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ORIGINAL PAPER

Household Preferences for Managing Coastal Vulnerability: State vs. Federal Adaptation Fund

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Abstract
People living in the coastal areas are highly vulnerable to the extreme weather events and climatic shocks. In this paper, we analyze households' willingness to pay (WTP) for public adaptation funds to support proactive measures that would potentially minimize the extent of coastal vulnerability. Using split-sample dichotomous choice contingent valuation (CV) method, we investigate households' preference for a state adaptation fund (SAF) versus a federal adaptation fund (FAF), lasting for either 5 or 10 years. We analyze more than 1200 randomly selected household responses from the counties of 10 Northeastern and Mid-Atlantic States that were adversely affected by a major hurricane (Sandy). From the annual estimates of median WTP, we observe that the households are willing to pay more for SAF ($68.37) than FAF ($27.35). The findings can provide inputs for policy evaluation to minimize coastal vulnerability, particularly to decide whether similar projects should be managed at the state or federal levels.

Keywords State adaptation fund (SAF) · Federal Adaptation Fund (FAF) · Willingness to pay (WTP) · Natural disasters · Hurricane Sandy

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Introduction

Hydro-climatic extreme weather events affect coastal areas in many ways. Coastal environments and communities are sensitive to sea level rise, warmer ocean temperatures, storm

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surges, severe rainfall events, flooding, landslides, ocean acidification etc. Oftentimes, the densely populated communities in the low-lying coastal areas are more vulnerable to natural disaster than that of inland areas (Bathi and Das 2016; Barbier 2014). In the United States, more than 150 million people in 673 coastal counties are exposed to the extreme weather events and climatic shocks (Ruth et al. 2007). During the last two decades, the coastal counties in the Atlantic and Gulf coasts have experienced intense hurricane events including Irma, Harvey, Sandy, Wilma, Ivan, Katrina, Rita, Ike and many others. These hurricanes resulted in thousands of fatalities, injuries, illnesses, disruptions of public utility services, and financial losses through property damages and destruction of infrastructures.

Hurricane Sandy, classified as one of the costliest Atlantic hurricane in the US history made landfall on October 29, 2012 (Manuel 2013). Sandy was blamed for more than 200 deaths and an estimated monetary loss of about US$ 78 billion in the United States (Kunz et al. 2013). According to Sullivan and Uccellini (2013), 24 states across the northeastern and mid-Atlantic regions were severely affected by this deadly storm. The coast of central and northern New Jersey and New York City metropolitan area suffered most from this catastrophic event. The governor's office of New Jersey and New York estimate that the total damages to the state are about $ 15.2 billion and $ 19 billion respectively (Blake et al. 2013). With these damages in mind, we have conducted a household survey in the specific hurricane Sandy affected counties to understand resident's preferences for an adaptation fund to manage coastal vulnerability. We tried to identify the factors that influence the households to contribute to the funds for coastal restoration, flood protection, and improved transportation at the state and at the federal levels. By using the split sample dichotomous choice contingent valuation methods, we are interested in knowing whether households are more willing to pay for the state adaptation fund (SAF) or for the federal adaptation fund (FAF). This will help us identifying whether the adaptation fund should be managed at the state or at the federal levels.

Although disasters triggered by extreme weather events are disruptive to coastal communities and their economies, disaster preparedness provides great opportunities to take proactive actions that can significantly reduce the adverse effects of coastal vulnerability and the additional threats posed by climate change and sea level rise (Burkett 2012). Available literature indicates that households, private sectors, and governments are three distinct units of an economy who can play significant role to reduce vulnerabilities from current and future hazard events by increasing hazard awareness, improving community resilience, and restoring coastal environments (Ewing et al. 2010; Birkmann 2007; Kent 2011; Godschalk 2003; Barbier 2014). Goeschl and Managi (2019) provide a synthesis of major drivers affecting household disaster preparedness.

Adaptation in terms of proactive (ex-ante) measures can be more effective than reactive (ex-post) measures (Letson et al. 2007; Kunreuther and Pauly 2006). However, designing comprehensive ex-ante measures are challenging as it involves an assessment of how to generate and manage the fund at the state and federal levels. Very few studies have paid attention to explore ex-ante mechanisms to finance adaptation and promoting resilience. With a few exceptions, Mozumder et al. (2014) found that more than one-fourth of homeowners would be willing to pay to finance a hurricane mitigation fund in Florida. The residents of New Orleans metropolitan area are willing to pay $301 for category 5 storm protection plan compared to $509 for the other U.S. citizen in the sample (Landry et al. 2011).

The study by the Multihazard Mitigation Council (2005) showed that on average, a dollar spent by the Federal Emergency Management Agency (FEMA) on hazard mitigation provides the nation about $ 4 in future benefits. Hochrainer-Stigler et al. (2019) demonstrate the economic benefits of building houses on raised plinths as a flood proofing mechanism in a

low-income country set-up (India). Unterberger (2018) explores the budgetary implications for municipalities when flood damages the public infrastructures in Austria. Vásquez and Mozumder (2017) conducted a choice experiment to investigate households' willingness to pay for establishing hurricane resistant housing in Northeastern and Mid-Atlantic United States and found that only a few households are willing to invest in making their homes more hurricane resistant. However, none of the studies have paid attention to the overall ex-ante mechanisms to adaptation and whether the adaptation funds should be managed at the state or at the federal level.

This paper tries to fill this research gap by examining households' willingness to pay for state/federal adaptation fund to mobilize resources statewide/countrywide to support proactive measures to minimize the adverse effects of hurricanes and related events such as coastal restoration, flood protection, and improved transportation. To restore coastal landforms and enhance flood protection levels, this fund will be used to barrier island restoration, fresh water diversion, ridge restoration, shoreline stabilization, land elevation among others. The fund will also be used to improve transit and highway infrastructure so that the successful transit can be used during emergency evacuation.

A few earlier studies (Landry et al. 2011; Petrolia and Kim 2009; and Petrolia et al. 2014) report that households are willing to pay for managing coastal vulnerability. For instance, Landry et al. (2011) administered a choice experiment in New Orleans to analyze household willingness to pay (WTP) for storm protection, coastal restoration, and modernized transportation for evacuation. They found positive WTP for storm protection in New Orleans, with category 5 levees preferred over coastal restoration and improved transportation. Petrolia and Kim (2009) examined household preferences (in terms of WTP) for a variety of restoration options for the Mississippi State's barrier islands (e.g. restoration options with and without historical references). Their results indicate that the overall WTP for coastal restoration is positively significant for most of the restoration options. Their findings suggest that the perceived hurricane protection is the primary reason to support restoration. In another study, Petrolia et al. (2014) estimate the WTP of the U.S. population for wetland restoration programs in southeast Louisiana. They found that the average U.S. household is willing to pay $149 for storm surge protection through wetland restoration programs. However, none of these studies addressed the issue whether these types of projects for reducing coastal vulnerabilities should be managed at the state or federal levels. Using similar type of dichotomous contingent valuation method adopted by Landry et al. (2011) and Petrolia and Kim (2009), we designed a survey to identify whether and to what extent households are willing to pay for managing coastal vulnerability at the state or at the federal levels.

Since the support for adaptation funds can have implications on the state or federal budgets and on households' wellbeing, it is pertinent to know how much money households are willing to pay for the proposed adaptation funds managed by either state or by federal agencies. Thus, the key objective of our paper is to analyze and compare households' preferences, in the form of their willingness to pay (WTP), between state and federally managed adaptation fund to minimize the adverse impacts of coastal hazards.

Factors Affecting the Management of Coastal Vulnerability

Sufficient funds for coastal restoration and flood protection are critical to keep the coastal communities safe from devastating natural disasters. These proactive measures can be more

effective than reactive recovery measures to minimize coastal vulnerability. One way of funding these proactive measures is to mobilize resources from the general public through taxes or fees. But it is critical to analyze the factors that affect households' decision to pay for these funds (e.g., perceived risks, income, program attributes, and household characteristics). Once there is enough support for proposed adaptation funds to be collected at the state or federal level, various protection measures can be taken for the coastal communities utilizing these funds. Among them, dredging (removal of slit, sand, and other sediment from the bottoms of rivers and other water bodies), and floodproofing (sealing a structure to prevent water from entering, installing flood resistant materials, elevating the structure to reduce the risk of flooding) are worth mentioning.

Proactive mitigation strategies could decrease the loss of human life as well as the massive economic impacts of hurricanes. Peacock et al. (2005) argue that the first step in planning mitigation strategies is fully assessing existing hazard risks. Despite state and federal actions, households may reassess the risks on their own and practice mitigation measures accordingly. Whether individuals intend to take actions to mitigate risks are often based on their past experiences and expectations of future hurricanes. Baker et al. (2012) conducted a survey on the behavior of 538 residents in suburban New York City, the coastal regions of New Jersey, Maryland, Delaware, and southeastern Virginia to determine households' perceived risk and preparatory actions towards hurricane Sandy. Their survey questions focused on the knowledge and information about the warning of the storm; threat perceptions; both short and long-term preparation actions; evacuation intentions; and experience of previous storm among others. The study showed that those severely impacted by storms often engage in mitigation, while those who have experience with hurricanes without substantial losses may downplay the risks and forgo mitigation.

Socioeconomic and demographic characteristics such as income, age, and education can also affect mitigation decisions and risk assessment (Mozumder et al. 2014; Vásquez and Mozumder 2017; Munro and Managi 2017; Chatterjee et al. 2019). Apart from these characteristics and personal experiences, another important factor of mitigation decisions is the presence of home insurance policies that are in place to cover damages caused by hurricanes. Much of the attention surrounding hurricane mitigation decisions focuses on what households can do to protect their homes against the impacts of hurricanes (Ge et al. 2011; Peacock et al. 2005; Simmons and Willner 2001; Young et al. 2012). A hurricane can wreak massive damages on homes in a variety of ways: powerful winds can detach the roof, debris can break windows, garage doors can be torn down and walls can be compromised or collapse. In such a case, households are more interested in installing shutters to protect houses from the storm.

With regard to extreme weather events, the perception of risk plays a crucial role in the decision-making process. Risk is essentially an assessment of the level of hazard a certain event presents to a decision-maker (Dash and Gladwin 2007; Riad and Norris 1998; Peters and Slovic 1996; Whitehead et al. 2000). The assessment of risk inherently incorporates subjectivity (Slovic and Weber 2002). In the context of natural hazards such as hurricanes and predispositions to coastal vulnerability, this perception of risk is often a primary factor to take actions to reduce these risks (Dash and Gladwin 2007; Riad and Norris 1998; Peters and Slovic 1996). Thus, the most widely used factors that drive adaptation behaviors to mitigate risks are socioeconomic and cognitive factors, experience and risk perceptions (Koerth et al. 2017; Mozumder et al. 2014; Paul and Routray 2011; Terpstra 2011; Kievik and Gutteling 2011).

In this paper, we not only pay attention to these explanatory factors but also focus on households' intention to generate adaptation fund at the state and federal level to understand

how effective financing of these funds can be planned. In addition, we also look into whether a short run (5 years) or a relatively long run (10 years) adaptation funds are preferable to the households both at the state and federal level.

Fund for Adaptation: State Vs. Federal Approach

Historically environmental regulations were primarily designed and managed by the state and local governments in the United States (Adler 2007; Vogel et al. 2012; Revesz 2001). However, after the emergence of National Environmental Policy Act (NEPA) in 1969, the federal role has increased significantly (Goulder and Stavins 2011). The notion of environmental federalism is not limited to the environmental pollution but also expanded to deal with the risks of natural disaster. Yet the setting of environmental standards still has some striking anomalies. For instance, home insurance policies are regulated by the state agencies, while flood insurance policies are managed by the federal agencies. It is a matter of argument that the state agency may not be trusted with the responsibility for setting environmental standards as they can prioritize economic development over the interest of environment (Oates 2001). However, states with coastal areas have decades-long experience in addressing multiple environmental stresses. They are often on the front lines in responding to natural disasters, especially with a focus on aiding vulnerable communities (Rosenzweig and Solecki 2014).

While dealing with the impacts of natural disaster on the coastal areas of United States, policy analysts mostly focus on the response and recovery strategies. For instance, state and local governments are the first line of emergency responses in disasters. They have fire, police, emergency medical services and emergency management agencies to respond to a disaster. At the federal level, the response and recovery are mostly associated with the funding mechanisms. Federal assistance, measured as a proportion of damage, has grown significantly over the last three decades to help communities recover from severe disasters. Since 1989, FEMA has spent more than 13 billion dollars to implement long term hazard mitigation projects in which 76% of total mitigation grant funding have been allocated for hurricane, storm and flood related disasters (Davlasheridze et al. 2017). On the other hand, states have to have an approved State Hazard Mitigation Plans (SHMPs) to receive federal disaster mitigation funding from FEMA (Babcock 2013).

To identify the residents experience in the aftermath of hurricane Sandy, we revisit the state and federal governments response during hurricane Sandy. Much of the damages caused by hurricane Sandy centered in the densely populated coastal areas of New Jersey and the New York metropolitan areas. In preparing for the storm both the New York and New Jersey governments responded proactively to mitigate the impacts of the storm. In New York City, the Office of Emergency Management (OEM) utilized texts, Twitter, YouTube, e-mail, and phone calls to notify residents of the impending danger of Sandy. Mayor of New York City, Michael Bloomberg, issued mandatory evacuation orders for city residents living in flood Zone A, which included 375,000 residents, 6 hospitals, 22 nursing homes, 1 psychiatric hospital, and 18 adult care facilities. Governor Andrew Cuomo of New York declared a “State of Emergency” in an effort to mobilize resources to prepare for the impact of Sandy. The New Jersey governmental agencies took similar steps to prepare for Sandy and ensure the safety of its residents. The New Jersey Governor Chris Christie also declared a “State of Emergency” in the days leading up to Sandy’s landfall. Governor Christie issued mandatory evacuations for the barrier islands such as Sandy Hook and Cape May.

President Obama approved a 100% cost share (starting October 31, 2012) for emergency work to restore power and transportation systems in designated counties in New Jersey, New York, and Connecticut. The Federal Emergency Management Agency (FEMA) and the Department of Defense (DOD) established Incident Support Bases in Massachusetts and New Jersey to pre-position supplies including water, meals, blankets and other resources closer to potentially impacted areas. The Federal government also ordered the establishment of a national power restoration. According to FEMA, more than 58,000 households in Connecticut, New York and New Jersey had registered for disaster assistance, and more than $5.9 million has been approved.

Though the analysis of Sandy's impacts emphasized the need for fast response and recovery, the priority should go in taking adaptive measures before the hurricane hits. Raising an adaptation fund beforehand will give the state and federal agencies to take proactive actions that can reduce the impacts of disaster. Against this backdrop, the key question is who are likely to contribute to the proposed adaptation fund at the state and federal level and how much? The homeowners who are the beneficiary of the adaptation measures have the reason to pay for it. Besides, the fund can also be collected through state or federal taxes as it benefits the entire community. We hypothesize that the household preferences for an adaptation fund are sensitive to how it is managed (state vs. federal) and associated time range or duration of the program. For instance, households may prefer a state adaptation fund in the short term to increase community resilience and to minimize the adverse effects of hurricane. On the contrary, a federal adaptation fund may be preferred in the long run to restore economic activities, rebuilding community facilities, infrastructure, and family housing for the successful recovery from future hazards.

Survey Design and Sampling Procedure

Study Area

An online survey was developed to investigate households' preferences between state and federally managed adaptation fund to minimize the adverse impacts of coastal hazards. The GfK group (formerly knowledge networks) conducted the survey between July 12 and July 22, 2013 on behalf of the researchers of Florida International University (FIU). GfK uses their unique panel (KnowledgePanel®) to respond to the survey. GfK's KnowledgePanel® is a probability-based panel in which all members have equal probability of selection. Once the study sample has been selected and fielded, Gfk adjusted the statistical weights to offset the known selection bias. This adjustment would reduce the effects of any non-response and non-coverage bias that may have occurred during the data collection process. Based on the demographic distributions of the Current Population Survey (CPS), Gfk conduct a post-stratification adjustment which makes the sample demographically balanced. In our sample of Gfk panel, the variables for post-stratification weight adjustments include gender, age, race, education, state and households' income.

The survey sample consisted of representative adults who lived in the specific hurricane Sandy affected counties in New Jersey, New York, Connecticut, Maryland, Massachusetts, Virginia, Delaware, Pennsylvania, Rhode Island, and West Virginia. Out of 3276 participants, 2028 (61.9%) completed the survey. GfK's KnowledgePanel® administered the response rate for the sample used in this survey. This response rate is the percent of cases that qualified for

the survey from the total number of participants complete the survey. With the qualified response rate of 59.76%, a total 1212 usable responses were received through this probability based representative survey. The proportion of respondents from each state are shown in Table 1, which shows that majority responders are from NY, NJ, MD, and PA respectively. Among them more than 50% of the respondents are from NY and NJ.

Survey Methods and Sample Selection

Finding an effective way that provides unbiased value estimates for public goods and services is a challenging task (Cummings and Taylor 1999). Contingent valuation (CV) methods are effective in this regard and widely used in the stated preference economics literature to obtain estimates of environmental public goods (Landry et al. 2011; Petrolia and Kim 2009; Petrolia et al. 2014; Ivehammar 2009). Furthermore, this is a handy method to evaluate preferences for public policies or projects that have not been implemented yet.

This induced us to use dichotomous choice CV methods to investigate public preferences or their willingness to pay (WTP) for adaptation fund. The objective of the proposed adaptation fund is to minimize the loss of life and property from future hurricanes. The fund will be used to minimize the adverse effects of hurricanes and related events such as coastal restoration, flood protection, improved transportation, prevent structural damages from wind and wind-driven rainwater among others.

The questionnaires in our study have a "referendum-style" structure that is common in the split-sample CV studies to determine the support for adaptation fund at the state and federal level. While answering this stated preference CV question, the respondent ought to believe that his or her response could potentially influence decision making and he/she is aware about the outcome of the decision making (Carson and Groves 2007; Carson et al. 2004)

The split-sample CV methods are designed to separate the full sample into two or more sub-sample so that we can get the estimator for each sub-sample independently (Petrolia et al. 2014; Haab and McConnell 2002). Another advantage of using the split-sample is to avoid both anchoring and ordering bias in a survey-based study. During decision making, anchoring bias occurs when individuals use an initial piece of information to make subsequent judgments and ordering bias arises when responses are affected by the order of choices to be made. The use of split-sample method mitigates both anchoring and ordering bias and make respondents to state their preferences as accurately as possible.

Table 1 Distribution of survey respondents (in percentage) across states

Name of the State	Percentage of Survey Respondents	Cumulative Percentage
Connecticut	6.87	6.87
Delaware	2.74	9.60
Massachusetts	3.95	13.56
Maryland	10.26	23.82
New Jersey	25.91	49.73
New York	33.45	83.18
Pennsylvania	10.10	93.27
Rhode Island	2.73	96.00
Virginia and West Virginia	4.00	100.00

We randomly ask one group of 606 households about their willingness to pay for SAF and another group of 606 households about their willingness to pay for FAF. The split-sample tests that are done in CV studies are planned for policy purposes where policy makers are interested in two or more outcome variables (Carson et al. 2001). We combined both group of households (1212) under combined adaptation fund (CAF) category to determine whether households are willing to support for either of the proposed adaptation fund (state/federal). Results from this stated preference study may be useful to policy makers to determine whether the fund should be raised through the state or federal income taxes and the project should be managed at the state or federal levels.

Our split-sample survey questions are designed to determine two interrelated things of the study. The first is to estimate the households' WTP for the proposed SAF and FAF and the second is to know whether households are in favor of shorter time frame of 5 years or the longer time frame of 10 years of payments through state/federal taxes.

Survey Question and Responses on SAF

We randomly select half of the total respondents and ask the following referendum-voting question on State Adaptation Fund (SAF) as follows.

> "Suppose that a referendum will be held for a proposed "State Adaptation Fund (SAF)". This fund will be managed at the state level and will mobilize resources statewide to support proactive measures to minimize the adverse effects of hurricanes and related events such as coastal restoration, flood protection and improved transportation. If this proposal is approved, an increase of ($100/$200/$300/$400/$500) will be charged in your state income taxes in each of the next (5/10 years). It is also notable that such increase in income taxes implies a decrease in your budget for goods and services such as food, health care, etc. Would you vote in favor of (Yes) or against (No) the proposed SAF?"

The survey responses to this question is presented in Table 2. For each dollar amount, more respondents said "no" to the proposed SAF, leading to a total of 64.36% "no" response rate. The remaining 35.64% of respondents indicate that they would vote "yes" for the proposed SAF.

The breakdown of the "yes/no" responses can reveal the preference for the duration of the program and for the payments through state taxes. The survey responses for this part is shown in the left panel of Fig. 1. We find that respondents are willing to pay more for 10 years long SAF (112 favorable responses) compared to 5 years long SAF (104 favorable responses). The households living in these states may view project with longer duration as more sustainable. That is, households are willing to pay more for a program that will continue to provide these services for a longer duration for managing coastal vulnerability.

Table 2 Willingness to pay (WTP) for state adaptation fund (SAF)

State Fund	Bid Amount					Total
	100	200	300	400	500	
No	55.00	62.10	70.00	69.23	65.57	64.36
Yes	45.00	37.90	30.00	30.77	34.43	35.64

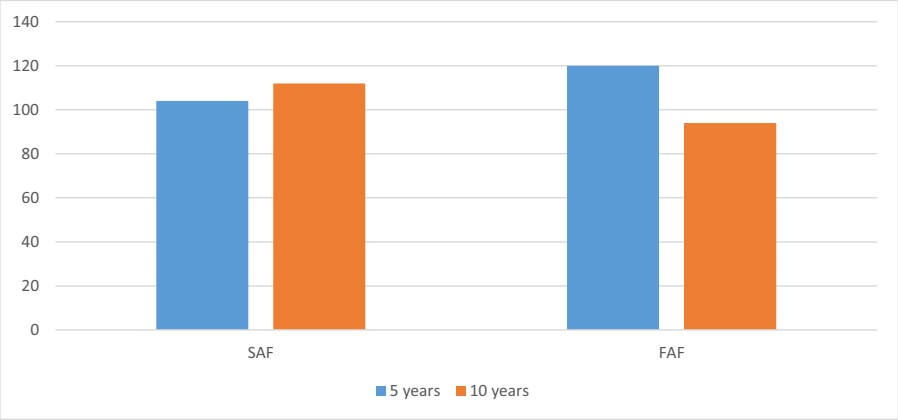

Fig. 1 Average willingness to pay (WTP) for the proposed state adaptation fund (SAF) and federal adaptation fund (FAF) for next 5 and 10 Years

Survey Question and Responses on FAF

We have asked the similar referendum-voting question on Federal Adaptation Fund (FAF) to the other half of the respondents as follows.

> "Suppose that a referendum will be held for a proposed "Federal Adaptation Fund (FAF)". This fund will be managed at the federal level and will mobilize resources nationwide to support proactive measures to minimize the adverse effects of hurricanes and related events such as coastal restoration, flood protection and improved transportation. If this proposal is approved, an increase of ($100/$200/$300/$400/$500) will be charged in your federal income taxes in each of the next (5/10 years). It is also notable that such increase in income taxes implies a decrease in your budget for goods and services such as food, health care, etc. Would you vote in favor of (Yes) or against (No) the proposed FAF?"

The survey responses to this question is presented in Table 3. For each dollar amount, more respondents said "no" to the proposed FAF, leading to a total of 64.69% "no". The remaining 35.31% of respondents indicate that they would vote "yes" for the proposed FAF.

The breakdown of the "yes/no" responses can reveal the preference for the duration of the program and for the payments through federal taxes. The survey responses for this part is shown in the right panel of Fig. 1. The respondents favored the shorter time frame (120 favorable responses for the 5 years long program) over the longer time frame (94 favorable responses for 10 years long program).

Table 3 Willingness to pay (WTP) for federal adaptation fund (FAF)

Federal Fund	Bid Amount					Total
	$100	$200	$300	$400	$500	
No	61.48	63.56	57.03	73.11	68.91	64.69
Yes	38.52	36.44	42.97	26.89	31.09	35.31

Empirical Framework and Variables of Interest

We use the following empirical framework to determine the marginal effects of the explanatory variables contributing to the support for proposed state and federal adaptation fund and estimate the household WTP for these programs. We apply the dichotomous choice CV methods by imposing payments (bid or asked price for implementing the program) that will be acceptable to the respondents if they want to support state or federal fund. Following Cameron (1988) and Mozumder et al. (2014), the willingness to pay for the proposed adaptation fund (state/federal) to manage coastal vulnerability is framed in a log-linear form as follows.

$$\ln\mathrm{WTP} = \mathrm{X}\beta + \varepsilon \tag{1}$$

where WTP for adaptation funds is a function of the vector of explanatory variables (X) that include perceived risk, program features (e.g. duration), and other household and locational characteristics. The β is a vector of coefficients to be estimated; and ε is the stochastic error term. The dichotomous choice approach used in this study does not allow us to directly observe lnWTP. This can be observed indirectly given that households are expected to provide a favorable answer to the dichotomous choice CV question only if their WTP is greater than or equal to the BID presented in the contingent scenario (Mozumder et al. 2014; Lopez-Feldman 2012). In that case, the probability of observing a positive response given the values of the explanatory variables is given by:

$$\begin{aligned} \mathrm{P}\,(\mathrm{Y}=1|\mathrm{x}) &= \mathrm{P}\,(\ln\mathrm{WTP} > \ln\mathrm{BID}) \\ &= \mathrm{P}\,(\mathrm{X}\beta + \varepsilon > \ln\mathrm{BID}) \\ &= \mathrm{P}\,(\varepsilon > \ln\mathrm{BID} - \mathrm{X}\beta) \end{aligned}$$

Assuming that $\varepsilon \sim \mathrm{N}\,(0,\sigma^2)$, we have

$$\begin{aligned} \mathrm{P}\,(\mathrm{Y}=1|\mathrm{x}) &= \mathrm{P}\left(\vartheta > \frac{\ln\mathrm{BID} - \mathrm{X}'\beta}{\sigma}\right) \\ &= 1 - \phi\left(\frac{\ln\mathrm{BID} - \mathrm{X}'\beta}{\sigma}\right) \\ \mathrm{P}\,(\mathrm{Y}=1|\mathrm{x}) &= \phi\left(\frac{\mathrm{X}'\beta}{\sigma} - \ln\mathrm{BID}\,\frac{1}{\sigma}\right) \end{aligned} \tag{2}$$

where $\vartheta \sim \mathrm{N}\,(0,1)$ and $\phi\,(\cdot)$ is the standard cumulative normal. This is similar to traditional logit model. Thus, Eq. (2) can be estimated by using the maximum likelihood estimation (MLE) method to solve for β and σ. The other option is to directly use the discrete choice logistic model and estimate the following.

$$\mathrm{P}\,(\mathrm{Y}=1|\mathrm{x}) = \alpha\mathrm{X} + \delta\ln\mathrm{bid} + \mathrm{e} \tag{3}$$

By doing so we obtain the estimates for Eq. (3) as:

$\hat{\alpha} = \frac{\hat{\beta}}{\hat{\sigma}}$ (the vector of coefficients associated to each one of the explanatory variables) and $\hat{\delta} = -\frac{1}{\hat{\sigma}}$ (the coefficient for the variable capturing the amount of the bid).

The final objective in our CV study is to estimate WTP along with the confidence intervals for state and federal adaptation fund. The median WTP can be computed by using the coefficients of Eq. (3) as follows:

$$\mathrm{WTP} = e^{(-x\hat{\alpha}/\hat{\sigma})} \tag{4}$$

Since WTP measures are non-linear functions of estimated parameters, procedures such as delta method is inappropriate as they yield symmetric confidence interval. Thus, we used Krinsky and Robb 95% confidence interval to measure median WTP as a better estimator (Creel and Loomis 1991; Jeanty 2007; Haab and McConnell 2002; Park et al. 1991).

The definition and descriptive statistics of explanatory and outcome variables used to estimate eq. (3) are shown in Table 4. From the descriptive statistics, we find that about 35.6% respondents support SAF and 35.3% respondents support FAF. It is also observed that about 52% of those respondents who prefer to support SAF are ready to make their payments through state income taxes for the next 10 years as opposed to the next 5 years. On the other hand, about 56% of those respondents who prefer to support FAF are ready to make their payments through federal income taxes for the next 5 years as opposed to the next 10 years. This implies that the respondents who are in favor of SAF prefer to make their contributions for a relatively longer duration (10-year state tax) while those who are in favor of FAF prefer to make their contributions for a shorter duration (5-year federal tax).

The association between evacuation and willingness to pay for state/federal adaptation fund is not directly observable. Evacuation intention may depend on several factors. People who evacuated during hurricane Sandy had a firsthand experience of vulnerability and may be more likely to realize the need for an adaptation fund. However, due to the budget and other resource constraints, and trust in the local or state government people are not equally capable to evacuate. According to our survey, only 7% of the respondents were evacuated during hurricane Sandy.

Insurance can be considered as the risk smoothing instrument in the context of coastal risk management (Linnerooth-Bayer et al. 2011). Respondents who have an insurance policy to cover damages by hurricane have greater economic security against hurricane-related risks (Vásquez and Mozumder 2017). Thus, we can hypothesize that those who has paid for insurance premium and are covered by the insurance policy may not feel the urge to contribute to the fund for adaptation. Since most of the respondents (59%) in our study have insurance policy to cover damages caused by hurricane Sandy, they may prefer to contribute less to the SAF and FAF compared to those who had no insurance policy to cover the damages.

Our referendum questions for both SAF and FAF indicates that the adaptation fund will be used to support proactive measures to minimize the adverse effects of hurricanes and related events such as coastal restoration, flood protection and improved transportation. These are the public risk reduction investments that will benefit the people of coastal communities. On the other hand, as a proactive measure, household install impact-resistant windows, doors, or shutters that have the potential to reduce hurricane-related damages. We hypothesize that these private risk reduction investments maybe correlated with the public risk reduction investments. From the behavioral perspective, households who are ready to invest privately for protecting their properties are more aware and concerned of the hurricane related risk and thus may be willing to pay more for the public risk reduction investments as well.

Table 4 Definition of variables of interest and descriptive statistics

Variable	Definition	Mean	Standard Deviation
SAF	If the respondent is in favor of the SAF (1 = yes, 0 = otherwise)	0.356	0.479
FAF	If the respondent is in favor of the FAF (1 = yes, 0 = otherwise)	0.353	0.478
CAF	If the respondent is in favor of either SAF or FAF (1 = yes, 0 = otherwise)	0.359	0.481
Ln(state bid)	Natural log of the annual contribution to the SAF	5.567	0.571
Ln(federal bid)	Natural log of the annual contribution to the FAF	5.561	0.567
Ln(bid)	Natural log of the annual contribution to any of the SAF/FAF	5.564	0.568
State tax time	If the respondent is in favor of the 5 years state taxes for SAF (1 = yes, 0 = otherwise; 10 years)	0.485	0.501
Federal tax time	If the respondent is in favor of the 5 years federal taxes for FAF (1 = yes, 0 = otherwise; 10 years)	0.561	0.497
Tax time	If the respondent is in favor of 5 years state/federal taxes for CAF (1 = yes, 0 = otherwise; 10 years)	0.521	0.499
Evacuation	If the respondent evacuated when hurricane Sandy hit (1 = yes, 0 = otherwise)	0.076	0.265
Insurance	If the respondent has an insurance policy to cover damages caused by Sandy (1 = yes, 0 = otherwise)	0.590	0.265
Window protection	If the respondent had window protection during Sandy (1 = yes, 0 = otherwise)	0.055	0.227
Expectation	If the respondent thinks that his home will be affected by hurricane in the next 10 years	0.754	0.511
Concern	If the respondent is concerned about the projected impacts of intense hurricane (1 = yes, 0 = otherwise)	0.512	0.501
Experience	If the respondent experienced hurricane Irene in the year of 2011 (1 = yes, 0 = otherwise)	0.684	0.464
Damage	Interior and exterior home damage due to hurricane Sandy (in USD)	1953	8405
State disaster preparedness ranking	Disaster preparedness ranking of the state [most prepared state is ranked with the highest number (50) as opposed to the least prepared state (1)]	20.644	5.647
Income	Household's income group (1 = less than 5000; 2 = 5000-9999; …….19 = 90,000+)	13.152	4.155
Age	Age of respondent (in years)	52.91	15.43
Education	Respondent's years of education (in number)	11.371	1.640
Household size	Number of household members	2.491	1.285

The binary variable concern is included in our study to control for the respondent's attitudes towards projected impacts of hurricanes, storm surge, flooding and other related events in the community. We anticipate that households who are more concerned about hurricane related impacts would be willing to pay more for the adaptation fund. The indicator variable expectation is considered to account for perceived hurricane risks, which is expected to have a positive effect on the household's willingness to pay for the proposed (state/federal) adaptation fund as a risk reduction strategy. We consider other hurricane events households may have experienced before hurricane Sandy. We ask the respondents whether they have experienced other recent hurricanes (e.g. hurricane Irene in the year of 2011). It is found that about 68% of the respondents have experienced hurricane Irene. We anticipate that those who have experienced hurricane Irene would be more

proactive and willing to pay more for the adaptation fund. We control for reported damages ($) attributed to the hurricane Sandy. The total amount of damages includes both the exterior and interior damages to the respondent's home. We anticipate that extent of hurricane-related damages may affect the willingness to pay for adaptation fund.

Socioeconomic variables such as income, age, education, and household size may have both positive or negative impact on adaptation behavior and willingness to pay. We hypothesize a positive association between income and support for fund. Since the costs of adaptation is a barrier, households with higher income are more likely to pay for the SAF and FAF. Age can have a bidirectional effect on willingness to pay for adaptation fund (Koerth et al. 2017). Higher aged people living in the coastal areas may have more knowledge and experiences about hurricanes than others. This may lead to a positive association between age of the respondent and support for the fund. On the other hand, older households may experience hurricane only in once or twice in their lifetime and are not motivated to pay for the proposed SAF and FAF. Respondents with a higher education level are more likely to support adaptation measures (Richert et al. 2017; Poussin et al. 2014). Thus, we hypothesize a positive association between higher education and willingness to pay for adaptation fund. We do not make any hypothesis on household size as it may affect the willingness to pay either positive or negative way.

Results and Discussion

Based on our split-sample survey design, we run the discrete choice logit model (Eq. 3) for two outcome variables i.e. support for SAF and support for FAF. The geo-coded location of respondents in support of the proposed SAF and FAF is shown in Fig. 2.

We also consider third outcome variable as CAF; that is the combination of first two outcome variables. More precisely, CAF is the support for either of the adaptation fund (state/federal). We run two different discrete choice logit models (Model 1 and Model 2) for each of these three outcome variables. We include the state fixed effects in both Model 1 and Model 2 to account for unobservable characteristics of the location specific factors that are correlated with the explanatory variables and may influence the respondents' WTP.

In Model 1, we only consider the risk related explanatory variables. Table 5 shows the marginal effects of these estimated logit specifications of WTP model for three outcome variables.

In Model 2, we include socioeconomic variables along with the risk related explanatory variables. Thus, Model 2 can be considered as the full model of our study. Table 6 shows the marginal effects of all explanatory variables of the WTP model for three outcome variables.

We present both models with the inclusion and exclusion of state fixed effects to show the considerable degree of robustness in terms of estimated marginal effects and WTP estimates. The Akaike Information Criterion (AIC) is used to compare models across different samples. All else being equal, the model with the smaller AIC (Model 2) is the better fitting model. In contrast, the Bayesian Information Criterion (BIC) favors a more parsimonious model specification (Model 1) over the full model (Model 2). While comparing two models on the same data, Pseudo R^2 would be higher (Model 2) for the model with the greater log likelihood. Also, the model with state fixed effects have lower AIC (better fitted model) and higher pseudo R^2 compare to the model with no state fixed effects. Since the sign and estimated coefficients of Model 2 (full model) are similar to Model 1 and both the value of AIC and Pseudo R^2 tend to support the model with household characteristics, we emphasize our discussion on the results of Model 2.

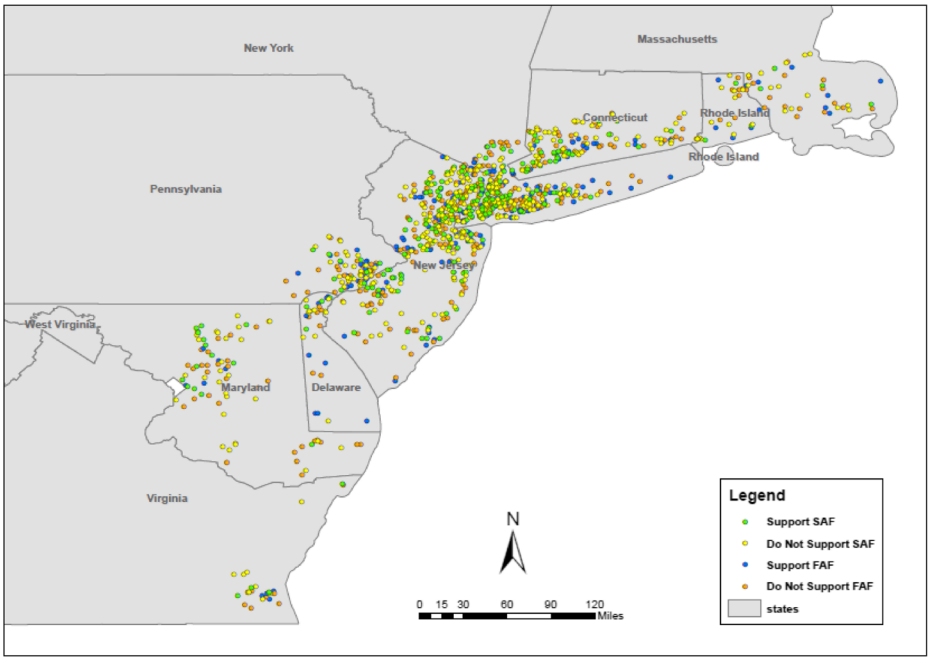

Fig. 2 Geo-coded household location and their preference for the proposed state adaptation fund (SAF) and federal adaptation fund (FAF)

In Model 2 with state fixed effects, the estimated coefficient on the bid parameter is negative and significant for all three outcome variables. This implies that an increase in the bid amount would decrease the probability of respondent's support for the proposed SAF and FAF by approximately 47% points and 26% points respectively. Meaning, the respondents are more sensitive to the bid for the SAF than FAF. The estimated coefficient for the duration of federal income tax is negatively significant for the FAF. This implies that respondents who are in favor of FAF are willing to pay more through federal income taxes for the longer duration (10 years) compared to the shorter duration (5 years). On the other hand, the estimated coefficient for the duration of state income tax is not significant for SAF. This reveals that the respondent prefers FAF for the long run mitigation policy whereas for the SAF they have no specific preference for project duration. The long run mitigation policies for federal fund are also supported by some other studies (Benson and Clay 2003; Hunt 2016).

Based on our priori assumption, it is difficult to relate a direct association between evacuation and WTP for adaptation fund. People who evacuated during hurricane Sandy had a firsthand experience of vulnerability and may be more likely to support the adaptation fund. On the other hand, people who did not evacuated may face greater vulnerability and realize the need for supporting adaptation fund. In addition, due to the budget and resource constraints, and trust in the local or state government, people are not equally capable to evacuate. In our study, evacuation is found positively significant for CAF but insignificant for both SAF and FAF. It is also notable that only 7% of the respondents of our study were evacuated during hurricane Sandy. The big reason behind the low evacuation rate was the

Table 5 Marginal effects from estimated logit model 1 (excluding socioeconomic factors)

	(SAF)	(FAF)	(CAF)	(SAF)	(FAF)	(CAF)
Ln(state bid)	−0.435 (0.155)***	–	–	−0.436 (0.159)***	–	–
Ln(federal bid)	–	−0.248 (0.154)	–	–	−0.235 (0.155)	–
Ln(bid)	–	–	−0.328 (0.108)***	–	–	−0.310 (0.110)***
State tax time	−0.124 (0.180)	–	–	−0.127 (0.182)	–	–
Federal tax time	–	−0.303 (0.177)*	–	–	−0.315 (0.179)*	–
Tax time	–	–	−0.202 (0.125)*	–	–	−0.197 (0.126)
Evacuation	0.486 (0.338)	0.397 (0.341)	0.409 (0.238)*	0.468 (0.333)	0.533 (0.356)	0.472 (0.242)**
Insurance	−0.327 (0.183)*	−0.103 (0.192)	−0.233 (0.131)*	−0.347 (0.187)*	−0.072 (0.196)	−0.230 (0.132)*
Window protection	0.591 (0.431)	0.505 (0.358)	0.475 (0.273)*	0.698 (0.436)	0.509 (0.361)	0.505 (0.272)*
Expectation	0.111 (0.213)	0.432 (0.222)**	0.258 (0.154)*	0.092 (0.214)	0.478 (0.224)**	0.257 (0.155)*
Concern	0.856 (0.187)***	0.285 (0.181)	0.561 (0.130)***	0.863 (0.193)***	0.311 (0.184)*	0.572 (0.131)***
Experience	0.088 (0.191)	−0.056 (0.194)	0.044 (0.134)	0.059 (0.191)	−0.055 (0.197)	0.036 (0.135)
Ln(damage)	0.000 (0.036)	−0.051 (0.038)	−0.021 (0.026)	0.000 (0.036)	−0.052 (0.038)	−0.022 (0.026)
Constant	1.386 (0.878)	0.604 (0.900)	0.938 (0.622)	1.340 (1.060)	0.401 (0.611)	0.501 (0.733)
State fixed effects	No	No	No	Yes	Yes	Yes
Psedu R^2	0.050	0.024	0.031	0.062	0.040	0.038
AIC	762.916	768.425	1505	756.881	763.396	1501.333
BIC	846.235	851.485	1601.231	805.118	811.483	1557.046
N	596	582	1178	596	582	1178

Note: Numbers in parentheses are the corresponding standard errors; *** Significant at 1% levels, ** Significant at 5% levels, * Significant at 10% levels

unawareness of evacuation notice (more than 87% of the respondents were not informed about the evacuation notice), lower households income, among others.

The estimated coefficient on insurance is negatively significant for CAF. This implies that insurance is a risk smoothing instrument. Households who have an insurance policy to cover damages during hurricane may not feel the urge to contribute to the CAF. However, this explanatory variable did not turn out to be significant for both SAF and FAF.

The estimated coefficient of window protection is not significant for both SAF and FAF. However, it is positively significant for CAF under state fixed effects scenario. We think this private risk reduction investment maybe correlated with the public risk reduction investment. That is, households who are ready to invest on installing impact-resistant windows are more aware and concerned of the hurricane related risk and thus may be willing to pay more for the public risk reduction investment as well.

The binary variable expectation is found positively significant for FAF. Those who expect that their houses may be affected by hurricanes in the next 10 years, are willing to pay more for

Table 6 Marginal effects from estimated logit model 2 (including socioeconomic factors)

	(SAF)	(FAF)	(CAF)	(SAF)	(FAF)	(CAF)
Ln(state bid)	−0.494 (0.167)***	–	–	−0.472 (0.164)***	–	–
Ln(federal bid)	–	−0.268 (0.156)*	–	–	−0.256 (0.148)*	–
Ln(bid)	–	–	−0.343 (0.111)***	–	–	−0.323 (0.113)***
State tax time	−0.145 (0.188)	–	–	−0.161 (0.192)	–	–
Federal tax time	–	−0.297 (0.181)*	–	–	−0.311 (0.182)*	–
Tax time	–	–	−0.237 (0.128)*	–	–	−0.231 (0.129)*
Evacuation	0.298 (0.358)	0.391 (0.347)	0.298 (0.246)	0.278 (0.363)	0.534 (0.359)	0.378 (0.250)**
Insurance	−0.308 (0.197)	−0.208 (0.208)	−0.244 (0.139)*	−0.311 (0.200)	−0.194 (0.213)	−0.239 (0.141)*
Window protection	0.490 (0.412)	0.537 (0.372)	0.434 (0.281)	0.617 (0.428)	0.536 (0.377)	0.461 (0.281)*
Expectation	0.108 (0.221)	0.392 (0.226)*	0.236 (0.157)	0.082 (0.224)	0.436 (0.227)**	0.233 (0.158)
Concern	0.959 (0.204)***	0.349 (0.186)*	0.616 (0.134)***	0.965 (0.208)***	0.374 (0.188)**	0.626 (0.135)***
Experience	0.112 (0.194)	−0.113 (0.197)	0.012 (0.136)	0.090 (0.197)	−0.115 (0.200)	0.006 (0.136)
Ln(damage)	0.024 (0.037)	−0.053 (0.040)	−0.009 (0.027)	0.027 (0.039)	−0.057 (0.041)	−0.010 (0.028)
Income	0.013 (0.004)***	0.006 (0.004)	0.009 (0.002)***	0.014 (0.004)***	0.006 (0.004)	0.010 (0.002)***
Age	−0.086 (0.034)**	−0.014 (0.035)	−0.048 (0.024)**	−0.091 (0.035)***	−0.100 (0.036)	−0.046 (0.024)**
Education	0.030 (0.013)**	0.017 (0.024)	0.027 (0.010)***	0.031 (0.013)**	0.013 (0.023)	0.027 (0.010)***
Household size	−0.329 (0.086)***	−0.028 (0.080)	−0.162 (0.057)***	−0.326 (0.091)***	−0.016 (0.080)	−0.157 (0.058)***
Constant	8.092 (1.972)***	2.226 (3.248)	5.390 (1.482) ***	8.141 (2.090)***	1.201 (3.166)	4.837 (1.529)***
State fixed effects	No	No	No	Yes	Yes	Yes
Pseudo R^2	0.101	0.043	0.057	0.118	0.056	0.066
AIC	731.629	769.555	1476.524	728.699	763.898	1472.763
BIC	845.600	883.217	1608.185	807.602	842.587	1563.913
N	596	582	1178	596	582	1178

Note: Numbers in parentheses are the corresponding standard errors; *** Significant at 1% levels, ** Significant at 5% levels, * Significant at 10% levels

FAF. When there is a severe disaster that is unmanageable to the local and state government, the federal government becomes the major source of support. This reliance on federal government might have influenced households' willingness to pay for FAF. Variable concern is included in our model to control for the respondent's attitudes towards projected impacts of hurricanes, flooding and other related events in the community. It is evident that the binary variable concern is positively significant for both SAF and FAF. This suggests that households who are more concerned about hurricane related impacts would be willing to pay more for the adaptation fund both at the state at the federal levels. We control for other hurricane events

(hurricane Irene) households may have experienced before hurricane Sandy. We anticipate that those who have experienced hurricane Irene would be more proactive and willing to pay more for the adaptation fund. However, the estimated coefficients of experience with other hurricanes are found insignificant in all models. We control for reported damages ($) attributed to the hurricane Sandy. We anticipate that the monetary loss (includes both the exterior and interior damages to the respondent's home) due to the hurricane Sandy may affect households' WTP for adaptation fund. However, the damage variable turned out to be insignificant for all the models.

Socioeconomic factors have significant effects on households WTP for SAF. For instance, income is positively significant for SAF but not for FAF. Thus, the higher income households are willing to contribute more to the SAF. The possible explanation for this is that the households in the area where the event occurs, and their local/state governments and voluntary agencies are the first responders to address the challenging situation. By contributing to the SAF, households expect proactive measures by the state agency which will immediately respond to protect the households from Hurricanes. A similar conclusion can be drawn for the households with higher level of education. In our study, the estimated coefficient of education is positively significant for SAF and insignificant for FAF. Meaning, the educated people are more likely to be skeptical on the disbursement of federal fund as it subject to administrative bureaucracy and so more willing to pay for SAF. Age is negatively significant for both SAF and FAF. Thus, it can be inferred that the older households may underestimate the benefits of SAF and FAF than younger households due to their residual lifespan (Ge et al. 2011).

As an alternative specification to the state fixed effects, we used some additional data[1] on most and least prepared states for natural disasters. The ranking of the state preparedness was determined by the four key factors. These are: (1) the frequency of disaster in each state, (2) emergency management budget of the state, (3) Number of national guard members per capita, and (4) state's infrastructure to stand against a disaster. Using the state disaster preparedness ranking data, we have tried to find whether households are willing to pay more (or less) at the most prepared state. The most prepared state is ranked with the highest number as opposed to the least prepared state. The findings suggest that the households are willing to pay more for the SAF at the better prepared states for natural disaster (See appendix Table 8). The finding is probably a reflection of the fact that people in those states may have greater trusts in their local and state governments than the federal government.

We also test for the multicollinearity to make sure independent variables are not linear combinations of each other. According to the general rule, variance inflation factor (VIF) exceeding 4 requires further investigation while VIF exceeding 10 are signs of serious multicollinearity that needs to be corrected. The mean VIF of the models in our study are less than 2 which means no major concern of multicollinearity. Based on the estimated coefficients of Model 1 and 2, we construct Krinsky and Robb 95% confidence interval of median WTP for all three outcome variables and reported in Table 7.

According to the WTP estimates, households are willing to pay more for the SAF than FAF in both models. Specifically, in Model 2 (full model) households are willing to pay $ 68.37 for the SAF compared to $ 27.35 for the FAF. Both the lower and upper bound of WTP are also higher for SAF compared to FAF in both Model 1 and 2. This is depicted in Fig. 3 and Fig. 4 respectively.

[1] See: https://www.goldeagle.com/tips-tools/least-prepared-states-natural-disasters/

Table 7 Krinsky and Robb 95% confidence intervals of median willingness to pay (WTP)

Model	Variable	Median WTP	Lower Bound	Upper Bound	ASL*
1	State Fund	63.82	2.47	122.01	0.000
	Federal Fund	25.50	0.23	59.67	0.008
	Fund (Combined)	40.72	1.17	88.79	0.008
2	State Fund	68.37	5.13	124.43	0.000
	Federal Fund	27.35	0.57	73.87	0.008
	Fund (Combined)	39.50	1.06	88.76	0.000

*Achieved Significance Level (ASL) is for testing H_0: WTP < =0 vs. H_1: WTP > 0

One argument in favor of higher WTP for SAF is that households may have considered federal government as more active in post disaster management than pre-disaster management. Thus, while they are willing to pay for the proposed adaptation fund they believe that the fund would be better utilized at the state level than at the federal level. In addition, the adaptation program managed by the federal government may need to pass through various levels of regulatory guidelines and may be subject to more bureaucratic scrutiny (Shobe and Burtraw 2012). Thus, implementing effective policy for ex-ante risk mitigation can be costlier and less efficient at the federal level compared to the state level.

During any extreme weather events, the response and recovery efforts are first initiated by the local/state government. For any proactive measures to minimize the adverse effects of hurricanes and related events such as coastal restoration, flood protection, and improved transportation; the local knowledge plays an important role for household level adaptation decisions and it may positively affect the support for state-managed adaptation programs (Adger et al. 2009). Also, state governments are often in a better position to know what infrastructure investments are critical in a locality before and after a natural disaster (Goodspeed 2013). Also, when federal government take actions to manage coastal vulnerability, some states may free ride on others and may not contribute the fair share that reflects their state specific risk exposures. All these factors are likely to contribute to lower WTP for FAF.

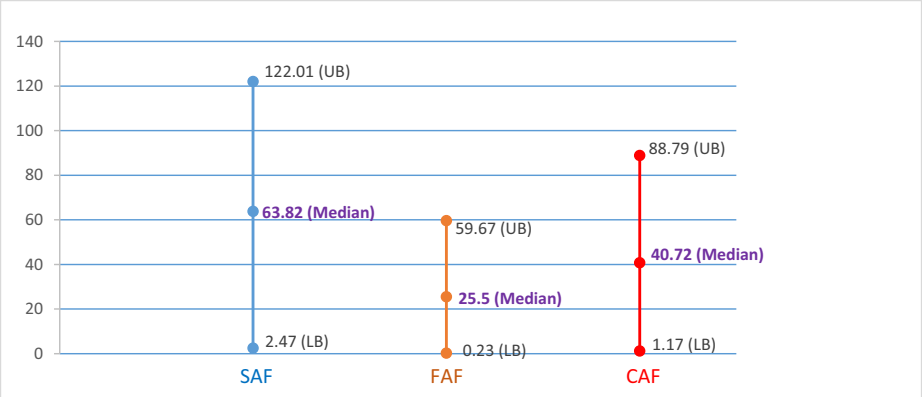

Fig. 3 Median willingness to pay (WTP) estimates with lower bounds (LB) and upper bounds (UB) from model 1

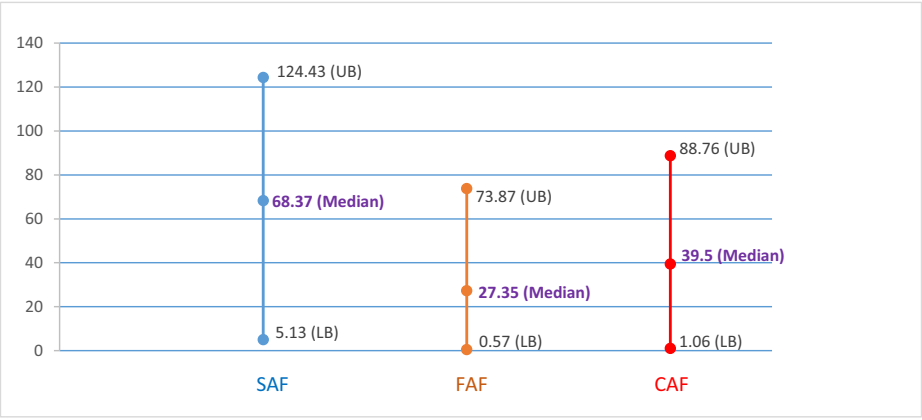

Fig. 4 Median willingness to pay (WTP) estimates with lower bounds (LB) and upper bounds (UB) from model 2

Conclusion

In this paper, we analyze households' preference for proactive adaptation measures to manage coastal vulnerability. Given that hurricane is a natural phenomena and we can not control its characterstics (e.g. intensity, time left for landfall, storm surge etc.), we propose establishing an adaptation fund to manage coastal vulnerability. We use a split-sample survey design for understanding household preferences for proposed state adaptation fund (SAF) and federal adaptation fund (FAF). We apply discrete choice logistic model to anlyze the survey data and show that households are willing to pay more for a state adaptation fund (SAF) compared to a federal adaptation fund (FAF). The findings imply that households consider state agencies more suitable than federal agency in managing extreme weather-related disaster risk in coastal communities. On the other hand, federal agency plays an important role in disbursing fund for disaster-management across different states.

Williams (2012) has used an analytical approach to evaluate the efficiency of state versus federal actions in implementing environmental policy measures. One of his major findings is that the state and federal tax for implementing environmental policy yield more efficient outcome than federal command and control policy. Moreover, if the states are more likely to supplement the national tax with their own taxes then this can lead to a more efficient outcome than a national tax alone. This suggests that there is a need of optimal mix of responsibility between state and federal governments in promoting environmental sustainability, which can be relevant for promoting adaptation and disaster management activities. More generally, households may consider contributing to both state and federal fund to manage coastal vulnerability.

In closing, we believe that this study provides some insights for policymakers to realize whether adapation policies to reduce coastal hazards risk should be managed at the state or federal level or a combination of both. Given that United States has a significant number of populations living in coastal areas who are exposed to increasing levels of vulnerabilities; the need for state and federal programs are on the rise. Against this backdrop, we studied households willingness to pay for implementing ex-ante adaptation policies at the state level or at the federal level or both. Household preferences to these ex-ante policies can provide insights to build proactive measures to minimize the adverse effects of hurricanes and scale up community resilience. Since the study is conducted after 9 months of hurricane Sandy, we recognize that WTP responses for adaptation funds may be subject to some upward bias. The longitudinal study by Shaw and Baker (2010) have shown that the

WTP for the Round I Katrina sample is relatively higher that of the Round II sample. This issue opens the scope to conduct a follow-up research to see whether household preference in managing coastal vulnerability is stable over time and space (e.g. across communities that are not affected by a recent hurricane).

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Appendix

Table 8 Marginal effects from estimated logit model 2 (considering state disaster preparedness ranking as a control variable)

	(SAF)	(FAF)	(CAF)
Ln(state bid)	−0.472 (0.163)***	–	–
Ln(federal bid)	–	−0.246 (0.156)	–
Ln(bid)	–	–	−0.317 (0.110)***
State tax time	−0.083 (0.182)	–	–
Federal tax time	–	−0.281 (0.180)	–
Tax time	–	–	−0.198 (0.126)
Evacuation	0.448 (0.371)	0.450 (0.349)	0.393 (0.251)
Insurance	−0.336 (0.189)*	−0.174 (0.203)	−0.239 (0.135)*
Window protection	0.599 (0.416)	0.621 (0.384)	0.527 (0.284)*
Expectation	0.107 (0.219)	0.427 (0.227)*	0.240 (0.156)
Concern	0.872 (0.198)***	0.318 (0.185)*	0.568 (0.132)***
Experience	0.061 (0.191)	−0.094 (0.199)	0.002 (0.136)
Ln(damage)	0.018 (0.027)	−0.058 (0.028)	−0.015 (0.019)
Income	0.010 (0.026)	0.050 (0.026)**	0.024 (0.018)
Age	−0.012 (0.006)**	−0.000 (0.006)	−0.006 (0.004)**
Education	0.099 (0.070)	0.089 (0.064)	0.105 (0.047)**
Household size	−0.307 (0.098)***	−0.020 (0.077)	−0.147 (0.060)**
State disaster preparedness ranking	0.033 (0.017)**	0.017 (0.015)	0.021 (0.011)**

Table 8 (continued)

	(SAF)	(FAF)	(CAF)
Constant	1.861	0.130	0.647
	(1.302)	(1.306)	(0.903) ***
Pseudo R^2	0.076	0.044	0.045
AIC	742.2041	756.5042	1485.172
BIC	807.956	822.078	1561.13
N	596	582	1178

Note: Numbers in parentheses are the corresponding standard errors; *** Significant at 1% levels, ** Significant at 5% levels, * Significant at 10% levels

Table 9 Marginal effects from estimated logit model 2 (considering state disaster preparedness ranking as a control variable)

	(SAF)	(FAF)	(CAF)
Ln(state bid)	−0.472	–	–
	(0.163)***		
Ln(federal bid)	–	−0.246	–
		(0.156)	
Ln(bid)	–	–	−0.317
			(0.110)***
State tax time	−0.083	–	–
	(0.182)		
Federal tax time	–	−0.281	–
		(0.180)	
Tax time	–	–	−0.198
			(0.126)
Evacuation	0.448	0.450	0.393
	(0.371)	(0.349)	(0.251)
Insurance	−0.336	−0.174	−0.239
	(0.189)*	(0.203)	(0.135)*
Window protection	0.599	0.621	0.527
	(0.416)	(0.384)	(0.284)*
Expectation	0.107	0.427	0.240
	(0.219)	(0.227)*	(0.156)
Concern	0.872	0.318	0.568
	(0.198)***	(0.185)*	(0.132)***
Experience	0.061	−0.094	0.002
	(0.191)	(0.199)	(0.136)
Ln(damage)	0.018	−0.058	−0.015
	(0.027)	(0.028)	(0.019)
Income	0.010	0.050	0.024
	(0.026)	(0.026)**	(0.018)
Age	−0.012	−0.000	−0.006
	(0.006)**	(0.006)	(0.004)**
Education	0.099	0.089	0.105
	(0.070)	(0.064)	(0.047)**
Household size	−0.307	−0.020	−0.147
	(0.098)***	(0.077)	(0.060)**
State disaster preparedness ranking	0.033	0.017	0.021
	(0.017)**	(0.015)	(0.011)**
Constant	1.861	0.130	0.647
	(1.302)	(1.306)	(0.903) ***
Pseudo R^2	0.076	0.044	0.045
AIC	742.2041	756.5042	1485.172
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Note: Numbers in parentheses are the corresponding standard errors; *** Significant at 1% levels, ** Significant at 5% levels, * Significant at 10% levels

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