Proactive and Reactive Policy Agendas During Hurricanes: A Textual Analysis of Budget Documents*

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Abstract: Prior studies on punctuated equilibrium theory mostly employed quantitative budget data to identify patterns of policy changes in government. However, in some policy areas, such as disaster management, the budget data available that gauge policy change is limited. This study is the first to use computational text analysis to overcome the limitation by exploiting text within the budget documents. The analysis focuses on budget documents from 2005 to 2020 across seven U.S. states most prone to 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, indicative of a punctuated policy change. 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.

Key words: punctuated equilibrium theory, computational text analysis, disaster management

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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.[1] 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, 2022a). 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] 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.

$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 tended to appear three-to-eight years later.

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.

The extent to which a government addresses this challenge remains an open question for empirical investigation. Therefore, this study aims to evaluate whether and how government attention to hurricanes has evolved over time. According to punctuated equilibrium theory (PET), policy change is characterized by a combination of incremental and occasionally, abrupt changes. To test this hypothesis, this study analyzes data across American states that are most prone to

hurricanes: Alabama, Florida, Georgia, Louisiana, North Carolina, South Carolina, and Texas. 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. A key source of data that can identify the executive's agenda for the corresponding fiscal year, including attention to hurricanes, is the state executive or governor's budget proposals. While prior studies focus on quantitative 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. Theory

Central to the field of public policy is the theory of incrementalism. 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 budget 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 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,' 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. Birkland (1997) synthesized other impetus for policy changes, including natural disasters and human-caused accidents. These occasional, large-scale policy changes against a stable, incremental government agenda are then termed 'punctuations' (Baumgartner and Jones, 2010; True et al., 2019), forming a new punctuated

equilibrium. Perfecting the idea of incrementalism in policy process, True (2000, p.1) argued that punctuated equilibrium theory (PET) is "a better way of relating politics, government institutions, and policies."

To revisit PET, 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. 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." In other words, the concerns of PET are the *aggregate changes* in budgets over time, as well as the *components of budgets*. Previous studies have also considered different policy areas individually, such as highway infrastructure (Chen & Flink, 2021), education (Flink, 2017; 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. Accordingly, the hypothesis is 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, the hypothesis is that the government's attention to hurricane is geared more toward reactive rather than proactive measures.

3. Methodology

3.1. From budget data to text-as-data

Investigating whether the government pays attention to some major policy areas and specific disaster type like hurricanes could be done using budget data or textual data. The former has thus far been more common than the latter in the literature. 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. Meanwhile, at the federal level, among the most prominent was a study by Baumgartner and Jones (2010), which analyzed policy stability and change while also empirically assessing the degree of attentiveness of policymakers to national issues based on the U.S. federal budget data.

However, budget information is sometimes limited, especially with respect to a specific issue like disaster management. 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 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 1 for a summary; details are provided in Appendix Table A1). 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 (2018), 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.

[Figure 1 here]

As for the federal level, a study from the Congressional Research Service (CRS) (2022) tracks the federal disaster relief appropriations since the 1960s. As seen in Figure 2, 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 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.

[Figure 2 here]

Unlike the budget data, text information is more readily in various government reports and publications. Textual analysis is leveraged in this study to take advantage of that. 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 mainly 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 2005 through 2020. 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 16 observations that correspond to the 16 budget documents extracted previously.

(2) Preprocessing data: Preprocessing transforms the data into a dataset that is ready for analysis. This requires obtaining the original texts within each corpus, converting all characters to lowercase, removing whitespaces and stop words, and eliminating 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 hurricane-related terms; to serve this specific purpose, a new dictionary is developed for this category. In the analysis, government attention to specific policy areas and topics is measured 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 PET. 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, some adjustment was made to leverage the textual data that had been 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. Finally, the results are presented and visualized to illustrate the key insights of some findings. Proper visualizations through maps, bar charts, box plots, and histograms enable easier interpretation especially among a wider audience.

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). Historically, the funds reserved have often been insufficient to cover revenue losses caused by economic downturns (Zhao, 2016). But the bottom line is that state governments can mobilize resources to undertake emergency measures.

To identify whether a major hurricane event occurs in a given state and year, my analysis refers 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, 2022b). Later in the discussion, the NOAA data is supplemented with the database provided by FEMA (2022), 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 A2). Figures 3 and 4 respectively show more recent records of where hurricanes and *severe* hurricanes typically landed in the U.S. between 2000-2021. Table 1 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.

[Figure 3 here]

[Figure 4 here]

[Table 1 here]

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 year (annually) or two years (biannually) 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.

Table 2 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 2 here]

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 PET and to confirm that governments change their attention to major policy areas mostly in small incremental steps with occasional punctuations. For this subsection, the analysis proceeds in two sequential steps. First, key terms in selected major policy areas are identified and quantified 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 5 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 5 here]

An additional procedure was taken 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, one policy area, environment, and the most recent year

in the dataset, was selected as a sample. Computational text analysis showed that mentions of environment-related terms across the seven states that year were 45 (Alabama), 58 (Georgia), 156 (Florida), 20 (Louisiana), 36 (North Carolina), 11 (South Carolina), and 164 (Texas). A manual check was conducted, for instance, in Alabama, to determine which environmental-related terms correspond to the 45 mentions and in which part of the budget documents they appear. Through this procedure, specific sentences mentioning "conservation," "environment," "water supply," and "hazardous waste" were located 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. (2007) 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, the level of attention to a specific policy area is determined by counting the number mentions of key terms in that policy area. Following Jones et al. (2003)'s approach, each entry is calculated 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 151 times in 2019 and 156 in 2020. The entry for this specific time and policy area is thus (156-151)/151 = 0.0331.

Figure 6 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), skewness and kurtosis normality test is also performed to supplement this frequency density distribution chart, generating a kurtosis value of 66.8. As comparison, normal distribution has a kurtosis value of 3. Using text as data, this analysis shows 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 PET studies and confirms the prevalence of incrementalism and punctuations in state government budget narratives.

[Figure 6 here]

Figure 7 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 25th percentile, the median, and the 75th 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.

[Figure 7 here]

To verify the validity of the results, a random check was conducted to determine what the outliers represent in the budget documents. In Figure 7, 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 multiple entries considered outliers. The state and year of those entries were located. 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). The same procedure was applied to at least one outlier in each policy area. My manual verification found no erroneous results.

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 hurricane-related terms. As an alternative, the exercise looks 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, the assumption is that more mentions of the terms indicate greater attention to disaster management in connection with hurricanes.

Figure 8 shows how state government attention to hurricanes in Alabama, Florida, Georgia, Louisiana, North Carolina, South Carolina, and Texas has developed over time. Figure 9 reproduces Figure 8 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.

[Figure 8 here]

[Figure 9 here]

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 estimated to cause at least 1,800 fatalities and more than $100 billion in damage, surpassing the destruction record previously held by Hurricane Andrew in 1992 (NOAA, 2022c). 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. The results suggest that the same type of event could trigger a punctuation in one place but not in the other place. In PET, what matters is not only the type of event but also the magnitude of that event, which could vary across time and place.

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, a simple regression is run 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. Figures 10-16 illustrate the trend for each state, represented by the fitted line across the years of observation. The detailed estimates and corresponding p-values are provided in Table 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.

[Figure 10 here]

[Figure 11 here]

[Figure 12 here]

[Figure 13 here]

[Figure 14 here]

[Figure 15 here]

[Figure 16 here]

[Table 3 here]

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).

New dictionaries that include terms like "prepare" and "mitigate" are included 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," the dictionary also considers "preparedness," "prepared," and "preparing." 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, my analysis is able to not only identify a specific key word but also analyze its surrounding words. A window of text can be set, such as five words before and after the key word of interest, which permits the analysis to get a better sense of the context. Results for the keyword “prepare” can also be sorted to identify those in proximity to the keyword 'hurricane.'" Table 4 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 proper context.

[Table 4 here]

In my analysis, attention to hurricanes is first identified through the same strategy as in the previous section. The dictionary of proactive and reactive measures, respectively, is then applied 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.

The results of this iteration are presented in Figure 17. 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.

[Figure 17 here]

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

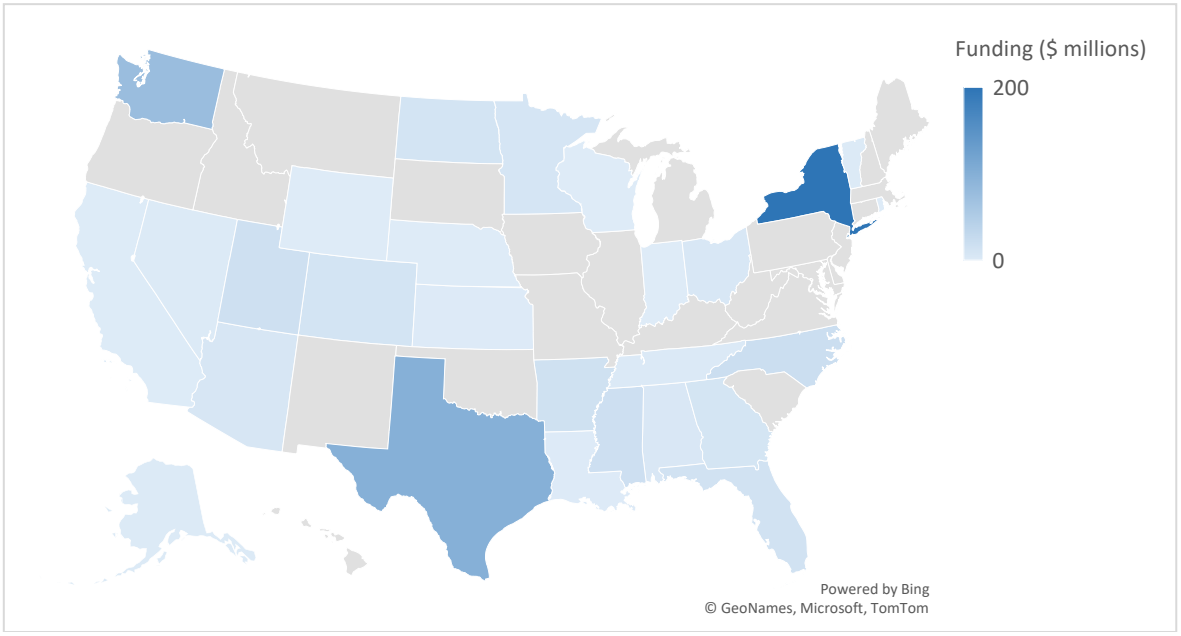
Natural disasters are on the rise, and hurricanes are no exceptions in the U.S. When a disaster hits an area, the government conducts response and recovery measures. More importantly, the government can coordinate mitigation and preparedness actions in anticipation of future occurrences. The government 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 often reactive rather than proactive, calling into question the general preparedness of state governments for future disasters.

Equally important from the methodological perspective, this study demonstrates how computational text analysis could be used as an alternative method to evaluate government agenda across different policy areas. Consistent with the literature on punctuated equilibrium theory, 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

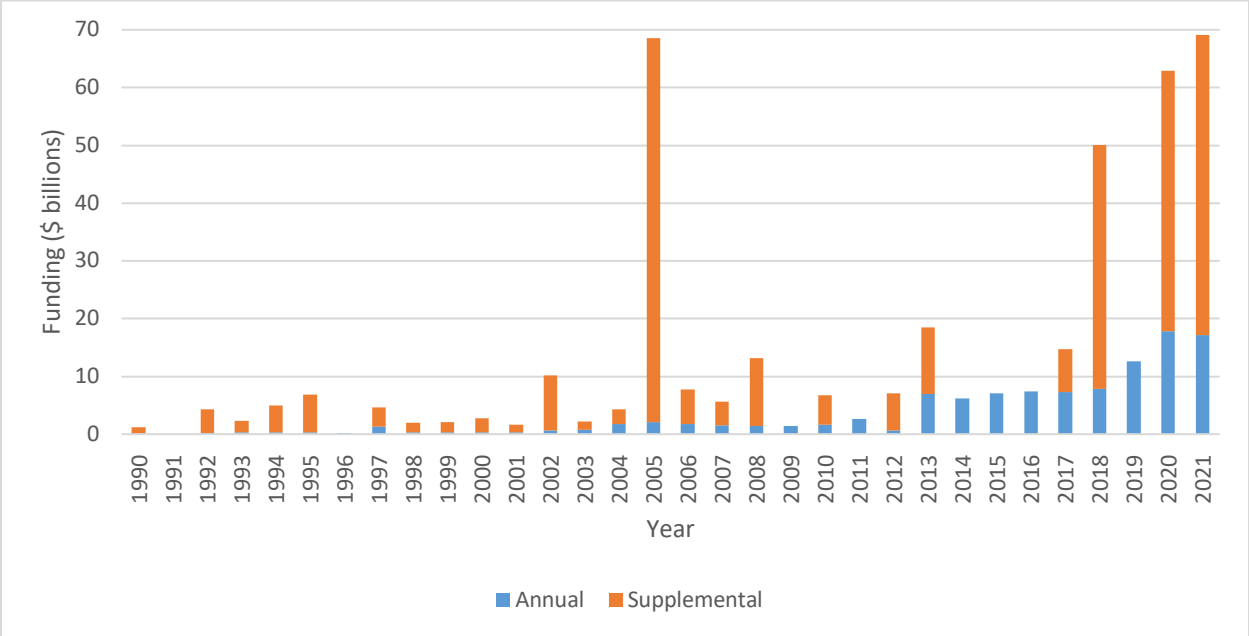
can tap into sources that contain rich information but have long been overlooked, including but not limited to the narrative portions of budget documents.

Figure 1. 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 A1. Source: Pew Charitable Trusts (2020)

Figure 2. Federal Disaster Relief Fund 1990-2021



Source: Congressional Research Service (2022)

Figure 3. Hurricane Events between 2000-2021 across U.S. States

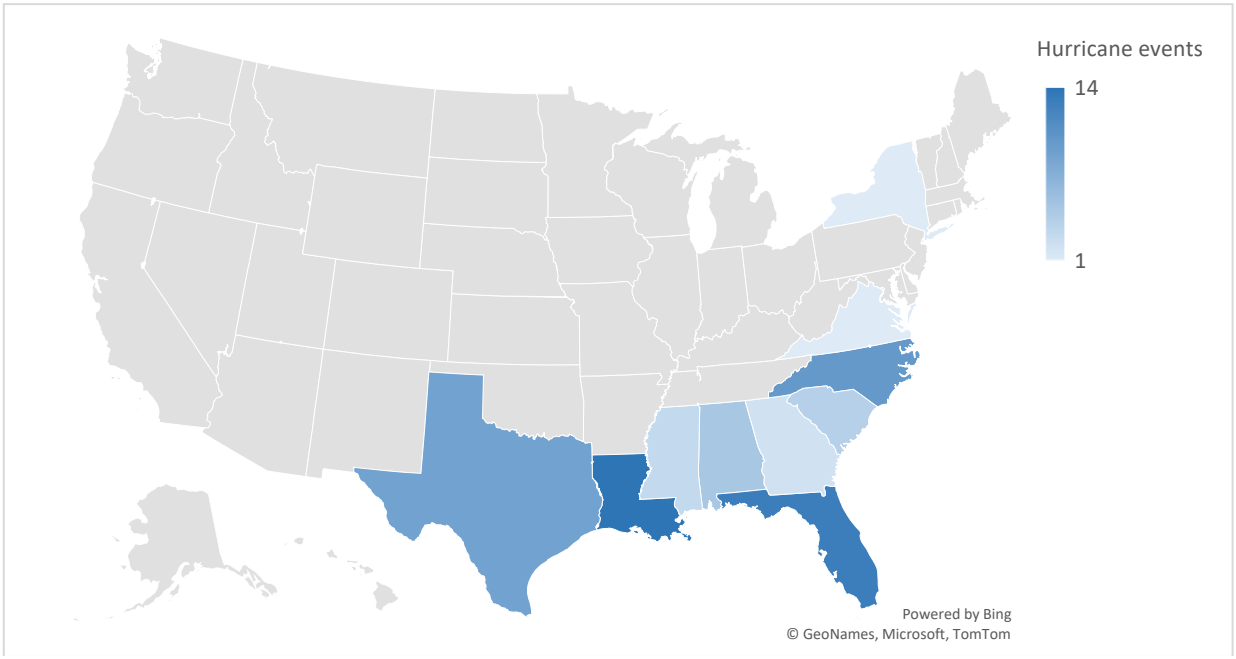


Figure 4. Severe Hurricanes (Category 3 or above) between 2000-2021 in U.S. States

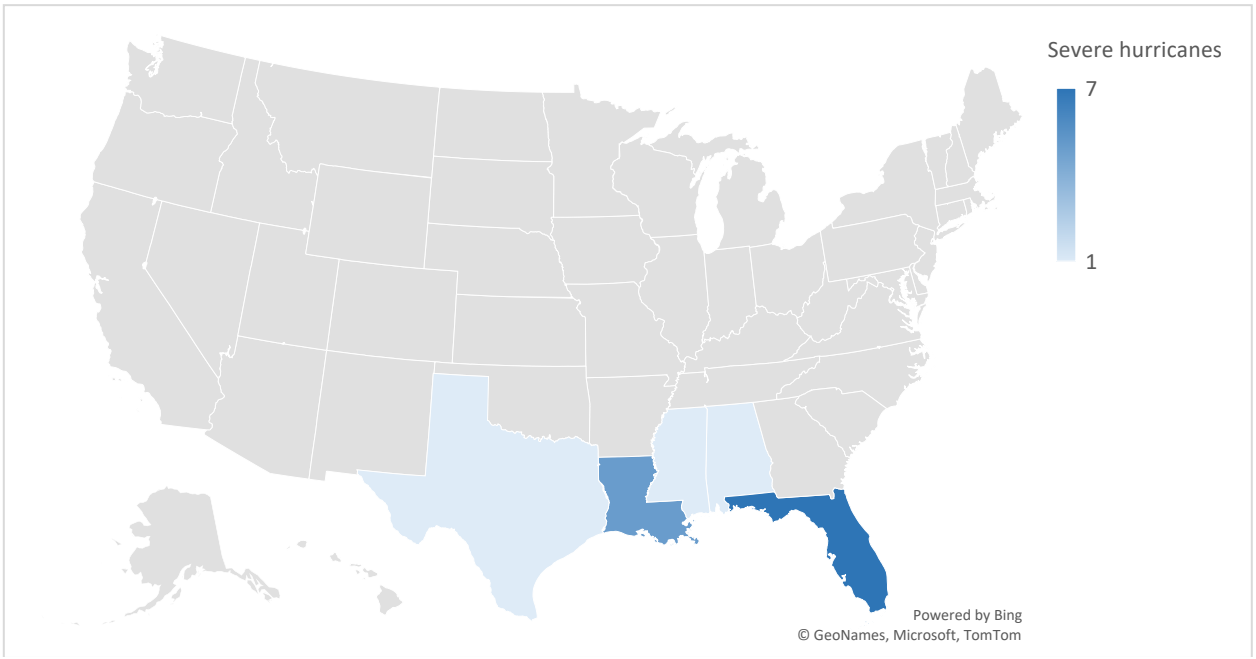


Figure 5. Major Policy Areas in the Budget Documents of the 7 Selected States

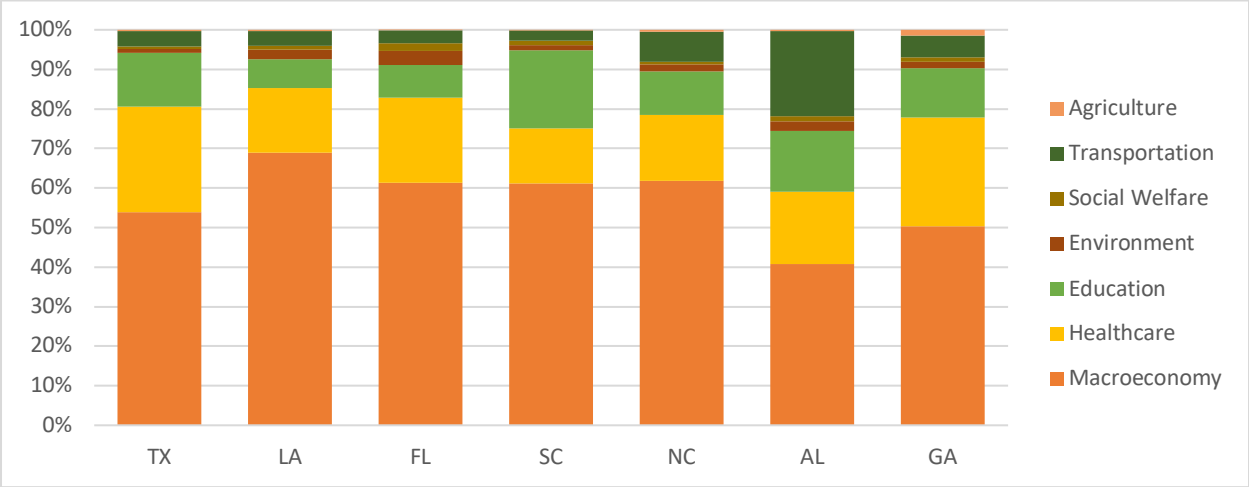


Figure 6. Changes in Government Attention to Major Policy Areas between Years

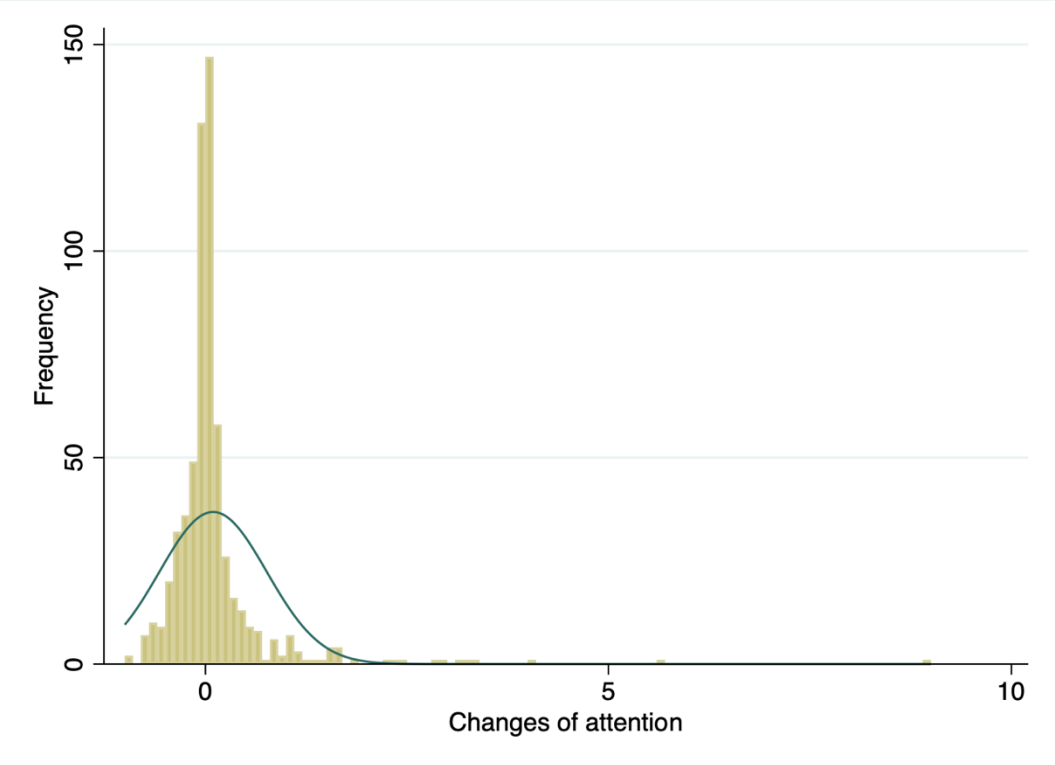


Figure 7. Changes in Government Attention across Different Policy Areas

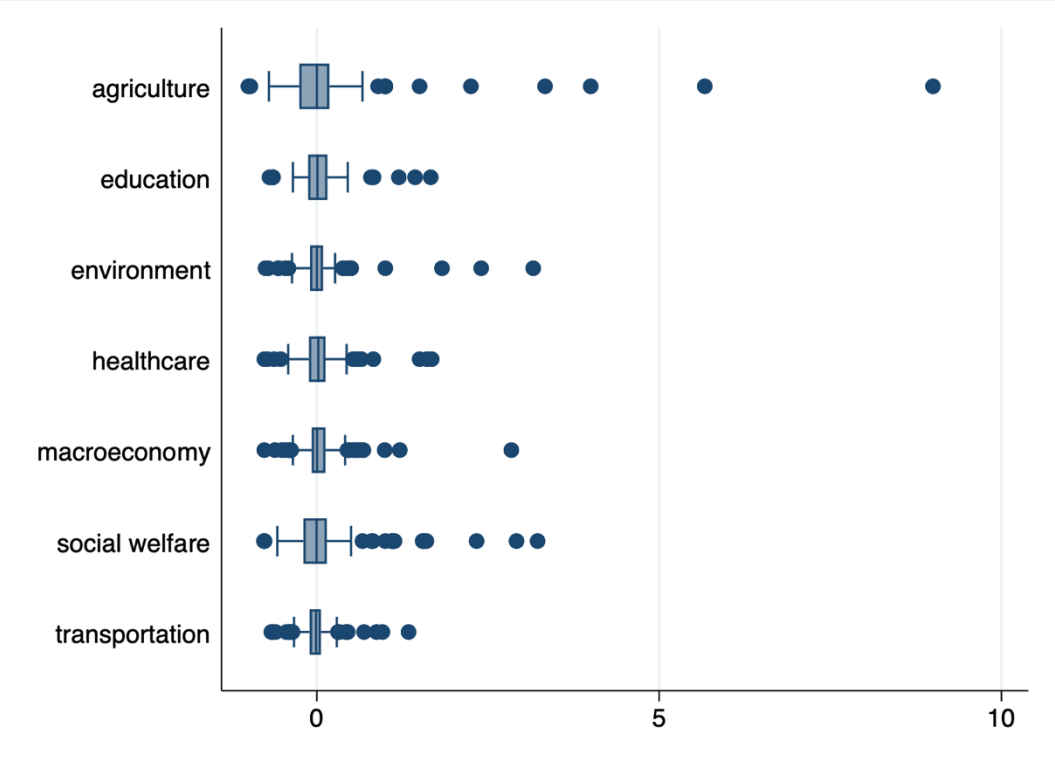


Figure 8. Mentions of Hurricane-related Terms in the 2005-2020 Budget Documents in 7 States

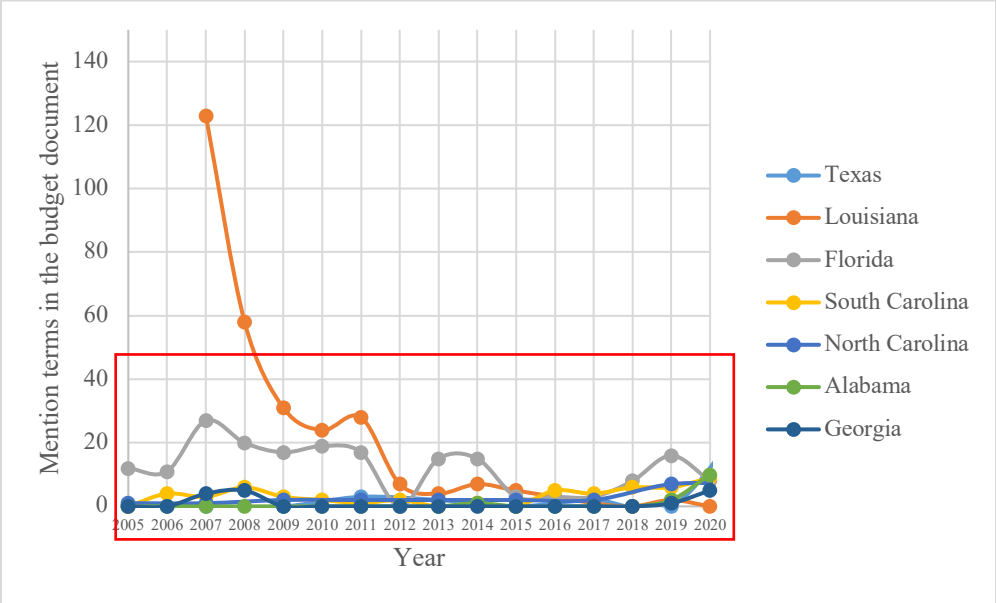


Figure 9. Mentions of Hurricane-related Terms in the 2005-2020 Budget Documents in 7 States

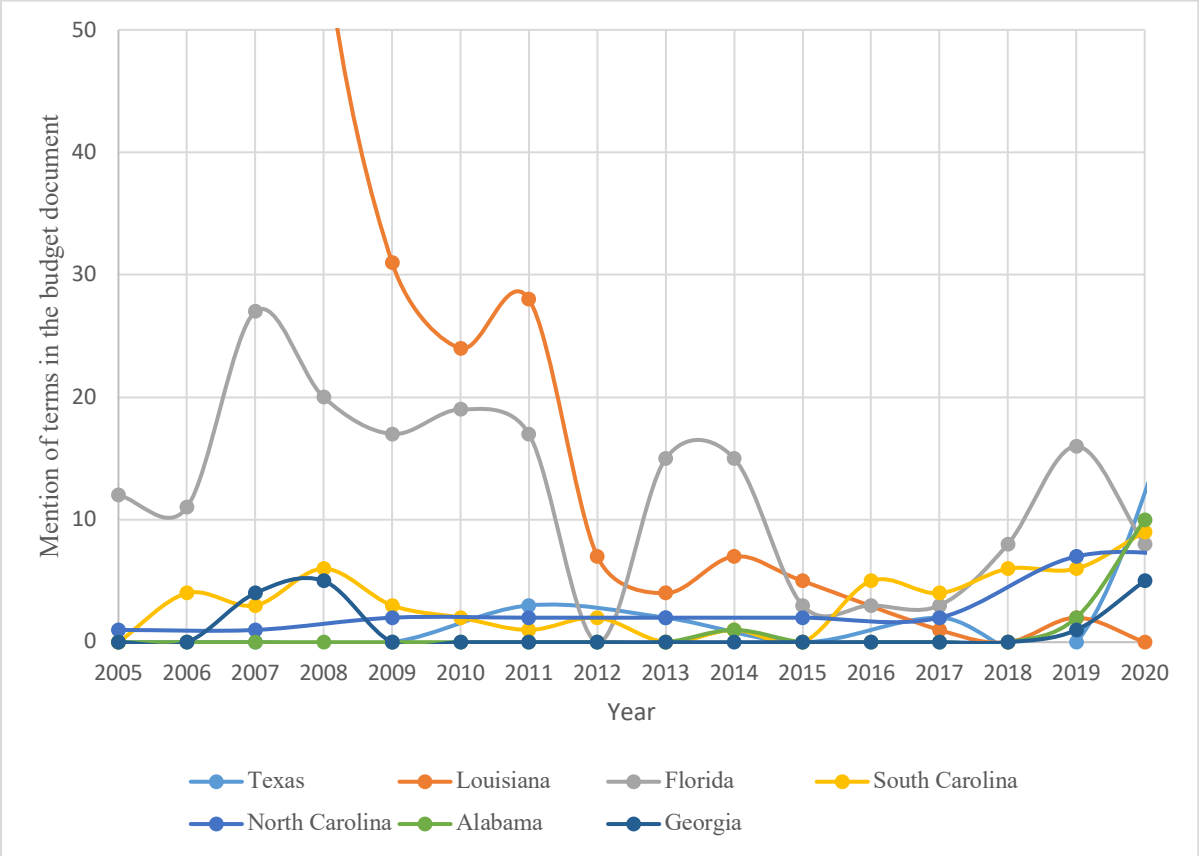


Figure 10. Mentions of Hurricane-related Terms in Budget Documents of Alabama

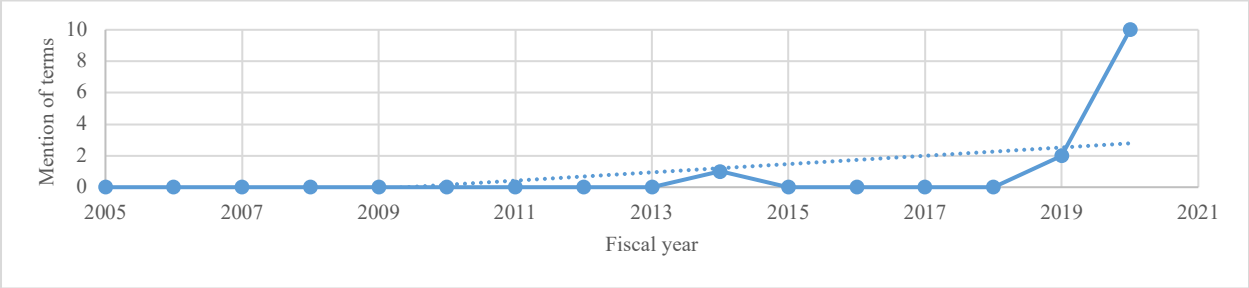


Figure 11. Mentions of Hurricane-related Terms in Budget Documents of Florida

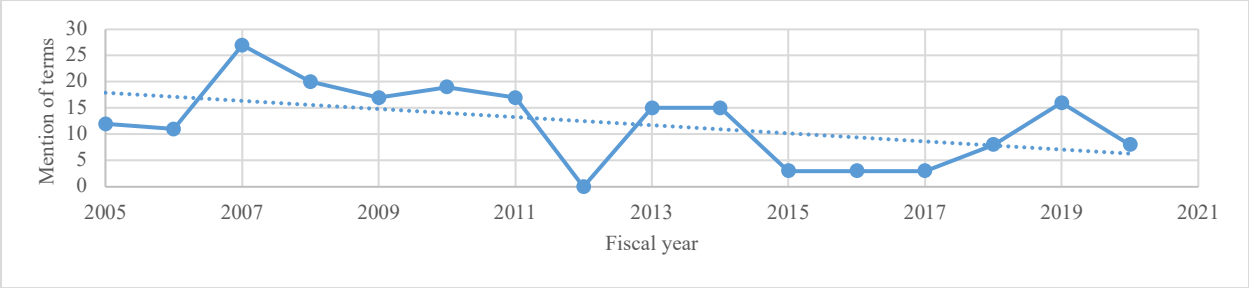


Figure 12. Mentions of Hurricane-related Terms in Budget Documents of Georgia

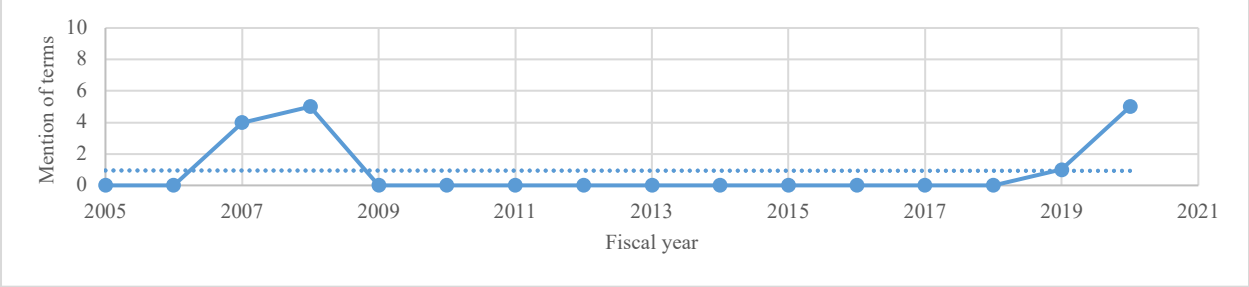


Figure 13. Mentions of Hurricane-related Terms in Budget Documents of Louisiana

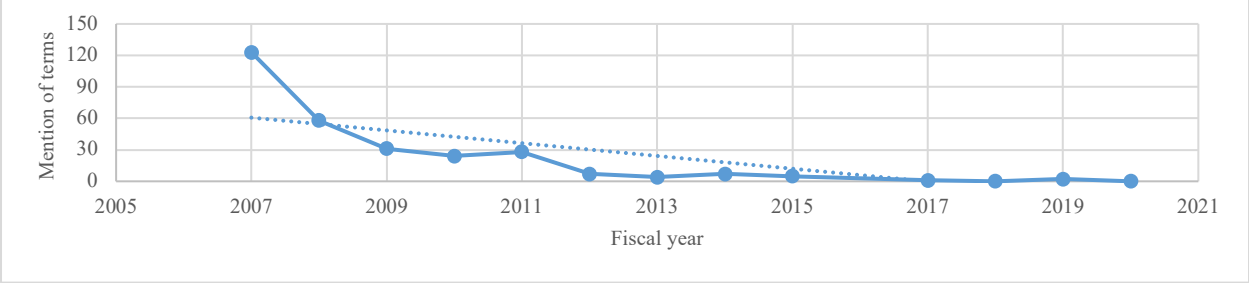


Figure 14. Mentions of Hurricane-related Terms in Budget Documents of North Carolina

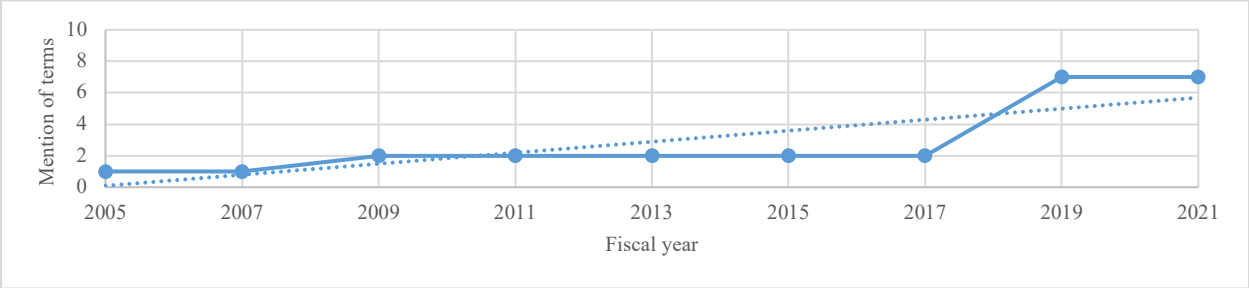


Figure 15. Mentions of Hurricane-related Terms in Budget Documents of South Carolina

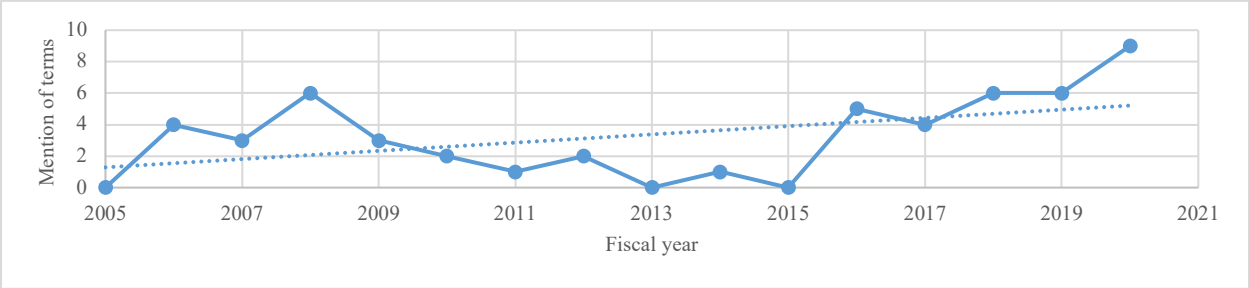


Figure 16. Mentions of Hurricane-related Terms in Budget Documents of Texas

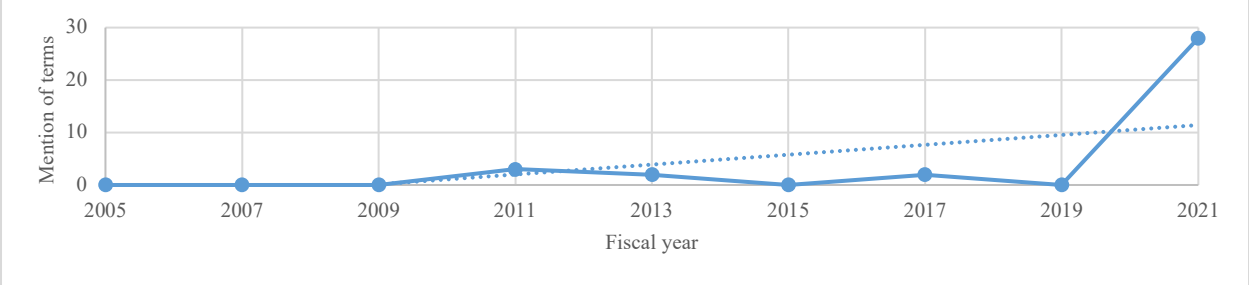


Figure 17. Attention to Proactive and Reactive Measures towards Hurricanes

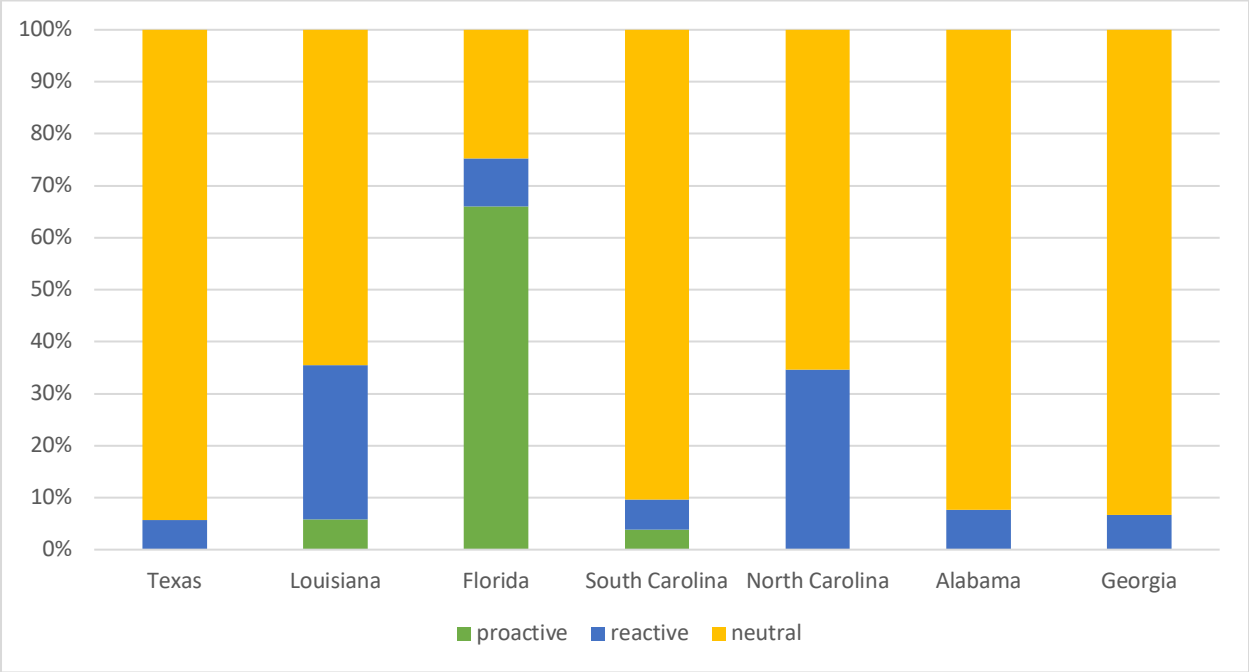


Table 1. Hurricane Events between 2000-2021

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: By convention, 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).

Table 2. 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	356	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.

Table 3. Estimates and P-Values of Trends of Attention to Hurricanes and Disasters in 7 States

	Trend of hurricane attention	p-value
Alabama	0.263**	0.049
Florida	-0.773*	0.053
Georgia	-0.001	0.989
Louisiana	-0.084***	0.003
North Carolina	0.35***	0.008
South Carolina	0.262**	0.066
Texas	0.941	0.112

Notes: Stars denote statistical significance

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

Table 4. 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

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Appendix

Appendix Table A1 - 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 A2 - 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)