ABSTRACT

Title of Dissertation: ESSAYS ON NATURAL DISASTERS AND FISCAL RESILIENCE

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This dissertation attempts to bridge two fields within public policy, sustainability and public budgeting and finance. Natural disasters have become more frequent, intense, and costly over the last few decades, and this study contributes to the discourse through a public finance lens. I develop three separate but interrelated essays, which seek to understand how environmental shocks like natural disasters affect government budgets, and what actions governments should take to maintain fiscal resilience and sustainability.

The first chapter evaluates the impact of flooding events on state government fiscal conditions. I construct a dataset with panel data from 50 U.S. states between 1997 to 2020 and employ a two-way fixed-effects model. The results show that increased severity of flooding leads to higher intergovernmental revenue two years after the disaster, but states do not necessarily pass down more funds to localities. There is also evidence that an increased flooding severity coincides with increased state tax revenue during and one year after the disaster. While federal assistance can help states stabilize during and after an emergency, I argue that it may also create problematic

incentives. Specifically, federal transfers may discourage states from allocating sufficient funds for ex-ante flood mitigation.

The second chapter examines whether and how government attention to hurricanes developed over time. I analyze budget documents from 2005 to 2020 across seven hurricane-prone states in the U.S.: Alabama, Florida, Georgia, Louisiana, North Carolina, South Carolina, and Texas. While prior studies focus on budget data, my study is the first to exploit the narrative portions of the budget documents using textual analysis. Computational text analysis is used to identify and quantify government attention toward different policy areas, including disaster management in connection with hurricanes. Cases from Louisiana, Alabama, and Florida show that an increased incidence of major hurricanes coincides with higher attention to hurricanes in the budget documents. There is also evidence that the attention to hurricanes is associated more with reactive rather than proactive measures, calling into question the general preparedness of most state governments for future disasters.

The third chapter surveys the government's disclosure of risks associated with natural disasters. It is intended as an exploratory analysis using audited financial reports from 50 U.S. states between 2002 and 2016. Audited financial reports are more technical and less political than the budget documents examined in my second chapter. I combine qualitative analysis with computational text analysis to understand the narrative portions of the source document. The results show that state governments do not widely disclose information regarding disaster risk despite the increasing threat of natural disasters. States that disclosed disaster risk in the past tend to disclose the same information in the future and past years, suggesting significant inertia in financial reporting. Finally, based on selected cases in hurricane-prone states, the study finds proactive as well as reactive risk disclosure, suggesting the need for governmental accounting

standards to incorporate mechanisms that specify how disaster risk should be recognized, measured, and presented in the financial reports.

ESSAYS ON NATURAL DISASTERS AND FISCAL RESILIENCE

by

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My parents, Ibu and Bapak, who taught me to read and write for the very first time thirty years ago, have always been an inspiration. The last but not the least, I would like to acknowledge my wife, Yurike, and our children, Banyan and Kinasih, for their unconditional love, unwavering strength, and good humor over the course of completing this magnum opus.

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Introduction

Sustainability and public budgeting and finance are fields within public policy that are front and center in sustainable development. However, these fields are often discussed in a separate fashion--debated by political leaders in unrelated forums, advocated by activists unfamiliar with each other, and studied by scholars from different fields. Through this dissertation, I aspire to bridge the two fields and contribute to a better understanding of their linkages. Based on observations across states in the U.S., my study seeks to understand how environmental shocks like natural disasters affect government budgets, and what actions governments should take to maintain fiscal resilience and sustainability.

Natural disasters have become more frequent, intense, and expensive over the last few decades. Across the globe, the annual number of medium to large-scale disasters, including weather-related disasters increased from around 100 in the 1970s to over 400 in 2020 (United Nations, 2022). If the current trend continues, by 2030 the projected major disasters will exceed 500 per year. In the United States, the overall number of disaster events is also on an upward trajectory. The National Oceanic and Atmospheric Administration (NOAA) shows that disasters with larger-than-$1-billion costs increased from around three per year in the 1980s to more than 12 per year in the 2010s.

A survey by Gallup (2022a) stated that one-third of adult Americans have been personally affected by an extreme weather event in the last two years. Another Gallup survey (2022b) suggested that globally, more than 25% of people said they experienced some types of disasters, including heavy rains, cyclones, and droughts, in the past five years. Yet studies also show that

people tend to underestimate and underinvest in disaster mitigation; therefore, the government plays a key role in coordinating collective efforts to prepare for future disasters. When a disaster strikes, the government will have to respond immediately, but ultimately effective response depends on the preparedness level or how much mitigation has taken place.

Any government intervention is realized through programs or initiatives, which would entail budget appropriations and allocations to authorized executive agencies. This is where a discussion of public finance becomes relevant. For example, the U.S. Congress has provided more than $139 billion in supplemental federal disaster funding to respond to disasters since 2017 (Federal Emergency Management Agency [FEMA], 2022a). More recently, the $1 trillion infrastructure bill that was passed by the United States Congress in 2021 included $47 billion to help communities prepare for extreme weather and natural disasters (Davenport and Flavelle, 2021). Conceptually, public budgeting involves "the selection of ends and the means to reach those ends (Lee et al., 2021, p. 1)." Disaster resilience is an end. The means could be an institutional arrangement, regulatory framework, programs, and initiatives implemented by the government, but generally, it involves two salient budgeting issues. First, on the expenditure side, policies need to be developed to allow these funds to be spent efficiently and effectively. Second, on the revenue side, enough money needs to be raised to sufficiently address the problem in the short term, and this funding needs to be sustained in the long term.

This dissertation is comprised of three individual essays that are connected in some ways. First, the three essays have a common theme around natural disasters and fiscal resilience. Some analysis focuses on certain types of disasters, such as flooding and hurricanes, while others consider natural disasters in a broader sense. Throughout the study, I apply theories and concepts from the public finance, budgeting, and accounting literature. Second, all essays consider states as

the unit of analysis. The geographic scope of state-level analysis is suitable because the extent of a natural disaster is unlikely to be contained within the border of lower jurisdictions. State governments also have the authority and resources to take mitigation and response measures. Third, as a policy scholar, I intend that the essays not only present rigorous analysis but also offer relevant perspectives applicable to the current practices in policymaking.

The first chapter evaluates the impact of flooding events on state government fiscal conditions. More specifically, I look at the implications of increased severity and frequency for different budget components, including intergovernmental revenue, tax revenue, and intergovernmental expenditure. To address the research question, I construct a dataset with panel data from 50 U.S. states between 1997 to 2020 and employ econometric methods. Several studies have investigated the implications of types of disasters for state finances, but my study is the first to examine flooding as a particular type of disaster that is increasingly common in the U.S. My analysis shows that increased flooding severity positively affected state tax revenue and intergovernmental revenue.

The second chapter analyzes the extent to which governments pay attention to hurricanes. Analyses are conducted into 2005-2020 budget documents across seven U.S. states that are the most prone to hurricanes: Alabama, Florida, Georgia, Louisiana, North Carolina, South Carolina, and Texas. While prior studies focus on budget data, my study is the first to exploit the narrative portions of the budget documents using textual analysis. Cases from Louisiana, Alabama, and Florida show that an increased incidence of major hurricanes coincides with higher attention to hurricanes in the budget documents. There is also evidence that in all observed states but Florida, the attention to hurricanes is associated more with reactive rather than proactive measures.

The third chapter surveys the government's disclosure of risks associated with natural disasters. It is intended as an exploratory analysis using audited financial reports from 50 U.S. states between 2002 and 2016. Audited financial reports are more technical and less political than the budget documents examined in my second chapter. I combine qualitative analysis with computational text analysis to understand the narrative portions of the source document. The results show that (1) state governments do not widely disclose information regarding disaster risk and (2) states that disclosed disaster risk in the past tend to disclose the same information in the future and past years. The study also finds proactive as well as reactive risk disclosure, based on selected cases of southern states that are hurricane-prone in the U.S.

Together, the three chapters in this dissertation show that the threat of natural disasters is increasing. However, my work also finds that most state governments do not take appropriate actions to prepare for future disasters and government actions, if any, are oriented more towards response and recovery rather than mitigation and preparedness. On a normative ground, the government needs to manage disasters not only ex-post but also ex-ante, and to improve resilience, policy actors need to start investing in preparedness and mitigation.

Chapter 1: The Fiscal Impact of Flood Disasters in State Government

Abstract

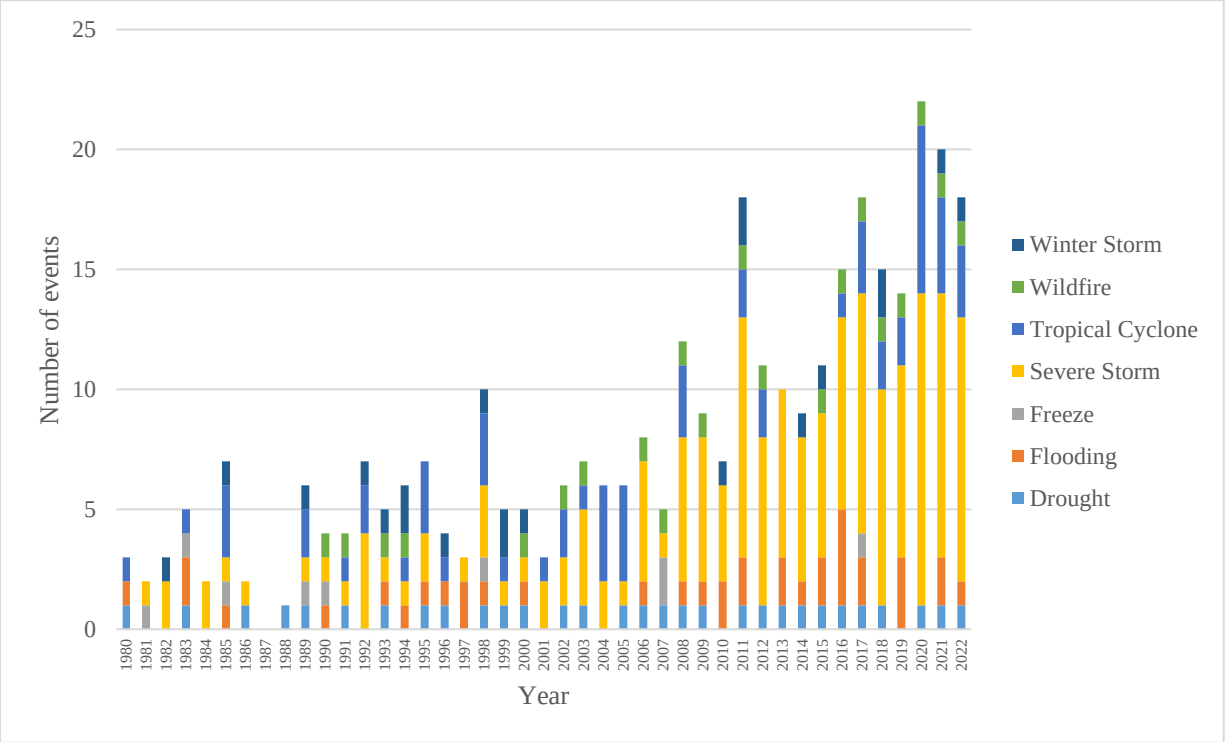
Flooding, like many other natural disasters, has become more frequent and destructive in recent decades in the U.S. and across the globe. This study attempts to estimate the impact of flooding events on state government fiscal conditions. More specifically, it evaluates whether and how flooding impacts state total revenue and expenditure, tax revenue, and intergovernmental revenue and expenditure. I construct a dataset with panel data from 50 U.S. states between 1997 to 2020 and employ a two-way fixed-effects model. The results show that (1) increased severity of flooding leads to higher intergovernmental revenue two years after the disaster, but (2) states do not necessarily pass down more funds to localities. There is also evidence that an increased flooding severity coincides with increased state tax revenue during and one year after the disaster. While federal assistance can help states stabilize during an emergency, it may also create problematic incentives. If states know that federal assistance is available when they experience an emergency, they may not allocate funds for ex-ante flood mitigation.

1. Introduction

The world has seen an increasing frequency and intensity in disaster events over the last few decades. The annual number of medium to large-scale natural disasters, including earthquakes, tsunamis, and weather-related events, increased from around 100 in the 1970s to over 400 in 2020 (United Nations [UN], 2022). If the current trend continues, by 2030 major disasters are projected

to reach 560 per year, or an average of about 1.5 each day. In the United States, the overall number of disaster events is also on an upward trajectory. The National Centers for Environmental Information (NCEI), under the National Oceanic and Atmospheric Administration (NOAA), keeps track of disasters with larger-than-$1-billion costs. As illustrated in Figure 1, the average count quadrupled from 3.1 per year in the 1980s to 12.8 per year in the 2010s. In 2022 alone, there were 18 major disaster events recorded across the country, including severe storms (11), tropical cyclones (3), wildfires (1), winter storms (1), drought (1), and flooding (1).

Figure 1. Billion-dollar Disasters in the United States (1980-2022)



Source: NOAA NCEI (2023)

One type of disaster, flooding, warrants special attention for several reasons. *First*, flooding is among the top three disasters (along with droughts and storms) that lead to the

world's largest human and economic losses (World Meteorological Organization, 2021). In the U.S., a NOAA technical memorandum marks that flooding was responsible for more than 100 fatalities per year from 1959 through 1991 (Dittmann, 1994). A separate record reports that between 1974 and 2014, the average damage due to flooding was around $8 billion annually (NOAA, 2015). Accounting for major events in the last five years, flood events have cost the federal government an aggregate of $49 billion and 93 deaths (NOAA NCEI, 2022a). The Federal Emergency Management Agency (FEMA, n.d., para. 3) additionally noted that "flooding causes more damage in the United States than any other severe weather-related event, an average of $5 billion a year."

Second, several observational studies have shown that flooding is becoming more intense across the globe, including in large areas of the U.S. (Archfield et al., 2016; Mallakpour & Villarini, 2015; Slater & Villarini; Tellman et al., 2021; Wing et al., 2022). Scientists have not unanimously attributed the increase of flood events solely to climate warming, noting certain societal factors (i.e., urban development and water management) might have concurrently influenced their prevalence (Hirsch & Ryberg, 2012; Hodgkins et al., 2017; Intergovernmental Panel on Climate Change [IPCC], 2014; Pielke, 1999; Prein et al., 2017). But it is undeniable that extreme precipitation contributes to flooding and, as suggested in the federal government's Fourth National Climate Assessment, that "observed increases in the frequency and intensity of heavy precipitation events in most parts of the United States are projected to continue" (Hayhoe et al., 2018).

Third, unlike some other forms of disasters, flooding is possible in all of the 50 states in the U.S. at any time of the year (National Severe Storms Laboratory, n.d.). The ubiquity of flooding is essential for this study as it helps with the estimation strategy employed in the analysis (more

on this later in the Methodology section). By way of comparison, other notable disasters like wildfires are typically found in the Western region of the U.S., while hurricanes mostly happen only in the Southern region; these limit the variability necessary to empirically estimate the average impact of a specific disaster across *all* states.

The socioeconomic impact of flooding is significant. For example, a country-level study by Dottori et al. (2018) found that river flooding under some warming assumptions reduced global welfare, measured by changes in consumption, by 0.23-0.53 percent. Using a dynamic model of the global economy, Desmet et al. (2021) projected that coastal flooding will cut real GDP by 0.19 percent. Flooding also has disproportionate impacts across different income and ethnic groups, as evidenced in the U.S. A report by FEMA shows that lower-income households (earning below $30,000 annually), who presumably find affordable housing in higher-risk areas, endure more flood damage than other income groups (Sarmiento & Miller, 2006). Controlling for incomes, African Americans suffer greater flood damage on average than other race or ethnic group. The literature also notes other harmful impacts of flood events, including injuries, psychological trauma, and displacement (Doocy et al., 2013; Rufat et al., 2015).

This study examines the fiscal impact of flooding in state government. More specifically, it will evaluate how flooding impacts state total revenue and spending, along with specific items such as tax revenue, intergovernmental revenue, and intergovernmental expenditure. In addressing the research question, the analysis applies two-way fixed effects model on a panel data of 50 U.S. states between 1997 and 2020. As no previous studies have investigated the incidence of flooding in the state budgeting context, this research supplements the existing literature.

Following this introductory section, this paper is organized as follows: Section 2 provides a discussion of the literature relevant to the fiscal implications of natural disasters; Section 3

describes data collection and sources; Section 4 reviews the methodology; Analysis results and discussion are presented in Section 5; and finally, Section 6 presents conclusions.

2. Literature Review

To minimize the harm to communities caused by flooding, it is imperative that governments carry out effective and efficient emergency management policies. The National Governors' Association (1979) describes four main phases of the 'comprehensive emergency management' framework: mitigation, preparedness, response, and recovery. The first two are undertaken before a disaster, while the latter two are after. The framework is applicable to many forms of emergencies, including floods and other types of natural disasters. After a disaster event, the undertaking geared toward response and recovery is crucial as it determines how much time is required for the economy to recover. Ideally, however, the government also invests in mitigation and preparedness to the extent possible. A study by the National Institute of Building Sciences (2020) estimated that for every $1 spent on federal mitigation grants for riverine floods, society saves up to $7. Phaup and Kirschner (2010) classified budgetary treatments before and after a disaster event as ex-ante budgeting and ex-post budgeting, respectively. They also argued that ex-ante budgeting is more favorable to reduce risk exposure, although it requires trade-offs of present consumption for disaster mitigation and preparedness.

Government actions may be performed at the national level, subnational level, or both. For instance, the 1000-year-rain event in St. Louis, Missouri in mid-2022 triggered major flooding resulted in the federal government's decision to provide emergency aid (Cappucci, 2022; FEMA, 2022b). In total, more than $33 million was approved to help flood victims in affected areas: $20.4 million in individual assistance grants for renters and homeowners, $8.6 million in claims for the

National Flood Insurance Program policyholders, and $4 million in disaster loans for households and businesses. Meanwhile, minor flooding that inundated parts of Maryland, Virginia, and Washington D.C. just a few weeks later was locally resolved. In Maryland's Prince George's County, more than ten school buildings were affected by the flooding event while the county's fire department had to respond to dozens of water rescue calls (Samenow, 2022). In its 2023 budget, Prince George's County (2022) allocated more than $240 million for flood mitigation programs, including stormwater management and watershed protection and restoration. These flooding events certainly have budgetary implications, both on the revenue and expenditure sides, and so do any other measures undertaken by the government.

Multiple studies have examined the fiscal impacts of various forms of natural disasters in the U.S., such as wildfires (Liao and Kousky, 2021), hurricanes (Deryugina, 2017; Jerch et al., 2020). Those studies, however, rarely focused on flooding despite its growing prevalence across the country. A limited number of studies considered either state government as the unit of analysis or flooding disasters specifically, but not both. For instance, Miao et al. (2018) examined U.S. states' responses but to natural disasters in a broad sense and Sarmiento et al. (2006) studied flood disasters but at the municipal level. The implications of flooding for state governments' finances remains unclear, and this is the focus of my study.

Studies in the public finance literature have found mixed results regarding the influence of disasters on various components of the government budgets. A disaster event could lead to an increase in tax revenue, partly attributable to a surge of recovery consumption (Ismayilov & Andrew, 2016; Miao et al., 2018) and property value reassessment (Liao & Kousky, 2021). However, tax revenue could also decrease due to disruption to local economic activities (Jerch et al., 2020) and reduced property values (Sarmiento et al., 2006; Miao et al., 2018). Meanwhile,

intergovernmental revenue could go up as more federal aid is transferred to state and local governments (Miao et al., 2018; Jerch et al., 2020). But a disaster could also interrupt activities and resources that would have been eligible for federal grants, resulting in lower intergovernmental revenue (Sarmiento et al., 2006). Beyond those, there were cases in which intergovernmental transfers were found to be unaffected by disaster events (Liao and Kousky, 2021).

For this study, the analysis begins with an examination of how the aggregate revenue and expenditure in state government is impacted by flooding events. I then look deeply at specific components of the state budget, such as tax revenue, intergovernmental revenue, and intergovernmental expenditure. When flooding occurs, affected governments likely face a fiscally challenging period. On the expenditure side, government actions in response to the disaster may incur extra spending, which requires additional funding from tax collection, intergovernmental transfers, or debt issuance. On the revenue side, flooding potentially disrupts local economic activities and, because residents are unable to work and run businesses, they pay fewer taxes to the government. I hypothesize that flood disasters reduce revenue through local taxes but increase revenue from intergovernmental assistance.

3. Data

3.1. Flooding in the United States

FEMA (2020) describes flooding as "a general and temporary condition of partial or complete inundation of 2 or more acres of normally dry land area or of 2 or more properties." Several things may cause this, such as an overflow of inland or tidal water, unusual runoff of surface waters, and collapse of land along the shore of a lake. In the U.S., however, there are no

scales or indexes that are conventionally used to categorize flooding events based on their severity and frequency levels. As a result, it becomes quite challenging to study this disaster through cross-sectional and intertemporal lenses. The NOAA database, for instance, includes four types of events -- "flood", "flash flood", "coastal flood", and "lakeshore flood,"[1] but does not specify the magnitude of each event. In contrast, NOAA documents and classifies hurricanes into five Saffir-Simpson severity scales. Another example comes from the National Drought Mitigation Center at the University of Nebraska-Lincoln, which develops the Drought Severity and Coverage Index to monitor drought levels (Akyuz, 2017). This study makes use of data that are available and proceeds with two flooding measures: in a given state and year, the amount of flooding insurance claims as a proxy for flooding severity, and the number of flooding events as a proxy for frequency.

Flooding insurance claims data are obtained from the National Flood Insurance Program (NFIP) records administered by FEMA (2022c). NFIP covers for buildings and contents within the building structures that are damaged by flooding events. This data set has more than 50 million transactions collected since the 1980s. Personally identifiable information is redacted, but other key information is retained, including types of damaged building structures, years of loss, locations, and claims. As part of data cleaning, I aggregate total claims in each state throughout the years of observation. Total claims represent amounts in dollar terms that are paid on the building claims as well as contents claims. To support that flooding insurance claims is an appropriate measure of severity, I tested its correlation with the monetary damage of weather disasters in a given state and year as measured by the National Weather Service (2021). This

[1] Flooding, which could last days or even weeks, is a longer-term event than a flash flood that typically clears within six hours or less (NOAA, 2022a). Flash floods are also often commonly referred to as rapid hydrological events triggered by local, intense rainfall (Kruczkiewicz et al., 2021).

exercise generated a strong correlation pattern with a correlation coefficient of 0.89. Higher flooding insurance claims are associated with more severe flooding incidence.

Figure 2. Flooding Insurance Claims (Aggregated at the State Level) from 1996-2020

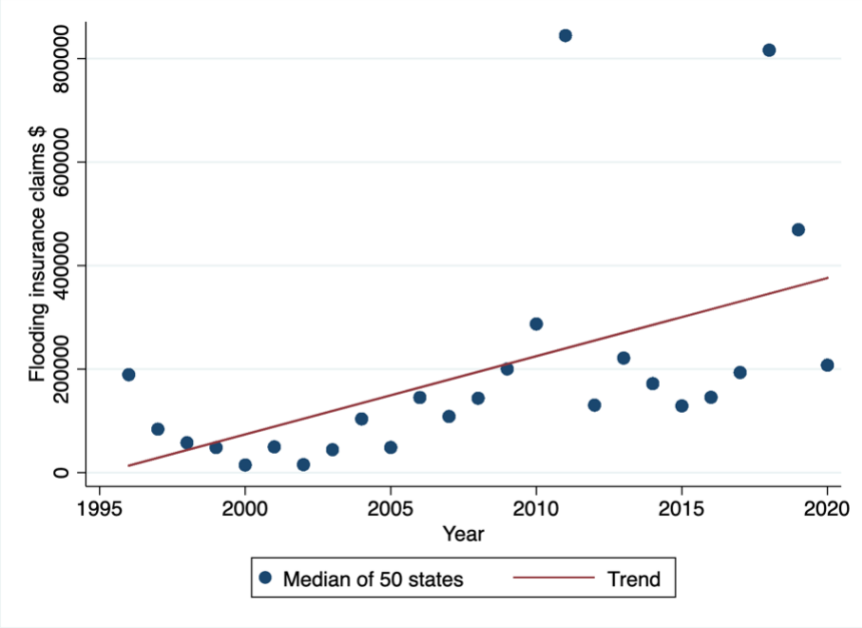
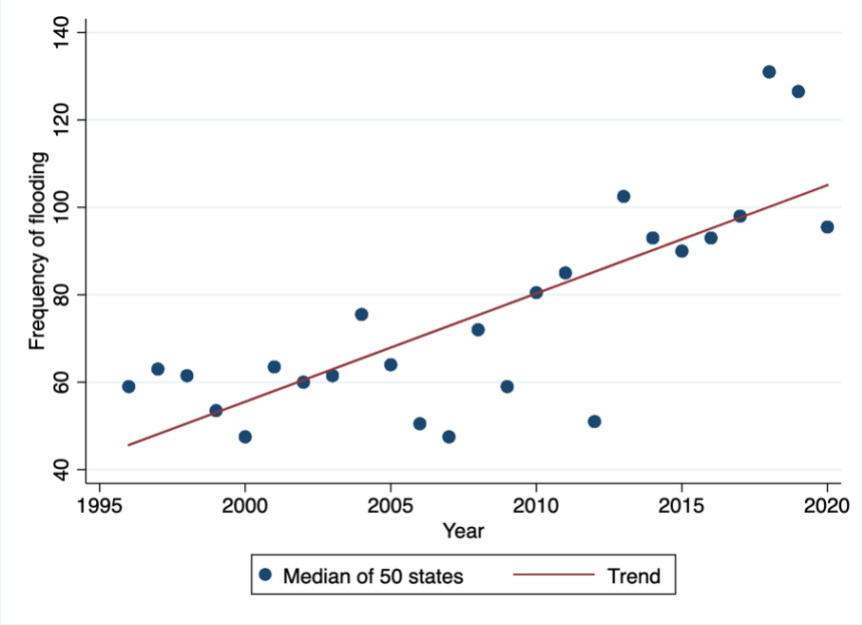


Figure 3. Flooding Events (Aggregated at the State Level) from 1996-2020



Flooding events data are collected from the NOAA's National Centers for Environmental Information (NCEI) official publication. The agency has recorded natural disasters in the U.S. since the 1950s. Until the 1990s, however, it documented only certain types of disaster events, such as tornados, thunderstorms, and hail. The agency then upgraded the database in 2000. Among the changes was the way an event was entered; instead of free-text entries, NOAA added predetermined types of disasters to improve data functionality and consistency. Previously, there had been up to 950 unique event types, but with the change the number was reduced to fewer than 50 event types (NOAA, 2022b). This standardization, applied to natural disasters recorded from 1996 onwards, allows for identification and analysis of a specific disaster type, like flooding. There are several types of floods in the NOAA database, such as flood, flash flood, coastal flood, and lakeshore flood, and all will be included in the analysis. This NOAA data further provides information as to when and where a disaster event occurred, which enables me to identify and quantify the number of flooding events in a given state and year.

There are potential limitations to the severity and frequency measures employed in this study. First, flooding insurance claims could be correlated with the quality of flood mitigation infrastructure provided by the government. A more severe disaster may not necessarily lead to higher damage if the government capacity to mitigate it is excellent. In contrast, with poor mitigation capacity, even a less severe disaster can result in an expensive monetary damage. To overcome potential endogeneity, my model will control for state government spending on sewerage. Second, flooding insurance claims could also be correlated with property values. For instance, flooding with the same magnitude can lead to higher (or lower) claims for households living in an affluent (or lower income) area. To address this potential endogeneity, per capita personal income will also be controlled for in the model. Other studies on natural disasters also

use similar type of measurement, such as the monetary costs of property and crop losses (Miao et al., 2018). Second, frequency might not perfectly capture the magnitude of a disaster. But frequency is a distinct concept in and of itself, and it is arguably a more direct measure of any disaster type relative to claims and monetary damage. From a policy standpoint, more frequent flooding events, regardless of their magnitude, can still negatively affect communities. Figures 2 and 3 demonstrate the increasing trend of these measures, flooding insurance claims and flooding events in the U.S. based on the FEMA and NOAA data.

3.2. Federal and State Budgets

Budget data were obtained from the U.S. Census Bureau. Every year, the agency conducts the Annual Survey of State Government Finances to collect budget data from all 50 states. The level of detail that goes beyond aggregate amounts (i.e., total revenue, total expenditure) provides an avenue for more granular analysis of the budget. Also, since data are stored in one place, accessing the database is more time efficient as compared to collecting the same information state by state (i.e., from each state government website.) An additional source for the state expenditure on sewerage data is the Willamette University's Government Finance Database (Pierson et al., 2015), which is a formatted and consolidated version of the U.S. Census Bureau's state finance data.

Figure 4 illustrates the state government budget structure analyzed in the study. At the broad level, the budget is comprised of two major flows: total revenue and total expenditure. Total revenue is subdivided into tax revenue, intergovernmental revenue, and other. State tax revenue is raised by the respective state and includes sales and income tax, among other subcomponents. Intergovernmental revenue, also included in the state budget structure, is money transferred from

other government entities, almost exclusively from the federal government. On the expenditure side, the components, according to the entity responsible for executing the budget, are direct expenditure, intergovernmental expenditure, and other. This essentially is fiscal federalism at work (Oates, 1972). The federal, state, and local authorities in the U.S. each contributes to government functions, as reflected in the way revenue and expenditure are structured and managed.

Figures 5 and 6 demonstrate state revenue per capita and state expenditure per capita, respectively, over the observation periods. Visually, revenue and expenditure increased over time, though total and tax revenues experienced dips around 2008-2009, due to the Great Recession.

Figure 4. State Budget Structure

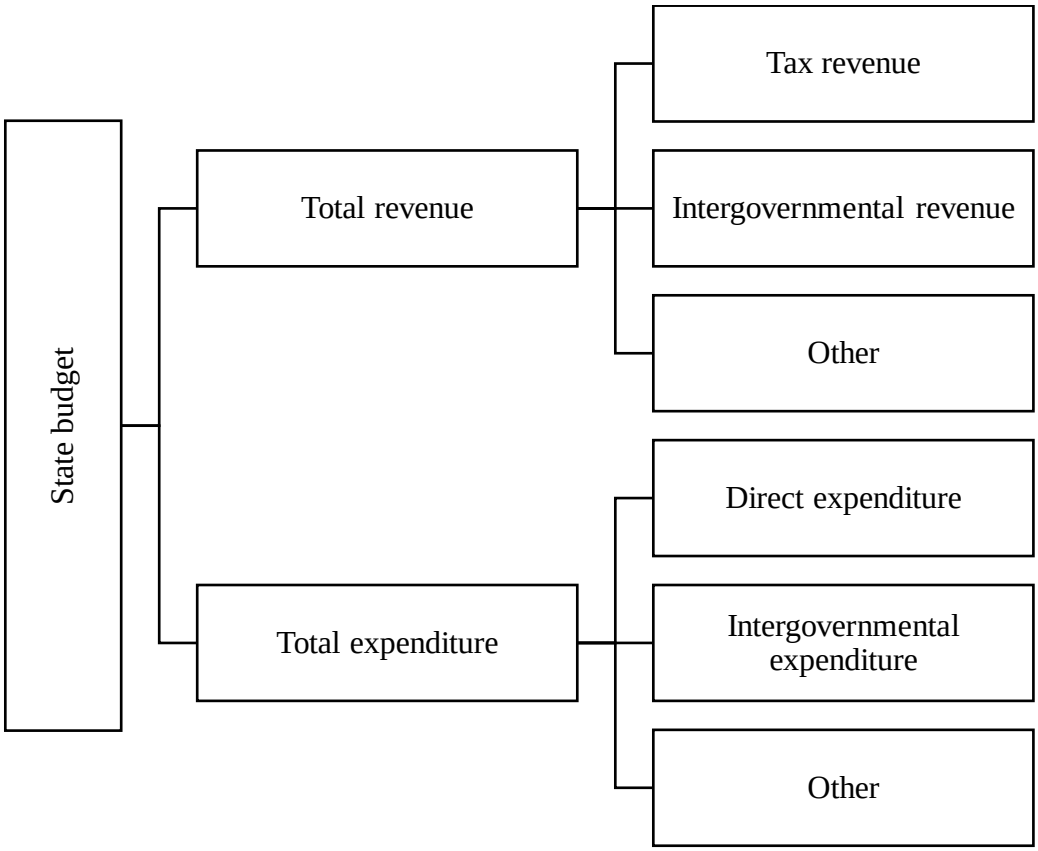


Figure 5. Per Capita State Revenues Trends

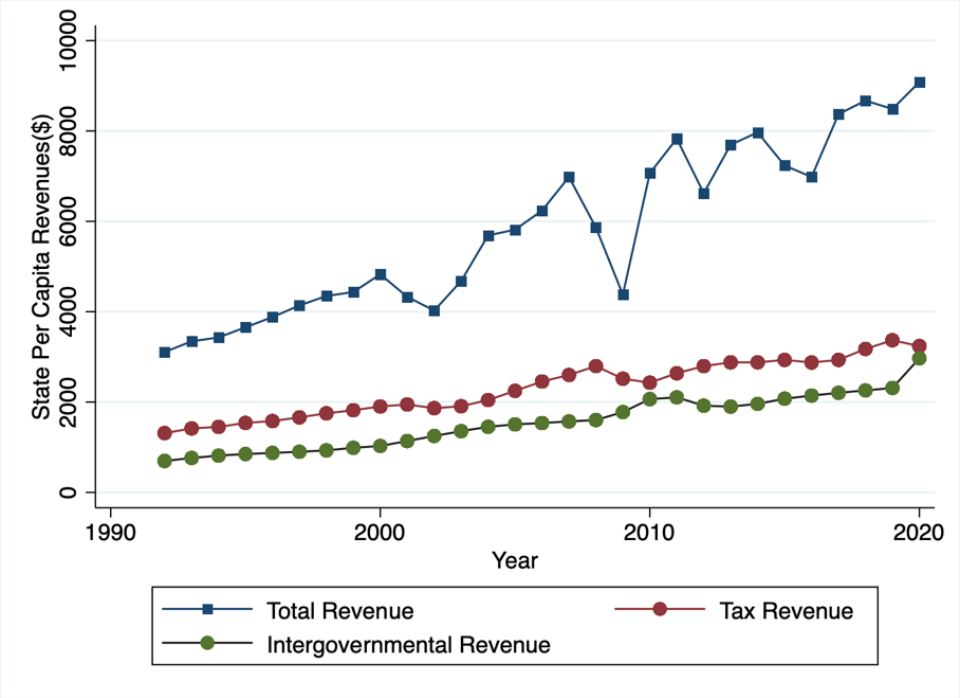


Figure 6. Per Capita State Expenditures Trends

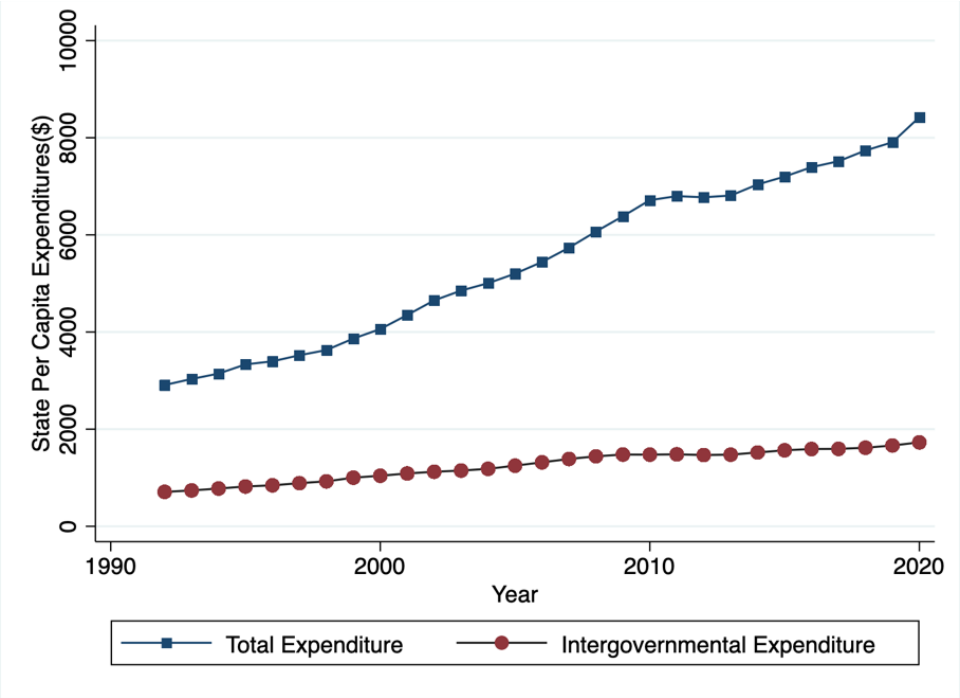


Table 1. Data Sources and Collection

Variable	Data source	Years Available
Flooding insurance claims ($)	FEMA	1996-2021
Flooding frequency (count)	NCEI	1996-2021
Total revenue ($ m)	US Census Bureau	1992-2020
Total expenditure ($ m)	US Census Bureau	1992-2020
Tax revenue ($ m)	US Census Bureau	1992-2020
Intergovernmental revenue ($ m)	US Census Bureau	1992-2020
Intergovernmental expenditure ($ m)	US Census Bureau	1992-2020
Population (thousand)	UKCPR National Welfare Data	1980-2020
Gross State Product ($ m)	UKCPR National Welfare Data	1980-2020
Unemployment rate (%)	UKCPR National Welfare Data	1980-2020
Personal income per capita ($)	UKCPR National Welfare Data	1980-2020
Governor is democrat (1 = Yes)	UKCPR National Welfare Data	1980-2020
Sewerage spending ($ m)	Willamette University	1996-2020
Number of state employees (m)	US Census Bureau	1997-2020

3.3. State Welfare Data and Other Control Variables

Welfare data and other control variables are obtained from the University of Kentucky Center for Poverty Research (UKCPR, 2022). The center collects relevant variables from various sources, such as U.S. Census Bureau (population, the number of state employees), Bureau of Labor Statistics (unemployment rate), U.S. Department of Commerce's Bureau of Economic Analysis (Gross State Product, personal income), and the Council of State Governments (governor's party affiliation). States like California and Texas are much different in terms of economic size and population from Wyoming and Vermont. Considering their influence on the size of the state budget, these need to be accounted for. Both unemployment rate and personal income are measures of affluence in a given state and year, which may correlate with how much a state collects in taxes and spends for public services. The number of full-time equivalent state employees are included in the analysis to control for government capacity. Lastly, governor's party affiliation reflects how the state government perceives and carries out tax policies and public spending.

Accounting for data availability, this study constructs a panel data with 50 cross-sectional units (i.e., 50 states) for a 24-year period from 1996 through 2020. The result is a balanced panel data with 1200 observations altogether. Table 1 summarizes sources from which data are obtained in the study, and Table 2 reports the summary statistics for all variables in the analysis.

Table 2. Summary Statistics

Variable	**(1) Mean**	**(2) Standard deviation**	**(3) Minimum**	**(4) Maximum**	**(5) Observations**
Flooding insurance claims ($ thousand)	10,136	110,646	0	3,015,920	1,250
Flooding frequency (count)	118	139	0	1,345	1,250
State total revenue ($ m)	35,695	47,016	2,146	433,081	1,250
State total expenditure ($ m)	34,074	44,611	1,983	422,066	1,250
State tax revenue ($ m)	14,539	19,497	626	188,235	1,250
State intergovernmental revenue ($ m)	9,383	12,053	650	102,420	1,250
State intergovernmental expenditure ($ m)	8,826	14,102	124	118,963	1,250
Population (thousand)	6,022	6,669	480	39,538	1,250
Gross State Product ($ m)	285,422	373,921	14,672	3,132,801	1,250
Unemployment rate (%)	5.41	1.94	2.30	13.70	1,250
Personal income per capita ($)	38,947	11,080	18,644	77,542	1,250
Governor is democrat (1 = Yes)	0.42	0.49	0	1	1,250
State sewerage spending ($ m)	42.7	119.1	0	2,019.6	1,250
Number of state employees	85,524	73,077	11,023	438,305	1,200

Note: Mean, standard deviation, minimum, and maximum values are calculated in 1996-2020, except for number of state employees 1997-2020.
Sources: FEMA (2022c); NOAA NCEI (2022b); UKCPR (2022); U.S. Census Bureau (2022a, 2022b)

4. Methodology

4.1. Identifying Assumption

This study employs a two-way fixed effects regression model to estimate the impact of flooding events on state finances. The model is appropriate for panel data, in which a set of states is observed repeatedly across several years. Throughout the analysis, the identifying assumption is that some unobservable state characteristics that affect both the outcome variable and independent variable of the regression are time-invariant. With the fixed effects model, these unobserved variables need not be measured but could be controlled for. The threat of omitted variable bias is greatly reduced as a result.

Examples of time-invariant state characteristics related to flooding are geographic and topographic features. Some states located near the coast (e.g., New York, South Carolina, and California) or bordering the Great Lakes (e.g., Wisconsin, Michigan, and Ohio) will unlikely change in the foreseeable future. Similarly, patches of an urban area or agricultural land within a state are likely to remain so, at least during the years this study considers. Inclusion of state fixed effects removes these presumably time-invariant characteristics, measuring changes "within" each state over time.

Studies report that flooding is influenced by not only the climate but also some societal factors (Kunkel et al., 1999; Changnon et al., 2000). For example, there is evidence that GDP and population, which account for social and economic conditions, can affect the level of flooding hazards (Barredo, 2006; Choi & Fisher, 2003; Pielke & Downton, 2000; Zhou et al., 2017). Others also discussed the role of government capacity in developing and implementing flood mitigation techniques (Brody et al., 2010; Shabman & Scodari, 2014). These variables vary from time to time and will not necessarily be accounted for by the fixed effects model. Since their omissions will

cause bias, this study proceeds by including in the model several relevant time-varying indicators as control variables in each state and year, such as gross state product, population, unemployment rate, personal income per capita, number of state government employees, state government spending on sewerage, as well as the governor's party affiliation.

Flooding, like many other disasters, is often unpredictable. While the weather forecast agency can predict whether the next few days or even weeks will have rain, the extent of likely flooding is typically assessed on a real-time basis (U.S. Geological Survey, 2022). A state can reasonably anticipate a flood, but it cannot fully control its occurrence.

4.2. Econometric Model

The model takes the following functional form:

$$budget_{it} = \alpha + \sum_{k=0}^{3} \beta_k flooding_{it-k} + \beta_4 gsp_{it} + \beta_5 population_{it} + \beta_6 unemployment_{it} + \beta_7 pcincome_{it} + \beta_8 bureaucracy_{it} + \beta_9 governor_{it} + \beta_{10} sewerage_{it} + \lambda_i T + \tau_t + \mu_i + e_{it}$$

$budget_{it}$	: budget indicator in state *i* in year *t*
$flooding_{it}$	: flooding frequency or severity (log-transformed) in state *i* in year *t*
gsp_{it}	: gross state product (log-transformed) in state *i* in year *t*
$population_{it}$	: population (log-transformed) in state *i* in year *t*
$unemployment_{it}$	: unemployment rate in state *i* in year *t*
$pcincome_{it}$	: per capita personal income in state *i* in year *t*
$bureaucracy_{it}$	: number of fulltime equivalent employees per capita in state *i* in year *t*
$governor_{it}$	: governor's party affiliation in state *i* in year *t*
$sewerage_{it}$	: sewerage spending as a share of total expenditure in state *i* in year *t*

λ_i : state-specific trend
T : year
τ_t : year fixed effect
μ_i : state fixed effect
e_{it} : idiosyncratic error terms
α : intercept

This study will run multiple regression models individually using a set of budget indicators ($budget_{it}$) as the dependent variable. The budget indicators are (1) state total revenue and (2) state total expenditure, each in log-transformed terms. Additionally, there is also a model using (3) state tax revenue, (4) state intergovernmental revenue, and (5) state intergovernmental expenditure as the dependent variables in the analysis. This log transformation is helpful to get the variables closer to a normal distribution as well as to make the data easier to interpret.

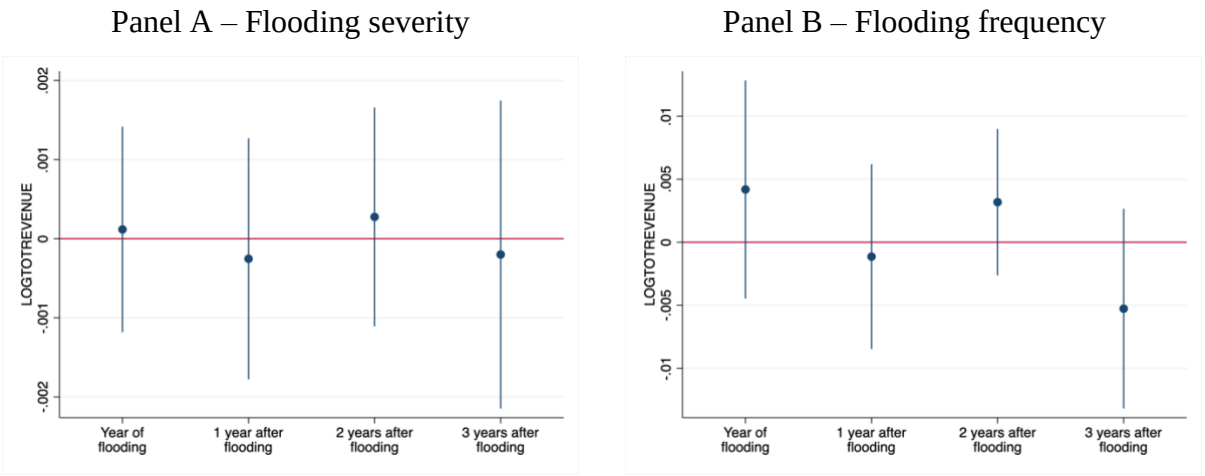
My analysis aims to evaluate the impact of an increased frequency and severity of flooding on the state government budget indicators. The key independent variable is $flooding_{it}$ which is comprised of two measures: flooding severity (i.e., the amount of flooding insurance claims) and flooding frequency (i.e., the number of flooding events), both log-transformed, in a given state and year. The analysis also considers *lagged* $flooding_{it}$, separately and collectively, in addition to $flooding_{it}$ in the regressions. This allows the analysis to assess the impact of a natural disaster not only during the year it occurs but also up to three years after. Taken together, the dependent variables and the key independent variable test the hypotheses whether a budget indicator changes with increased frequency and increased severity of flooding.

The model includes several control variables. First, gsp_{it} is the gross domestic product of state *i* in year *t*, and $population_{it}$ measures the number of state population in state *i* in year *t*. Next, $unemployment_{it}$ is the unemployment rate of state *i* in year *t* while $pcincome_{it}$ is per capita personal income in state *i* in year *t*. To control for government capacity in providing public goods

and services (i.e., capital outlay and maintenance expenditure) associated with flood mitigation, the model includes $sewerage_{it}$, sewerage spending as a share of total expenditure, and $bureaucracy_{it}$, the number of fulltime equivalent employees per capita in state i in year t. $governor_{it}$ denotes the governor's party affiliation in state i in year t.

λ_I is state-specific trend, which captures the budget trend over the years of observation. Year dummies (τ_t) are included to control for variables that are constant across states but may change through time. One example is the condition of the U.S. national economy (i.e., economic boom or economic crisis) that might have affected all 50 states. The state fixed effect is denoted μ_i. Finally, the model also considers robust standard errors, clustered at the state level, to overcome outliers in the observations. It will safely correct the standard errors under heteroskedasticity.

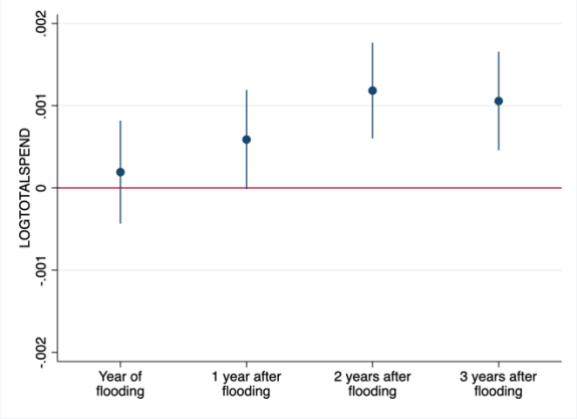
Figure 7. The Effect of Flooding on State Total Revenue



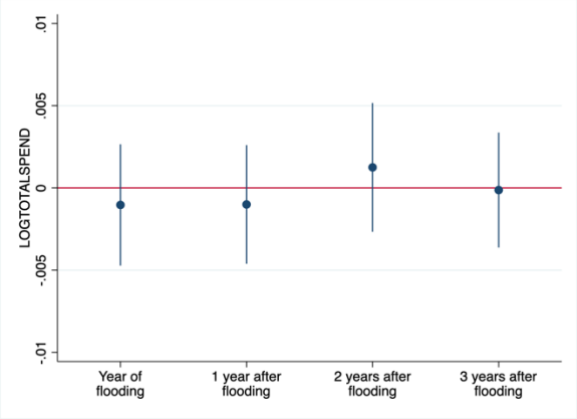
Note: Bars correspond to a 90% confidence interval around the point estimate. The regression table with detailed estimates is available in the Appendix section.

Figure 8. The Effect of Flooding on State Total Expenditure

Panel A – Flooding severity



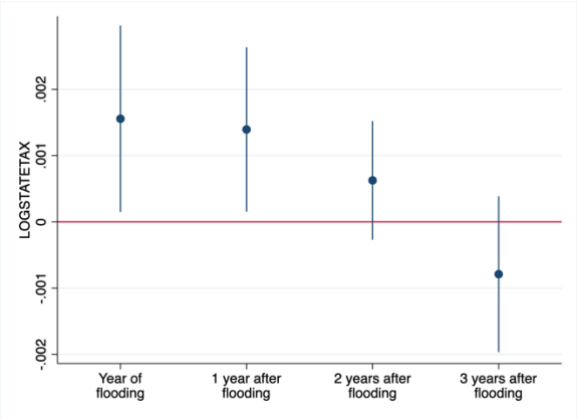
Panel B – Flooding frequency



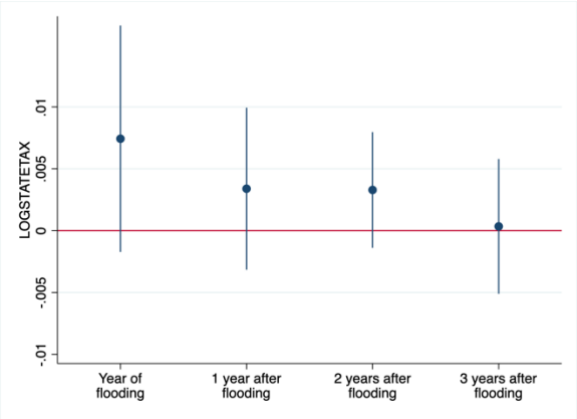
Note: Bars correspond to a 90% confidence interval around the point estimate. The regression table with detailed estimates is available in the Appendix section.

Figure 9. The Effect of Flooding on State Tax Revenue

Panel A – Flooding severity

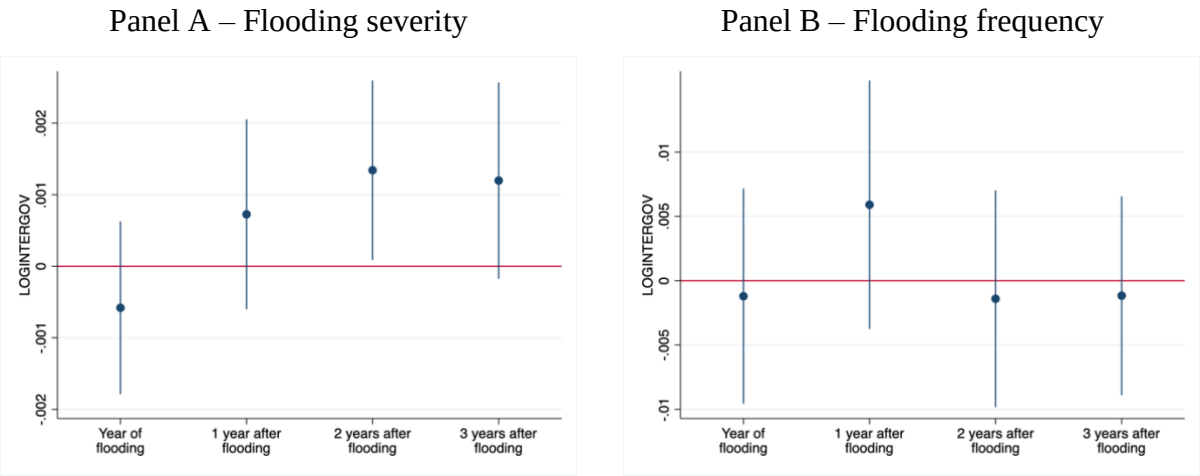


Panel B – Flooding frequency



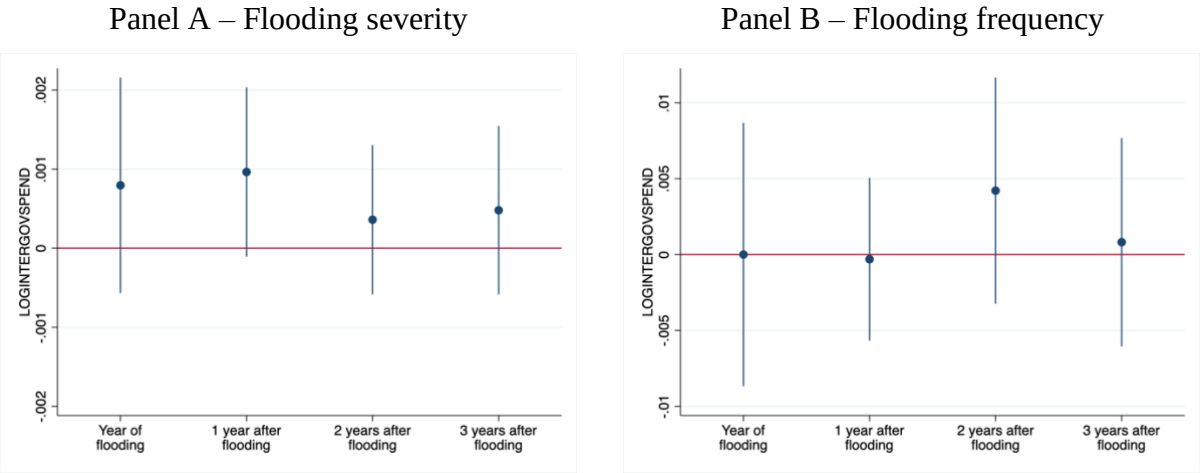
Note: Bars correspond to a 90% confidence interval around the point estimate. The regression table with detailed estimates is available in the Appendix section.

Figure 10. The Effect of Flooding on State Intergovernmental Revenue



Note: Bars correspond to a 90% confidence interval around the point estimate. The regression table with detailed estimates is available in the Appendix section.

Figure 11. The Effect of Flooding on State Intergovernmental Expenditure



Note: Bars correspond to a 90% confidence interval around the point estimate. The regression table with detailed estimates is available in the Appendix section.

5. Results and Discussion

My analysis begins with an examination of the implications of flooding for the state total revenue and total expenditure. As seen in Figure 7, Panels A and B, neither flooding severity nor frequency had significant effects on the state total revenues up to three years following the events. A more obvious effect is observed on the expenditure side. Figure 8 Panel A shows that more severe flooding events increased total expenditure up to three years after the disaster. However, Panel B of Figure 8 shows that more frequent flooding did not lead to higher state total expenditure. The results show contrasting effects between flooding severity and flooding frequency on the state budgets. Severe flooding is potentially a disruption to the local economy, hence higher expenditure is justified as a countercyclical measure by the government. State spending in that case becomes a mechanism to stabilize the economy (Musgrave, 1959).

The full estimation results are presented in Appendix Tables A1 and A2 as well as Appendix Tables A3 and A4, respectively. Holding all other things constant, a 1-percent increase in the severity of flooding, measured by the number of flooding insurance claims, coincides with a 0.001-percent increase in total expenditure on year 2 and 3 after flooding. Including all control variables, the results are statistically significant at the 1-percent level. It may seem tiny in percentage terms, but the number translates to a significant amount in dollar terms. Consider the annual budget of the state of Florida as an example. In Fiscal Year 2019, just before the COVID-19 pandemic, Florida's total expenditure according to the U.S. Census Bureau was around $103.1 billion. A 0.001-percent increase in Florida's total expenditure is equal to an additional spending of more than one million dollars.

While the aggregate revenues were not impacted, revenue components may still fluctuate after flooding events. Next, I evaluate the impact of flooding on one of the components: state tax

revenue. As Figure 9 Panels A and B show, state tax revenue was positively affected by an increased severity of flooding, but not by an increased frequency of flooding. The effect appears during the year of flooding and one year after the disaster struck. Appendix Tables A5 and A6 provide the estimates of flooding's severity and frequency effects on state tax revenues. Holding all other things constant, a 1-percent increase in the severity of flooding coincides with a 0.001-percent increase in tax revenue during the year of flooding, and the effect was sustained one year after flooding. The results are statistically significant at the 10-percent level.

The positive effect of increased severity on state tax revenue might seem counterintuitive, partly because severe flooding, in theory, should have negatively impacted the economy. As the productivity of the economy was curtailed, tax collection by the state would have been lower. Prior studies, however, discussed alternative mechanisms through which tax revenues increased rather than decreased following a major disaster. For instance, Gillespie (1991, p. 2 as cited in Baade et al., 2006, p. 2063) argued that in the aftermath of Hurricane Hugo, the economic disruption was just temporary and the reconstruction activities "more than offset the brief loss of jobs in the tourism and trade sectors." In a post-disaster study of Hurricane Andrew, Burrus et al. (2002, p. 118) observed that the substantial damage on the local economy was "ameliorated by reconstruction-related local spending (financed largely from extra-regional sources, such as insurance claim payments and federal disaster funds)." Similarly, Baade et al. (2006, p. 2072) suggested that taxable sales in Miami reached its post-Andrew peaked "within 3 months and the bump in economic activity persisted for fully 18 months." Higher consumption associated with local reconstruction is more likely the case after major floods. The same argument might also explain the differential impacts of increased severity and increased frequency of flooding events.

State intergovernmental revenue also increased after flooding, though there is a nuance to this finding. Both Panels A and B of Figure 10 show increases in year 1 after flooding, but none of the estimates are statistically significant. In year 2, the effect associated with an increased severity (Panel A) was even higher, while that associated with an increased frequency (Panel B) moved closer to zero. The full estimation results are provided in Appendix Tables A7 and A8. Holding all else equal, a 1-percent increase in the number of flooding insurance claims coincides with a 0.001-percent increase in intergovernmental revenue two years after flooding. The positive result is statistically significant at the 10% level. Using Florida's fiscal year 2019 budget as before, its total revenue consisted of tax revenue ($44.8 billion), intergovernmental revenue (29.3 billion), and other revenue sources ($32.7 billion). Taken together, 0.001-percent increases in both tax and intergovernmental revenues equal more than half a million dollars. The accumulated amount in a given year might be even higher if the state experiences more severe flooding events.

The federal government provides emergency funding to state governments mainly through FEMA, whose mission statement is "helping people before, during, and after disasters." This is manifested in various programs, including disaster relief and assistance in response to disasters. Other federal agencies also provide emergency assistance to states for natural disasters, including the U.S. Departments of Agriculture, Commerce, Health and Human Services, Defense, Interior, and Justice (Healy & Malhotra, 2009). One presumption that justifies intergovernmental transfers to states, almost exclusively from the federal government, is that natural disasters like flooding can negatively affect local economies, which contributes to weaken the nation as a whole. The transfer is thus seen as part of the stabilization function by the federal government. However, I found no evidence of weakening local economies within three years after flooding, at least from a

budgetary lens. My empirical results show that state tax collection was positively affected by increased flooding severity and was unaffected by increased flooding frequency.

There could be unintended consequences resulting from federal assistance. While the predictable availability of federal assistance helps states *after* floods have occurred, this may also create a problematic incentive for states experiencing high severity of flooding. In particular, it may cause them to favor ex-post response over ex-ante mitigation. Previous studies already suggested the tendency for governments to underinvest in emergency preparedness. Within funds allocated for disaster-related expenditures, only 12.7 percent are allocated to preparedness, while the rest is spent on reconstruction, rehabilitation, and emergency response (Kellet & Pichon, 2013). Donahue and Joyce (2003) highlight institutional rules and politics as factors explaining such inclination based on the emergency management practice in the U.S. federal budget. Looking at data from more than 3000 counties in the U.S., Healy and Malhotra (2009) also present evidence that voters reward the incumbent presidential party for delivering disaster relief spending, but not for investing in disaster preparedness spending. Flooding, like other disasters, provides electoral leverage and is a politically appealing issue. This is demonstrated by surveys that reveal that one-third of U.S. adults report they have been personally affected by an extreme weather event in the past two years (Gallup, 2022a), and more than 70 percent of registered voters across the U.S. support policies that will enable communities to better prepare for and respond to floods (Pew Charitable Trusts, 2018a). State leaders may not act to mitigate the harm resulting from floods if they know that federal assistance is available when states experience an emergency.

The last portion of the analysis looks at the effect of flooding on state intergovernmental expenditure. As states receive more intergovernmental funding after flooding, it is worth exploring whether and the extent to which state governments pass down the aid to localities. Significantly,

however, the federal-state fiscal relationship – whereby federal authorities give help to the states -- may or may not be replicated in the state-local fiscal relationship. Panels A and B of Figure 11 illustrate the statistically null results within three years after flooding, and Appendix Tables A9 and A10 report the full estimation results. The coefficients are not statistically distinguishable from zero, suggesting no changes in transfers from states to other government entities, most of which are local governments.

This study finds asymmetry between federal-state-local relationships. After flooding events, states receive higher intergovernmental funds but do not necessarily pass down more funds to localities. This finding is consistent with the study by Sarmiento et al. (2006), which indicates that flooding has little statistical relationship with inter-governmental revenues in local government. Whether or not this is a good practice depends on what types of public programs and activities the government pursues.

In fiscal federalism theory, Oates (1972) uses the term 'correspondence principle' to explain that the assignment of government expenditure for public goods should align with the benefit coverage. Intergovernmental transfers generate benefits that are geographically concentrated, but the burden is shared nationally. It could also multiply intergenerationally if the federal government finances the transfers using debt. Relevant to the discussion are two contrasting theories of fiscal federalism: functional theory and legislative theory (Peterson, 1995). Functional theory takes an optimistic stance, suggesting that federalism can work since each government level focuses on the responsibilities for which it is most suitable for. However, legislative theory is less optimistic, acknowledging that most elected representatives have incentives to seek reelection. Therefore, they tend to support federal projects that have local benefits but diffuse costs.

The transfer could be inefficient from a budgetary standpoint, and budget policies in this direction should be carefully developed and taken only when the overall socioeconomic benefit outweighs the cost. Spending through state agencies is better for programs that span beyond local boundaries, require intergovernmental coordination, and entail economies of scale, such as flood-resilient infrastructure projects (Miao et al., 2020; Pew Charitable Trusts, 2021). However, spending through localities is better for programs that benefit from local implementation and monitoring, such as interactive flood risk maps and property acquisition and redevelopment (Fraser et al., 2003).

6. Conclusion

Flooding, like many other natural disasters, has become more frequent and destructive in recent decades in the U.S. and across the globe. Last year, the U.S. witnessed flooding incidents spanning Texas, Mississippi, Kentucky, Missouri, and Colorado, among other places. These events, as much as any other response measures undertaken by the government, will have budgetary implications. Flooding likely disrupts economic activity and erodes corresponding tax bases, such as sales and income. Government actions in response to a disaster may also generate extra spending. The incidence of natural disasters could reduce potential revenue through state taxes but increase revenue from intergovernmental assistance. The net impact warrants empirical investigation.

I estimate the impact of flooding on state government fiscal conditions, such as total revenue and expenditure, tax revenue, and intergovernmental revenue and expenditure. A panel of 50 U.S. states between 1997 and 2020 is constructed and a two-way fixed-effects model is employed to address the research question. The main results show that increased severity of

flooding leads to higher intergovernmental revenue two years after the disaster, and that an increased flooding severity coincides with increased state tax revenue during and one year after the disaster. Reliance on federal assistance can help some states facing budget constraints, but this may also create problematic incentives for states. Knowing that federal assistance is, at least historically, of unlimited amount and is always available when states need an emergency response, they may not allocate enough resources for flood mitigation. This study also finds that although states receive higher intergovernmental funds, they do not necessarily pass down more funds to localities after flooding.

This study focuses on what happens post-disaster, though its findings should also give insights into what should be done in anticipation of future disasters. The increasing prevalence of flooding triggers the need for further thought on how to design an effective and efficient emergency management policy. A sound budgetary policy is an essential part of such policy as it also aims to minimize the degree to which flooding harms communities. My hope is that this study sheds some light on the fiscal behavior of states after flooding and will encourage policymakers and scholars to jointly think about an enhanced framework for pre-disaster mitigation, post-disaster response, and fiscal resilience in the public budgeting context.

Appendix

Appendix Table A1. The Effect of Flooding Severity on State Total Revenue

	(1) Total revenue (log)	(2) Total revenue (log)
Year of flooding	0.00112	0.000117
	(0.000975)	(0.000775)
1 year after flooding	0.00128	-0.000254
	(0.00131)	(0.000909)
2 years after flooding	0.00139	0.000275
	(0.000927)	(0.000825)
3 years after flooding	0.000635	-0.000200
	(0.00109)	(0.00116)
Year FE	Yes	Yes
State FE	Yes	Yes
Controls	No	Yes
Observations	1100	1100
Adjusted R2	0.893	0.923

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix Table A2. The Effect of Flooding Frequency on State Total Revenue

	(1) Total revenue (log)	(2) Total revenue (log)
Year of flooding	-0.000342	0.00419
	(0.00675)	(0.00516)
1 year after flooding	0.00000422	-0.00114
	(0.00636)	(0.00437)
2 years after flooding	0.00514	0.00318
	(0.00409)	(0.00346)
3 years after flooding	-0.00264	-0.00527
	(0.00519)	(0.00472)
Year FE	Yes	Yes
State FE	Yes	Yes
Controls	No	Yes
Observations	1100	1100
Adjusted R2	0.892	0.923

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix Table A3. The Effect of Flooding Severity on State Total Expenditure

	(1) Total expenditure (log)	(2) Total expenditure (log)
Year of flooding	0.000246	0.000192
	(0.000518)	(0.000374)
1 year after flooding	0.000848	0.000588
	(0.000544)	(0.000360)
2 years after flooding	0.00107*	0.00118***
	(0.000610)	(0.000347)
3 years after flooding	0.00115**	0.00106***
	(0.000479)	(0.000357)
Year FE	Yes	Yes
State FE	Yes	Yes
Controls	No	Yes
Observations	1100	1100
Adjusted R2	0.956	0.984

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix Table A4. The Effect of Flooding Frequency on State Total Expenditure

	(1) Total expenditure (log)	(2) Total expenditure (log)
Year of flooding	-0.00349	-0.00103
	(0.00555)	(0.00220)
1 year after flooding	0.0000756	-0.00100
	(0.00459)	(0.00215)
2 years after flooding	0.00329	0.00125
	(0.00470)	(0.00234)
3 years after flooding	0.00463	-0.000131
	(0.00414)	(0.00208)
Year FE	Yes	Yes
State FE	Yes	Yes
Controls	No	Yes
Observations	1100	1100
Adjusted R2	0.956	0.983

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix Table A5. The Effect of Flooding Severity on State Tax Revenue

	(1) State tax revenue (log)	(2) State tax revenue (log)
Year of flooding	0.00194	0.00156*
	(0.00124)	(0.000840)
1 year after flooding	0.00311	0.00139*
	(0.00195)	(0.000740)
2 years after flooding	0.00156	0.000626
	(0.00140)	(0.000534)
3 years after flooding	-0.000375	-0.000790
	(0.00109)	(0.000702)
Year FE	Yes	Yes
State FE	Yes	Yes
Controls	No	Yes
Observations	1100	1100
Adjusted R2	0.748	0.901

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix Table A6. The Effect of Flooding Frequency on State Tax Revenue

	(1) State tax revenue (log)	(2) State tax revenue (log)
Year of flooding	-0.00602	0.00743
	(0.0112)	(0.00546)
1 year after flooding	-0.00317	0.00339
	(0.00808)	(0.00391)
2 years after flooding	-0.00130	0.00329
	(0.00685)	(0.00279)
3 years after flooding	-0.00288	0.000345
	(0.00637)	(0.00325)
Year FE	Yes	Yes
State FE	Yes	Yes
Controls	No	Yes
Observations	1100	1100
Adjusted R2	0.745	0.900

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix Table A7. The Effect of Flooding Severity on State Intergovernmental Revenue

	(1) State intergovernmental revenue (log)	(2) State intergovernmental revenue (log)
Year of flooding	0.000422	-0.000581
	(0.000777)	(0.000720)
1 year after flooding	0.00195**	0.000726
	(0.000878)	(0.000792)
2 years after flooding	0.00242***	0.00134*
	(0.000781)	(0.000748)
3 years after flooding	0.00204*	0.00120
	(0.00103)	(0.000818)
Year FE	Yes	Yes
State FE	Yes	Yes
Controls	No	Yes
Observations	1100	1100
Adjusted R2	0.908	0.945

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix Table A8. The Effect of Flooding Frequency on State Intergovernmental Revenue

	(1) State intergovernmental revenue (log)	(2) State intergovernmental revenue (log)
Year of flooding	0.00149	-0.00120
	(0.00524)	(0.00499)
1 year after flooding	0.0137**	0.00591
	(0.00652)	(0.00576)
2 years after flooding	0.00820	-0.00141
	(0.00544)	(0.00502)
3 years after flooding	0.00851	-0.00117
	(0.00606)	(0.00461)
Year FE	Yes	Yes
State FE	Yes	Yes
Controls	No	Yes
Observations	1100	1100
Adjusted R2	0.908	0.944

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix Table A9. The Effect of Flooding Severity on State Intergovernmental Expenditure

	(1) State intergovernmental expenditure (log)	(2) State intergovernmental expenditure (log)
Year of flooding	-0.000504	0.000795
	(0.00116)	(0.000813)
1 year after flooding	0.000445	0.000964
	(0.000890)	(0.000638)
2 years after flooding	-0.000398	0.000360
	(0.00123)	(0.000563)
3 years after flooding	-0.0000159	0.000480
	(0.000993)	(0.000635)
Year FE	Yes	Yes
State FE	Yes	Yes
Controls	No	Yes
Observations	1100	1100
Adjusted R2	0.781	0.914

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix Table A10. The Effect of Flooding Frequency on State Intergovernmental Expenditure

	(1) State intergovernmental expenditure (log)	(2) State intergovernmental expenditure (log)
Year of flooding	-0.0173	0.00000306
	(0.0115)	(0.00517)
1 year after flooding	-0.0101	-0.000308
	(0.00864)	(0.00320)
2 years after flooding	-0.00115	0.00421
	(0.00987)	(0.00445)
3 years after flooding	0.000601	0.000815
	(0.00707)	(0.00410)
Year FE	Yes	Yes
State FE	Yes	Yes
Controls	No	Yes
Observations	1100	1100
Adjusted R2	0.785	0.913

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Chapter 2: Do Governments Proactively Mitigate or Reactively Respond to Hurricanes? A Textual Analysis of Budget Documents

Abstract

This paper examines whether and how government attention to hurricanes has developed over time. It is based on analyses of 2005-2020 budget documents across seven U.S. states that are the most prone to hurricanes: Alabama, Florida, Georgia, Louisiana, North Carolina, South Carolina, and Texas. While prior studies focus on quantitative budget data, my study is the first to exploit the narrative portions of the budget documents using textual analysis. Computational text analysis is used to identify and quantify government attention toward different policy areas, including disaster management in connection with hurricanes. Cases from Louisiana and Alabama show that an increased incidence of major hurricanes coincides with higher attention to hurricanes in the budget documents. There is also evidence that in all observed states except Florida, the attention to hurricanes is associated more with reactive rather than proactive measures, calling into question the general preparedness of most state governments for future disasters.

1. Introduction

Over the past few decades, natural disasters have become more frequent, severe, and costly. The United Nations (2022) confirms that the number of global disasters, including droughts and extreme temperature events, has been increasing since the 1970s. Assuming the current trends continue, by 2030, the number of disaster events is projected to reach 560 per year. A report by the World Meteorological

Organization (2021) shows that economic losses due to weather, climate, and water-related disasters have increased sevenfold, from around $49 million per day on average in the 1970s to $383 million per day on average in the 2010s.

In the United States, following the world-wide trend, the overall number of disaster events is also on an upward trajectory. The National Oceanic and Atmospheric Administration's National Centers for Environmental Information (NOAA NCEI, 2023) shows that disasters with costs exceeding $1 billion increased from around three per year in the 1980s to more than 12 per year in the 2010s.[2] Exceeding that average, in 2022, there were 18 major disaster events recorded across the country. Among the most recent and notable events were Hurricane Ian (September 2022), western wildfires (Spring-Fall 2022), Kentucky-Missouri flooding (July 2022), and Southern Plains drought and heatwave (January-September 2022).

This study focuses on hurricanes, which among all recorded weather disasters have caused the most deaths and destruction in the U.S. (NOAA, 2022c). Scientists have observed increased intensity of hurricanes in recent decades, which are associated with increased precipitation, winds, and extreme sea level events partly attributable to climate change (Collins et al., 2019; Walsh et al., 2015). Between 1980 and 2021, hurricanes were responsible for more than 6,600 deaths and $1.1 trillion in economic loss in the U.S., with an average cost of $20.5 billion per event. The deleterious economic effects of hurricanes are significant also in the Caribbean and Central America. Bluedorn (2005) finds that hurricane strikes damaged physical capital and immediately reduced the current account over GDP by five percentage points, although signs of improvement

[2] The costs include physical damage to residential, commercial, and municipal buildings, vehicles, agricultural assets, and public infrastructure, among others. The estimates are considered conservative as they do not take into account losses to environmental degradation, healthcare related costs, and the value of statistical life.

tended to appear three-to-eight years later. In addition to the economic effects, there are also irreparable social costs to displaced communities and cultural bonds.

When an area is hit by a disaster, its recovery depends on various factors. Among them, Hawkins and Maurer (2009) discussed social capital (e.g., sense of community and individual leadership) and Skarbek (2014) highlighted bottom-up approaches (e.g., contributions by nonprofit organizations). Yet there is a tendency for individuals and households to underestimate and underinvest in disaster preparedness (Neumayer, 2014). A government is thus justified to intervene; for instance, Phaup and Torregrosa (1999) discussed that it could do so by raising taxes to increase national savings prior to a disaster in order to augment underinvestment in mitigation efforts and improve allocations of available resources for public goods. Governments maintain a significant role given their authority and access to resources, and the extent of government actions is broader as it covers comprehensive emergency management from ex-ante preparedness and mitigation to ex-post response and recovery (National Governors' Association, 1979). Adopting the Sendai Framework, the United Nations (2015) recognized that each government has a responsibility to prevent and reduce disaster risk. Whether a government takes on this challenge, however, is an open area for empirical investigation.

This study aims to evaluate whether and how government attention to hurricanes has developed over time. It focuses on states in the U.S. that are most prone to this type of disaster. States are selected as the unit of analysis given the ability of a state government to undertake proactive emergency management policies, and also because a hurricane's impact typically goes beyond municipal and county boundaries. Data for the analysis are obtained from the executive or governor's budget documents, which indicate the government's agenda for a given year. While

prior studies focus on budget data, my study is the first to exploit the narrative portions of the budget documents using computational textual analysis.

Following this introductory section, this study is organized as follows. Section 2 discusses the theoretical framework. Section 3 elaborates on computational text analysis as the methodology in this study. Section 4 describes data sources and collection. Three subsections in Section 5 present analysis results. Finally, Section 6 concludes.

2. Theoretical Framework

Central to the field of public budgeting and finance is the concept of incrementalism. The idea first developed in the context of policy process. Lindblom (1959) argued that policy actors have limited capacities to consider all the available information, values, and alternatives when dealing with complex problems, so they follow the 'successive limited comparisons.' Incrementalism focuses on the existing situation and departs from it with a relatively small degree of changes. The process is driven internally within an organization, and the exercise usually leads to a relatively predictable outcome. It is very practical, yet the method also has limitations for potentially overlooking better alternatives not suggested by the modest changes and successive series of policy decisions.

Davis, Dempster, and Wildavsky (1966) made the same observation but specifically in the field of public budgeting. It is rarely the case that decision-makers in the budgetary process exhaust all alternatives and actively review the whole budget. Instead, this year's budget is often based on the previous year's budget, with perhaps a narrow range of increases or decreases. Dempster and Wildavsky (1979) formalized two defining characteristics of incremental budgeting -- (1) an

existing base and (2) regularity of the changes – and noted that the U.S. federal budget process reflects both. At least at a macro level, there have been gradual increases from time to time.

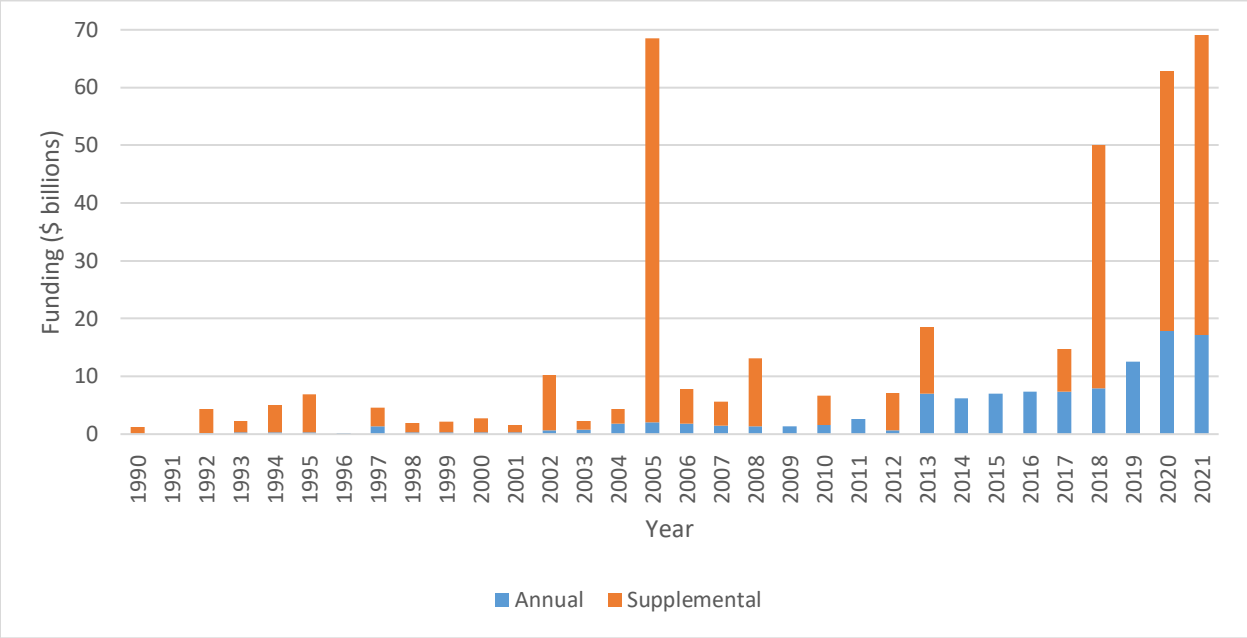
In laying out the theory, Dempster and Wildavsky (1979) also explained how budget increments, slow and steady changes, may encounter a 'shift point,' that is, a sudden burst of changes that depart from incrementalism. Typically, such events are caused by external factors, such as wars, economic depressions, and major political events. These occasional, large-scale policy changes against a stable, incremental government agenda are then termed 'punctuations' (Baumgartner and Jones, 2010; True et al., 2019). To revisit this theory, my study begins with conducting a distribution analysis to reassess government attention to seven major policy areas, leveraging computational text analysis. I will test the hypothesis that policy agendas in state governments mostly reflect a lot of incremental changes along with a few punctuations. The goal is to demonstrate that, as an alternative approach, computational text analysis generates results that are consistent with the existing literature and is the proper methodology for the purpose of this study.

My study then proceeds with two analyses. *First*, it assesses government attention with respect to one specific issue: disaster management in connection with hurricanes. The concerns of incrementalism and punctuations are the *aggregate changes* in budgets over time, as well as the *components of budgets*. Punctuations, as Jones et al. (1998, p. 2) put it, "can occur at all levels of activity in programs, in agencies, within broad functional categories of government activities" and may affect "related subsystems without affecting the rest of government." Previous studies have also considered different policy areas individually, such as highway infrastructure (Chen & Flink, 2021), education (McLendon, 2003; Robinson, 2004), environment (Salka, 2004), and social welfare (Jensen, 2009); they found that while some areas attracted little attention, there were also

times when the level of attentiveness spiked, indicative of punctuations. I hypothesize that an increased incidence of hurricanes coincides with the government's increased attention to hurricanes during the period of observation.

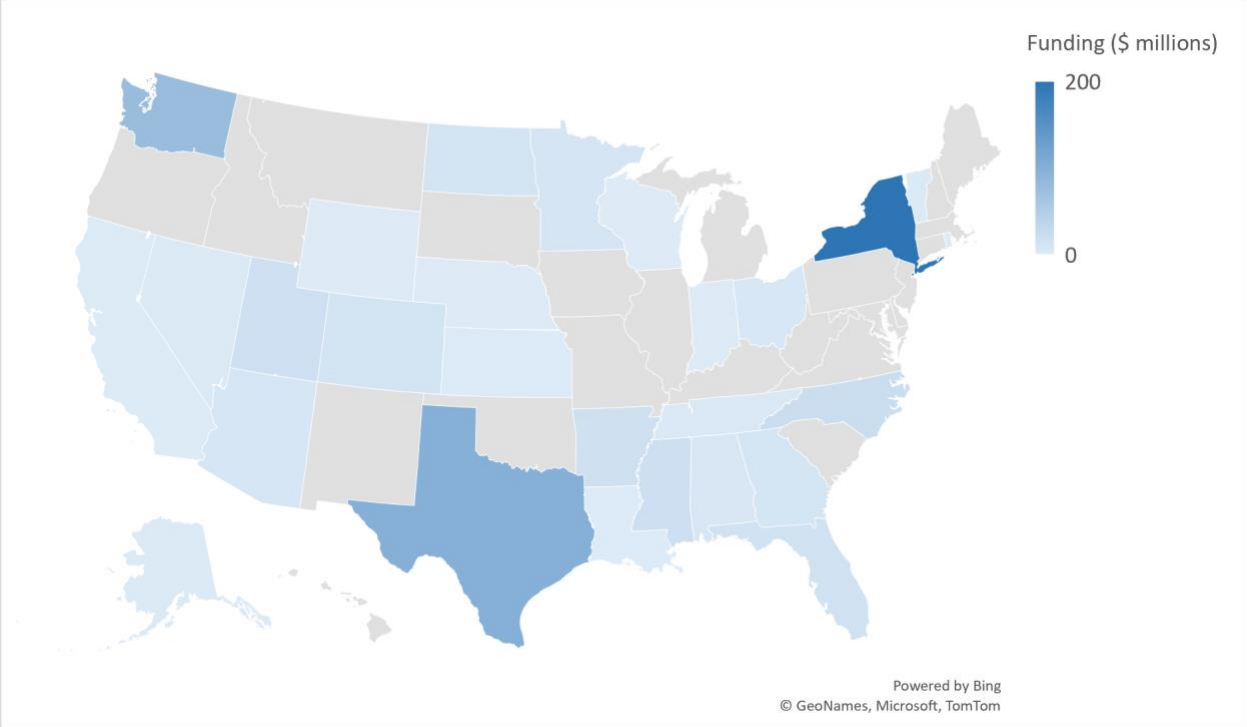
Second, this study takes a closer look at hurricane-specific issues and examines whether government attention, if any, is associated with proactive or reactive measures. This analysis borrows from the Comprehensive Emergency Management (National Governors' Association, 1979) framework and guidance for coordinating stakeholders when managing natural disasters, including hurricanes. Formally, activities surrounding emergency management are clustered into four key phases: mitigation, preparedness, response, and recovery. Mitigation and preparedness, conducted prior to a disaster, are proactive measures. Response and recovery are reactive as they are carried out after a disaster. Previous studies have found the tendency for governments to favor reactive over proactive actions due to a combination of political and institutional factors (Donahue & Joyce, 2003; Healy & Malhotra, 2009; Kellet & Pichon, 2013). In this vein, I hypothesize that the government's attention to hurricane is geared more toward reactive rather than proactive measures.

Figure 12. Federal Disaster Relief Fund 1990-2021



Source: Congressional Research Service (2022)

Figure 13. New Funding to Disaster Account Across 27 States at the Beginning of FY 2018



Notes: Grey indicates either data are unavailable or no new funding is recorded in FY 2018. Detailed data are provided in Appendix Table B1. Source: Pew Charitable Trusts (2020)

3. Methodology

3.1. Quantitative Data Versus Text Data

Investigating whether the government pays attention to some major policy areas and specific disaster type like hurricanes could be done using numerical data or textual data. The former has thus far been more common than the latter in the literature. Among the most prominent was a study by Baumgartner and Jones (2010), which analyzed policy stability and change in the federal government, while also empirically assessing the degree of attentiveness of policymakers to national issues based on budget data. More recently, Chen and Flink (2021) used a dataset of 50 U.S. states from 2005 to 2013 to evaluate changes in budgetary inputs in connection to organizational performance outcomes.

However, budget information is sometimes limited, especially with respect to a specific issue like disaster management. A study from the Congressional Research Service (CRS) (2022) tracks the federal disaster relief appropriations since the 1960s. As seen in Figure 12, there has been an increase in total federal appropriations for disaster funds over the last few decades. The CRS data also show the detail of appropriations, such as whether funds went through annual or supplemental appropriations in the budget process. Given its coverage, the CRS data are well-suited for time series analysis. For example, it enables identification of years when appropriations were significantly higher due to major disaster events, such as in 2005 following Hurricane Katrina. However, there is quite limited information regarding states and localities to which the federal aids were channeled. Disaster funds are also such a broad category that includes all kinds of emergencies, including the COVID-19 pandemic. Without more disaggregated information, it is difficult to know how much was allocated for a specific type of disaster like hurricanes.

The U.S. Census Bureau (2006) surveys the state spending of all states on an annual basis. While the data are provided in a considerable detail, the existing budget classification does not include a specific category or subcategory for disaster management, disaster mitigation, or disaster response. Disaster-related items are incorporated in other budget components; for instance, disaster assistance from FEMA to states is classified as "All Other" under "Intergovernmental Revenue." By contrast, the Census survey creates specific codes to identify federal aid expenses associated with other key functions, such as "Education," "Health and Hospitals," "Highways," "Housing and Community Development," and "Public Welfare." "All Other" is a broad category that lumps federal assistance for disasters together with other federal transfers for economic development, libraries, public broadcasting, parks and recreation, and water transportation activities. As a result, it is impractical to use the Census data to identify, trace, and analyze budget allocations for disasters, let alone for a specific type of disaster like hurricanes, in a given state and year.

In 2015, U.S. Government Accountability Office (GAO) documented disaster spending information, but this analysis was limited to only in 10 selected states for a single fiscal year (2014). Pew Charitable Trusts (2020) assessed statewide disaster accounts and compiled some disaster funding data, but only 27 states and one fiscal year (2018) were included in the study (see Figure 13 for a summary; details are provided in Appendix Table B1). Since disaster spending data are available for one or two years, it is not possible to evaluate intertemporal patterns of disaster management in a given state, let alone government response to a specific type of disaster such as hurricanes. According to a survey of state emergency managers by the Pew Charitable Trusts (2018b), most states do not comprehensively track natural disaster spending. In a broader climate change context, Gilmore and St. Clair (2018) found that state budgets provide little detail on

climate-related programs, which makes it difficult to quantitatively assess state responses to climate change.

The concern over the lack of comprehensive disaster budget data has also been acknowledged by disaster policy practitioners. The United Nations Office for Disaster Risk Reduction (2021) found that most countries in Asia-Pacific and sub-Saharan Africa do not track disaster-related investments and expenditures, noting how the absence of such information restricts deeper analysis of mechanisms to reduce disaster risks efficiently. During the COVID-19 pandemic in 2022, the House of Representatives, through its Committee on Rules' Subcommittee on Legislative and Budget Process, conducted a hearing for using budget principles to prepare for future disasters. In his testimony, Columbia University's National Center for Disaster Preparedness Director Jeffrey Schlegelmilch (2022, para. 10) reiterated the need for better data on disaster spending and illustrated how the Congress and government agencies "will go a long way to methodically tracking disaster spending at all phases and bringing together the disparate data sets to help frame and understand the problem in a more cohesive and data driven way."

Unlike the quantitative data, text information is more readily in various government reports and publications. I take advantage of that by leveraging textual analysis for this study. Studies in the field of public policy have used textual analysis as a means of qualitative method for decades, including to examine budget documents, so this methodology is not entirely new. The biggest difference is that the analysis traditionally had been done manually, whereas quite recently researchers began applying it computationally. The availability of computer assistance allows for a faster and more systematic way to collect and analyze data, and for that reason it has gained growing popularity among public policy scholars and practitioners (Anastasopoulos and Whitford, 2019). Computational text analysis has been used in recent studies to examine various sources of

information, including governments' social media, financial reports, and audit results (Anastasopoulos et al., 2017; Marlowe, 2021; Yang, 2021).

3.2. Computational Text Analysis

Computational text analysis proceeds with the following steps:

(1) Importing data: Budget documents, typically in Portable Document Format (PDF), are commonly posted on government websites. In each state, the search will generate a collection of budget documents from different years. In the state of Florida, for example, there are 15 budget documents from 2002 through 2016. Once the documents are retrieved, relevant texts can be extracted using automated commands through a programming package. If it is a manually scanned file, such as the case of budget documents from Georgia and North Carolina, texts within the document may not be perfectly recognized. Hence, extra steps are needed using Optical Character Recognition (OCR) feature to enhance the document's readability. The result is a text *corpus*, which is equivalent to a dataset that contains document-level variables and a designated variable for texts. Referring to the Florida example, its corpus contains 15 observations that correspond to the 15 budget documents extracted previously.

(2) Preprocessing data: Preprocessing transforms the data into a dataset that is ready for analysis. This requires that I take the original texts within each corpus, then convert all characters in the texts into lower case, remove whitespaces and stop words, and eliminate any numbers. In Florida's 2019 budget document, for example, a line item like "GRANTS AND AIDS - STATE AND FEDERAL DISASTER RELIEF OPERATIONS FROM FEDERAL GRANTS TRUST FUND" would simplify into "grants aids state federal relief operations federal grants trust fund." The procedure eliminates a hyphen and two stop words, "and" and "from", from that portion of

the text. The preprocessing thus reduces text complexity without losing its key message, which helps with computation by making it parsimonious (Grimmer et al., 2022).

(3) Analyzing text using a dictionary: Next, a dictionary-based text analysis involves the identification of key terms on pre-selected topics. The goal is to determine the frequency of some key terms, as well as to map the trends over a period of time. The dictionary related to major policy areas in this study is based on the Lexicoder Topic Dictionaries developed by Albugh et al. (2013). It covers several policy categories with over 400 key terms in total. However, the dictionary does not contain disaster-related and hurricane-related terms; to serve this specific purpose, I develop new dictionaries for both categories. The detailed list of key terms in all dictionaries is available in Appendix Table B2. In the analysis, I measure government attention to specific policy areas and topics by determining how many times related terms (those listed in the dictionaries) appear in the budget documents in a given year and state.

Past studies have leveraged various methods, qualitative and quantitative, to test for the existence of incrementalism and punctuations. Jones et al. (1998) discussed how earlier evidence that relied more on general observation and case studies motivated them to use a more quantitative approach. By leveraging time series analysis, they showed two major punctuations that affected the spending patterns of the federal government: high increases after 1956 attributable to the post-war period, and slower growth after 1976 due to political disagreement between the Congress and the executive branch concerning control over the budgetary process. Robinson et al. (2007) used frequency density histograms to illustrate that the federal government's budgets were characterized by large and small changes.

This study will replicate the approach similar to that done by Robinson et al. (2007). Building on their work, I make some adjustment to leverage the textual data that I have extracted

computationally. Part of the analysis is geared toward confirming whether there are more data points (i.e., changes of attention to major policy areas) in the center and in the tails, suggesting the presence of leptokurtosis. Leptokurtic pattern is different from the normal distribution that appears like a bell curve, suggesting that data near the mean are more frequent in occurrence than data in the tails.

(4) *Visualizing results*: Finally, the results are then presented and visualized to illustrate the key insights of some findings. Proper visualizations enable easier interpretation especially among a wider audience. For this study, I present maps, bar charts, box plots, and histograms.

Table 3. Hurricane Events between 2000-2021

State	**Category**					**All hurricane events**	**%**	**Severe hurricane events**	**%**
	1	2	3	4	5				
Louisiana	7	2	3	2		14	22.6%	5	33.3%
Florida	3	3	4	2	1	13	21.0%	7	46.7%
N. Carolina	7	3				10	16.1%	0	0.0%
Texas	6	2		1		9	14.5%	1	6.7%
Alabama	3	1	1			5	8.1%	1	6.7%
S. Carolina	4					4	6.5%	0	0.0%
Mississippi	1	1	1			3	4.8%	1	6.7%
Georgia	1	1				2	3.2%	0	0.0%
Virginia	1					1	1.6%	0	0.0%
New York	1					1	1.6%	0	0.0%
					Total	62	100%	15	100%

Notes: Hurricanes are considered severe only if they are category 3 or above. Other U.S. states with zero hurricane events between 2000-2021 were not included in the table. Data are tabulated and analyzed based on hurricane records of NOAA's Hurricane Research Division (2022).

Figure 14. Hurricane Events between 2000-2021 across U.S. States

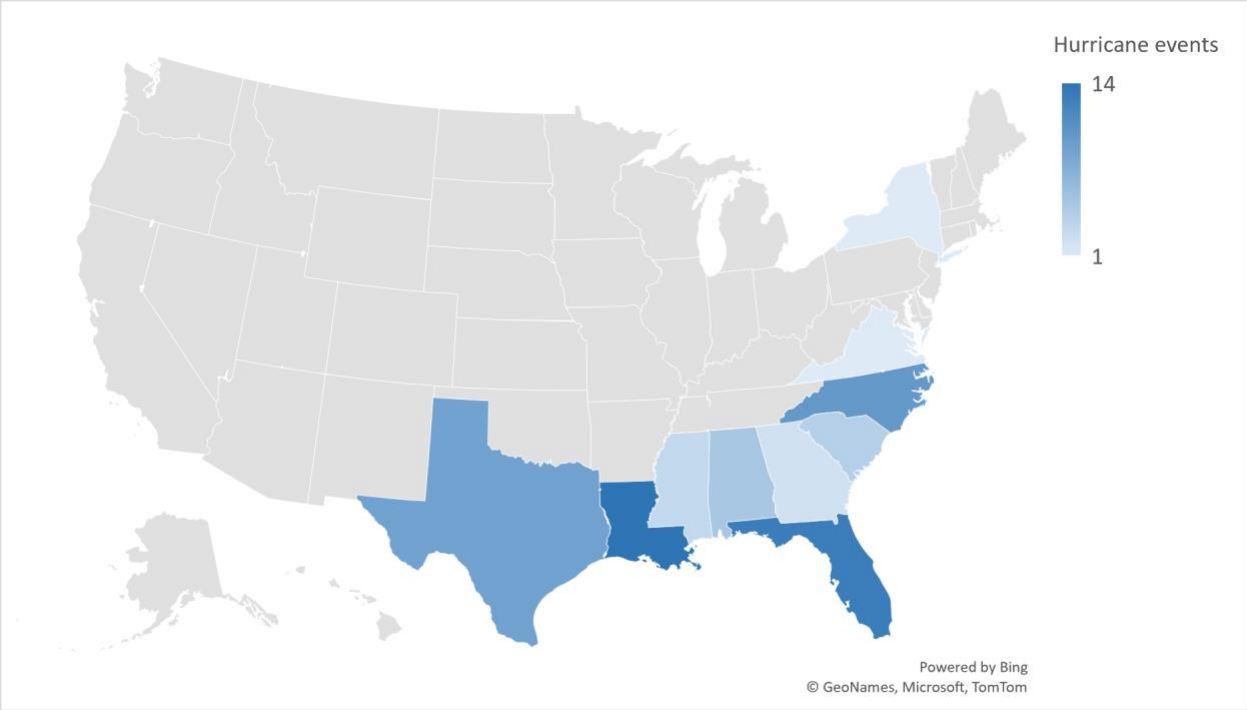
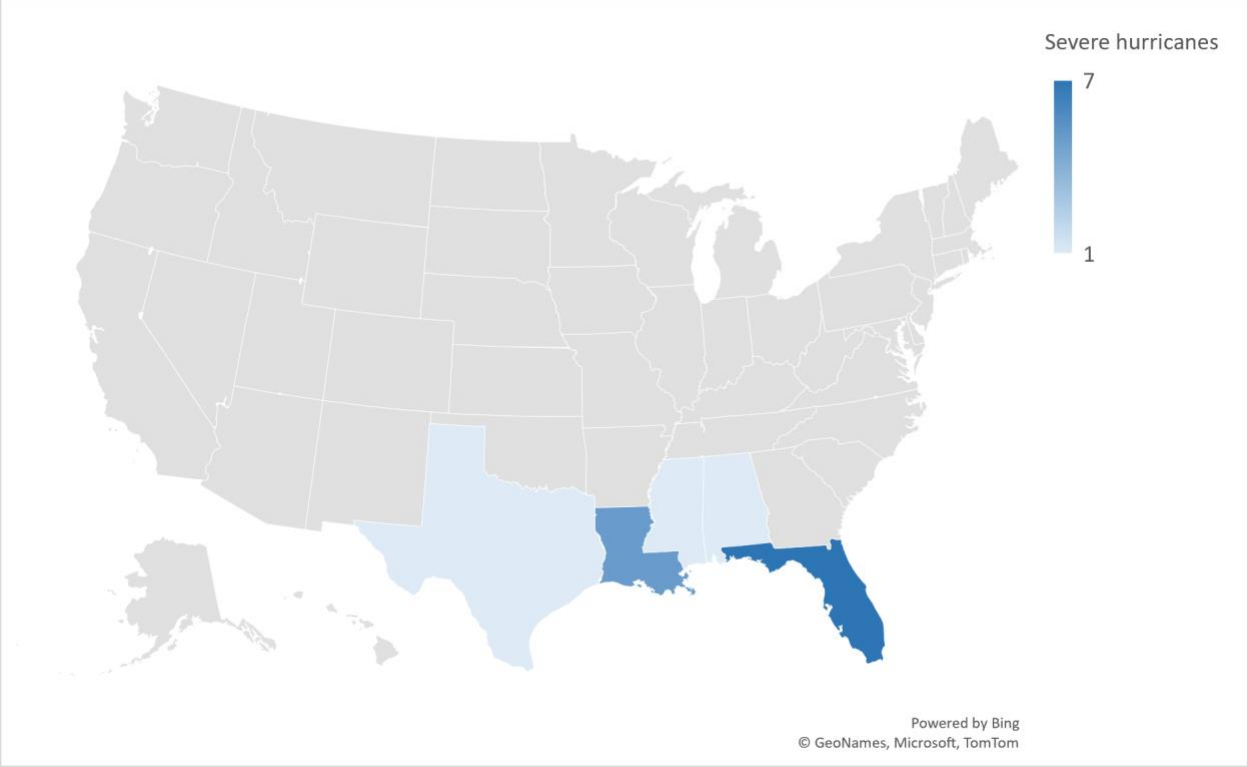


Figure 15. Severe Hurricanes (Category 3 or Above) between 2000-2021 in U.S. States



4. Data

This study considers states as the unit of analysis for two reasons. First, the force of a hurricane is unlikely to be contained within the smaller borders of counties and municipalities; at the same time, a study of the whole country may be too broad and could be skewed by information from wholly unaffected regions. Therefore, the geographic boundaries of states appear most suitable. Second, state leaders have the authority to declare an emergency status when a disaster strikes and to take certain responsive steps, and they typically allocate funds (often called budget stabilization or rainy-day funds) specifically for disaster management purposes (Hou, 2004). In other words, state governments can mobilize resources to undertake proactive emergency measures.

A key source of data to identify and quantify attention to hurricanes in state governments from year to year is the state executive or governor's budget proposals (hereafter budget documents), particularly their narrative portions. The documents, produced every one or two years in accordance with the state's budget cycle, reflect the executive's agenda for the corresponding fiscal year. This is a useful, but not always ideal, source. They do not lend themselves to easy comparisons. In the U.S., budget documents prepared by the various states do not follow common standards, nor are there federal rules that govern how they are formatted and disseminated.

To identify whether a major hurricane event occurs in a given state and year, I refer to data provided by NOAA's Hurricane Research Division (2022). This agency has documented hurricanes by chronological order since the 1950s, along with their names, location, and time. NOAA also assesses the strength, as measured by the central pressure, maximum wind speed, and Saffir-Simpson Hurricane Wind Scale categories. This scale rates maximum sustained wind speeds: Category 1: 74-95 miles per hour (mph), Category 2: 96-110 mph, Category 3: 111-129

mph, Category 4: 130-156 mph, and Category 5: 157 mph or higher (NOAA, 2022d). Later in the discussion, the NOAA data is supplemented with the database provided by FEMA (2022d), which records individual major disaster and emergency declarations by state and by year.

This study purposively selects seven states in the South region that are the most prone to hurricanes: Alabama, Georgia, Florida, Louisiana, North Carolina, South Carolina, and Texas. A technical memorandum released by NOAA (2005) reported that between 1851 and 2004, more than 80 percent of hurricane direct hits in the U.S. occurred in these states (the detailed table is provided in Appendix Table B3). Figures 14 and 15 respectively show more recent records of where hurricanes and *severe* hurricanes typically landed in the U.S. between 2000-2021. Table 3 provides the same information with additional details of hurricane categories on the Saffir-Simpson scale. Consistent with older data, almost all hurricanes in the US between 2000-2021 occurred in these seven states, except Hurricane Isabel in Virginia (2003) and Hurricane Sandy in New York (2012). This study also takes data availability into consideration when deciding what states and periods to observe. Among the seven states, most budget documents are available as far back as 2005 through 2020 fiscal years. Louisiana is an exception with missing budget documents in 2005, 2006, and 2016. Mississippi also experienced hurricane events multiple times, but its budget documents are not publicly accessible; therefore, this state is excluded from the observation.

Table 4 presents a summary of the budget documents corpus under observation. It shows the variations across states in terms of the number of documents, pages, sentences, and words contained in their respective documents. Note that the numbers represent a median over the course of 16 years within a state. The medians of pages are 357 (Alabama), 353 (Florida), 425 (Georgia), 208 (Louisiana), 218 (North Carolina), 347 (South Carolina), and 992 (Texas). The median

sentences also vary from 1,181 (Louisiana) to 19,328 (Texas). Median tokens, which indicate the number of words used in a budget document are highest in Texas (596,275), followed by Florida (189,708), South Carolina (185,909), Alabama (149,691), North Carolina (83,249), and Louisiana (73,828). Meanwhile, the number of unique words range from 6,761 to 30,374.

Table 4. Summary of Corpus of Budget Documents in Seven Selected States

	AL	FL	GA	LA	NC	SC	TX
Year	2005-2020	2005-2020	2005-2020	2007-2015, 2017-2020	2005-2021	2005-2020	2005-2021
Budget cycle	Annual	Annual	Annual	Annual	Biannual	Annual	Biannual
Budget Documents	16	16	16	13	9	16	9
Pages	357	353	425	208	218	347	992
Sentences	1,370	8,583	4,276	1,181	1,452	4,069	19,328
Tokens (Words)	149,691	189,708	132809	73,828	83,249	185,909	596,275
Unique words	26,897	15,426	14,832	6,761	8,671	18,205	30,374

Notes: Pages, sentences, tokens, and unique words are the medians across observed years within a given state. Token is a technical term in text analysis used to describe a "word" or "term." AL = Alabama; FL = Florida; GA = Georgia; LA = Louisiana; NC = North Carolina; SC = South Carolina; TX = Texas.

5. Analysis

5.1. Distribution Analysis

This section is divided into three subsections that correspond to each analysis. Using computational text analysis, the first aims to revisit the incrementalism theory and to confirm that governments change their attention to major policy areas mostly in small incremental steps with

occasional punctuations. For this subsection, my analysis proceeds with two sequential steps. I first identify and quantify key terms in selected major policy areas according to the Lexicoder Topic Dictionaries. These are seven areas over which a state government has relatively significant control: macroeconomy, healthcare, education, environment, social welfare, transportation, and agriculture. Figure 16 illustrates how much each policy area is discussed in the most recent budget documents of the respective state. Macroeconomy, which includes issues such as "food price," "inflation," "recession," and "tax," and education, covering topics like "college," "kindergarten," "school," and "vocational," appear dominant across most states. By contrast, agriculture and social welfare are least mentioned. Transportation and healthcare are also moderately discussed in the respective budget documents.

Figure 16. Major Policy Areas in the Budget Documents of the 7 Selected States

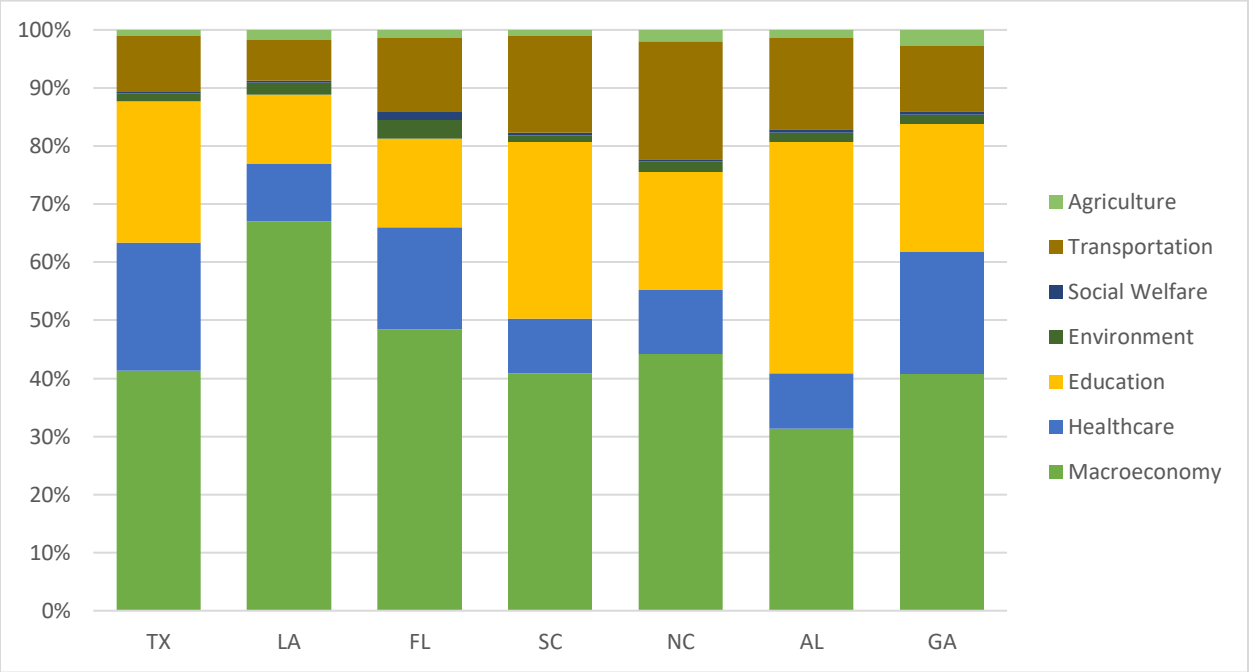


Figure 17. Changes in Government Attention to Major Policy Areas between Years

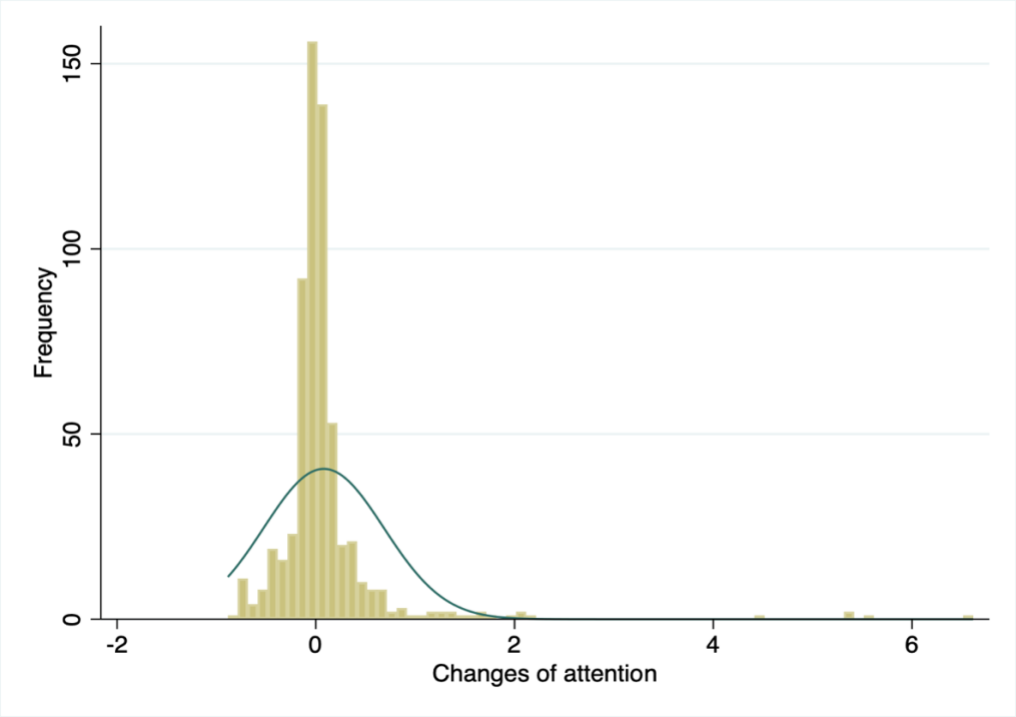
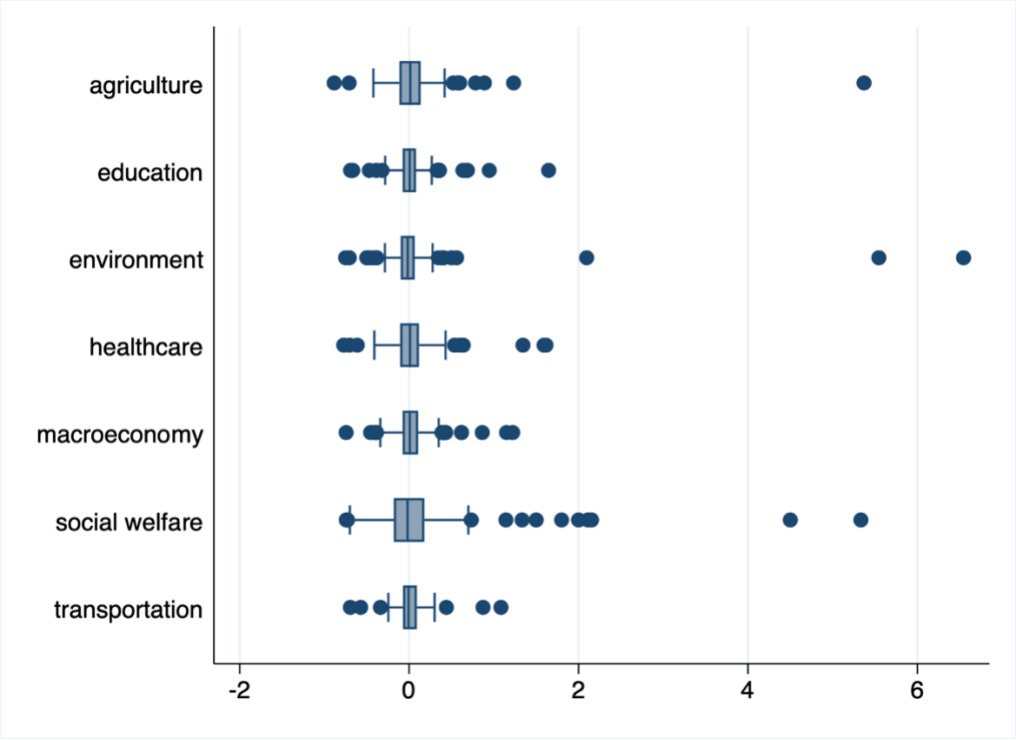


Figure 18. Changes in Government Attention across Different Policy Areas



I took an additional procedure to check the validity of the results generated by computational text analysis. The number of mentions was randomly examined and compared to what is in the budget documents. To do so, I selected one policy area, environment, and the most recent year in the dataset, 2020, as a sample. Computational text analysis showed that mentions of environment-related terms across the seven states that year were 71 (Alabama), 90 (Georgia), 184 (Florida), 34 (Louisiana), 64 (North Carolina), 18 (South Carolina), and 317 (Texas). I checked manually, for instance, in Alabama, what environmental-related terms the 71 mentions correspond to, and in which part of the budget documents. Through this procedure, I was able to locate specific sentences mentioning "conservation," "environment," "contamination," "pollution," "pollutant," and "ecological" in Alabama's budget documents. The same steps were also performed to the rest of the states. A false positive error is when terms unrelated to environment are erroneously included, whereas a false negative error is when environmental-related words are erroneously excluded. My manual verification found none of the error types and confirmed that the results from computational text analysis were valid.

The second step builds on the works of Jones et al. (2003) and Robinson et al. (2007) that use the frequency density histogram to illustrate changes to the federal government's budget. In their analysis, Jones et al. (2003) calculated each entry in the histogram as "the inflation-adjusted expenditure in a budget category in a year, minus that expenditure the year before, divided by the earlier expenditure." Robinson et al. considered the percentage changes in instructional spending per pupil as an indication of how the organization's educational strategy changes over time, and categorized punctuations as changes that are plotted beyond the outer intersection of a normal distribution. Instead of budget changes, however, my analysis uses changes of attention level to the seven policy areas within a state from one year to the next. As previously described, I determine

the level of attention to a specific policy area by counting the number mentions of key terms in that policy area. Following Jones et al. (2003)'s approach, I then calculate each entry as the attention to a policy area in a year, minus the attention the year before, divided by the earlier attention. As an example, in Florida, environment-related terms were mentioned 182 times in 2019 and 184 in 2000. The entry for this specific time and policy area is thus (184-182)/182 = 0.0110.

Figure 17 illustrates the distribution of the entries in the form of a frequency density histogram. The x-axis indicates changes of attentiveness level to a given policy area; an entry that is closer to zero indicates smaller changes between two observed years in a given state, while an entry that is far from zero indicates bigger changes. Each bar takes an interval of 0.1 and is formed by how many entries lie within that range. The y-axis indicates the frequency--the taller the bar chart, the more frequent. Visually, the highest bar hovers around zero value; entries are most concentrated around the center. The further it goes from the center, the lower the bar, except little increases in the tails, indicative of punctuations. Similar to Jones et al. (2003), I additionally perform skewness and kurtosis normality test to supplement this frequency density distribution chart, generating a kurtosis value of 56. As comparison, normal distribution has a kurtosis value of 3. Using text as data, I show that policy agenda in state government appears to be characterized with a lot of small changes and a few large changes. This result substantiates previous studies and confirms the prevalence of incrementalism and punctuations in state government budget narratives.

Figure 18 looks deeply into each of the seven policy areas. The y-axis indicates the policy area, and the x-axis indicates changes of attention to a given policy area. There is a graph box that corresponds to each policy area, indicative of the 25^{th} percentile, the median, and the 75^{th} percentile. An adjacent line outside the box shows the lower and upper adjacent values, and beyond

those ranges are outliers. Major changes of attention are more salient on the right-hand side of the boxes, suggesting positive rather than negative changes. Greater volatility is observed more in agriculture, environment, and social welfare policy areas, at least visually.

To verify if the results are valid, I randomly checked what the outliers represent in the budget documents. In Figure 18, these are entries that lie outside the box plot in each policy area. Consider education policy as an example. There were 88 entries in total, with 16 entries considered outliers. I located the state and year of those entries. For instance, one of the large, positive changes of attention to education was observed in Florida between 2013 and 2014. Around the same time, Florida state legislature agreed to increase spending on several education programs (National Public Radio, 2014), so I determined that the results make sense. The same procedure was applied to at least one outlier in each policy area. My manual verification found no erroneous results.

Figure 19. Mentions of Hurricane-related Terms in the 2005-2020 Budget Documents in 7 States

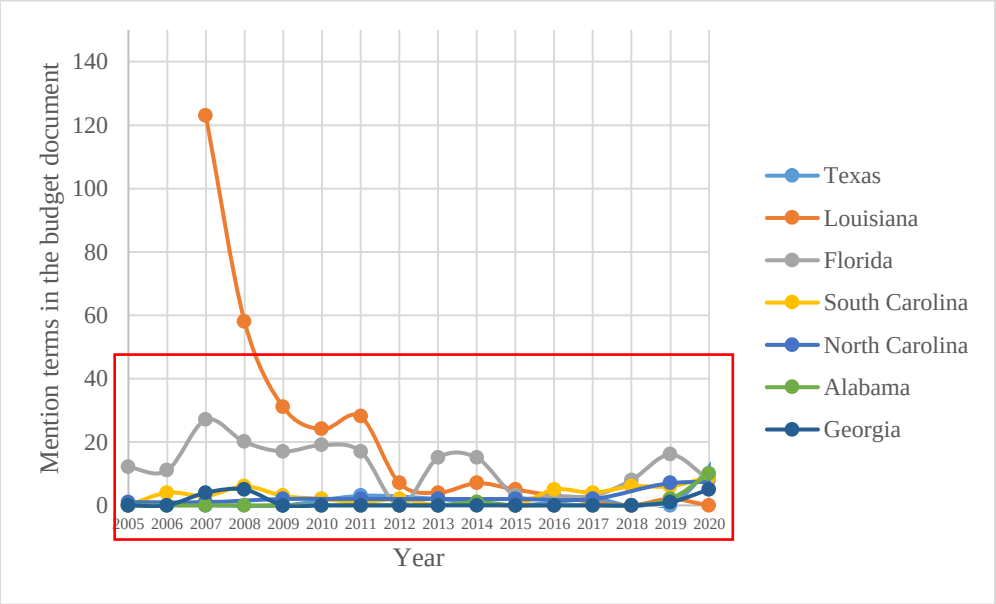


Figure 20. Mentions of Hurricane-related Terms in the 2005-2020 Budget Documents in 7 States

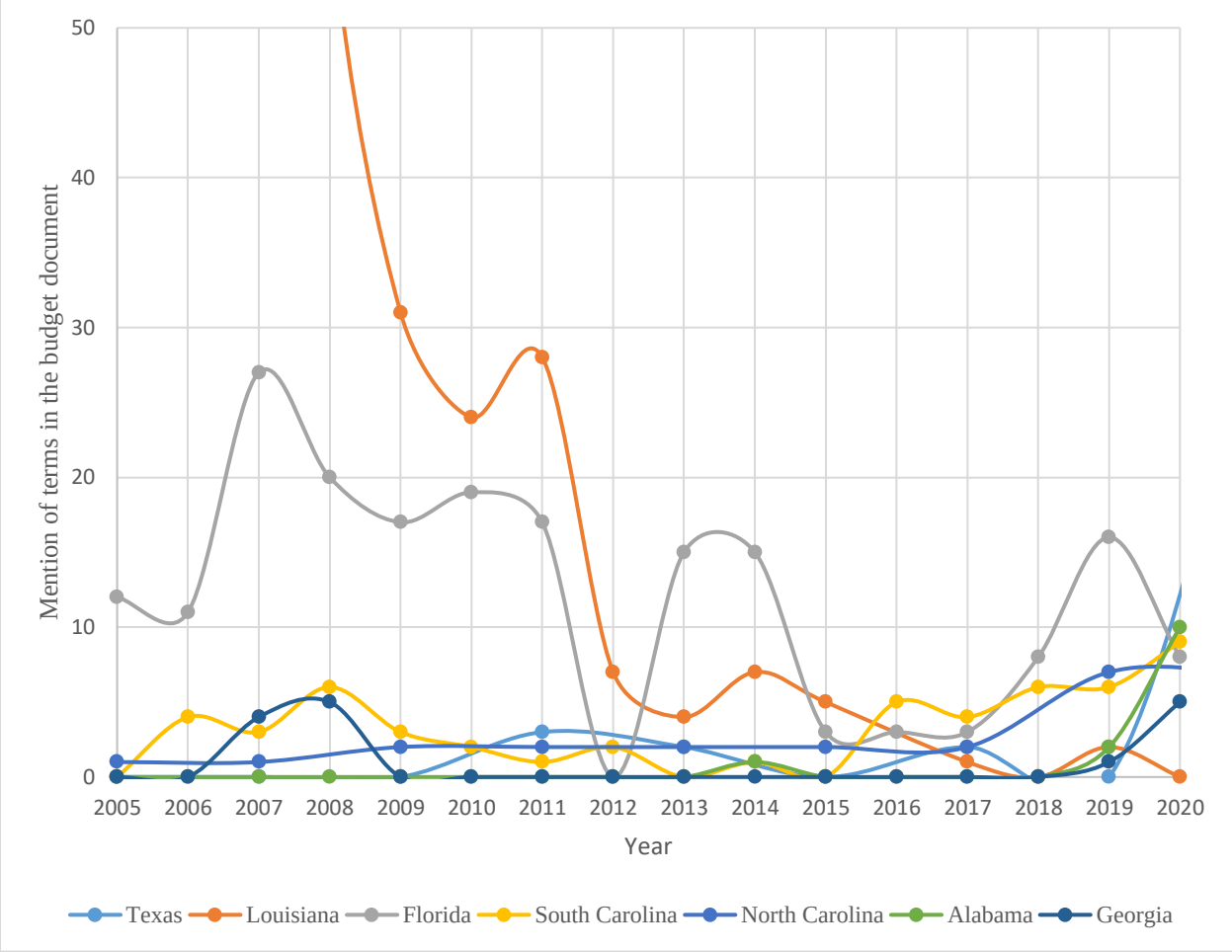


Figure 21. Mentions of Hurricane-related Terms in Budget Documents of Alabama

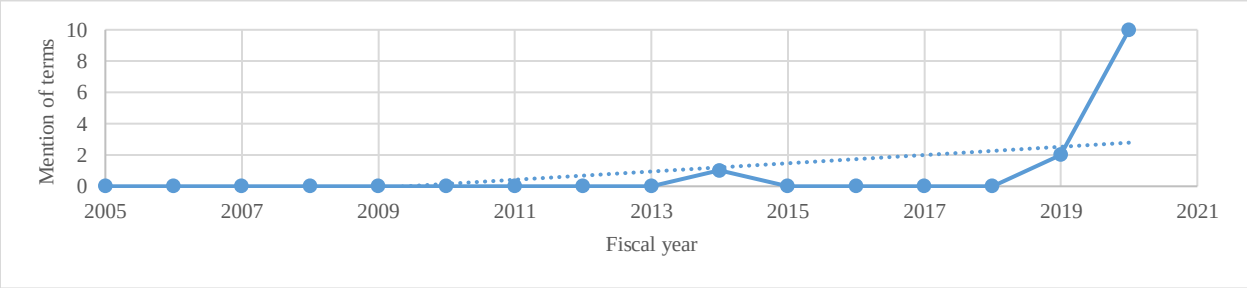


Figure 22. Mentions of Hurricane-related Terms in Budget Documents of Florida

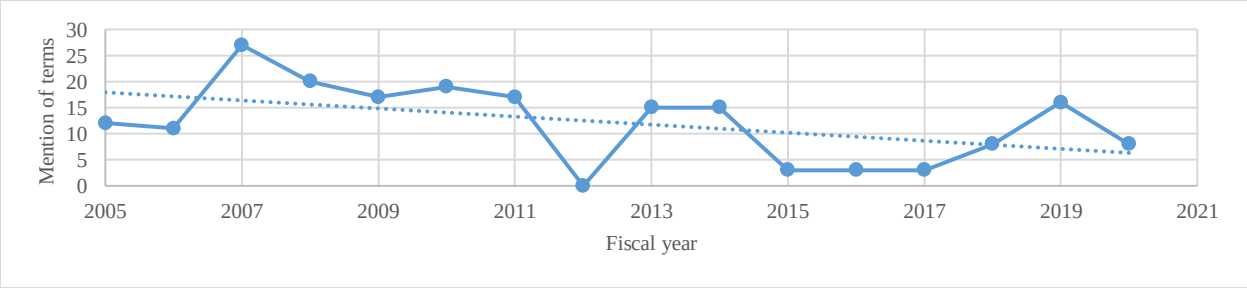


Figure 23. Mentions of Hurricane-related Terms in Budget Documents of Georgia

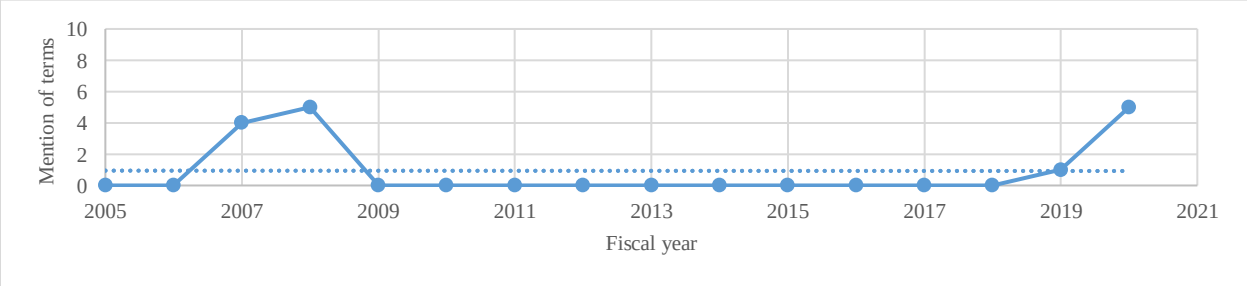


Figure 24. Mentions of Hurricane-related Terms in Budget Documents of Louisiana

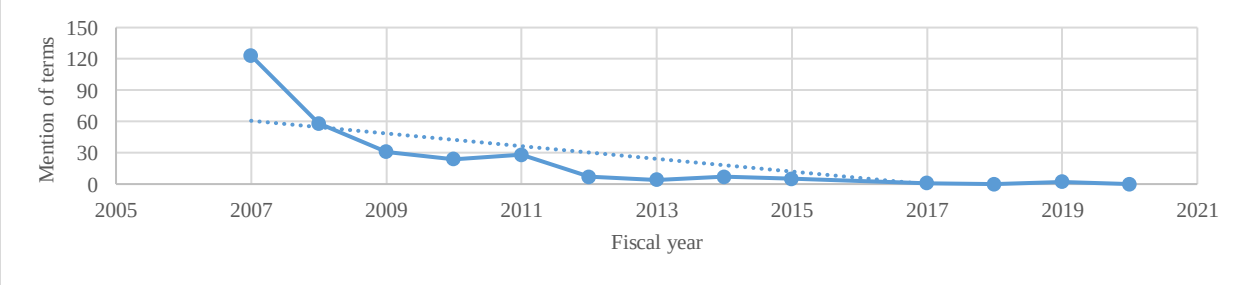


Figure 25. Mentions of Hurricane-related Terms in Budget Documents of North Carolina

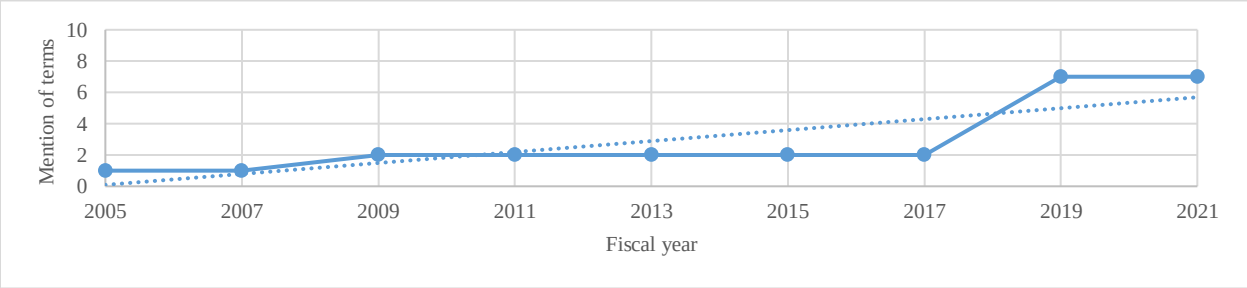


Figure 26. Mentions of Hurricane-related Terms in Budget Documents of South Carolina

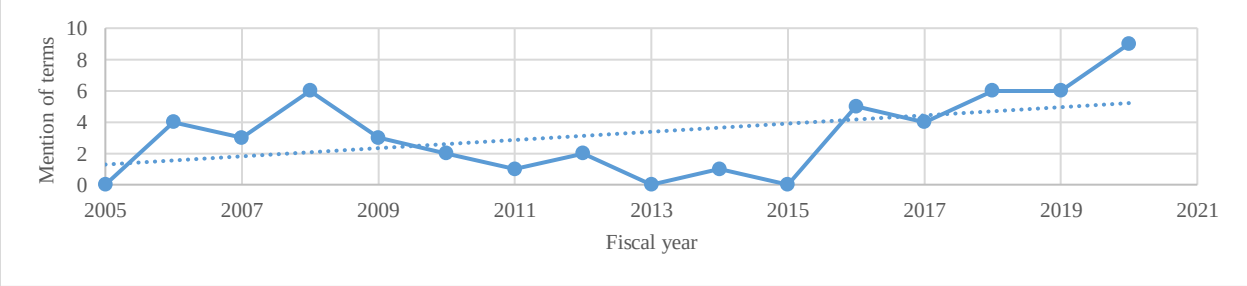
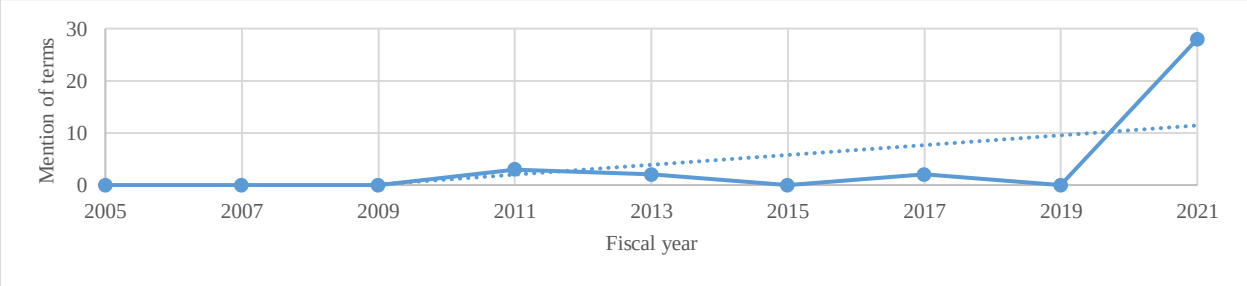


Figure 27. Mentions of Hurricane-related Terms in Budget Documents of Texas



5.2. Attention to Hurricanes over Time

This subsection considers government attention to disaster management in connection with hurricanes. Accordingly, the list of words is narrower and specifically related to hurricanes. Existing dictionaries, such as the Lexicoder Topic Dictionaries and the Laver and Garry Dictionary of Policy Positions (Laver & Garry, 2000), do not have a list of disaster-related and hurricane-related terms. As an alternative, for hurricane-related dictionary, I look for two terms, "hurricane" and "cyclone." In the U.S., both terms are used interchangeably to describe hurricane-related events. Text analysis is performed computationally to identify and quantify these key words as a proxy for government attentiveness to hurricanes in each state and year. As before, I assume that more mentions of the terms indicate greater attention to disaster management in connection with hurricanes.

Figure 19 shows how state government attention to hurricanes in Alabama, Florida, Georgia, Louisiana, North Carolina, South Carolina, and Texas has developed over time. Figure 20 reproduces Figure 19 but excludes attention levels for some outlier years in Louisiana, to show the detail of attention for more typical years in other states. In both charts, the y-axis indicates the level of attention to hurricanes, while the x-axis corresponds to the fiscal year. Each line corresponds to each state.

The most striking pattern indicative of punctuations is visible in Louisiana, which starts off extremely high and then declines significantly. The high attention to hurricanes in Louisiana in 2007 is likely primarily a reaction to Hurricane Katrina, which devastated the state in 2005. Katrina was responsible for 1,833 fatalities and more than $100 billion in damage, surpassing the destruction record previously held by Hurricane Andrew in 1992 (NOAA, 2022e). NOAA's Hurricane Research Division also shows that Hurricane Katrina struck neighboring states Florida

and Alabama, although with much less severity despite making a landfall in those states. On the Saffir Simpson Hurricane Scale, Katrina was rated 3 in Louisiana and 1 in Florida and Alabama. Katrina did create local effects, such as storm rain and injuries in Florida and power outages and structural damage in Alabama. But the ramifications to the local economies were not as damaging as in Louisiana, which might explain why the three states reacted differently to the disaster event.

Other than the fluctuations described above, changes of attention to hurricanes appear to be incremental across the board. Overall, in Florida and Louisiana, government attention to hurricanes is declining over the period of observation, but in Alabama, North Carolina, South Carolina, the attention trends upward. As part of the analysis, I run a simple regression to estimate the relationship between the independent variable (year) and the dependent variable (mentions of the hurricane-related terms) in each state. Unlike the other states, the trends are not statistically distinguishable from zero in Georgia and Texas. The detailed estimates and corresponding p-values are provided in Appendix Table A4. Figures 21-27 illustrate the trend for each state, represented by the fitted line across the years of observation.[3] Note that these seven states are the most exposed to the disaster in the US. With growing intensities of hurricanes, ideally attention also increases. This study, however, shows mixed results among these states.

[3] In addition to attention to hurricane, Appendix Figures B1-B7 assess the state government's attention to disasters, which is broader than hurricanes. The directions of trends in attention to hurricane appear to follow that of attention to disasters in Florida, Louisiana, and North Carolina. See detailed estimates in Appendix Table B4.

Table 5. Example of Keywords-in-Context in South Carolina's Budget Documents

	Pre	Keyword	Post
Result 1	Summer Schools student's work Academy	*Preparatory*	Dance grade level Summer Programs
	higher institutions provide access SAT	*preparation*	prep classes high achieving students
Result 2	providing million Adjutant General's Office	*preparation*	aftermath natural disasters hurricanes tornadoes
	accountability review updating reports Hurricane	*Preparedness*	Plan development spending plans well

5.3. Attention to Hurricanes: Proactive Versus Reactive

As previously discussed, individuals tend to underinvest in disaster mitigation (Neumayer, 2014) and the government has an important role in correcting the behavior, including and especially through budget instruments (Phaup and Kirschner, 2010). This is also consistent with FEMA's (2018) strategic plan in 2018-2022, which emphasized on the importance of building a culture of preparedness as part of the effort to improve disaster resilience. To unpack this, the third subsection takes a closer look at state government's attention to hurricanes and analyzes whether, and the extent to which, the attention is associated with proactive measures (i.e., preparedness and mitigation) and reactive measures (i.e., response and recovery).

I develop new dictionaries that include terms like “prepare” and “mitigate” to assess proactive measures undertaken by the government, and “respond” and “recover” to evaluate reactive measures. Additionally, the respective dictionary includes English derivational morphology of the terms. For instance, along with “prepare,” I also include “preparedness,” “prepared,” and “preparing” in the dictionary. One challenge with this exercise is that the stem words, such as “prepare” and “respond,” are quite generic. Applying these key words to budget documents produces results that are full of noise and potentially misleading as a basis to draw insights. Computational text analysis provides a way to get around this issue, specifically using keywords-in-context analysis that explores the themes under which a specific word is presented in a text document (Benoit et al., 2018).

Applying “keywords-in-context” technique, I am able to not only identify a specific key word but also analyze its surrounding words. I can set a window of text, such as five words before and after the key word of interest, which permits me to get a better sense of the context. I can also sort results of “prepare” as a key word that are in proximity with another key word “hurricane.” Table 5 provides examples of results from applying the technique to South Carolina’s budget documents. The first two rows are examples of results that contain the key word of interest (i.e., “prepare” or its derivational morphology) but relate to an entirely different context (education policy). The bottom two rows, incorporating the keywords-in-context analysis, are results that are correct and contain key words with the right context.

Figure 28. Attention to Proactive and Reactive Measures towards Hurricanes

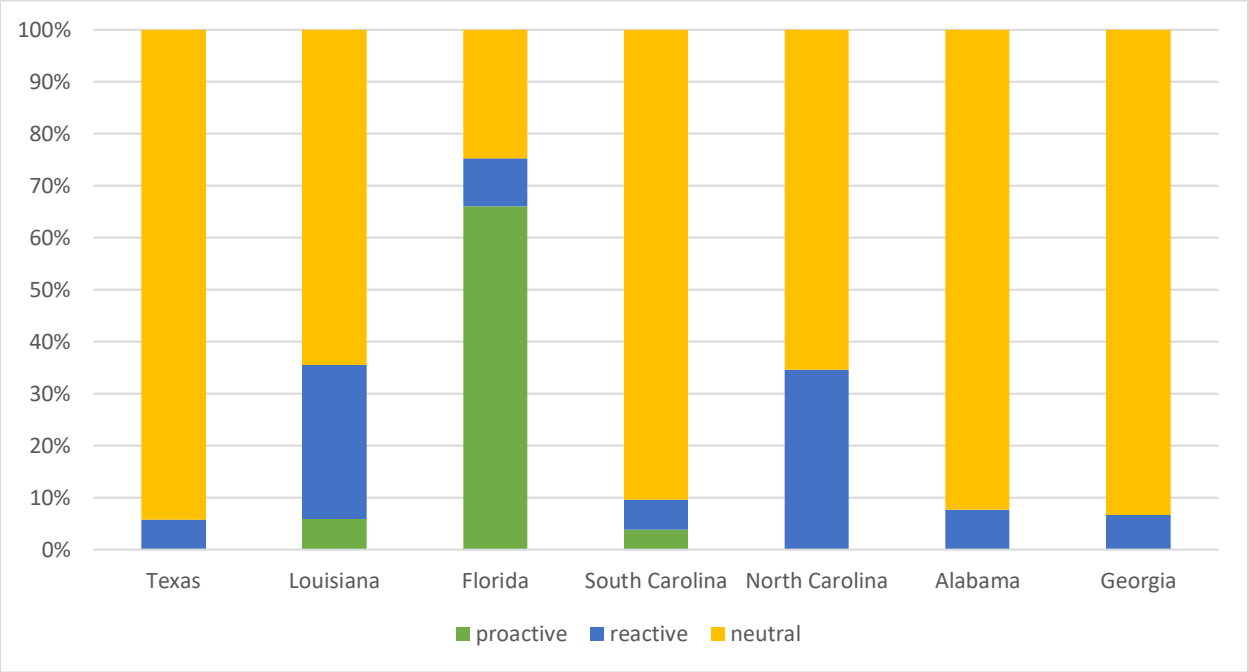
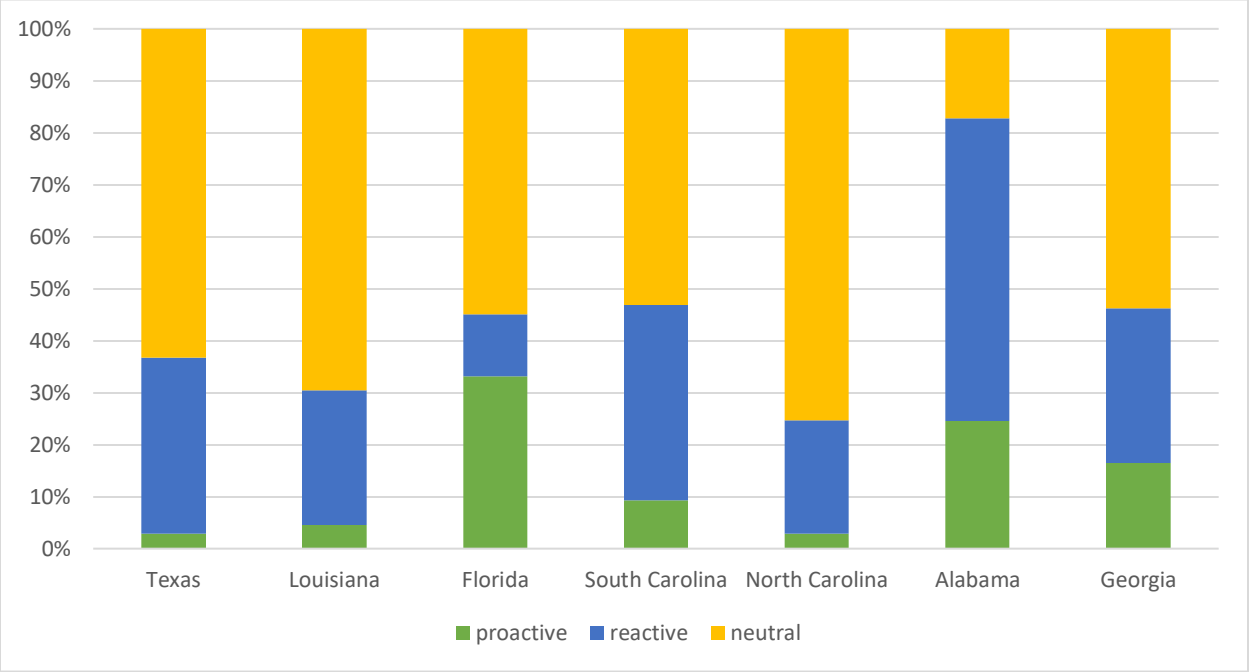


Figure 29. Attention to Proactive and Reactive Measures towards Disasters in General



In my analysis, attention to hurricanes is first identified through the same strategy as in the previous section. I then apply the dictionary of proactive and reactive measures, respectively, to categorize each attention to either group. There are instances where attention is categorized as neutral because the surrounding words do not match with either proactive or reactive dictionary. One limitation to this approach is that the dictionary may not be exhaustive, resulting in categorization that is less than perfect. To check for this potential problem, I additionally verified the results manually and made corrections where suitable.

The results of this iteration are presented in Figure 28. The x-axis shows the 7 states: Alabama, Florida, Georgia, Louisiana, North Carolina, South Carolina, and Texas. The-y axis denotes the proportions of attention that are proactive, reactive, and neutral. Each bar, representing a state, appears in three colors: green denoting proactive measures, blue denoting reactive measures, and yellow denoting neutral. Focusing on the portions of reactive and proactive measures in each state, government attention to hurricanes is associated with reactive measures more than with proactive measures in all observed states but Florida. The pattern is most noticeable in Louisiana and North Carolina, and also to a lesser extent in Texas, South Carolina, Alabama, and Georgia.

After examining attention to hurricanes specifically, I next assess attention to disasters more generally. I develop a dictionary to capture disaster-related issues broader than just hurricanes. In addition to “hurricane” and “cyclone,” this new dictionary also includes other terms such as "disaster," "natural disaster," "disaster risk," and "natural hazard." Other types of disasters as defined by National Risk Index developed by FEMA (2021) are added: "avalanche," "coastal flooding," "cold wave," "drought," "earthquake," "hail," "heatwave," "hurricane," "ice storm," "landslide," "lightning," "riverine flooding," "strong wind," "tornado," "tsunami," "volcanic

activity," "wildfire," and "winter weather." The results of this iteration are shown in Figure 29. Consistent with the previous finding, the proportions of attention to reactive measures are higher than proactive measures. Over the years of observation, the state governments paid less attention to preparedness and mitigation than to response and recovery. While all phases of comprehensive emergency management are interlinked, proactive mitigation and preparedness are especially important; they are undertaken before a disaster strikes and when done effectively could significantly save money and lives. This study shows that Florida is the only southern state where attention to hurricanes is geared toward proactive rather than reactive measures.

6. Conclusion

Natural disasters are on the rise, and hurricanes are no exceptions in the U.S. When a disaster hits an area, the government conducts response and recovery measures. More importantly, the government can coordinate mitigation and preparedness actions in anticipation of future occurrences. The government must respond immediately after a hurricane strikes, but how much response is needed ex-post also depends on the ability to prepare and mitigate ex-ante.

This study takes on this question by attempting to understand whether and how government attention to major policy areas as well as disaster management in connection with hurricanes has developed over time. Focusing on seven hurricane-prone states in the U.S. between 2005-2020, the analysis yields two key results. First, an increased incidence of hurricanes coincides with higher attention to hurricanes, as observed in cases of major hurricanes in Louisiana, South Carolina, and Florida. Changes in attention are less noticeable following less severe hurricane events. The analysis also showed that attention to disaster management in connection with hurricanes is declining in Florida and Louisiana, but it trends upward in Alabama, North Carolina,

and South Carolina. Second, there is evidence that in all observed states but Florida, the attention to hurricanes is more reactive rather than proactive, calling into question the general preparedness of state governments for future disasters.

This study demonstrates how computational text analysis could be used as an alternative method to evaluate government agenda across different policy areas. Consistent with previous studies, my analysis shows that government attention to major policy areas in the selected U.S. states changes mostly incrementally, with some punctuations. The availability of computer assistance allows for a faster and more systematic way to collect and analyze textual data. As a result, empirical research can tap into sources that contain rich information but have long been overlooked, including but not limited to the narrative portions of budget documents.

Appendix

Appendix Table B1 - New Funding to Disaster Accounts across 27 States at the Beginning of Fiscal Year 2018

State	Funding ($)	State	Funding ($)
Alabama	6,264,608	Montana	N/A
Alaska	2,000,000	Nebraska	250,000
Arizona	8,000,000	Nevada	2,000,000
Arkansas	17,569,984	New Hampshire	N/A
California	1,000,000	New Jersey	N/A
Colorado	12,500,000	New Mexico	N/A
Connecticut	N/A	New York	200,000,000
Delaware	N/A	North Carolina	22,300,000
Florida	15,284,704	North Dakota	12,292,597
Georgia	11,062,041	Ohio	7,500,000
Hawaii	N/A	Oklahoma	N/A
Idaho	N/A	Oregon	N/A
Illinois	N/A	Pennsylvania	N/A
Indiana	718,460	Rhode Island	250,000
Iowa	N/A	South Carolina	N/A
Kansas	1,315,138	South Dakota	N/A
Kentucky	N/A	Tennessee	4,000,000
Louisiana	1,100,000	Texas	100,000,000
Maine	N/A	Utah	18,310,257
Maryland	N/A	Vermont	2,000,000
Massachusetts	N/A	Virginia	N/A
Michigan	N/A	Washington	77,483,000
Minnesota	10,000,000	West Virginia	N/A
Mississippi	20,000,000	Wisconsin	711,200
Missouri	N/A	Wyoming	500,000

Notes: N/A indicates either data are unavailable or no new funding is recorded in FY 2018

Source: Pew Charitable Trust (2020)

Appendix Table B2 - List of terms based on the Lexicoder Topic Dictionaries

1. Macroeconomics

aggregate demand	*fiscal*	*supply shock*
aggregate supply	*gini coefficien*	*supply side*
business cycle	*gold standard*	*supply-side*
demand shock	*government spending*	*cost of living*
demand side	*gst*	*revenue*
demand-side	*hst*	*supply of money*
econom	*hyperinflation*	*unemploy*
employment rate	*income distribution*	*labour market*
full employment	*income inequalit*	*tax*
food price	*inflation*	*taxes*
industr	*interest rate*	*taxation*
keynes	*monetar*	*standard of living*
bank of canada	*money supply*	*living standard*
bank of england	*population boom*	*gross national product*
bear market	*population growth*	*gross domestic product*
bretton woods	*population trend*	*gdp*
budget	*price ceiling*	*keynesian*
bull market	*price control*	*austerity*
changing demographic	*price floor*	*lender of last resort*
coinage	*price index*	*jobless*
debt	*price indices*	*jobs*
deficit	*price level*	*gold standard*
deflation	*quantitative easing*	*nationalize*
demographic change	*recession*	*nationalise*
distribution of income	*macroeconom*	*nationalization*
econom	*microeconom*	*nationalization*
european central bank	*productivity*	*privatiz*
federal reserve	*supply and demand*	*privatis*

2. Healthcare

aids	*nephrolog*	*euthanasia*
alcoholism	*neurolog*	*in vitro fertilization*
allerg	*neurosurger*	*contracept*

anaesthesiolog	*nicotine*	*stem cell*
anesthesiolog	*nurs*	*ambulance*
cancer	*obstetric*	*sex ed*
cardiolog	*oncolog*	*sexually transmitted*
cardiothoracic	*opthalmolog*	*sexually-transmitted*
cardiovascular	*orthodont*	*std*
cigarette	*orthopaedic*	*sti*
dermatolog	*orthopedic*	*stds*
dietic	*palliative*	*stis*
disease	*patholog*	*pain killer*
disorder	*pediatric*	*nhs*
doctor	*pharmac*	*flu*
drug treatment	*physician*	*influenza*
drug abuse	*prescription*	*common cold*
endocrin	*primary care*	*mental ill*
gastroenterolog	*proctolog*	*mentally ill*
geriatric	*psychiatr*	*osteoporosis*
gerontolog	*pulmonol*	*nutrition*
gynaecolog	*radiolog*	*sars*
gynecolog	*radiotherap*	*drinking age*
haematolog	*respiratory*	*vitamin supplement*
health	*rheumatolog*	*diet supplement*
hematolog	*sickness*	*blood supply*
hepatolog	*surgeon*	*blood donation*
hiv	*surger*	*blood services*
hiv/aids	*surgical*	*hema-quebec*
hiv positive	*syndrome*	*alzheimer's*
hiv negative	*therap*	*alzheimers*
hiv-positive	*tobacco*	*high blood pressure*
hiv-negative	*urolog*	*hypertension*
hospital	*vaccin*	*heart attack*
hospitals	*vascular*	*cardiac*
illness	*drunk driving*	*cholesterol*
immunis	*medicine*	*patients' bill of right*
immuniz	*dentist*	*obamacare*
immunolog	*dental*	*affordable care act*
infectious	*epidemic*	

intensive care	*pandemic*	
maxillofacial	*tuberculosis*	
medical	*obesity*	
medicare	*obese*	
medicaid		

3. Education

10th grade	*college*	*grade 9*
11th grade	*teach*	*graduate*
12th grade	*collegiate*	*kindergarten*
1st grade	*diploma*	*learn*
2nd grade	*educat*	*postsecondary*
3rd grade	*grade 1*	*post-secondary*
4th grade	*grade 10*	*school*
5th grade	*grade 11*	*student*
6th grade	*grade 12*	*tuition*
7th grade	*grade 2*	*undergraduate*
8th grade	*grade 3*	*universit*
9th grade	*grade 4*	*vocational*
alumna	*grade 5*	*apprenticeship*
alumni	*grade 6*	*curricul*
alumnus	*grade 7*	*syllabus*
cegep	*grade 8*	

4. Environment

acid rain	*emission*	*sustainability*
cap and trade	*endangered species*	*threatened species*
cap-and-trade	*environment*	*drinking water*
carbon pricing	*extinct*	*water supply*
carbon sink	*geoengineering*	*potable water*
carbon tax	*glacier*	*hazardous waste*
climate change	*global warming*	*smog*
climate engineering	*greenhouse effect*	*air quality*
climate intervention	*greenhouse gas*	*asbestos*
climate remediation	*ozone*	
conservation	*pollut*	

contaminat	*sea ice*	
deforest	*sea levels*	
ecolog	*species at risk*	

5. Social welfare

employment insurance	*public welfare*	*social service*
food bank	*shelter*	*unemployment insurance*
impoverish	*single mother*	*welfare*
low-income	*single parent*	*poverty*
old age security	*single-mother*	*guaranteed income*
pension	*single-parent*	*food stamp*
poverty	*social assistance*	*food assistance*
public assistance	*social deprivation*	

6. Transportation

aero	*transport*	*road*
air canada	*travel*	*roads*
westjet	*truck*	*port*
airline	*highway*	*bicycle*
air safety	*freeway*	*pedestrian*
air service	*bridge maintenance*	*sidewalk*
air traffic	*speed limit*	*walking*
air travel	*coast guard*	*cycli*
aviation	*cargo*	*megabus*
bus rapid transit	*freight*	*greyhound*
mass transit	*taxi*	*coach canada*
public transit	*limo*	*auto industry*
public bus	*limousine*	*automobile*
intercity bus	*airport*	*car*
inter-city bus	*tsa*	*cars*
rail	*toll road*	*driver licens*
railroad	*traffic jam*	*driver licenc*
ship	*congestion pric*	*drivers licens*
subway	*parking*	*drivers licenc*
tramway	*drivers licens*	*driver's licens*

	speed limit	*driver's licenc* *vehicle*

7. Agriculture

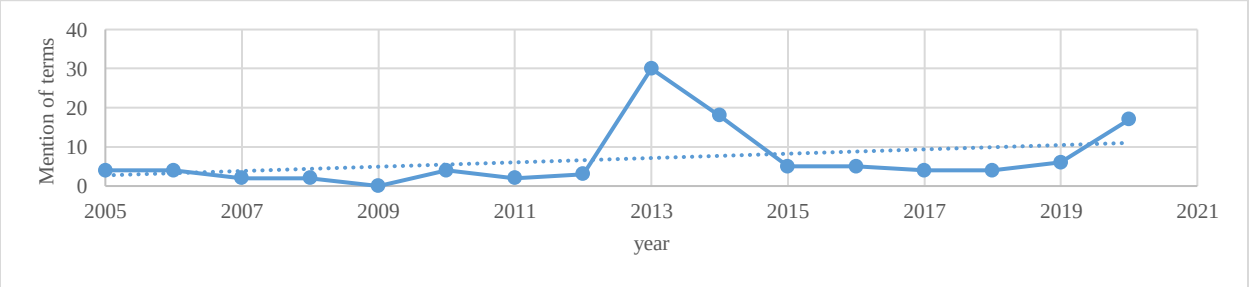
agricult	*thresh*	*pesticide*
cattle	*orchard*	*manure*
cultivat	*food inspect*	*genetically modified*
grain	*farm*	*gmo*
wheat	*food import*	*gmos*
barley	*aquacult*	*feed*
beef	*foot and mouth*	*e coli*
pork	*livestock*	*mad cow*
poultry	*crop*	*bovine spongiform encephalopathy*
tractor		

Appendix Table B3 - Hurricane Hits across U.S. States by Saffir-Simpson Scale, 1851-2004

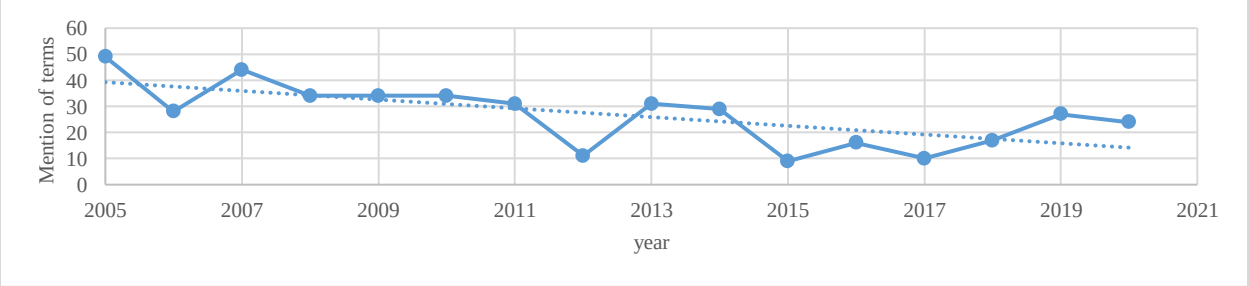
State	Saffir-Simpson Hurricane Wind Scale categories					Total
	1	2	3	4	5	
Florida	**43**	**32**	**27**	**6**	**2**	**110**
Texas	**23**	**17**	**12**	**7**	**0**	**59**
Louisiana	**17**	**14**	**13**	**4**	**1**	**49**
North Carolina	**21**	**13**	**11**	**1**	**0**	**46**
South Carolina	**19**	**6**	**4**	**2**	**0**	**31**
Alabama	**11**	**5**	**6**	**0**	**0**	**22**
Georgia	**12**	**5**	**2**	**1**	**0**	**20**
Mississippi	2	5	7	0	1	15
Virginia	9	2	1	0	0	12
New York	6	1	5	0	0	12
Connecticut	4	3	3	0	0	10
Massachusetts	5	2	3	0	0	10
Rhode Island	3	2	4	0	0	9
Maine	5	1	0	0	0	6
Maryland	1	1	0	0	0	2
Delaware	2	0	0	0	0	2
New Jersey	2	0	0	0	0	2
New Hampshire	1	1	0	0	0	2
Pennsylvania	1	0	0	0	0	1

Source: (NOAA, 2015)

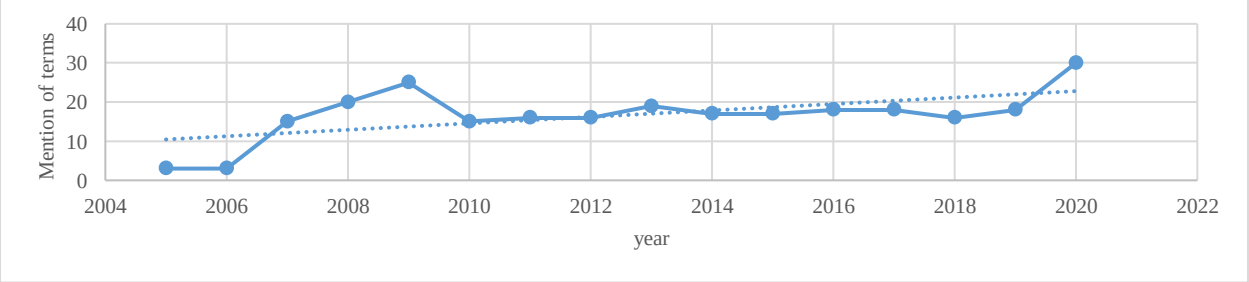
Appendix Figure B1 – Mention of Disaster-related Terms in Budget Documents of Alabama



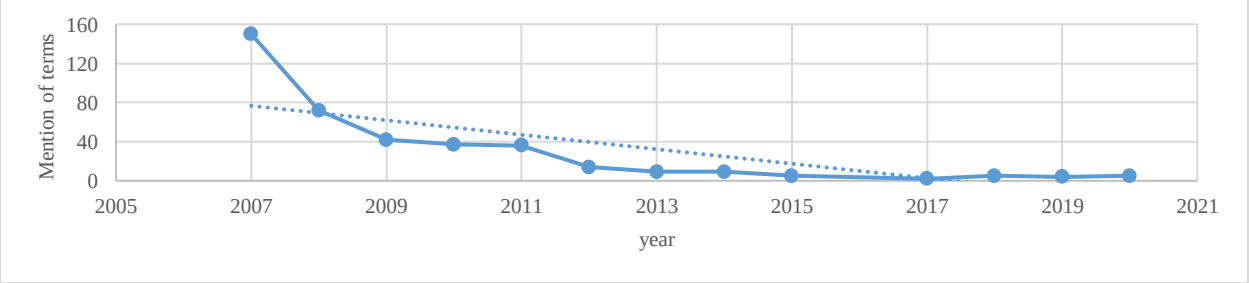
Appendix Figure B2 – Mention of Disaster-Related Terms in Budget Documents of Florida



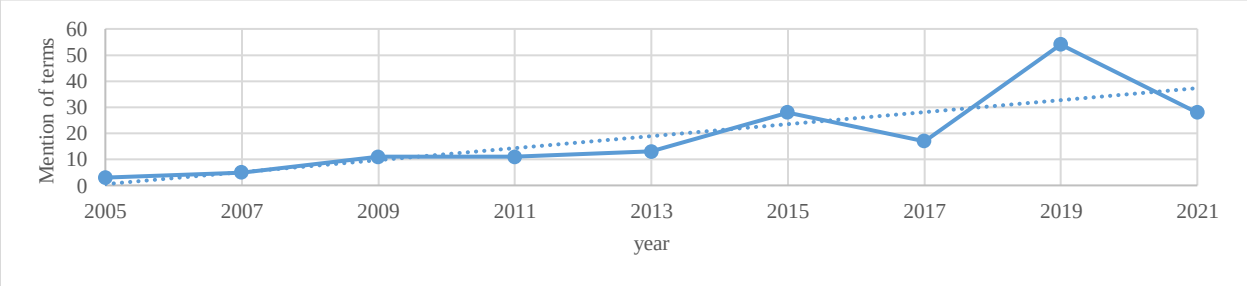
Appendix Figure B3 – Mention of Disaster-related Terms in Budget Documents of Georgia



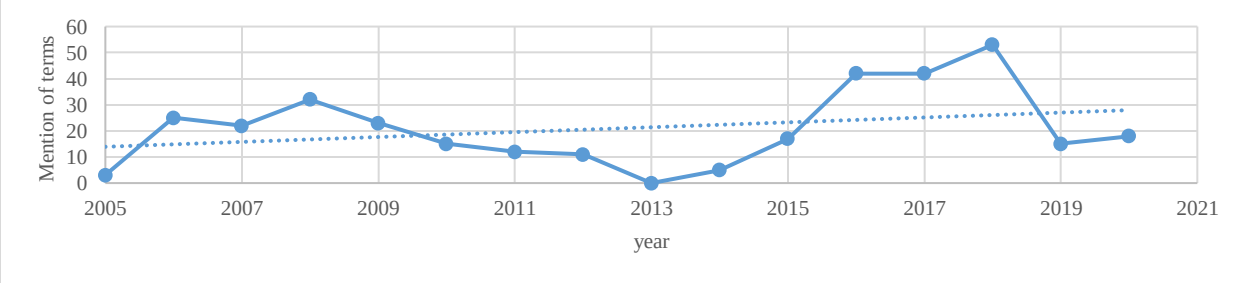
Appendix Figure B4 – Mention of Disaster-related Terms in Budget Documents of Louisiana



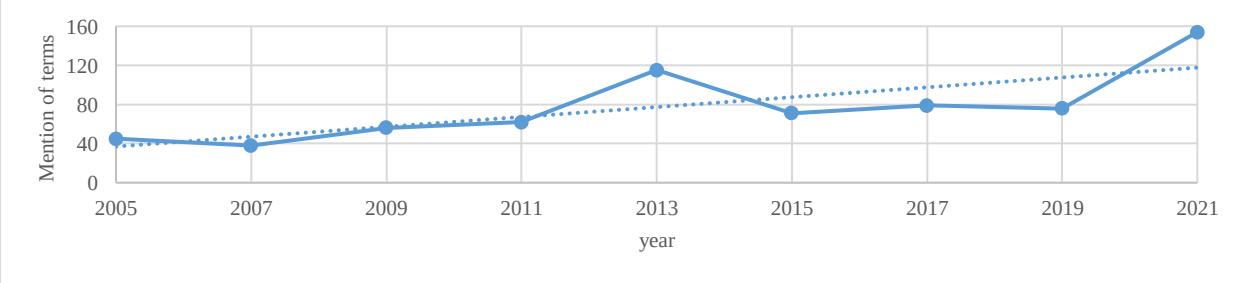
Appendix Figure B5 – Mention of Disaster-related Terms in Budget Documents of North Carolina



Appendix Figure B6 – Mention of Disaster-related Terms in Budget Documents of South Carolina



Appendix Figure B7 - Mention of Disaster-related Terms in Budget Documents of Texas



Appendix Table B4 – Estimates and P-Values of Trends of Attention to Hurricanes and Disasters in 7 States

	Trend of hurricane attention	p-value	Trend of disaster attention	p-value
Alabama	0.263**	0.049	0.552	0.209
Florida	-0.773*	0.053	-1.673***	0.004
Georgia	-0.001	0.989	0.823**	0.015
Louisiana	-0.084***	0.003	-7.401***	0.003
North Carolina	0.35***	0.008	2.3*	0.01
South Carolina	0.262**	0.066	0.937	0.261
Texas	0.941	0.112	5.041	0.018

Notes: Stars denote statistical significance

** p < 0.10, ** p < 0.05, *** p < 0.01*

Chapter 3: Disaster Risk Disclosure: Evidence from U.S. State Governments

Abstract

This study surveys the government's disclosure of risk associated with natural disasters. It is intended as an exploratory analysis using audited financial reports from 50 U.S. states between 2002 and 2016. Data on major hurricane events are obtained from selected states in the southern U.S. region. The study combines qualitative analysis with computational text analysis to understand whether and how the financial reports discuss risk, resulting in three findings. First, state governments do not widely disclose information regarding disaster risk, despite the increasing threat of natural disasters. Second, states that have disclosed disaster risk in the past tend to disclose the same information in the following years, suggesting inertia in financial reporting. Third, based on selected cases in hurricane-prone states in the southern U.S. region, the study also finds proactive as well as reactive risk disclosure.

1. Introduction

The critical role of government in navigating through calamity is substantiated by the recent financial and pandemic crises. Government programs, including those carried out during crises, are funded by the people's money. At least two aspects are relevant here: from a policy standpoint, each program should be carefully designed to achieve the outcomes as intended; from a financial management standpoint, the programs need to be supported by an adequate budget. At

a minimum, revenues must be sufficient to pay for expenditures at present as well as in the future. This concept aligns with the idea of sustainability, which the United Nations defines as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987, para. 27). As part of the public expenditure management framework, Schick (1998) included the concept of "aggregate fiscal discipline," which means the aggregate budget must be sustainable over the medium or longer term. Accordingly, the government should have the capacity to adopt policies that will protect the budget from exposure to external shocks. A different, but related accounting principle is known as "going concern" (International Financial Reporting Standards Foundation, 2021). Going concern assumes that a government entity will continue operating even after the fiscal year closes. To that end, the government needs to assess its capacity to remain in operation and mitigate risks that could potentially interfere with its ongoing financial sustainability.

This study focuses on one type of risk--a potential external shock--that is increasingly prevalent in the U.S.: natural disasters. Data from the National Centers for Environmental Information (2023), a part of the National Oceanic and Atmospheric Administration (NOAA), show that the number of disaster events in the US has been increasing over the last few decades. In the 1980s, disasters with costs exceeding $1 billion occurred about three times per year. In the 2010s, the average number rose to 12 per year. Exceeding that number, 18 major disaster events were recorded across the country in 2022, including severe storms, tropical cyclones, and flooding. While scientists are working on event attribution assessment to examine the extent to which specific natural disasters are influenced by climate change (Stott et al., 2015), the Intergovernmental Panel on Climate Change (2014, p. 7) noted in its Fifth Assessment Report that "changes in many extreme weather and climate events have been observed since about 1950."

The notion of *disaster risk* is made up of two elements: *hazard* and *vulnerability* (Garatwa & Bollin, 2002). Hazard is defined as natural events that are so extreme that they can have adverse impacts on the community, such as storms, hurricanes, and wildfires. Risks emerge only when a certain hazard is combined with vulnerability. For example, the inadequacy of the community to protect itself against the adverse consequences of a natural event. To assess risk to valuable assets, Hallegatte et al. (2017) developed slightly different definitions and incorporated a third element: *hazard* (the probability that an event occurs in an area), *exposure* (the community and asset in the affected area), and *asset vulnerability* (the monetary value of asset lost in the affected area.) Borrowing from the literature, this study will use the term "disaster risk" and "natural disaster risk" interchangeably to capture a similar concept that considers not only a natural hazard but also the potential damage it brings to the community.

The adverse impact of natural disasters on the government budgets should not be underestimated. Otero and Marti (1995) found several episodes when the budget deficit significantly rose after disaster events in Latin America and Caribbean countries. In a different country-level study, Melecky and Raddatz (2011) discussed how disasters negatively impact deficit levels, though there were heterogeneous effects conditional upon the development stage and initial government debt. In the US, Miao et al. (2018) observed fluctuations in state governments' sales, income, and property tax revenues following natural disasters. Studying natural disasters in the context of government finances paves a way to better understand state financial behavior and promote budget resilience and sustainability.

Beyond academia, managing risks associated with disasters has been a relevant topic among policy practitioners for a longer time. In 1989, the United Nations adopted a resolution to inaugurate the 1990s as the International Decade for Natural Disaster Reduction and designated

the second Wednesday of October as the International Day for Natural Disaster Reduction—an event that continues to be celebrated to date (United Nations, 1989). More recently, the U.S. Government Accountability Office (2019) introduced the Disaster Resilience Framework, which suggests that natural disaster risk should be accurately and comprehensively measured to help policymakers assess their risk better. On the same theme, the World Bank (2022) developed a disaster resilience framework applicable to governments across regions that require their central budget offices to actively assess risks related to the foreseeable impacts of disaster events. The assessment encompasses risk reduction, response, and recovery planning, in which the central budget office works in collaboration with the disaster management agency within the government.

This study surveys how governments assess risks associated with natural disasters. It is intended as an exploratory analysis using audited financial reports from 50 U.S. states between 2002 and 2016. Analysis is conducted primarily based on the information disclosed in the state's audited financial reports. Audited financial reports are suitable sources of data for at least two reasons: (1) they encapsulate strategic, managerial, and financial decisions of a government entity in a given year, including those pertaining to risk management, and (2) the reports are, as a rule, publicly available, which helps with data collection and is a requirement before an analysis can be conducted. To the best of the author's knowledge, this is the first risk disclosure study to cover all 50 U.S. states over 15 years of observation. In public sector risk management, textual analysis is less commonly used relative to other methodology, such as field study, interviews, survey, and normative analysis (Bracci et al., 2021). My research also offers an alternative approach and also adds methodological novelty to the literature.

The remainder of this chapter is organized as follows. Following this introductory section, Section 2 reviews the literature on risk and disclosure. Section 3 describes data collection and

sources. Section 4 discusses the methodology. Section 5 provides analysis and summarizes the results. Finally, Section 6 reports the conclusions.

2. Background

2.1. Risk

The concept of risk can be traced to the Bernoulli era in the 1600s. Along with other mathematicians, the Bernoullis contributed to the early development of the probability theory that was central to understanding risk and saw that it was possible to make precise statements about uncertainties (Polasek, 2000). But it was only after World War II that risk was integrated into management practice, particularly in the private sector (Dionne, 2013). The study of risk management was initially concerned with the use of market insurance to protect businesses and individuals from losses from accidents, though in the following decades it grew to also cover other instruments to insure against risks. Around the 1980s, regulations pertaining to risk were introduced. However, they were not adequate to prevent corporate frauds and scandals, including the fraud that led to the notable collapse of Enron in 2001. Responding to the public demand for stricter regulation and better corporate governance, the Sarbanes-Oxley Act (SOX) was passed in 2002 (Hart, 2009). Among other things, SOX requires that the CEO of listed companies certify the accuracy of the financial reports, maintain internal controls, and disclose any organizational deficiencies to the auditors.

In the public sector, the discourse around risk management gained impetus in the 1980s, riding the New Public Management movement (Lapsley, 2009). The concept is distinct from the private sector; rather than focusing on profitability, risk management in the public sector is

positioned to help the government deliver public services and pursue public interests (Black, 2005). But it was only after 2000 that frameworks and practices of risk management in government began to diffuse more rapidly (Bracci et al., 2021). In academia, the quantity of scholarly publications covering a diverse range of specific themes but within the government context has since increased. Most of the research deals with risk management in general, although there are also specific types of risks that are addressed, such as hazard risk, financial risk, operational risk, and strategic risk.

The Governmental Accounting Standards Board (GASB, 1989a, p. 50-51) defines risk as "uncertainty of loss, chance of loss, or the variance of actual from expected results."[4] The mechanism to minimize adverse effects resulting from those losses, such as through risk control and financing, is then called risk management. This study construes risk using a finance lens, noting how it can negatively affect the financial condition of governments. Brixi and Schick (2002) refer to the financial stress a government potentially faces in the future as "fiscal risk." Their discussion illustrates how the governments in some countries often must spend unbudgeted resources during a crisis, increasing the level of debt and other obligations. As these obligations come due for payment, fiscal challenges emerge and expose the government to greater risks. Public Expenditure and Financial Accountability (PEFA) (2021) -- a program initiated by international development donors, including the European Commission, International Monetary Fund (IMF), and World Bank -- takes a rather different stance in defining fiscal risk in subnational government. Specifically, it focuses on risks arising from state-owned enterprises and contingent liabilities. Meanwhile, the IMF (2009, p. vii) describes fiscal risk as "the possibility of deviations of fiscal

[4] The definitions of "risk" and "risk management" referred to here are based on the GASB Statement No. 10.

outcomes from what was expected at the time of the budget or other forecast." This definition focuses on risks that have a reasonable chance to materialize within a few years.

As part of risk management, in 2004 the Committee of Sponsoring Organizations (COSO) recommended that private organizations recognize a range of events attributable to the negative impact. COSO's framework builds on the accounting system within an organization and emphasizes a controls-based approach (Power, 2009). In the public sector environment, the GASB Statement No. 10 recognizes an array of probable events, such as torts, destruction of assets, business interruption, and natural disasters. The IMF (2009) also has a list of factors associated with risks applicable to national governments, including natural disaster events.[5] To better classify the events, COSO introduced two categories that correspond to internal and external factors. Internal factors stem from choices and decisions that management makes, typically pertaining to human personnel, organizational process, and administrative infrastructure. Meanwhile, external factors are things that management is unable to fully control, such as macroeconomic, political, social, and environmental influences, including natural disasters. Note, however, that practical limitations may hinder complete prediction of their occurrences.

The literature above touches upon three dimensions of risk that are relevant to my selection of natural disasters as the focus of this study. First, a disaster potentially interferes with government operations and harms the public interest in general. The environment being examined is thus the public sector rather than the private sector. Second, disasters can lead to increased public spending, reduced revenues, or additional financing needs that must be met through borrowing by the government. Hence, the risk at interest has financial effects to a certain extent. Third, the force of

[5] Other factors include banking crises, state-owned enterprises, public private partnership, subnational government, legal claims, and guarantees.

a disaster is driven by external rather than internal factors, and thus is beyond the control of the government. Another type of risk, legal risk, also fulfills the three dimensions, and will be used as comparison to disaster risk later in the analysis.

2.2. Disclosure

In his seminal paper, Akerlof (1978) illustrated how asymmetrical information gives rise to quality uncertainty in the market and could lead to market collapse. Disclosure is one of the mechanisms to overcome this problem; it eliminates information asymmetries and improves economic efficiency. Disclosure within firms reduces information asymmetries among investors, and as they feel more confident in closing transactions, the liquidity of a company's stocks increases (Diamond and Verrecchia, 1991; Kim and Verrecchia, 1994; Easley and O'Hara, 2005). Consistent with these findings, Leuz and Verrecchia (2000) demonstrated how companies with a higher disclosure standard have lower bid-ask spreads and higher share turnover; increased levels of disclosure reduce the possibility of information asymmetries among the firm, its stockholders, and potential stockholders.

The benefits of information disclosure are not limited to the financial market. Fung et al. (2007) showed how the disclosure practice changes the way the U.S. automotive industry operates in one key aspect. In 2000, a series of auto accidents caused many deaths in the U.S. It was later revealed that many of the troubled cars were SUVs produced by a certain car manufacturer. But initially, information asymmetries existed between the sellers and buyers of cars. The manufacturer had been aware of a pattern of fatal accidents but had done nothing to alert consumers. The U.S. Congress noticed the developing story and decided to implement a risk disclosure policy as an imperative action. It required auto companies to give car buyers the facts

about each model's rollover record so that consumers could make an educated safety choice when buying cars. Since then, buyers have been able to make informed decisions, buying safer cars and rejecting companies that neglected safety measures. Not only did disclosure make the public better informed about risks embedded in certain car makes, but the policy also incentivized auto companies to improve their vehicle design.

Other studies have documented how disclosure benefits an organization internally. Using a sample of more than 800 firms in France, Derouiche et al. (2021) showed how operational efficiency is significantly higher among firms that practice greater risk disclosure. Clarkson et al. (2008) followed more than 190 sampled companies in the U.S. and found a positive correlation between the level of environmental disclosures and corporate environmental performance. Meanwhile, a country-level study by the IMF suggested that greater fiscal risk disclosure is associated with higher sovereign bond ratings and greater access to international capital markets (Lusinyan et al., 2009).

In some cases, however, disclosure requirements may inadvertently impose administrative burdens and reduce business flexibility to the organization (Kinderman, 2015). Also, while limited information is undesirable, Fung et al. (2007) described the other extreme in which people are drowning in information; excessive disclosure could also lead to information overload. When useful information remains hidden, the higher amount of information fails to improve the decision-making process.

GASB sets the criteria for what and how certain information should be presented in different parts of the financial reports of state and local governments. An integral component are the notes to financial statements, which are required to communicate information that may be essential but is not set out on the face of the financial report. To date, no specific requirements are

available to govern whether and the extent to which natural disasters risks are disclosed in the government financial reports. Disclosure practices appear to be more advanced in the private sector than in the public sector. More investors consider environmental, social, and governance (ESG) relevant to their investment decisions, and accordingly they demand not only greater availability but also enhanced quality of that information. While many corporations respond positively through voluntary disclosure, some have argued that there is a potential setback associated with greenwashing (Clarkson et al., 2011; Marquis et al., 2016).

Given the prevalence of disaster incidences in the U.S., disclosure of natural disaster risks is deemed essential. Deegan and Rankin (1996, p. 62) argued that "annual reports that omit particular environmental information, or provide it in a biased manner, are misleading in that they do not provide a full picture of the operations of the business for the period under review." Unfortunately, research on risk disclosures pertaining to natural disasters has been limited. Bracci et al. (2021) found that disaster risk studies represent only less than 5 percent of all risk management work. This study aims to fill the literature gap and is intended to provide a general overview of the state of risk disclosures in the public sector.

Three parts of my analysis are developed and conducted based on available data across U.S. state governments, as follows. The first portion considers temporal dimension to capture the trend of disaster risk disclosure over time. The second analysis looks at the spatial dimension to identify which states disclose disaster risk information in the financial reports. The third analysis looks more deeply into selected states to qualitatively assess whether disaster incidences coincide with higher mentions of relevant information in the financial reports. For this study, I focus on hurricanes, given their magnitude in the U.S., and on the Southern states, specifically considering their relative proximity to where hurricanes typically occurred.

3. Data

States are selected as the unit of analysis in this study. This is appropriate because state governments have authority to take actions when a disaster strikes as well as access to resources. Unlike lower-level jurisdictions (i.e., municipalities and counties), state leaders can declare an emergency status and request federal assistance when a disaster emergency arises. In the U.S., it is also the norm for state governments to allocate a fraction of their budgets as rainy-day funds (Hou, 2004), though in many states the amount that was set aside was historically not enough to offset revenue shortfalls during economic downturns (Zhao, 2016).

This study will first consider all 50 states in the analysis (Sections 5.1 and 5.2). However, in the later part (Section 5.3), I narrow down the sample to a smaller number of states. For Section 5.3, my analysis focuses on one type of disaster that has an enormous impact to the community, hurricanes, and on states that are most directly exposed to them. Those states are Alabama, Delaware, Florida, Georgia, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, Texas, and Virginia. The selection of hurricanes as opposed to other disaster types reflects the availability of data and the significance of the events. One, by nature, hurricanes cannot possibly occur in all of the 50 states, although this consequently restricts my observations to a smaller number of states. But in the U.S., hurricane events are well-documented and the records are widely accessible relative to other disaster events, such as flooding and wildfires. Two, of all recorded weather disasters, NOAA (2022c) noted that hurricanes were considered to be the most dangerous and destructive. Over the last four decades, hurricanes are estimated to have caused 6,697 deaths and more than 1 trillion dollars in economic losses in the country. Among the most intense hurricanes in recent years were Hurricanes Laura (Louisiana, 2020), Sally (Alabama, 2020),

Florence (North Carolina, 2018), Michael (Georgia and Virginia, 2018), and Harvey (Texas, 2017).

In each state, two types of data are collected: hurricanes data and risk disclosure data. *First,* hurricane data are tabulated from the list made available by the Hurricane Research Division of NOAA (2022). Each hurricane strike is documented along with other information, such as month and year of occurrence, strength according to the Saffir Simpson categories, storm names, and affected states. This data, however, does not provide the number of fatalities and the monetary damages resulting from a hurricane event. The National Centers for Environmental Information has a summary of fatalities and financial damages resulting from weather-related disasters. But the summary lumps all weather-related disasters without distinguishing, hence it is hard to disentangle fatalities and damages that are specifically attributable to hurricane events. To obtain estimates of fatalities and damages, I refer to multiple other sources, including the Federal Emergency Management Agency (FEMA) database of major hurricane events and several media accounts.

Second, disaster risk disclosure data are extracted from financial reports in each state and year. State governments typically prepare financial reports on an annual basis, in accordance with their respective budget cycles. The reports contain information on an organization's financial position and activities during the fiscal year. An external auditor will then audit these reports and give assurances (i.e., independent opinions) regarding compliance with the applicable accounting standard and adequacy of internal controls exercised by the audited organization. Financial reports should be publicly accessible, but in some cases, availability is limited to only recent years only. To improve efficiency in data collection, I first searched for all documents in the financial reports database of the Center for Municipal Finance (2022). If they were not available there, I searched the respective state government websites. Produced after the end of the fiscal year, these reports

are retrospective in nature; they summarize all economic transactions that have occurred in major categories, such as revenues, expenditures, assets, and liabilities. But they are also forward-looking, signaling to stakeholders about risks and other material information that might affect the financial condition of the entity. Parallel to the adage of "what gets measured gets managed," in accounting it is perhaps "what gets disclosed gets measured and managed."

State governments' financial reports contain abundant numerical information that summarizes the financial condition of an entity and often serves as the key source of data in empirical studies. However, their narrative portions also contain insights that are worth exploring. Frazier et al. (1984) discussed specific parts, such as management analyses, footnotes, and annotations of explanatory data that often contain fruitful extension of material information in financial reports. The analysis carried out in this study will specifically use the narrative portions in the financial reports to evaluate whether the state government sufficiently identifies fiscal risks that are associated with natural disasters.

With 50 states and 15 years (from 2002-2016) of observation, a complete dataset covers 750 financial reports. Unfortunately, the quality of some documents is poor, and additional steps using the Optical Character Recognition (OCR) were required to enhance their readability. This procedure was effective when applied to most, but not all, of the unreadable documents. Around 1.2% of the full data set (9 out of 750 financial reports) remained in poor quality even after applying OCR, and therefore cannot be used for analysis. My dataset thus does not include financial reports from the following state governments and years: Utah (2004, 2005), South Dakota (2006), Arkansas (2008), Hawaii (2010, 2011), Iowa (2011), Alaska (2013), and Maryland (2014).

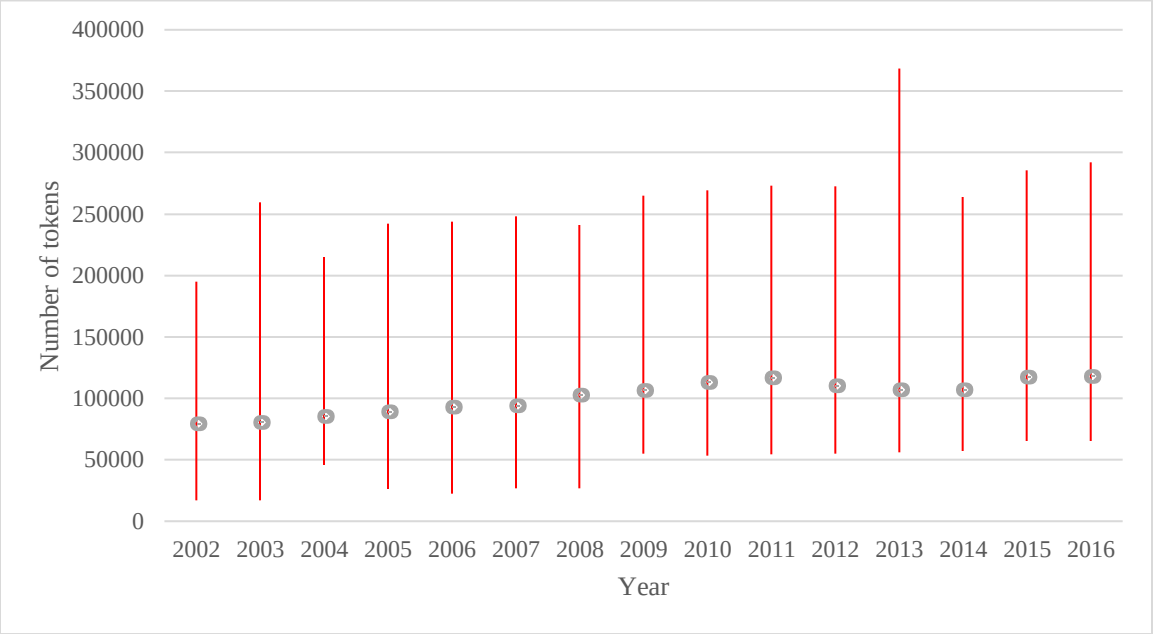
Figures 30 and 31 respectively summarize the length and number of tokens (i.e., words) in financial reports being examined in this study from 2002-2016. Red bars indicate the maximum

and minimum points based on data of 50 states in a given year. Each bar has a grey mark, denoting a median point. In Figure 30, consider year 2016 as an example; the number of pages ranges between 159 (Nebraska) and 385 (Illinois), with a median point of 268 (Oregon and Wyoming). In Figure 31, the minimum number of tokens in 2016 is around 65,000 (Connecticut) and the maximum is around 290,000 (Pennsylvania), with a median point in the ballpark of 110,000 (North Dakota and Wisconsin). In both figures, the maximum, minimum, and median appear to trend upward. This illustrates that state governments generally provided more narrative information in 2016 than in 2002, though it remains unclear whether higher availability of information in the state government financial reports is associated with better quality of information. Regardless, the extensive number of pages and tokens makes computational text analysis a reasonable approach to apply, which I will discuss in the next section.

Figure 30. Length of Financial Reports across 50 States from 2002-2016

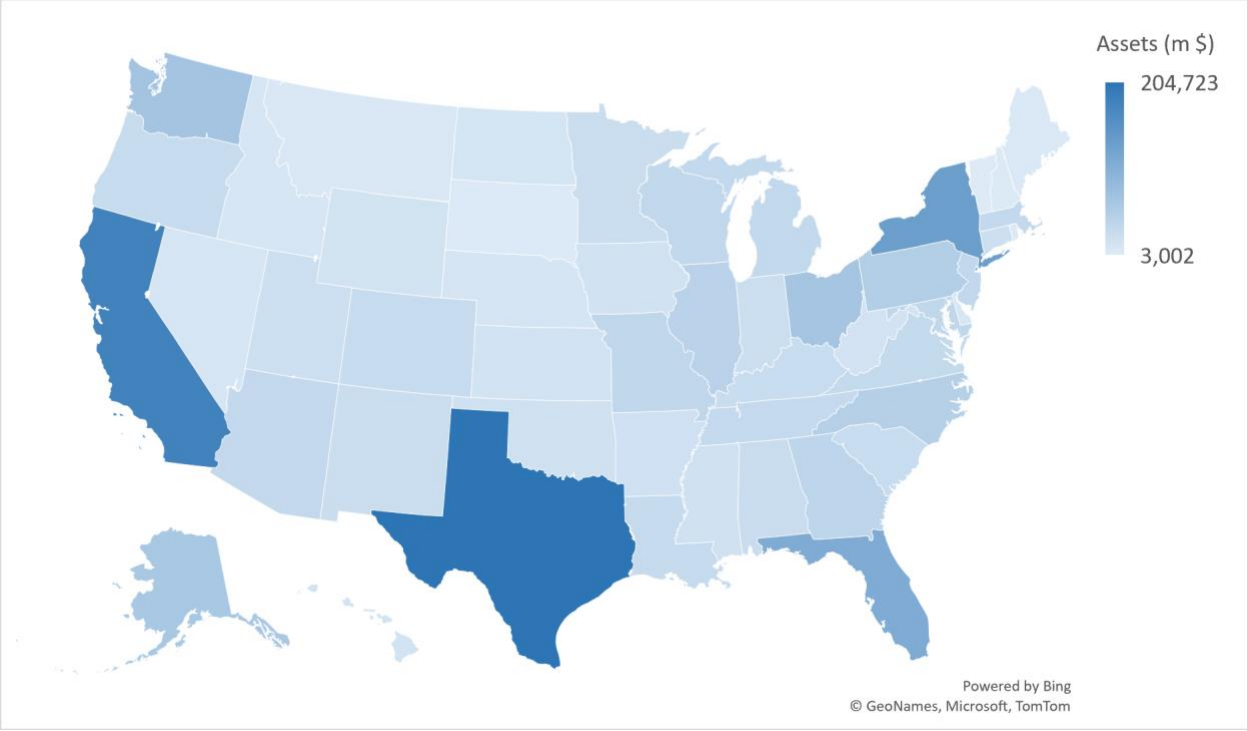
Notes: Bars indicate maximum and minimum points in each year based on data from all 50 states; Grey dots indicate the median point of each year.

Figure 31. Tokens in Financial Reports across 50 States from 2002-2016



Notes: Bars indicate maximum and minimum points in each year based on data from all 50 states. Grey dots indicate the median point of each year. Tokens are equivalent to words.

Figure 32. Mean State Assets, 2002-2016 (in Millions of Dollars)



Note: Actual numbers for each state are provided in the Appendix Table C1

4. Methodology

This study relies upon qualitative analysis informed by textual data that are extracted and tabulated computationally. There are three analyses; the first two look at all 50 states to identify patterns over time and across states, while the third analysis considers selected cases from southern U.S. states. Case studies are preferred for answering the "how" question and investigating a distinct phenomenon like hurricanes. While they encounter limitations when it comes to representativeness, case studies promise depth. When drawing inferences, quantitative method based on large-N and data-set observations may no longer capture idiosyncratic factors by state and over time, at which point it would be more useful to pursue in-depth analysis of causal-process observations (Brady, 2010). Causal-process observations provide an alternative source of inferential leverage through details of cases (Collier et al., 2010).

Using financial reports as a primary data, researchers typically focus on the numerical data that measure the financial state of a government entity. As an illustration, I manually collected some of the major items in the financial reports across 50 states for 15 years in this study: assets, liabilities, revenues, and expenses. From this information, I can show how the economic and budget size of a state is positively correlated with the assets. As seen in Figure 32, states like Texas, California, Florida, and New York are shown in darker blue to indicate they have the largest assets among all 50 states in the U.S.

Figure 33. Solvency and Profitability Ratios across 50 States in 2005

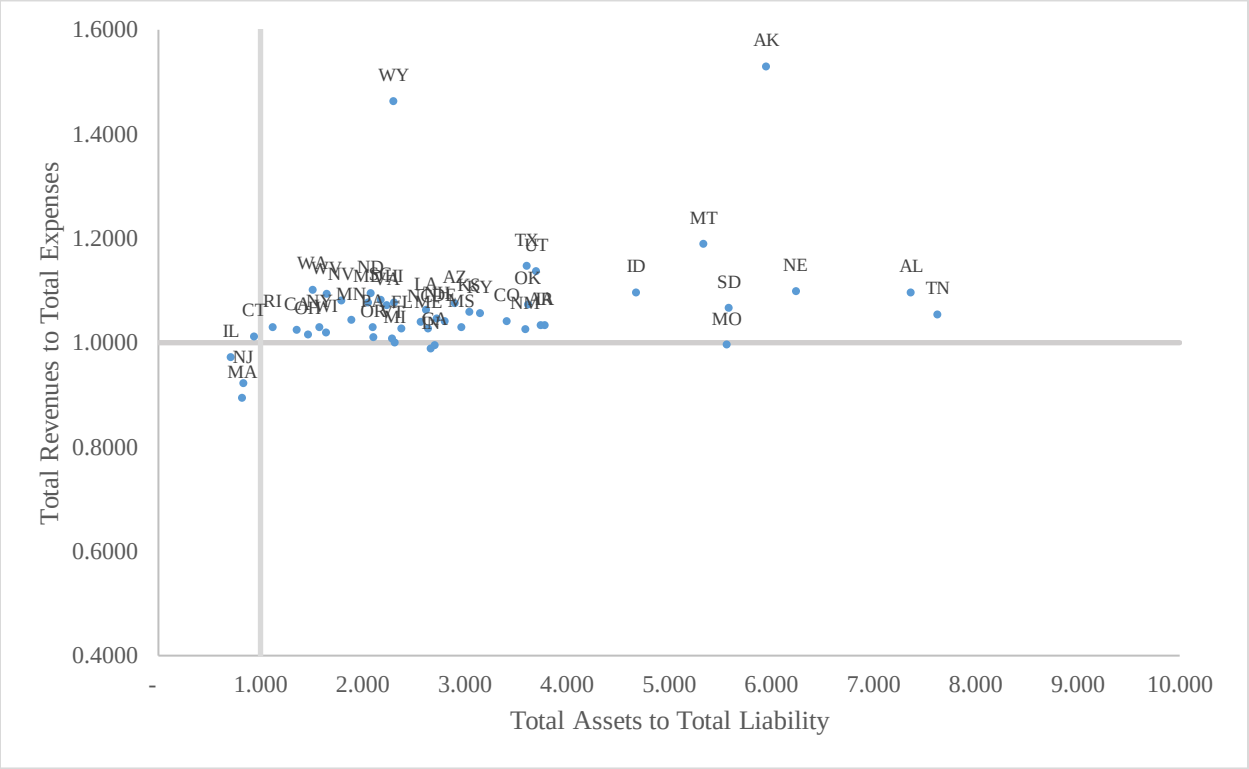


Figure 34. Solvency and Profitability Ratios across 50 States in 2010

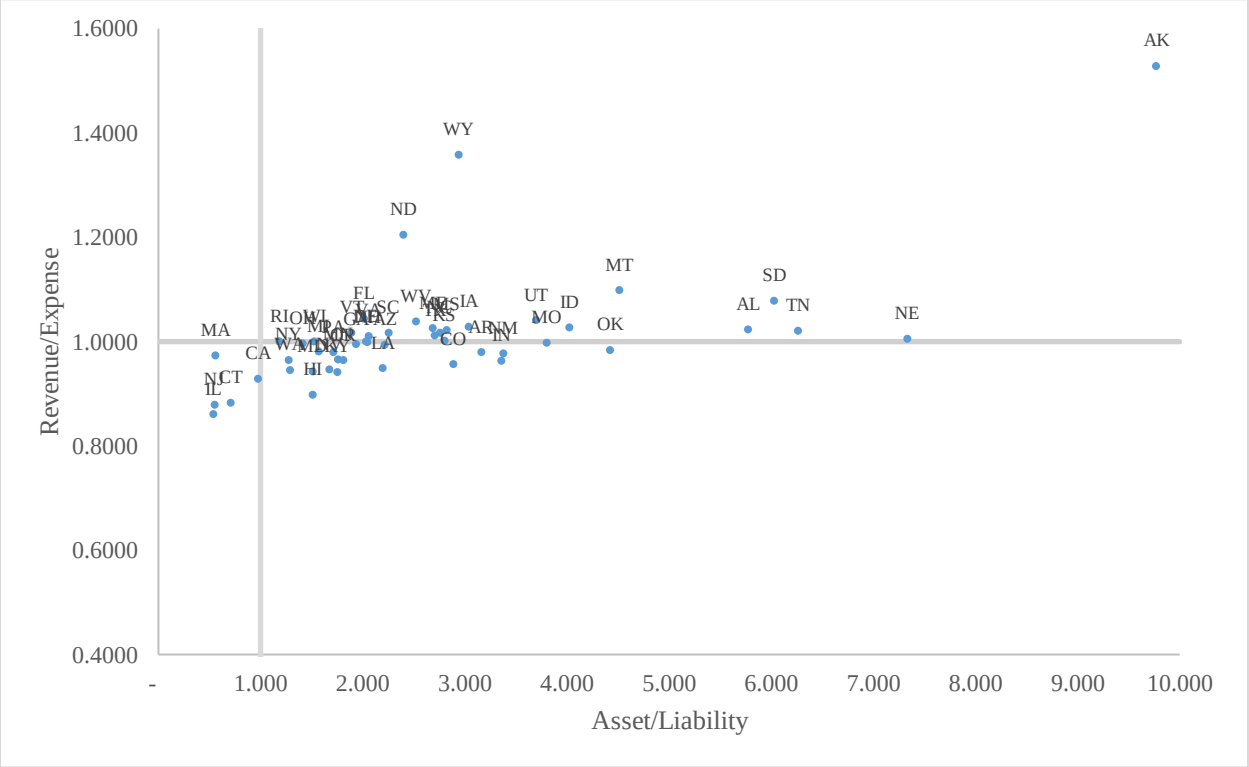
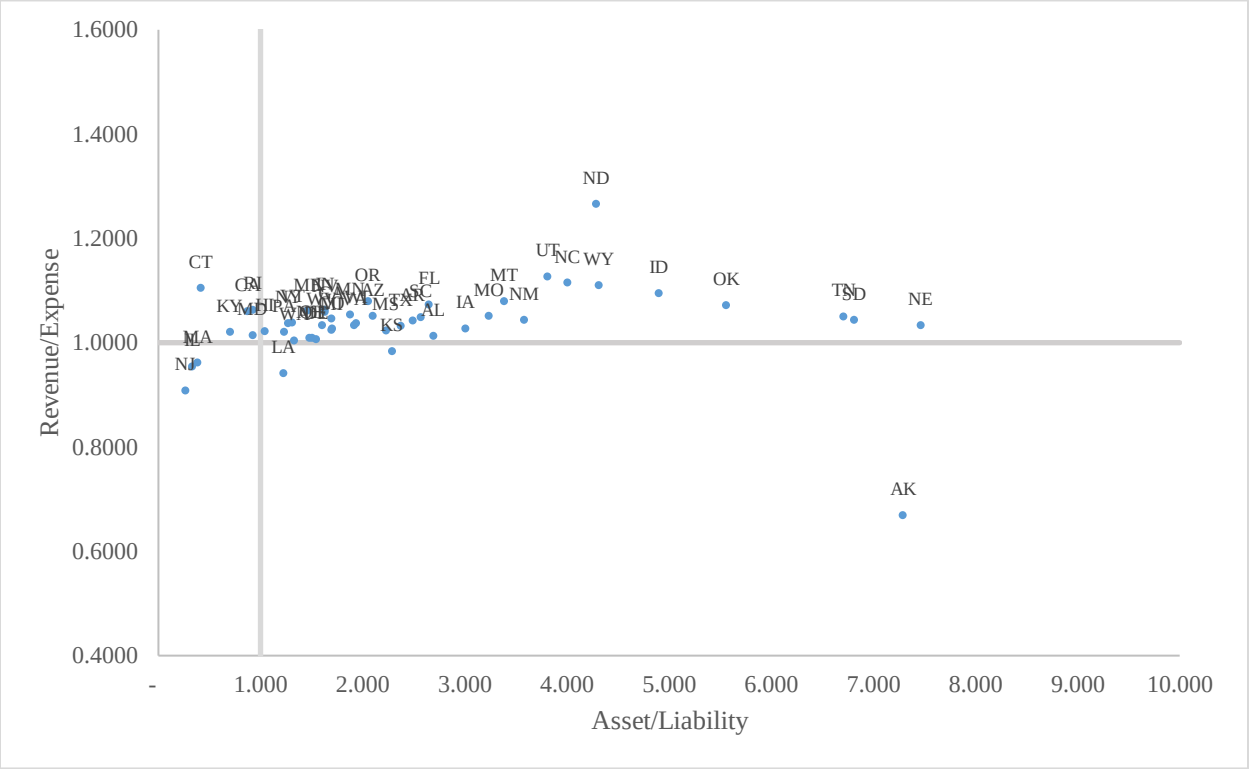


Figure 35. Solvency and Profitability Ratios across 50 States in 2015



The financial analysis could go further, mapping states according to their profitability (i.e., whether the state government's revenues meet its expenses) and their solvency (i.e., whether the entity has enough resources to meet its near-term and long-term liabilities) (Kioko and Marlowe, 2016). In Figures 33, 34, and 35, the vertical axis represents the ratio of assets to liabilities in a given state in 2005, 2010, and 2015, respectively. A value greater than 1 indicates solvency because total assets are greater than liabilities. The horizontal axis denotes the ratio of revenue to expense; a value greater than 1 implies profitability as enough revenues are raised by a state government to pay for its expenses. The scatterplots represent all 50 states, which are divided into four quadrants. While solvency risk is present among states in the upper and lower left-hand quadrants, those in the lower-left quadrant is particularly worrying for a specific reason: not only

are liabilities greater than assets, but also expenses are greater than revenues. Absent reform, states in the lower-left quadrant are fiscally unsustainable: Illinois and Connecticut (in 2010); New Jersey and Massachusetts (in 2005, 2010, and 2015).

Numerical data in the financial reports allow for various analyses, but also present limitations, especially in the context of fiscal risk. For instance, constraints arose as I attempted to examine the extent to which state governments recognize risks specifically associated with natural disasters. The Pew Charitable Trusts (2018b) surveyed state emergency managers and found that most states do not comprehensively track natural disaster spending. Similarly, in a broader climate change context, state governments often provide little details on climate-related programs (Gilmore & St. Clair, 2018). With that in mind, textual data become an alternative information source when numerical data are unavailable, inaccessible, or incomplete. Computational text analysis thus serves as a reasonable approach on studying disaster risk management.

Analysis of textual content in financial reports is not entirely new. Elzahar and Hussainey (2012) use content analysis to explore the level of risk information in the narrative portions of interim reports in 72 listed companies in the UK. Their methodology quantifies the number of risk-related sentences as a proxy for risk disclosure level. Yang (2020) leverages textual analysis to examine disclosure languages in the Management's Discussion and Analysis section of the 2016 financial reports across several U.S. local governments. Bischof et al. (2021) applies automated searches based on U.S. companies to identify equivalent terms for loan (i.e., "loan," "mortgage") and for loss (i.e., "loss," "decrease," "write down," "reduce," "reduction").

Following a similar approach, I apply computational text analysis to extract and perform analysis of the content of financial reports across U.S. state governments. This methodology assists in processing data quickly and systematically; it is more time-efficient than reviewing thousands

of pages of documents manually. Computational text analysis is first performed to collect and preprocess data, in order to ensure that data are ready for analysis. Computational text analysis is then used to analyze the corpus.

To illustrate the steps from the beginning to the end, I use Maryland as an example. I begin by obtaining Maryland's financial reports between 2002-2016 from the database of the Center for Municipal Finance (2022). Once collected, the documents are examined to determine readability. While a regular Portable Document Format (PDF) is usually suitable, a scanned document may not be. The software will often recognize the content of scanned documents as image rather than text, which prevents textual analysis to be completed. The images therefore need to be converted into text using Optical Character Recognition (OCR). After this procedure, all text in the financial report document should be computationally recognizable.

The next step is to preprocess data, generating a corpus that is ready for analysis. A corpus is equivalent to a dataset that includes an additional variable for texts extracted from the financial reports. In my dataset, each state has one corpus. The corpus for Maryland includes 15 observations that correspond to the 15 years under observation, from 2002-2016. Text in the corpus contain a lot of unneeded information, and preprocessing is performed to reduce the degree of complexity so that further analysis becomes computationally manageable (Grimmer et al., 2022). The steps include converting all characters into lower case, removing whitespaces and stop words, and eliminating any numbers. The same steps are repeated in other states.

The final step is analysis of the corpus. Using Maryland's financial reports to illustrate the process, I apply dictionaries of terms that are developed to capture the extent to which an issue, for instance disaster risk management, is identified, recognized, and disclosed in the state's financial reports. The analysis includes an evaluation of texts using techniques such as bag-of-

words model and keywords-in-context analysis. In the Natural Language Processing literature, the bag-of-words model is often used to classify text, count how many times a word appears in a document, and identify how a focus on a specific topic (e.g., policy priority) has changed over time (Grimmer et al., 2022). Meanwhile, keywords-in-context analysis can be used to explore the themes under which a specific term is presented in a source document (Benoit et al., 2018). The results, comprising all 50 states under observation, are presented in the next section.

5. Analysis and Discussion

5.1. Temporal Dimension of Disaster Risk Disclosure

The analysis begins with a general overview of disaster risk disclosure across U.S. state governments between 2002 and 2016. It is split into two parts; this part will consider the temporal dimension and address disaster risk disclosure between 2002 and 2016, while the next part, Section 5.2, will look at its spatial dimension in each of the 50 states. The first analysis looks to identify whether disaster risk disclosure exists, and how it has developed over the years of observation.

I first develop a dictionary of basic terms that are related to disasters, such as "disaster," "natural disaster," "disaster risk," "natural hazard." Types of disasters applicable to the US context are then added to the dictionary: "avalanche," "coastal flooding," "cold wave," "drought," "earthquake," "hail," "heatwave," "hurricane," "ice storm," "landslide," "lightning," "riverine flooding," "strong wind," "tornado," "tsunami," "volcanic activity," "wildfire," and "winter weather." The disaster categories refer to the National Risk Index developed by FEMA (2021). Another term that is often used to describe “hurricane” -- “cyclone” -- is also added. Financial reports may also refer to legal risk, which is also included in the analysis to serve as a comparison

to disaster risk in this study. I generate a new dictionary with a set of technical terms that represent legal risk, such as "lawsuit," "legal claim," "legal case," "litigation," and "class action."

To identify legal risks, I apply the bag-of-words model. The legal-term dictionary is simply applied to the corpus of financial reports of a given state. The existence of these key words in the financial reports indicates their recognition in a given state and year. For disaster risks, I take an extra step to perform keywords-in-context analysis, combining disaster-term dictionary with risk-related terms, such as “risk,” "exposure,” "vulnerability,” and "contingent liability." This procedure is a bit restrictive but ensures that only key words within the right context are counted. Keywords-in-context analysis enables me to identify disaster-related terms in the financial reports that are in proximity with risk-related terms.

The result is illustrated in Figure 36. The y-axis indicates the number of states, and the x-axis indicates the years of observation. There are two vertical bars in each year; the blue bar denotes disaster risk and the orange bar indicates legal risk. The higher the bar, the more states disclosed information about a particular sort of disaster or legal risk in their financial reports. Between 2002 and 2016, an average of fewer than 15 out of 50 state governments disclosed risks associated with natural disasters in their financial reports. It is interesting that the proportion of states disclosing disaster risk is remaining flat despite an increase in disaster events as well as public attention to climate change. At the same time, there was a higher level of disclosure of legal risk; usually by more than 40 states each year.

There are three possible explanations to this finding. First, while some information is required for disclosure, other information is left to the reporting entity to decide, giving rise to inconsistencies across entities. In the GASB Statement No. 10, for example, contingent liabilities for pending litigations with a reasonable possibility of loss to the organization need to be disclosed.

But reporting risks pertaining to environmental risks is often considered voluntary (Deegan & Rankin, 1996). As of this writing, GASB (2022) is still developing a new guidance for certain risk disclosures to require governments to disclose information about risks that could affect the level of services they can provide; however, it focuses more on vulnerabilities due to concentration of government's revenue sources and does not include natural disasters.

Second, the contrast between disclosure of disaster risk and disclosure of legal risk may be attributed to their distinct nature. As elaborated in the GASB (1989b) Statement No. 62, the norm in financial reporting is to disclose contingent risks that are both probable and estimable. While both legal and disaster risks are probable, the two differ with respect to estimability. The financial implications of a legal risk are clearer and more easily estimated in monetary terms than those of natural disasters. Third, there could be differential impacts of a disaster depending on various factors, including its type and severity. States might not disclose disaster risks because there is not a significant financial impact, even if disasters occur frequently.

Alabama and California serve as good examples of how disaster and legal risks are presented differently in their financial reports. Alabama's 2015 financial reports include, within their "Contingencies" section, a subsection of "Litigation" that describes pending lawsuit cases against the state government involving probable significant material effects. Since losing these cases will cost the state, the lawsuit information is deemed financially relevant. Alabama is quite prone to disasters, and a catastrophic event in the area has a potentially large fiscal impact to the state government. However, disaster risk is neither recognized nor disclosed in its financial reports.

In California's 2015 financial reports, there is also a subsection of "Litigation" in the "Contingent Liabilities" section. It discloses legal proceedings that, if decided against the state government, may either reduce its revenues or add to its expenditures. The discussion is

supplemented with the amount of potential claims in dollar terms. Unlike Alabama, California's financial reports contain a discussion of natural disasters although only to a limited extent. Under the "Commitments" section, the amount allocated for disaster-preparedness response projects is highlighted. California has experienced a series of wildfires in the past; one of the largest in the state's history was in 2003, burning more than 750,000 acres of land in Los Angeles, Riverside, San Bernardino, and San Diego (FEMA, 2004). However, it contains no projections of possible revenue losses or extra expenditures in its financial reports should a similar disaster happen again.

Figure 36. Disaster Risk Disclosure as Compared to Legal Risk Disclosure

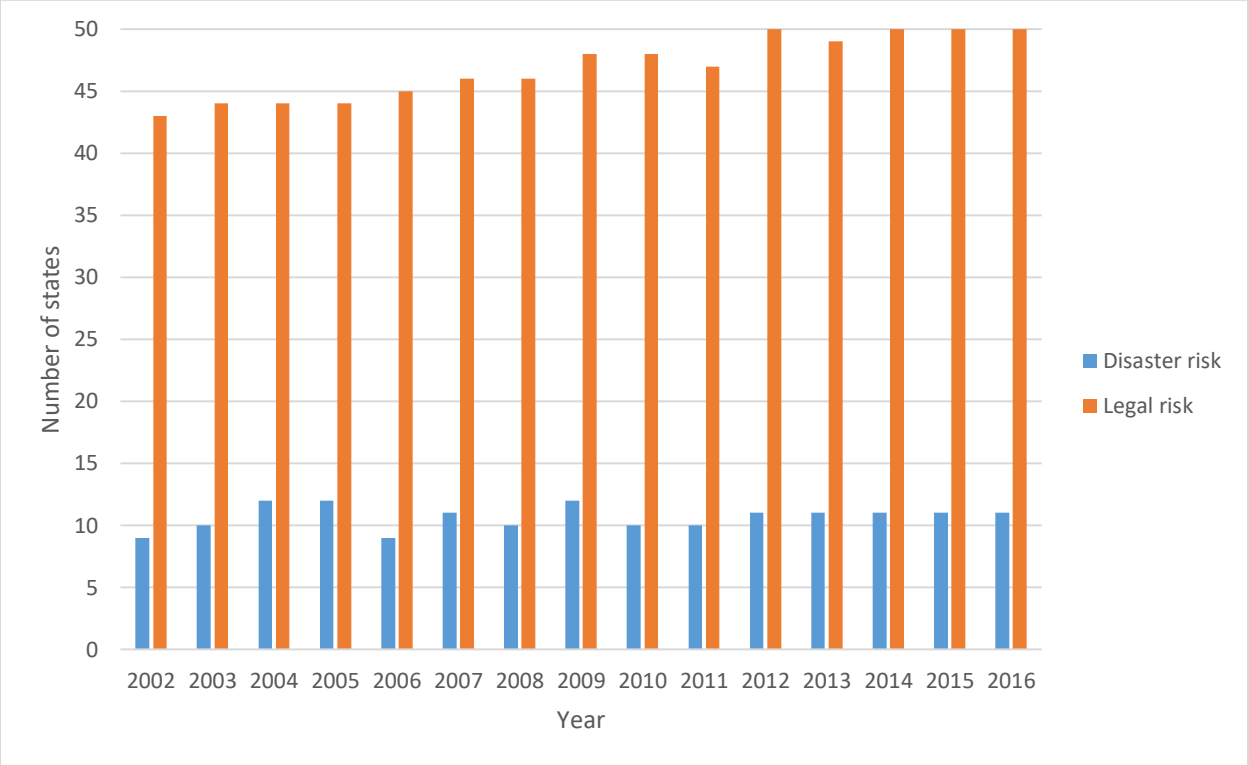
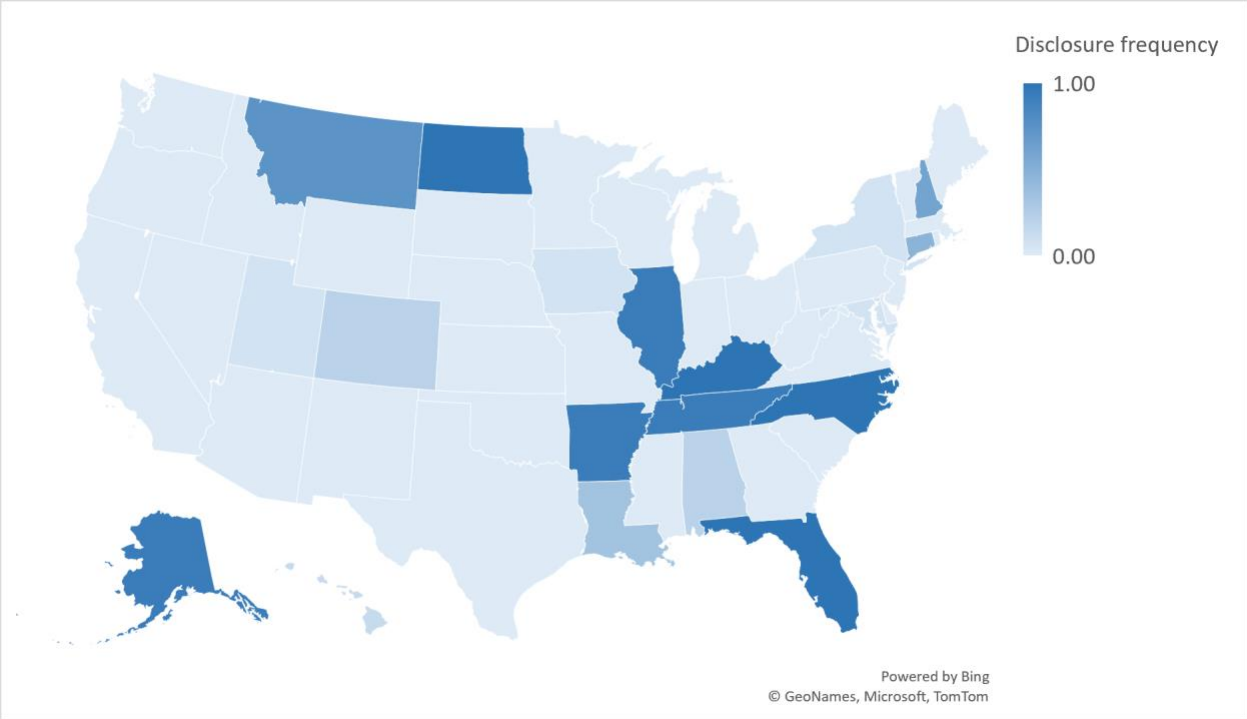


Figure 37. Frequency of Disaster Risk Disclosure across 50 U.S. States



Notes: Actual percentage for each state are provided in Appendix Table C2. Disclosure frequency is measured by how many years (out of 15 years under examination) a state disclosed information about disaster risk

5.2. Spatial Dimension of Disaster Risk Disclosure

Having already evaluated the temporal dimension in the previous section, this section analyzes the spatial dimension of disaster risk disclosure. I apply the same dictionary of disaster-related terms as before to measure the frequency of disaster risk disclosure in each of the 50 U.S. states. The objective is to identify whether and how frequently state governments disclosed disaster risk in the financial reports throughout the years of observation. Two outputs are possible within every state: years in which the state discloses disaster risk information and years in which it does not.

Figure 37 shows the result on a map of 50 U.S. states. The more frequently a state discloses disaster risk in all of the 15 years, the darker its color will appear on the map. To enable

comparison, the frequency of each state is presented in percentage terms. If a state disclosed in all 15 years, then the frequency is 100 percent. By contrast, a state that never disclosed is 0 percent. Some states always (one hundred percent of the time) disclosed disaster risk in the financial reports, such as Florida, Kentucky, North Carolina, and North Dakota. Other states did this in most years (14 out of 15 years), such as Alaska, Arkansas, Illinois, and Tennessee. Montana provided disclosure in 11 years, followed by New Hampshire (9 years), Connecticut (7 years), Louisiana (5 years), Alabama and Colorado (3 years), Hawaii (2 years), and Iowa, Maryland, New York, and Utah (1 year). The rest of the states did not disclose disaster risk information at all.

One possible explanation might be inertia in financial reporting. Given the accounting conventions of how financial information is structured, the major parts of the reports are designed to be consistent from time to time. For example, assets and liabilities will be presented under the balance sheet, while revenues and expenditures appear under the activity statement. Reporting practices are not adaptive and are conducted as a routine practice within the organization. While reporting practices may change, a previous study by Aerts (2010) showed similar inclination and a significant degree of consistency in the content of accounting narratives over time. This study finds that states that made the disclosure in the past would likely follow the same pattern in the following years.

The case of North Dakota is a relevant example to this finding. As in other states, North Dakota's financial reports includes a portion of notes to financial statements. But distinct from other states, North Dakota's notes to financial statements provide a specific section for "the State Fire and Tornado Fund." Positioned under the "Risk Management" section, it discloses information about funds that the state accumulates to cover risks associated with tornado strikes. My examination shows that identical statements are presented in all 15 years of North Dakota's

financial reports, confirming the inertia in disaster risk disclosure. The only part that changes from year to year is the number attached to the section's heading (i.e., "Note)," which is expected since other sections may have been inserted before and after this part in the financial reports. A sample from the detailed statements is illustrated in Figure 38 below.

Figure 38. Disaster Risk Disclosure in North Dakota's Financial Reports

NOTE 12 – RISK MANAGEMENT

Several funds accumulate assets to cover risks that the State may incur. Specifically, the State assumes a portion or substantially all risks associated with the following:

THE STATE FIRE AND TORNADO FUND

The State Fire and Tornado Fund, an Enterprise Fund, is financed by premiums charged to the participating funds of the State. All monies collected must be paid into the fund for use only for the purpose outlined in NDCC 26.1-22.02.

All losses occasioned by the hazards provided for in the North Dakota Century Code must be paid out of the fund, with the fund being reimbursed by a third-party insurance carrier for all losses in excess of $1,000,000 per occurrence. The limit of liability of such reinsurance contract is no less than $1,000,000 during each twelve month period.

Source: Comprehensive Annual Financial Reports of North Dakota 2002-2016

Figure 39. Disaster Risk Disclosure in North Carolina's Financial Reports

NOTES TO REQUIRED SUPPLEMENTARY INFORMATION

D. Budgetary Reserves

Disaster Relief Reserve (Session Law 2005-1, Senate Bill 7). During fiscal year 2004-2005, $248.17 million was transferred to the Disaster Relief Reserve. This $248.17 million was funded from required agency, university, and community college transfers, a Savings Reserve Account transfer, and transfers of funds from the unreserved credit balance. At the end of the fiscal year 2006-2007, the remaining balance of this reserve was $114.04 million.

Source: Comprehensive Annual Financial Reports of North Carolina 2007-2016

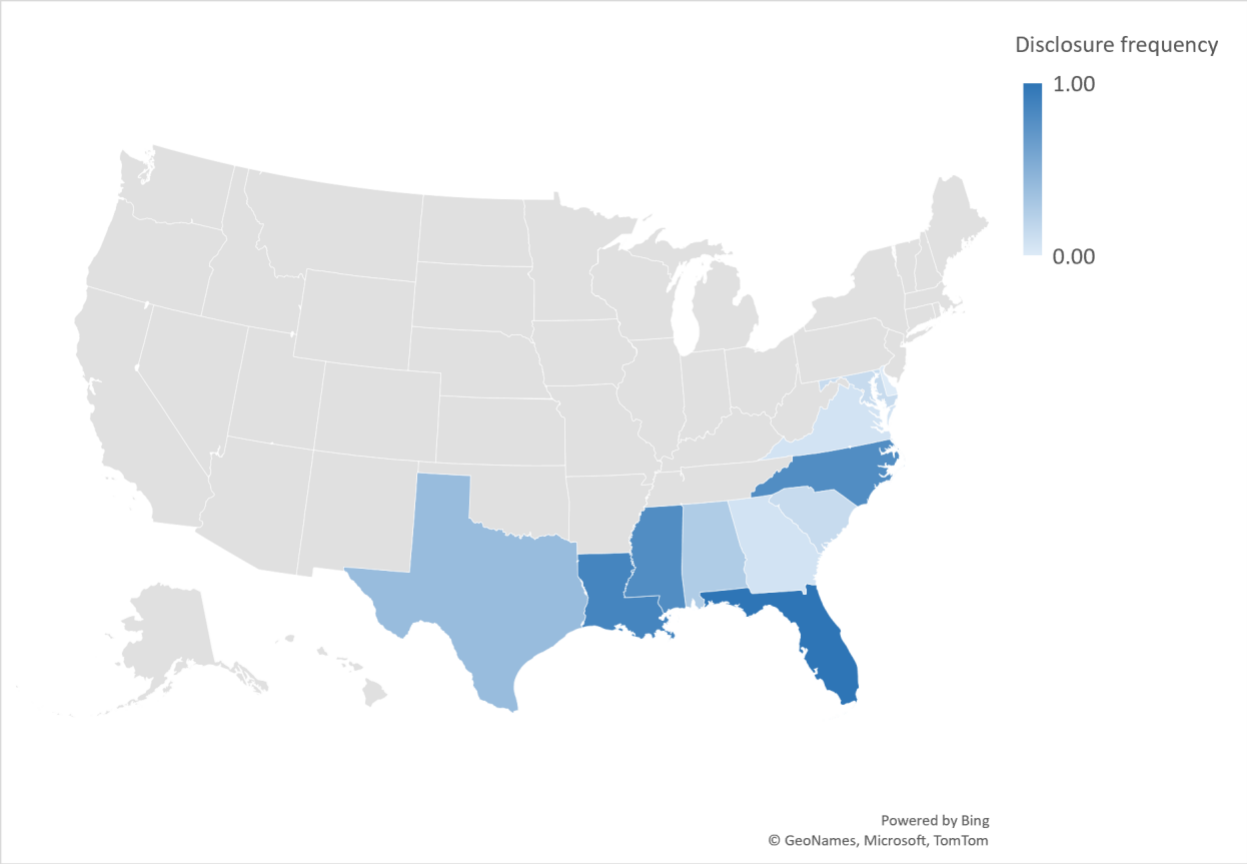
Another example is from North Carolina's financial reports. Starting in 2007, the state's financial reports include paragraphs that discuss "Disaster Relief Reserve." These are positioned under "Budgetary Reserves" section, part of the "Notes to Required Supplementary Information." My observation finds that the same paragraph is presented from 2007 to 2016, suggesting the inertia in disaster risk disclosure. The only exception is the last sentence, which changes according to how much of the reserve funds were used and for what events in some years. For example, in the 2009 financial reports (p. 186-187), the last sentence was replaced by a longer statement, explaining that "$44.2 million was disbursed for disaster related expenditures and $9 million was transferred to General Fund availability as directed by the Governor to help ensure that the State not incur a deficit. At the end of the fiscal year 2008-09, the remaining balance of this reserve was $43.95 million." A sample from the detailed statements is illustrated in Figure 39.

5.3. Financial Reports and Hurricane Events in Selected States

This section takes a closer look at cases of hurricanes and their implications for disaster-related information in the state financial reports. As I discussed previously in Section 3, hurricanes are chosen for two reasons, the first reflects the availability of data and the second concerns the significance as an event. Accordingly, my observations are focused on the Southern region of the U.S., which are most more prone to this type of disaster. According to the U.S. Census, the region includes 11 states: Alabama, Delaware, Florida, Georgia, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, Texas, and Virginia. The goal is to investigate whether those states have more disaster-related information in their financial reports following increased incidence of hurricanes. To unpack this, the analysis uses two sets of data in each state: severe hurricane events and disaster-related text contained in the financial reports between 2002 and 2016.

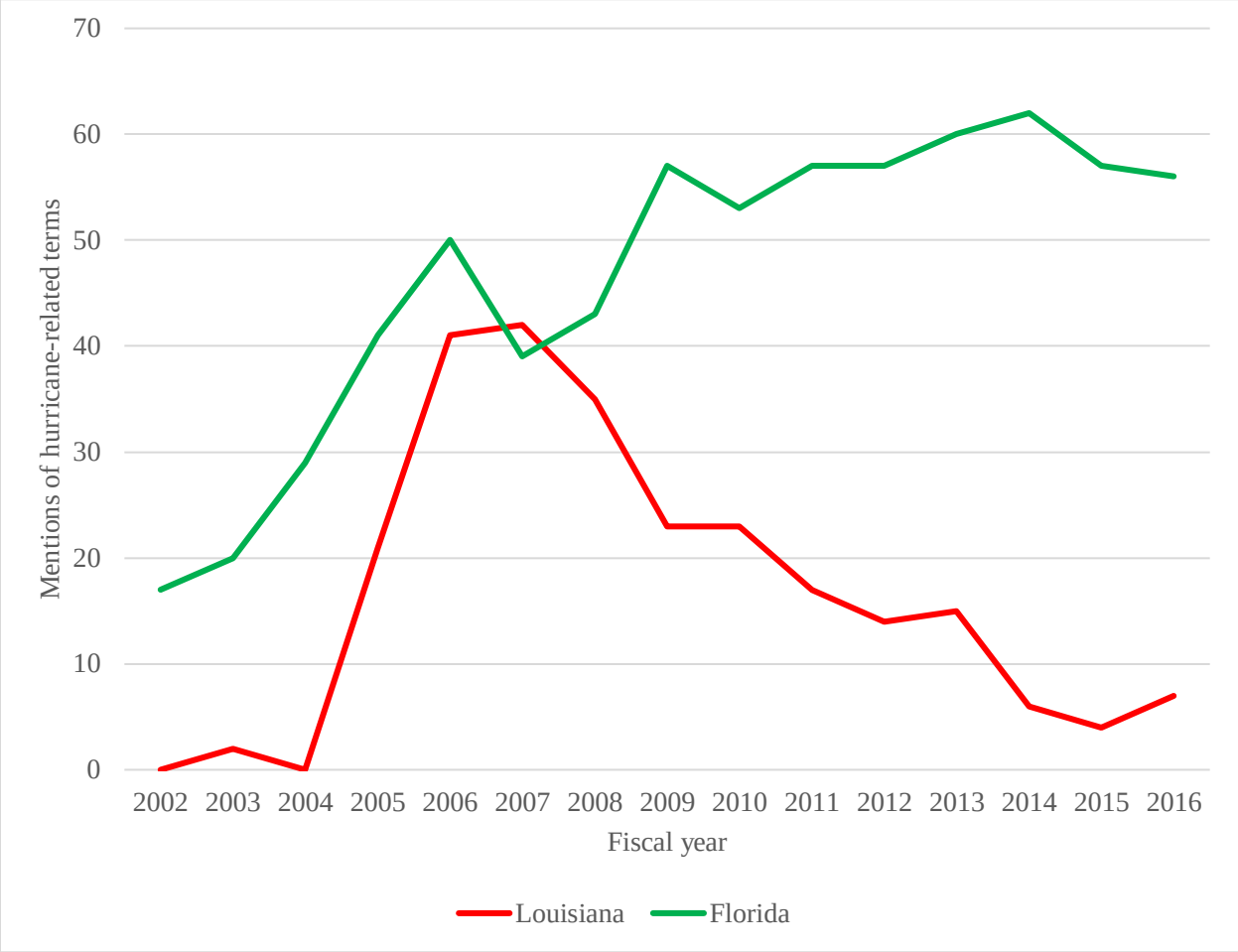
Following the discussion in the previous section, computational text analysis is applied to the financial reports of each state. The dictionary, however, is different as it contains terms that are specifically related to hurricane events: “hurricane” and “cyclone.” Figure 40 provides a map of Southern region states summarizing the first result. The darker color indicates that throughout the 15 observed years, the more frequently a state discloses information associated with hurricanes in the financial reports. While there is variation across the states, mentions of hurricane-related terms are most frequent in Louisiana and Florida. I use this variation to qualitatively assess the extent to which the recognition of hurricanes as risk changes following a major hurricane event in a given state.

Figure 40. Frequency of Hurricane-related Terms Disclosure in Southern States



Figures 41 illustrates the second result, depicting fluctuations of mentions of terms associated with hurricanes, specifically in Louisiana and Florida. Being extreme cases of hurricane-prone areas, both states are interesting to look into and are suitable examples for this study. Individually, they also provide useful comparisons of similar inclination immediately after a major hurricane but divergent patterns in the longer term. The complete results of all southern states are provided in Appendix Figure C1. In each graph, the y-axis indicates mentions of hurricane-related terms, while the x-axis indicates years under examination.

Figure 41. Mentions of Hurricane-related Terms in the Financial Reports of Louisiana and Florida



Before 2005, Louisiana's financial reports rarely contained information associated with disaster and hurricane. In its 2003 and 2004 financial reports, for instance, "disaster" and "hurricane" were mentioned twice at most. However, in 2005 and 2006, appearances of the two words increased to more than 20 times. This increase coincides with the two hurricanes that occurred in 2005, Katrina and Rita, each rated as a category 3 hurricane on the Saffir Simpson Hurricane Scale. A report by FEMA (2006) estimated that Hurricane Katrina destroyed more than 300,000 single-family homes and displaced hundreds of thousands of people in Louisiana as well

as its neighboring state Mississippi. A separate study by the Congressional Budget Office (2005) estimated foregone revenue ranging between $3 billion and $6 billion in Louisiana.

Florida also showed an increase of mentions of hurricane-related terms following category 4 Hurricanes Charley in 2004, category 3 Hurricanes Ivan and Jeanne in 2004, and category 3 Hurricanes Dennis and Wilma in 2005. Given their severity, these events triggered major disaster declarations by Florida's governor, allowing for federal assistance to be transferred to the state. A study by Malmstadt et al. (2009) included Wilma, Charley, and Ivan in the top ten loss events from Florida hurricanes between 1900-2007, with estimated monetary damages of $20.6 billion, $16.3 billion, and $15.5 billion, respectively. In 2002-2004, there were fewer than 30 mentions of hurricane-related terms in Florida's financial reports. After 2004, the number increased by more than 50 percent. This is indicative of how increased incidence of disaster coincides with higher mentions of relevant information in the financial reports.

As seen in Figure 41, the immediate reactions of Louisiana and Florida to major hurricanes were quite similar initially, but not after a few years. In Louisiana, mentions of hurricane-related terms were extremely prevalent after 2005 but then declined gradually, with a marked decline after 2008. By contrast, the mentions in Florida went up around 2005 and stayed high throughout the rest of the years. According to NOAA's Hurricane Research Division record, the two states did not experience any major hurricanes (i.e., category 3 or above) until after 2015. In the absence of major hurricanes since the 2004-2005 hurricanes apparently, I observe divergent patterns between the two states. The fluctuations around hurricane information in the financial reports are greater in Louisiana than in Florida.

Depending on several factors, risk disclosures could be proactive or reactive. In a study of the 20 largest banks in the U.S. and Europe during the Great Recession, Bischof et al. (2021) found

that banks' disclosures about subprime exposures were initially sparse. Out of fear of adverse reactions from the market, such as possible bank runs, major banks did not immediately disclose relevant risks (Goldstein & Sapra, 2014; Bouvard et al., 2014; Goldstein & Leitner, 2018). However, as concerns emerged and the market learned about the severity of the risk, the banks reacted strategically and improved their disclosure of risk. Applying this concept to the public sector, Louisiana's behavior is indicative of reactive disclosure. In contrast, Florida shows an example of proactive disclosure, at least over the years of this study. Skeptics may argue that public officials who are actively disclosing disaster information do so to maintain credibility and to share the blame should a disaster occurs. More optimistic view considers this necessary and proper as part of the state's disaster mitigation strategy.

6. Conclusion

This study examines disaster risk disclosure by governments using a dataset of 50 U.S. states between 2002 and 2016. I combine computational text analysis with qualitative analysis to collect, extract, and analyze data. My analysis is mainly based on textual data from the narrative portions of state governments' financial reports as well as the record of disaster events in a given state and year. Computational text analysis is suitable for this study given its ability to "understand" texts in financial reports—a source of information that is often underexplored. This study presents methodological novelty in that regard.

The analysis results in three findings, as follows. First, despite an increasing threat of natural disasters in the U.S., most state governments do not appropriately disclose information regarding disaster risk. Second, states that disclosed disaster risk in the past tend to disclose the same information in the future and past years, suggesting significant inertia in financial reporting.

Third, based on selected cases in hurricane-prone states in the Southern U.S. region, the study finds proactive as well as reactive risk disclosure.

As part of the mitigation plan, U.S. states that are prone to disasters need to properly recognize and disclose risks associated with natural disasters. As of this writing, there are no regulations that specifically govern disclosures of disaster risks in particular and other environmental risks in general, resulting in reporting inconsistencies across state governments. Going forward, the governmental accounting standards need to incorporate mechanisms that specify how those risks should be recognized, measured, and presented in financial reports. Disclosure of such risks in financial reports indicates how capable that governments are at managing the issue. Proper identification of risk helps to moderate the exposure of both the financial assets of the state government and the people living in the state to disasters, leading to improved resilience. Additional investments in disaster resilience are an important action to reduce fiscal exposure and the adverse impacts on the economy and society in general.

Appendix

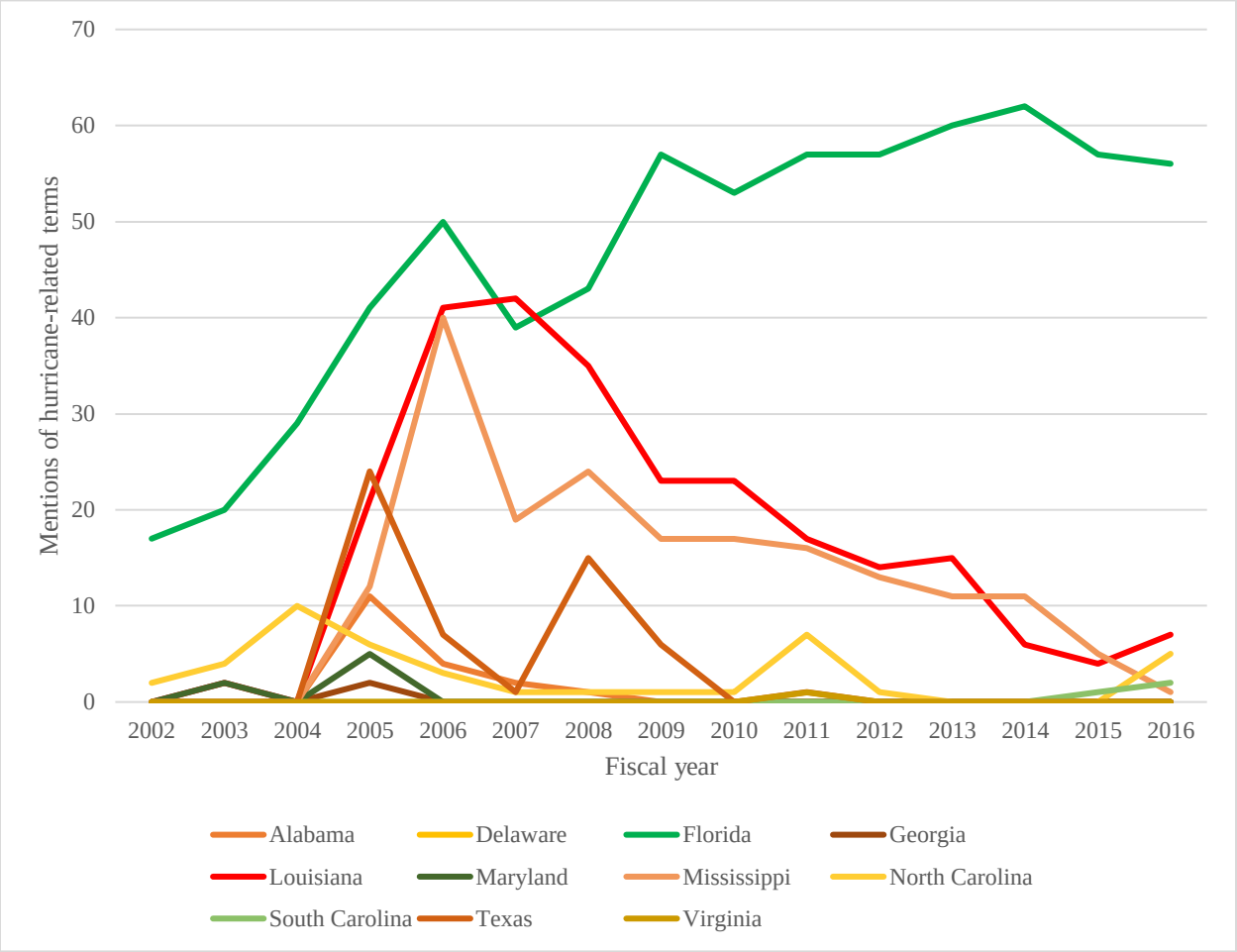
Appendix Table C1. Asset Values of U.S. States, 2002-2016 Average (Millions of USD)

State	Average assets ($ m)	State	Average assets ($ m)
AL	26,887	MT	8,026
AK	63,175	NE	12,482
AZ	32,997	NV	11,399
AR	19,947	NH	4,925
CA	181,868	NJ	35,014
CO	29,085	NM	24,689
CT	22,461	NY	132,991
DE	9,729	NC	49,374
FL	112,357	ND	13,902
GA	39,349	OH	68,176
HI	16,471	OK	18,499
ID	11,311	OR	29,467
IL	43,569	PA	51,838
IN	24,121	RI	4,699
IA	18,219	SC	27,761
KS	16,339	SD	5,763
KY	27,785	TN	31,296
LA	29,559	TX	204,723
ME	6,391	UT	22,497
MD	36,635	VT	3,002
MA	32,946	VA	32,640
MI	34,313	WA	69,157
MN	25,916	WV	15,908
MS	18,981	WI	34,537
MO	37,105	WY	17,010

Appendix Table C2. Frequency of Disaster Risk Disclosure across 50 U.S. States

State	Percentage (out of 15 years)	State	Percentage (out of 15 years)
Alaska	93%	Montana	73%
Alabama	20%	North Carolina	100%
Arkansas	93%	North Dakota	100%
Arizona	0%	Nebraska	0%
California	0%	New Hampshire	60%
Colorado	20%	New Jersey	0%
Connecticut	47%	New Mexico	0%
Delaware	0%	Nevada	0%
Florida	100%	New York	7%
Georgia	0%	Ohio	0%
Hawaii	13%	Oklahoma	0%
Iowa	7%	Oregon	0%
Idaho	0%	Pennsylvania	0%
Illinois	93%	Rhode Island	0%
Indiana	0%	South Carolina	0%
Kansas	0%	South Dakota	0%
Kentucky	100%	Tennessee	93%
Louisiana	33%	Texas	0%
Massachusetts	0%	Utah	7%
Maryland	7%	Virginia	0%
Maine	0%	Vermont	0%
Michigan	0%	Washington	0%
Minnesota	0%	Wisconsin	0%
Missouri	0%	West Virginia	0%
Mississippi	0%	Wyoming	0%

Appendix Figure C1. Mentions of hurricane-related Terms in the Financial Reports of Southern States



Conclusion

Following worldwide trends, most U.S. states have experienced increasing frequency and intensity of disasters over the last few decades. Some recorded disasters were considered historical due to their extreme damage and casualties, such as Hurricanes Maria and Harvey in 2017 and Hurricane Katrina in 2005. To minimize the degree to which a disaster event harms communities, the role of government is crucial in coordinating mitigation, preparedness, response, and recovery.

The impact of natural disasters is suitable for multidisciplinary research. This dissertation examines the phenomenon from a public finance lens. Prior studies show that the fiscal impact of natural disasters on the government budgets could be positive or negative. My first chapter demonstrates that an increased severity of flooding positively affected state tax revenue. The analysis further shows that (1) an increased severity of flooding leads to increased state intergovernmental revenue, but (2) states do not necessarily pass down more funds to localities. While federal assistance can help states stabilize during an emergency, it may also create problematic incentives. If states know that federal transfers are always available when they need emergency response, they may not allocate enough funding for ex-ante flood mitigation.

Prior studies also show that policy actors tend to respond to rather than mitigate disasters. I find corroborating evidence through my second chapter. Cases from Louisiana, Alabama, and Florida show that an increased incidence of major hurricanes coincides with higher attention to hurricanes in the budget documents. Further, in most observed states, the government attention to hurricanes is associated more with reactive rather than proactive measures. The third chapter presents another evidence that also indicates the government's inclination to react rather than

mitigate disaster events. Based on selected cases in hurricane-prone states in the southern U.S. region, I find that increased numbers of disaster incidents coincide with increased mentions of related terms in the financial reports. In general, state governments do not widely disclose information regarding disaster risk despite an increasing threat of natural disasters in the U.S.

My second and third chapters apply the same method, computational textual analysis, but the sources of data are different. Chapter 2 assesses state budget documents and Chapter 3 evaluates state financial reports. On one hand, the two source documents are uniquely tied as both are the products of the same budget cycle, albeit different phases. On the other hand, they have contrasting characteristics. Budget documents are developed at the beginning of the fiscal year as part of the budget preparation phase. The documents describe what the state governor intends to do that year. Meanwhile, financial reports are published after the end of the fiscal year, usually following the budget execution phase. The reports constitute a summary of all economic transactions that have taken place as well as other information that is deemed financially relevant. Second, budget documents do not usually follow common standards and are more political in nature. By contrast, financial reports are very technical as they must comply with certain reporting standards set by GASB. While this study focuses on a small number of cases of Southern states, future research could consider a larger set of observations across all 50 states or other government levels to empirically test the correlation between the narratives contained in the budget documents and audited financial reports.

As expected, some challenges were encountered in the process of completing this dissertation, and limitations on data were one of them. Earlier studies find that most state governments in the U.S. do not comprehensively track disaster mitigation spending. Meanwhile, my analysis relies heavily on both budget and disaster data. Budget data are typically obtained

from budget documents and audited financial reports, but they do not have categories that specifically identify allocations for disaster-related programs. As for disaster data, such as flooding and hurricane events, researchers often turn to NOAA and FEMA, which provide a comprehensive record of disaster events, but do not include sufficient budget information. Being at the intersection of natural disasters and public finance, this revelation was at first discouraging, though it led me to a new frontier of research. Using computational text analysis as an alternative approach, I was able to exploit the narrative portions of the budget documents and audited financial reports to quantify how much the government cares about certain policy areas, including emergency management in connection with disasters. These are sources of information that are widely available but have long been underexplored. Going forward, public finance and budgeting field scholars could benefit more from the application and development of computational text analysis.

Future research should further maintain relevance in the public policy field. For instance, in Chapter 1, I found that increased severity led to increased state intergovernmental revenue, but it remains unclear which groups of the population benefits from the additional funds. Equity has become an integral aspect in public policy, and it should also be integrated into the future work around the fiscal impact of natural disasters. Also, the analysis in this study is conducted mainly based on U.S. states data. Therefore, the results may not be applicable to other countries. This study considers only two types of disasters, such as flooding in Chapter 1 and hurricanes in Chapters 2 and 3. As a result, the findings may not be generalizable to other types of disasters. While these limitations are acknowledged, they also provide directions for future work to expand the analysis to other regions and different types of disasters. Note, however, that outside the U.S., disaster types are different. For example, European and Asian countries have had severe floods in the past, but they rarely experience hurricanes. Even with the same type of disaster, the fiscal

impact may not be identical to the U.S. experience. Many countries in those regions have different institutional arrangements (i.e., parliamentary versus presidential system, unitary versus federal government, autocracy versus democracy) that dictate how disaster funds are raised, managed, and spent.

The directions of future research should also strengthen the intersectionality between sustainability and public budgeting and finance. Scholars from both fields should work more closely to address some of the most pressing problems of our time. For instance, this dissertation shows that most state governments did not sufficiently mitigate disaster risks. But how much mitigation investment and spending are considered sufficient from the budgetary standpoint? What programs are most effective in addressing the issue from a sustainability lens? An equally important agenda is to develop a budget resilience and sustainability framework applicable to different levels of governments. Numerous indexes have been used to evaluate governments against specific metrics and compare them with each other, such as the Sustainable Development Goals (SDG) Index and PEFA framework. However, there is no index that specifically assesses the resilience and sustainability of government budget. Ultimately, my goal is to collectively produce work that contributes novelty to the literature as much as illuminate relevant insights among policymakers.

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