0.003)	0.022 (0.013)	0.021*** (0.005)	0.008 (0.060)	0.050 (0.026)
Shock <sub>τ-4</sub>	-0.011 (0.009)	0.003 (0.004)	-0.010 (0.008)	-0.002 (0.003)	0.006 (0.017)	0.022*** (0.005)	0.027 (0.061)	0.026 (0.026)
Shock <sub>τ-5</sub>	-0.005 (0.009)	0.012*** (0.004)	-0.011 (0.008)	0.006* (0.003)	0.012 (0.017)	0.013* (0.005)	0.038 (0.066)	0.006 (0.027)
Shock <sub>τ-6</sub>	0.005 (0.010)	0.006 (0.004)	-0.004 (0.009)	0.005 (0.004)	0.005 (0.020)	0.009 (0.006)	-0.018 (0.074)	-0.023 (0.028)
Shock <sub>τ-7</sub>	-0.003 (0.011)	0.006 (0.004)	-0.005 (0.010)	0.003 (0.004)	0.021 (0.019)	0.011 (0.006)	-0.005 (0.079)	-0.021 (0.028)
Shock <sub>τ-8</sub>	-0.011 (0.011)	0.001 (0.004)	-0.010 (0.010)	-0.001 (0.004)	0.039* (0.018)	0.010 (0.007)	-0.055 (0.084)	-0.039 (0.029)
Shock <sub>τ-9</sub>	-0.035*** (0.011)	0.003 (0.004)	-0.018 (0.011)	-0.001 (0.004)	0.051*** (0.018)	0.015* (0.006)	0.006 (0.083)	-0.065* (0.029)
Observations	63,147	333,980	63,147	333,980	63,147	333,980	63,147	333,980
R <sup>2</sup>	0.151	0.189	0.186	0.240	0.089	0.097	0.010	0.010
<b>Drought</b>								
Shock <sub>τ</sub>	-0.011 (0.012)	0.003 (0.006)	-0.008 (0.012)	0.004 (0.005)	0.039 (0.030)	-0.012 (0.013)	0.001 (0.067)	0.011 (0.036)
Shock <sub>τ-1</sub>	-0.031* (0.014)	-0.016* (0.007)	-0.015 (0.012)	-0.006 (0.006)	0.010 (0.031)	-0.014 (0.015)	0.057 (0.084)	0.040 (0.042)
Shock <sub>τ-2</sub>	-0.012 (0.019)	-0.014 (0.009)	-0.003 (0.016)	-0.014 (0.007)	-0.049 (0.033)	0.006 (0.015)	0.076 (0.110)	0.022 (0.050)
Shock <sub>τ-3</sub>	0.029 (0.020)	-0.004 (0.008)	0.013 (0.019)	-0.012 (0.007)	-0.007 (0.037)	0.017 (0.015)	0.205* (0.119)	0.035 (0.053)
Shock <sub>τ-4</sub>	0.020 (0.021)	-0.002 (0.008)	0.005 (0.020)	-0.006 (0.007)	-0.052 (0.037)	-0.005 (0.015)	0.166 (0.120)	0.013 (0.056)
Shock <sub>τ-5</sub>	0.013 (0.018)	-0.011 (0.008)	0.002 (0.016)	-0.007 (0.007)	-0.011 (0.038)	0.016 (0.014)	0.202 (0.131)	0.053 (0.055)
Shock <sub>τ-6</sub>	-0.006 (0.023)	-0.010 (0.008)	-0.012 (0.020)	-0.018* (0.007)	-0.047 (0.043)	0.019 (0.015)	0.131 (0.149)	0.074 (0.055)
Shock <sub>τ-7</sub>	-0.030 (0.020)	-0.012 (0.009)	-0.013 (0.020)	-0.013 (0.008)	-0.034 (0.046)	0.014 (0.015)	0.209 (0.136)	0.057 (0.055)
Shock <sub>τ-8</sub>	0.017 (0.025)	-0.027*** (0.009)	-0.001 (0.022)	-0.011 (0.008)	0.008 (0.043)	0.036* (0.018)	0.190 (0.147)	0.023 (0.056)
Shock <sub>τ-9</sub>	0.014 (0.030)	-0.012 (0.010)	0.013 (0.026)	-0.011 (0.008)	-0.026 (0.047)	-0.017 (0.017)	0.225 (0.176)	0.068 (0.054)
Observations	38,323	222,709	38,323	222,709	38,323	222,709	38,323	222,709
R <sup>2</sup>	0.163	0.201	0.203	0.261	0.058	0.063	0.010	0.010

*Note* : \*p<0.05; \*\*p<0.01; \*\*\*p<0.001 ; All models control for financial time-variant characteristics (revenues from local taxation, from grants and from loans), political (years before elections), institutional (type of inter-municipal cooperation, state fixed effect), socioeconomic (median income and percent of unemployment) and socio-demographic factors (population size, percent of young, and percent of old population), and year fixed effects. Heteroskedasticity-consistent Standard errors in parentheses, using White's covariance matrix. The sample of municipalities with a NHPP contains only those municipalities that had a natural hazard prevention plan before the occurrence of a natural disaster. In contrast, the municipalities in the "no NHPP" sample are those that did not have a prevention plan before the disaster occurred. However, some of them have put in place a NHPP after the shock.

### 9.3 Robstness check - Part 2

#### 9.3.1 Sensitivity analysis

Table 7: Heckman Model - Occurrence of natural disaster at different times in the cycle

	Pooling					
	The shock occurred before the election:					
	1 year before	2 years before	3 years before	4 years before	5 years before	during the cycle
<i>Selection equation : candidate (1 or 0)</i>						
Shock	0.045*	0.021	0.006	-0.018	-0.009	-0.010
	(0.018)	(0.015)	(0.014)	(0.014)	(0.013)	(0.013)
NHPP	-0.039*	-0.038*	-0.038*	-0.036*	-0.037*	-0.036*
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
log(InvExpand)	0.078***	0.078***	0.079***	0.079***	0.079***	0.079***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
log(Debt)	-0.010***	-0.010***	-0.010***	-0.009***	-0.010***	-0.010***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
EPCI (Integrated)	-0.031*	-0.030	-0.029	-0.028	-0.028	-0.028
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
EPCI (Isolated)	-0.089	-0.090	-0.091	-0.095	-0.092	-0.092
	(0.064)	(0.064)	(0.064)	(0.064)	(0.064)	(0.064)
Inc. gender (M)	0.268***	0.268***	0.268***	0.268***	0.268***	0.268***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Inc. age	0.012*	0.012*	0.012*	0.012*	0.012*	0.012*
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Inc. age <sup>2</sup>	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Nb. competitors	0.019***	0.019***	0.019***	0.019***	0.019***	0.019***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Population	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Control for 2014 election	0.708***	0.708***	0.706***	0.703***	0.704***	0.704***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
log(Median Income)	0.006	0.005	0.006	0.006	0.006	0.006
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Constant	-1.653***	-1.645***	-1.642***	-1.635***	-1.641***	-1.641***
	(0.210)	(0.210)	(0.210)	(0.211)	(0.210)	(0.210)
<i>Outcome equation : Reelection</i>						
Shock	-0.115***	-0.126***	-0.141***	-0.154***	-0.127***	-0.127***
	(0.022)	(0.019)	(0.018)	(0.018)	(0.017)	(0.017)
NHPP	-0.114***	-0.111***	-0.104***	-0.105***	-0.104***	-0.104***
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
log(InvExpand)	0.023**	0.024**	0.024**	0.024**	0.024**	0.024**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
log(Debt)	-0.043***	-0.042***	-0.042***	-0.042***	-0.042***	-0.042***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
EPCI (Integrated)	-0.201***	-0.200***	-0.197***	-0.195***	-0.198***	-0.198***
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
EPCI (Isolated)	0.005	-0.002	-0.006	-0.011	0.005	0.006
	(0.088)	(0.088)	(0.088)	(0.088)	(0.088)	(0.088)
Inc. gender (M)	0.164***	0.165***	0.165***	0.165***	0.164***	0.164***
	(0.022)	(0.022)	(0.023)	(0.023)	(0.023)	(0.023)
Inc. age	0.027***	0.027***	0.027***	0.028***	0.027***	0.027***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Population	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Control for 2014 election	0.046*	0.036	0.040	0.040	0.045*	0.044*
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
log(Median Income)	-0.059**	-0.055**	-0.056**	-0.055**	-0.058**	-0.058**
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Constant	0.499*	0.471*	0.484*	0.476*	0.514*	0.520*
	(0.223)	(0.224)	(0.225)	(0.225)	(0.225)	(0.225)
Observations	54920	54920	54920	54920	54920	54920
Log Likelihood	-38500.56	-38493.85	-38484.64	-38472.73	-38486.09	-38485.6
$\rho$	-0.735	-0.728	-0.723	-0.721	-0.735	-0.737
	(0.082)	(0.083)	(0.085)	(0.087)	(0.087)	(0.087)

Note : \*p<0.05; \*\*p<0.01; \*\*\*p<0.001 ; All control variables are listed in the table above. Heteroskedasticity-consistent Standard errors in parentheses, clustered at the municipal level.

Table 8: Heckman Model - Occurrence of a **major natural disaster** during the election cycle

	Major natural disaster			
	Pool	2020	2014	2008
<i>Selection equation : candidate (1 or 0)</i>				
Shock	0.040 (0.024)	0.031 (0.027)	-0.015 (0.056)	-0.078 (0.103)
NHPP	-0.035 (0.024)	-0.008 (0.032)	0.003 (0.047)	-0.020 (0.067)
log(InvExpand)	0.073*** (0.007)	0.057*** (0.008)	0.103*** (0.019)	0.115*** (0.023)
log(Debt)	-0.010*** (0.003)	0.001 (0.004)	-0.016 (0.009)	-0.002 (0.007)
EPCI (Integrated)	-0.034 (0.019)	-0.034 (0.023)	-0.007 (0.039)	0.114 (0.067)
EPCI (Isolated)	-0.047 (0.081)		0.450 (0.370)	0.079 (0.087)
log(Median Income)	0.019 (0.016)	0.004 (0.016)	-0.276* (0.126)	-0.025 (0.119)
Inc. gender (M)	0.241*** (0.020)	0.258*** (0.025)	0.286*** (0.046)	0.275*** (0.063)
Inc. age	0.007 (0.007)	0.004 (0.009)	0.000 (0.016)	0.011 (0.019)
Inc. age2	0.000*** (0.000)	0.000*** (0.000)	0.000 (0.000)	0.000 (0.000)
nb. competitors	0.022*** (0.001)	-0.002 (0.001)	0.230*** (0.005)	-0.032*** (0.005)
Control for 2014 election	0.767*** (0.016)			
Constant	-1.631*** (0.254)	-1.097*** (0.293)	1.102 (1.326)	-1.188 (1.278)
<i>Outcome equation : Reelection</i>				
Shock	-0.142*** (0.030)	-0.130*** (0.034)	-0.161** (0.057)	-0.293** (0.107)
NHPP	-0.135*** (0.031)	-0.128** (0.040)	-0.168*** (0.048)	0.049 (0.076)
log(InvExpand)	0.020* (0.010)	0.012 (0.010)	-0.014 (0.020)	0.112*** (0.025)
log(Debt)	-0.040*** (0.005)	-0.020*** (0.006)	-0.120*** (0.020)	-0.007 (0.009)
EPCI (Integrated)	-0.261*** (0.026)	-0.083** (0.030)	-0.515*** (0.039)	0.020 (0.076)
EPCI (Isolated)	-0.074 (0.114)		-0.826** (0.280)	0.026 (0.098)
log(Median Income)	0.001 (0.024)	0.022 (0.022)	-0.340** (0.127)	0.136 (0.139)
Inc. gender (M)	0.167*** (0.028)	0.169*** (0.033)	0.092* (0.047)	0.335*** (0.074)
Inc. age	0.027*** (0.002)	0.023*** (0.001)	0.031*** (0.002)	0.048*** (0.004)
Control for 2014 election	0.069* (0.027)			
Constant	-0.067 (0.270)	-0.170 (0.241)	4.016** (1.268)	-4.605*** (1.398)
Observations	54920	54920	59810	89265
Log Likelihood	-25769.52	-14448.7	-6332.968	-3253.019
$\rho$	-0.708 (0.118)	-0.999 (0.0002)	-0.832 (0.030)	0.94 (0.031)

Note : \*p<0.05; \*\*p<0.01; \*\*\*p<0.001 ; All control variables are listed in the table above. Heteroskedasticity-consistent Standard errors in parentheses, clustered at the municipal level.

Table 9: Heckman Model - Occurrence of natural disaster during the electoral cycle

	Flood				Drought			
	Pool	2020	2014	2008	Pool	2020	2014	2008
<i>Selection equation : candidate (1 or 0)</i>								
Shock	-0.015 (0.015)	-0.037 (0.020)	0.004 (0.031)	-0.045 (0.043)	0.029 (0.017)	0.003 (0.020)	-0.008 (0.043)	0.043 (0.054)
NHPP	-0.043* (0.020)	-0.050 (0.028)	0.015 (0.038)	-0.011 (0.054)	-0.032 (0.021)	-0.009 (0.027)	0.003 (0.043)	-0.021 (0.058)
log(InvExpand)	0.080*** (0.006)	0.068*** (0.008)	0.102*** (0.016)	0.119*** (0.021)	0.077*** (0.006)	0.066*** (0.008)	0.104*** (0.018)	0.124*** (0.022)
log(Debt)	-0.008** (0.003)	0.004 (0.003)	-0.015 (0.008)	-0.002 (0.007)	-0.009*** (0.003)	0.000 (0.003)	-0.013 (0.009)	-0.004 (0.007)
EPCI (Integrated)	-0.001 (0.017)	0.014 (0.021)	-0.007 (0.033)	0.149** (0.055)	-0.013 (0.017)	-0.007 (0.021)	0.008 (0.037)	0.132* (0.059)
EPCI (Isolated)	-0.045 (0.069)		0.494 (0.300)	0.056 (0.074)	-0.071 (0.071)		0.521 (0.350)	0.019 (0.077)
log(Median Income)	0.009 (0.015)	-0.008 (0.015)	-0.133 (0.107)	-0.071 (0.103)	0.012 (0.015)	0.002 (0.015)	-0.288* (0.118)	0.007 (0.111)
Inc. gender M	0.260*** (0.017)	0.274*** (0.022)	0.324*** (0.039)	0.269*** (0.057)	0.268*** (0.018)	0.283*** (0.022)	0.310*** (0.044)	0.320*** (0.059)
Inc. age	0.012 (0.006)	0.009 (0.007)	0.005 (0.013)	0.015 (0.017)	0.006 (0.006)	0.004 (0.008)	-0.006 (0.015)	0.018 (0.018)
age2	0.000*** (0.000)	0.000** (0.000)	0.000* (0.000)	0.000 (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000* (0.000)	0.000 (0.000)
nb. competitors	0.022*** (0.001)	-0.001 (0.001)	0.223*** (0.004)	-0.029*** (0.004)	0.017*** (0.001)	-0.003** (0.001)	0.231*** (0.004)	-0.032*** (0.004)
Control for 2014 election	0.749*** (0.014)				0.725*** (0.016)			
Constant	-1.701*** (0.228)	-1.203*** (0.264)	-0.414 (1.128)	-0.878 (1.106)	-1.509*** (0.231)	-1.140*** (0.268)	1.348 (1.244)	-1.780 (1.190)
<i>Outcome equation : Reelection</i>								
Shock	-0.141*** (0.019)	-0.148*** (0.026)	-0.124*** (0.031)	-0.175*** (0.053)	-0.169*** (0.022)	-0.143*** (0.026)	-0.237*** (0.043)	-0.072 (0.061)
NHPP	-0.110*** (0.025)	-0.104** (0.036)	-0.158*** (0.037)	0.053 (0.063)	-0.128*** (0.026)	-0.114** (0.036)	-0.165*** (0.043)	-0.017 (0.066)
log(InvExpand)	0.019* (0.008)	0.008 (0.012)	0.002 (0.017)	0.131*** (0.024)	0.020* (0.009)	0.018 (0.013)	-0.021 (0.019)	0.129*** (0.025)
log(Debt)	-0.042*** (0.005)	-0.019*** (0.005)	-0.125*** (0.018)	-0.011 (0.009)	-0.042*** (0.005)	-0.023*** (0.006)	-0.124*** (0.020)	-0.013 (0.009)
EPCI (Integrated)	-0.256*** (0.022)	-0.082** (0.027)	-0.468*** (0.033)	-0.020 (0.069)	-0.243*** (0.023)	-0.099*** (0.027)	-0.480*** (0.037)	0.014 (0.068)
EPCI (Isolated)	-0.093 (0.094)		-0.950*** (0.197)	0.030 (0.089)	0.003 (0.102)		-0.832*** (0.244)	0.042 (0.090)
log(Median Income)	-0.045* (0.022)	-0.018 (0.020)	-0.321** (0.107)	0.116 (0.123)	-0.038 (0.022)	-0.017 (0.021)	-0.300* (0.119)	0.159 (0.129)
Inc. gender M	0.158*** (0.024)	0.180*** (0.030)	0.057 (0.040)	0.338*** (0.069)	0.167*** (0.026)	0.195*** (0.036)	0.061 (0.045)	0.325*** (0.072)
Inc. age	0.027*** (0.001)	0.023*** (0.001)	0.032*** (0.002)	0.049*** (0.003)	0.028*** (0.002)	0.024*** (0.002)	0.031*** (0.002)	0.049*** (0.003)
Control for 2014 election	0.056* (0.023)				0.043 (0.025)			
Constant	0.421 (0.240)	0.252 (0.233)	3.730*** (1.075)	-4.485*** (1.230)	0.313 (0.248)	0.100 (0.273)	3.679** (1.193)	-4.905*** (1.289)
Observations	47966	22620	20175	5171	44382	23372	16346	4664
Log Likelihood	-33012.69	-17718.83	-8803.958	-4300.009	-30885.57	-18191.42	-6937.405	-3834.358
$\rho$	-0.754 (0.097)	-0.924 (0.096)	-0.855 (0.027)	0.905 (0.044)	-0.717 (0.112)	-0.826 (0.193)	-0.855 (0.033)	0.925 (0.034)

Note : \*p<0.05; \*\*p<0.01; \*\*\*p<0.001 ; All control variables are listed in the table above. Heteroskedasticity-consistent Standard errors in parentheses, clustered at the municipal level.

### 9.3.2 Heterogeneity analysis

Table 10: Heckman Model - Occurrence of natural disaster during the electoral cycle - all candidates, regardless of competition - Sample with proportional, list, two-round voting system

Pooling - Sample with proportional, list, two-round voting system				
	All municipalities	> 10000	10000 < & > 3500	< 3500
<i>Selection equation : candidate (1 or 0)</i>				
Shock	0.063** (0.020)	-0.032 (0.068)	0.069 (0.041)	0.036 (0.025)
NHPP	0.045 (0.025)	0.062 (0.068)	0.082 (0.049)	-0.002 (0.032)
log(InvExpand)	0.142*** (0.015)	0.075 (0.068)	0.126*** (0.036)	0.120*** (0.017)
log(Debt)	0.025*** (0.007)	0.011 (0.026)	0.043** (0.013)	0.009 (0.008)
EPCI (Integrated)	0.115*** (0.022)	0.219** (0.077)	0.069 (0.042)	0.021 (0.027)
EPCI (Isolated)	0.144 (0.117)	0.295 (0.177)	-0.168 (0.168)	-0.306 (0.732)
Inc. gender (M)	0.341*** (0.027)	0.400*** (0.084)	0.286*** (0.059)	0.345*** (0.033)
Inc. age	-0.010 (0.008)	0.008 (0.023)	-0.027 (0.017)	0.015 (0.011)
Inc. age <sup>2</sup>	0.000*** (0.000)	0.000 (0.000)	0.000** (0.000)	0.000 (0.000)
Nb. competitors	-0.151*** (0.012)	-0.084*** (0.020)	-0.207*** (0.020)	
Control for 2014 election	0.018 (0.021)	0.093 (0.065)	0.096* (0.043)	-0.005 (0.027)
log(Median Income)	-0.177*** (0.043)	0.084 (0.148)	-0.122 (0.096)	-0.102* (0.051)
Constant	0.714 (0.505)	-1.672 (1.719)	1.014 (1.110)	-0.898 (0.609)
<i>Outcome equation : Reelection</i>				
Shock	-0.058* (0.023)	0.041 (0.065)	-0.040 (0.044)	-0.070* (0.031)
NHPP	-0.064* (0.028)	-0.088 (0.066)	-0.028 (0.051)	-0.054 (0.039)
log(InvExpand)	0.053** (0.018)	0.085 (0.066)	0.117** (0.039)	0.073*** (0.022)
log(Debt)	-0.045*** (0.010)	-0.081** (0.026)	-0.072** (0.023)	-0.021 (0.011)
EPCI (Integrated)	-0.042 (0.024)	-0.041 (0.076)	0.047 (0.045)	0.009 (0.034)
EPCI (Isolated)	0.147 (0.120)	0.284 (0.171)	0.275 (0.198)	-0.637 (0.705)
Inc. gender (M)	0.130*** (0.032)	0.257** (0.086)	0.326*** (0.065)	0.062 (0.043)
Inc. age	0.029*** (0.001)	0.037*** (0.003)	0.028*** (0.002)	0.026*** (0.002)
Control for 2014 election	-0.176*** (0.024)	-0.432*** (0.064)	-0.243*** (0.045)	-0.120*** (0.033)
log(Median Income)	0.028 (0.049)	-0.142 (0.146)	-0.067 (0.105)	0.023 (0.064)
Constant	-0.840 (0.522)	0.187 (1.554)	-0.443 (1.092)	-0.790 (0.669)
Observations	18644	2206	4680	11804
Log Likelihood	-16487.38	-1892.789	-4234.281	-10306.03
$\rho$	-0.952 (0.020)	-0.999 (0.0002)	-0.872 (0.032)	-0.900 (0.051)

Note : \*p<0.05; \*\*p<0.01; \*\*\*p<0.001 ; All control variables are listed in the table above. Heteroskedasticity-consistent Standard errors in parentheses, clustered at the municipal level.

Table 11: Probit Model - Occurrence of natural disaster during the electoral cycle - all candidates, regardless of competition - Sample with majority, multi-member, two-round system

	Sample with majority, multi-member, two-round system			
	pool	2020	2014	2008
<i>Outcome equation : Reelection (1 or 0)</i>				
Shock	-0.032** (0.012)	-0.049* (0.020)	0.000 (0.020)	-0.073** (0.023)
NHPP	-0.024 (0.017)	-0.115*** (0.032)	0.053 (0.027)	-0.022 (0.032)
log(InvExpand)	0.074*** (0.005)	0.069*** (0.008)	0.066*** (0.009)	0.109*** (0.011)
log(Debt)	-0.003 (0.002)	-0.003 (0.003)	-0.001 (0.003)	-0.006 (0.004)
EPCI (Integrated)	-0.035* (0.017)	-0.057* (0.024)	-0.082** (0.031)	-0.012 (0.042)
EPCI (Isolated)	-0.127** (0.039)		0.000 (.)	-0.070 (0.040)
Inc. gender (M)	0.289*** (0.015)	0.280*** (0.024)	0.306*** (0.023)	0.327*** (0.032)
Inc. age	0.039*** (0.001)	0.040*** (0.001)	0.035*** (0.001)	0.038*** (0.001)
log(Median Income)	0.030* (0.013)	-0.003 (0.014)	0.030 (0.069)	0.135* (0.064)
Control for 2014 election	-0.140*** (0.011)			
Constant	-2.850*** (0.136)	-2.512*** (0.160)	-2.747*** (0.687)	-4.096*** (0.632)
Observations	56218	19434	21647	15136
Log Likelihood	-35193.598	-11365.661	-13924.435	-9836.5422
Pseudo R2	0.0682	0.0831	0.0551	0.0531

Note : \*p<0.05; \*\*p<0.01; \*\*\*p<0.001 ; All control variables are listed in the table above. Heteroskedasticity-consistent Standard errors in parentheses, clustered at the municipal level.



Table 12: Heckman Model - Occurrence of natural disaster during the electoral cycle

	Pooling			
<i>Selection equation : candidate (1 or 0)</i>				
Shock	-0.004 (0.013)	0.000 (0.013)	-0.026* (0.013)	-0.051*** (0.010)
NHPP	-0.028 (0.018)	-0.028 (0.018)	-0.050** (0.018)	-0.034* (0.014)
log(InvExpand)	0.080*** (0.006)			
log(Debt)	-0.009*** (0.002)			
EPCI (Integrated)	-0.009 (0.015)	-0.005 (0.015)		
EPCI (Isolated)	-0.064 (0.064)	-0.030 (0.064)		
log(Median Income)	0.005 (0.013)	0.000 (0.013)		
Inc. gender (M)	0.268*** (0.016)	0.273*** (0.016)	0.252*** (0.015)	
Inc. age	0.011* (0.005)	0.012* (0.005)	0.010* (0.005)	
Inc. age <sup>2</sup>	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	
Nb. competitors	0.018*** (0.001)	0.018*** (0.001)	0.017*** (0.001)	
Control for 2014 election	0.704*** (0.014)	0.709*** (0.013)	0.727*** (0.013)	0.793*** (0.012)
Constant	-1.600*** (0.208)	-1.179*** (0.205)	-1.051*** (0.147)	0.473*** (0.006)
<i>Outcome equation : Reelection</i>				
Shock	-0.140*** (0.017)	-0.154*** (0.017)	-0.178*** (0.016)	-0.181*** (0.014)
NHPP	-0.120*** (0.022)	-0.129*** (0.022)	-0.162*** (0.021)	-0.150*** (0.019)
log(InvExpand)	0.019* (0.008)			
log(Debt)	-0.044*** (0.005)			
EPCI (Integrated)	-0.240*** (0.020)	-0.252*** (0.019)		
EPCI (Isolated)	-0.058 (0.087)	-0.053 (0.087)		
log(Median Income)	-0.052* (0.020)	-0.049* (0.020)		
Inc. gender (M)	0.158*** (0.022)	0.150*** (0.022)	0.129*** (0.020)	
Inc. age	0.027*** (0.001)	0.027*** (0.001)	0.026*** (0.001)	
Control for 2014 election	0.033 (0.020)	0.025 (0.019)	0.079*** (0.017)	0.366*** (0.023)
Constant	0.512* (0.220)	0.374 (0.205)	-0.107* (0.055)	1.118*** (0.036)
Observations	54920	54920	59810	89265
Log Likelihood	-38549.54	-38714.63	-41415.79	-70864.84
$\rho$	-0.792 (0.092)	-0.820 (0.080)	-0.897 (0.062)	0.261 (0.047)

Note : \*p<0.05; \*\*p<0.01; \*\*\*p<0.001 ; All control variables are listed in the table above. Heteroskedasticity-consistent Standard errors in parentheses, clustered at the municipal level.