GOVERNMENT ACQUISITION OF HOMES TO REDUCE FLOOD DAMAGE, HOUSEHOLD WILLINGNESS TO PARTICIPATE, AND IMPLICATIONS FOR ACQUISITION POLICY

By

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Studies show that a relatively small proportion of properties are responsible for a large proportion of the National Flood Insurance Program's claims. While several household-level flood risk mitigation measures exist to address the pervasive losses, government acquisition of at-risk homes is the most effective household-level flood mitigation approach to eliminate the flood risk to properties, but also the most expensive. The program, despite its potential, is arguably the most controversial and thus under-utilized by homeowners. To encourage participation, flood risk mitigation officials and policy makers want to know the factors that affect homeowners' willingness to participate in the program.

So, to better inform policy makers, in this dissertation I examine empirically the factors that affect homeowner participation, including acquisition contract attributes, future insurance pricing, and availability of alternative mitigation efforts. Thus, this dissertation contributes to the growing literature on natural hazard risk mitigation and decision-making by providing evidence on the factors that influence homeowner participation in the government acquisition program. Also, this work provides valuable information on the potential effect of proposed programmatic

changes on participation. In addition to attributes of the offered program, this dissertation explores how observables, like homeowner demographics and flood risk to the home, and latent characteristics, like homeowners' perceptions of flood risk, also impact willingness to participate. The dissertation consists of an introductory chapter and three self-contained papers organized into three chapters.

In the first paper, which is presented in chapter 2, I combine homeowners' stated preference, socioeconomic, and flood risk data to examine acquisition price effects on participation and provide willingness to accept estimates. This paper has been published in the *Southern Economic Journal*.

The second paper builds on the first paper in several ways. I use data from a national survey that elicits homeowners' stated preference for household-level flood risk mitigation, to examine how proposed changes to the buyout program, coupled with availability of alternative mitigation options like home elevation and future insurance pricing, will affect buyout participation. I estimate a conditional logit model and a random parameter logit model and provide willingness to accept estimates.

In the final paper, which is presented in chapter 4, I evaluate the policy implications of utilizing subjective or objective risk indicators in hazard risk management tools. In the paper, I derive a single index each for subjective and objective risk using factor analysis, then integrate these indices with the discrete choice data from chapter 3. I then estimate conditional logit models to derive willingness to accept estimates to better understand how different risk indicator types affect hazard policy recommendations.

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by

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DEDICATION

This work is dedicated to my family.

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CHAPTER 1 : INTRODUCTION

Flooding due to extreme weather events has proven to be among the costliest natural disasters due to the scope and frequency of this hazard. Between 1980 and 2011, losses from floods around the world increased from an annual average of $7 billion to $24 billion (Kundzewicz, et al. 2012). In the U.S., between 2015 and 2019, the National Oceanic and Atmospheric Administration lists 19 flood events as “Billion-Dollar Weather and Climate Disasters” (NOAA 2020) (see Table 1.1).

Table 1.1: 2015-2019 events with significant flooding

Event/ flooding	Year	Damage (billion $)
Missouri River and North Central Flooding	March 2019	10.9
Arkansas River Flooding	June 2019	3.1
Mississippi River, Midwest, and Southern Flooding	July 2019	6.3
Tropical Storm Imelda	September 2019	5.6
Hurricane Dorian	September 2019	1.6
Hurricane Michael	October 2018	25.5
Hurricane Florence	September 2018	24.5
California Flooding	February 2017	1
Missouri and Arkansas flooding	April 2017	1.7
Hurricane Harvey	August 2017	126.3
Hurricane Maria	September 2017	90.9
Hurricane Irma	September 2017	50.5
Texas and Louisiana	March 2016	2.3
Houston	April 2016	2.7
West Virginia flooding	June 2016	1
Louisiana	August 2016	10.1
North Carolina flooding due to Hurricane Mathew	October 2016	10.1
Texas and Oklahoma flooding	May 2015	2.6
South Carolina and east coast flooding	October 2015	2.1

There is a consensus that the greater share of the losses is concentrated in the coastal environment where millions of people live.[1] Coastal U.S. is vulnerable to tropical cyclones (hurricanes, tropical and sub-tropical storms, and nor'easters)[2] (Marks and Shay 1998), with the Gulf and Atlantic Coasts struck almost annually by a tropical cyclones (Curtis 2013). The resulting storm surge, compounded by eustatic sea-level rise, riverine and estuarine flooding, rising coastal populations, and increasing assets, results in dramatic flood losses (NOAA 2000). Unfortunately, predictions indicate that the intensity of tropical cyclones and sea-level rise are expected to increase due to climate change (Knutson, et al. 2010; Intercontinental Panel on Climate Change - IPCC, 2007; United Nations International Strategy for Disaster Reduction - UNISDR, 2011). In low-income environments where properties are not insured, losses from floods could have significant impacts on livelihoods, and where flood insurance is the norm, the ability of insurers to meet growing damage claims is questionable.

Since 1968, the National Flood Insurance Program (NFIP) has provided federally subsidized flood insurance to homeowners and businesses. Unsurprisingly, over 70 percent of the policies are concentrated in coastal areas (Smith and Katz 2013). One particular problem that has plagued NFIP is rising numbers and magnitude of flood damage claims. The program's debt was scheduled to exceed its $30 billion borrowing limit until $16 billion in debt was canceled in October 2017. Over the last 50 years, NFIP has gone through a series of reauthorizations to address perverse incentives that exacerbated losses. Unfortunately, efforts to raise premiums have failed. Considering this, other approaches to mitigate flood losses, such as government acquisition (buyouts) of at-risk homes has received considerable attention at all policy making

[1] The United States Census Bureau (USCB) estimates that about 94 million (29%of U.S. population) people live in coastline counties and 60 million people are in the path of tropical cyclones (USCB 2018).
[2] Between 1980 and 2000, tropical cyclones caused the most damage ($954.4 billion, CPI-adjusted) (NOAA 2000).

levels. Nevertheless, participation in the program is voluntary, and individuals frequently will not engage in cost-effective hazard risk mitigation measures voluntarily (Kunreuther 2006)[3]. Thus, it is important to understand what factors affect a homeowner's decision to participate in the government acquisition program. Acquisition of the most at-risk properties will aid in improving the solvency of NFIP.

To that end, the purpose of this work is to strengthen the understanding of the factors that affect a homeowner's decision to participate in the government acquisition program. Specifically, the objectives of this work are to examine;

1. The extent to which the size of acquisition payment affects homeowners' willingness to accept acquisition contracts, and whether price effects vary with the timing of acquisition contracts (i.e., before or after a hurricane event damages a home), and other observables.
2. How proposed changes to the government acquisition program, coupled with availability of alternative mitigation options like home elevation and future insurance pricing, will affect participation.
3. The policy implications of utilizing subjective or objective risk indicators in hazard risk management tools.

Managing Flood Risk in the U.S.

Flood risk management decisions are made at all levels- public (i.e., federal and local government) and private (households and businesses). The public, through federal and state institutions such as the U.S Army Corps of Engineers (USACE) and the Federal Emergency

[3] Several reasons account for why individuals will not mitigate against hazard risk voluntarily. "They underestimate the likelihood of a future disaster, often believing that it will not happen to them; have budget constraints; are myopic in their behavior; and/or do not want to be the only one on the block modifying their structure" Kunreuther (2006).

Management Agency (FEMA), oversees different types of flood mitigation and flood related activities by implementing structural (e.g., construction of dams, levees, drainage channels), non-structural (e.g., land use and building regulations and standards, and flood insurance), and green approaches (e.g., wetlands) (Carter, et al., 2018 and Bakkensen, 2020). The private, on the other hand, is responsible for participating in government flood risk mitigation programs by purchasing flood insurance, retrofitting private property or relocating to less flood risk zones.

Prior to 1965, the public heavily relied on structural approaches to manage flood risk. However, between 1965 and 1992, flood risk management shifted from predominantly structural to non-structural approaches. Currently, flood risk management has turned towards relocating existing structures from floodplains and preventing development of new ones (Fraser, et al. 2003). To encourage residents to relocate from floodplains and other high-risk areas, the federal government, through FEMA, has implemented the government acquisition program.

Acquisition refers to the purchase of at-risk property (e.g., land and/or structure) by the government or relocate structures (e.g. manufactured homes) from floodplains to zones with lower flood risk (Handmer, 1985). The acquisition program is primarily financed through the Hazard Mitigation Grant Program (HMGP) which is a flood risk reduction program under the Hazard Mitigation Assistance (HMA) grant program and is authorized by Section 404 of the Stafford Act, 42 U. S. C. 5170c (FEMA 2015) (Frimpong, et al. 2019). The program, although started in 1990, gained popularity in recent decades. “Several communities with significant flood risk have used HMGP funds to acquire flood prone properties. For example, after the Great Midwest Floods in 1993, Cherokee and Story County in Iowa bought 157 properties and 28 properties respectively (FEMA 2011). About 800 properties were bought out in Grand Forks, North Dakota after the floods of 1997 (De Vries and Fraser 2012). Another 400 properties were

acquired in San Antonio, Texas in 1998 (De Vries and Fraser 2012). After Hurricanes Fran and Floyd in 1999, about 1,150 properties were bought in Greenville and Kinston, North Carolina (De Vries and Fraser 2012). Before funds are disbursed for a prospective property, Benefit-Cost Analysis is used to assess the cost-effectiveness of the acquisition (FEMA 2005)" (Frimpong, et al. 2019). The federal government supports up to 75% of the cost of acquiring at-risk properties while additional funds come from local or state government, the homeowner, and other non-governmental agencies (FEMA 2018a). "This collective of potential funding groups implies that total compensation may fall short of or exceed 100% of property value (Binder and Greer 2016)" (Frimpong, et al. 2019). "Individual homeowners cannot directly apply to FEMA to secure acquisition contracts for their property. Instead, states, territories, and federally-recognized tribes are eligible to apply for funds from the HMGP (FEMA 2015). Once funds are distributed to a state, territory, or federally recognized tribe, a local agency (e.g. state hazard mitigation officer or tribe representative) is responsible for managing the funds and approaching property owners with acquisition offers. Property owner participation in the acquisition program is voluntary. Acquired structures are demolished or relocated to higher ground if possible. Once the lot is cleared, it typically becomes open space or may be converted to a recreational area (FEMA 2005)" (Frimpong, et al. 2019).

"The program generally benefits both parties (i.e., property owners and the implementing government agencies). Barnhizer (2003) notes that for every $1 invested in the acquisition program, property owners who accept acquisition contracts generated $2 in reduction of future flood insurance premia. Further, the program gives homeowners the opportunity to financially protect against decreased property value (Greer and Binder 2017). Governments, both federal and local, also save on future expenditures for flood mitigation and response when an area is

cleared of flood prone structures (Barnhizer 2003). Acquisition can also benefit other members of society, as the resulting open space may be used for fishing, hunting, boating, and hiking (Barnhizer 2003). The open space may also help to mitigate future floods (Brody and Highfield 2013). The effect on adjacent property values is mixed with Barnhizer (2003) showing an increase in nearby property values and Zavar (2015) finding no effect" (Frimpong, et al. 2019).

Despite these benefits, government acquisition programs face challenges including high cost of implementing the program (Barnhizer 2003) and low participation rates (Fraser, et al. 2003; deVries 2017; Bukvic and Owen 2017) and so officials are considering programmatic changes to the program. The proposed changes will potentially allow homeowners to retain ownership of the deed-restricted lot and build new structures so long as they meet current local building codes (Flavelle 2018). The program is also expected to run on a continuous basis and not just after a presidential disaster declaration. It is in this regard that I seek to explain what factors motivate homeowners to participate in the acquisition program.

The rest of the dissertation is organized into 3 chapters. Chapter 2 addresses objective 1 of the study while chapters 3 and 4 address objectives 2 and 3 respectively

CHAPTER 2 : MEASURING HETEROGENEOUS PRICE EFFECTS FOR HOME ACQUISITION PROGRAMS IN AT-RISK REGIONS[4]

Abstract

Any entity offering flood insurance, whether it is private or government- administered such as the National Flood Insurance Program (NFIP), faces the challenge of solvency. This is especially true for the NFIP, where homeowner affordability criteria limit the opportunity to increase premia. One solution is to remove the highest flood risk properties from the insurer's book of business. Acquisition (buyout) of flood prone structures is a potentially permanent solution that eliminates the highest risk properties while providing homeowners with financial assistance to relocate in a less risky location. To encourage participation, homeowners are offered a pre-flood fair market value of their damaged (or at-risk of damage) structures. Although many factors have been shown to affect a homeowner's decision to accept an acquisition offer, very little research has been devoted to the influence of price or monetary incentive offered on homeowners' willingness to participate in acquisition programs. We estimate a pooled probit model and employ a bootstrap methodology to determine the effects of hypothetical home price offers on homeowners' acquisition decisions. We do so while controlling for environmental factors, property characteristics, and homeowner socio-demographic characteristics. Results show price indeed has a positive effect on likelihood of accepting an acquisition contract. Further, estimated homeowner supply curves differ

[4] With Jamie Kruse, Gregory Howard, Rachel Davidson, Joseph Trainor, and Linda Nozick; in *Southern Economic Journal*. This work was supported by the National Science Foundation under collaborative awards #1435298, 1433622, and 1434716. The statements, findings, and conclusions are those of the authors and do not necessarily reflect the views of the National Science Foundation.

significantly bases on the timing of the acquisition offer, as well as homeowner and property characteristics.

Introduction

The National Flood Insurance Program (NFIP) is tasked with multiple, sometimes contradictory goals. These include providing insurance at affordable premiums, gaining high participation rates in at-risk areas, and generating sufficient revenues to support the cost of the program. In recent decades, the NFIP has fallen short of this final solvency goal, often to the tune of billions of dollars per year. The Biggert-Waters Flood Insurance Reform Act of 2012 (B-W 12), an attempt to address solvency through a move towards risk-based premium rate structures, met with such public resistance that the Homeowner Flood Insurance Affordability Act of 2014 (HFIAA) was enacted to postpone or roll back proposed rate increases. Consequently, as of March 2017 the U.S. General Accountability Office (GAO) reported that the Federal Emergency Management Agency (FEMA), which administers the NFIP, owed the Department of Treasury $24.6 billion (before the devastating 2017 hurricane season).

In an effort to eliminate the recurring societal and economic damages from floods, the Federal Emergency Management Agency (FEMA) introduced programs such as the Hazard Mitigation Grant Program (HMGP) to incentivize owners with repeat flood loss homes to move or retrofit the at-risk structures or sell to the government for demolition (FEMA 2015). Government acquisition programs are usually activated after a presidential disaster declaration. Homeowners' participation in the HMGP is voluntary, and those who choose to participate are offered a price based on the pre-damage fair market value of their damaged or at-risk property. Up to 75% of the cost of acquiring such properties is supported by the federal government while

additional funds come from local or state government, the homeowner, and other non-governmental agencies (FEMA 2018a). This collective of potential funding groups implies that total compensation may fall short of or exceed 100% of property value (Binder and Greer 2016).

The HMGP was introduced in 1988 (Fraser, Doyle, and Young 2006) and gained prominence after the Great Midwest Floods of 1993 when FEMA began financing the acquisition of damaged properties (Greer and Binder 2017). As of 2004, an estimated 100,415 structures were identified as repetitive loss properties according to a 2004 GAO Report (General Accounting Office 2004).[5] By 2012, it was estimated that 20,000 damaged and at-risk properties have been acquired and demolished or relocated (Maly and Ishikawa 2013). That is, homeowners' participation in the HMGP acquisition program has not been encouraging (Fraser, et al. 2003; deVries 2017; Bukvic and Owen 2017). The question therefore is, why are some homeowners with property in high flood risk areas willing to accept acquisition contracts while others are not, and what factors influence this decision?

Prior empirical studies that have attempted to answer the preceding question note that socio-demographic factors, environmental factors, property characteristics, program funding, ability of local flood mitigation officials to guide homeowners through the process, and sense of place affect property owners' decision to accept acquisition contracts (Handmer 1985; Fraser, et al. 2003; Fraser, Doyle, and Young 2006; Fraser, De Vries, and Young 2006; De Vries and Fraser 2012; Kick, et al. 2011; Zavar, Hagelman, and Rugeley 2012; Bukvic, Smith, and Zhang 2015; Reeser 2016; Robinson, et al. 2018). Surprisingly, sensitivity to price changes in acquisition contracts has <u>not</u> been rigorously addressed in the literature.

[5] Repetitive loss properties have experienced two or more flood insurance claims of $1,000 or more (GAO 2004).

This chapter examines the extent to which the size of acquisition payment affects homeowners' willingness to accept acquisition contracts, and whether price effects vary with the timing of acquisition contracts (i.e., before or after a hurricane event damages a home) and other observables. We address these important questions using survey data of eastern North Carolina homeowners. We estimate a panel-style pooled probit model to determine the effect of hypothetical home price offers on homeowners' decisions to accept acquisition contracts. We also examine the effect of environmental factors, property characteristics, and homeowner socio-demographic characteristics on both i) the average willingness to accept a contract and ii) homeowner response to changes in the offered buyout payment. We use these models to construct buyout property supply curves illustrating the quantity of homes willing to accept buyout contracts for a range of payment levels. A block bootstrap methodology is then used to test for heterogeneity in supply along the covariates. Results reveal a positive price effect on likelihood of accepting an acquisition contract. This effect is universal, but not uniform, instead varying in magnitude depending on the timing of the contract offer and other factors described below.

The chapter is organized as follows. The next section provides related literature review on homeowners' decision to participate in acquisition. We then proceed with the survey design and administration, the econometric model, results and discussion, and finally concluding remarks and future work.

Related Literature

Several previous studies have explored a variety of factors that affect homeowners' acquisition decision-making. Handmer (1985) analyzed survey data of homeowners from three communities

in Australia to understand homeowners' behavior toward acquisition programs. Their mode of analysis was purely descriptive, and their results show that perception of benefit from acquisition, perception of flood risk, and attachment to community or place affect acquisition behavior. In the U.S., Fraser, et al. (2003) collected survey data from four study sites (Greenville and Kinston in North Carolina; Grand Forks, North Dakota; and San Antonio, Texas) to study homeowners' decisions to accept acquisition offers. Based on their descriptive analysis, perception about the likelihood of future flooding, ability to find affordable homes, fear of greater debt, loss of rental homes, attachment to the community, length of time it takes for officials to approach homeowners after a flood disaster, and length of time to complete the acquisition process affects a homeowner's decision to participate in the acquisition program.

Other studies have approached the issue using different analytical methods. Fraser, Doyle, and Young (2006) used a logistic regression framework to analyze survey data of homeowners of repetitive loss structures in the U.S. They controlled for variables including property condition, neighborhood attachment, helpfulness of mitigation officials, income, and presence of children in households. They find that helpfulness and site match have positive effects on the likelihood of accepting acquisition, while property condition, neighborhood attachment, median income, and presence of children in households had a negative relationship. In a similar study, Fraser, De Vries, and Young (2006) interviewed homeowners in eight repetitive loss sites in the U.S. They find that a host of factors affect the decision to accept mitigation programs in North Carolina, including program funding, income, ability of local flood mitigation officials to guide homeowners through the process, neighborhood attachment, presence of children, and perception of property condition.

De Vries and Fraser (2012) analyzed data from a Fraser, et al. (2003) survey to determine factors affecting the homeowner acquisition decision. They controlled for the extent of damage to the neighborhood, homeowners' ability to live in the home after the flood, home repairs after the flood, importance of family members, clarity of information, length of time for officials to approach homeowners, perception of voluntariness of the program, availability of alternative choices, perceived pressure felt to participate, trust in officials, opportunity of flooded residents to provide input, opposition voiced by residents, age, years left on mortgage, education, income, location fixed effects, and race. Only the importance of family members, availability of alternative choices, trust in officials, and income were significant in explaining the acquisition decision. Zavar, Hagelman, and Rugeley (2012) also investigated the relationship between site characteristics (total area of parcel, land value prior to flood, and structural improvement value prior to flood, and parcel proximity to central business district), location relative to river valley features, and property owners post disaster decision-making after the 2002 flood event in the central Texas Guadalupe River Valley. Results from a multinomial logistic regression model show that distance to river and land value prior to flood were negatively related to the decision to relocate or participate in acquisition. Other variables in the model were not significant. Bukvic, Smith, and Zhang (2015) also examined the effect of pre-disaster socio-economic household characteristics, level of preparedness, disaster exposure, experience with recovery, community embeddedness, and resource loss on the decision to relocate away from high risk areas in New Jersey after Hurricane Sandy. A correlation analysis revealed that the household decision to relocate is influenced by respondent's age, disaster exposure, level of experienced stress related recovery, personal financial recovery concerns, future cost of living in the high-risk area, concerns with increase in crime, future flooding, and disaster-induced resource loss.

More recent studies on homeowner acquisition decisions have found similar results. For example, Reeser (2016) examined factors that affect homeowners' willingness to pay to secure acquisition contracts and willingness to accept for acquisition contracts tied to mandatory flood insurance purchase. Homeowner-level data were collected using an online payment card contingent valuation survey. The survey considered the entire U.S., finding that homeowners are willing to pay an average of $605 to secure an acquisition contract. In determining factors affecting willingness to accept for an acquisition contract that was coupled with a requirement to buy flood insurance, Reeser (2016) controlled for variables such as self-reported flood risk, household size, environmental concern, income, race, neighborhood tenure, elevated homes, age, education, and past claims. Logistic regression results show that self-reported flood risk, household size, environmental concern, and income had a positive relationship with acquisition acceptance. Robinson, et al. (2018) also explored factors that affect homeowners' decision to accept government acquisition in eastern North Carolina. Survey data from homeowners were analyzed, and results from a logistic regression model revealed that location in the floodplain, expected future tenure, the number of hurricanes previously experienced, fatalism, and race were the only variables significant in explaining homeowner decision to accept government acquisition.

Kick, et al. (2011) is the study that comes closest to examining the effect of offered price on acquisition acceptance. They analyze survey data on repetitive-loss homeowners' mitigation decision to determine factors that affect the ease of reaching a relocation mitigation decision. Data were collected across 8 study sites throughout the southern and western U.S. In addition to explanatory variables considered in previously mentioned studies, the authors examine whether state or local agencies offered a 25% site match on top of the 75% offered by federal agencies.

Results from a structural Equation model show offering a 25% site price match, which raises the buyout offer from 75% of market value to 100%, increases the ease of reaching a relocation mitigation decision.

In summary, there is strong support and general consensus in the literature regarding the effects of attachment to place, property condition, site characteristics, location in floodplain, and distance to shore/coastline on acquisition acceptance, while evidence on the effects of other variables is limited or mixed.

Survey Design and Administration

The survey was designed to collect primary data on homeowners' hurricane mitigation decisions. Prior to evaluating the questions, respondents were informed that the survey was funded by the National Science Foundation and that their responses will benefit emergency planning professionals, researchers, and themselves (homeowners). This was done with the goal of establishing policy consequentiality among respondents, though no additional questions or tests of perceived consequentiality followed in the body of the survey. The survey took approximately 20 minutes to complete, with the first three questions acting as screening questions that ask homeowners whether they (i) are at least 18 years old, (ii) owned and lived at the delivery address of the survey, and (iii) take part in making decisions related to the property. The bulk of the survey collected data on hurricane experience, home retrofit decision, homeowner preferences for acquisition programs, and sociodemographic factors. While the survey collected data on a broad range of hurricane mitigation questions, in this chapter, we analyze questions that focus on acquisition. Respondents were briefed on acquisition programs using the following short script: *Property acquisition (buyout) programs pay residents to move away from dangerous*

areas so that no one will suffer damage or injury in that home during future events, and were also asked whether the government has ever made an offer to buy their home. Figure 2.1 presents the survey questions used to capture homeowner acquisition decisions given hypothetical offers. Homeowner addresses were geocoded and used to collect data on distance to coastline, lot size, and whether the property is located in a floodplain. Data on lot size were obtained from county web sites (e.g., Wake County Government 2018) and the real estate web site "Zillow" (Zillow 2018) while property location in a floodplain was determined based on FEMA's flood map data (FEMA 2018b). Table 2.1 presents a description of variables used in our analyses. The survey was mailed to respondents in January 2017. A total of 2,500 households were randomly selected for the study. The sample was purchased from "Genesys," a branch of the Marketing Systems Group, which utilizes the U.S. Postal Service's address database system to select random addresses for research purposes. Our sample consists of only single-family households in eastern North Carolina. In administering the survey, we followed the recommendations of Dillman (2007) to achieve high survey response rates. Four contacts through first-class mail were made to each household. First, postcards were mailed indicating that respondents' participation in a scientific research study was being requested. One week after the postcards were sent, the surveys were mailed. The survey packet consisted of the questionnaire, a stamped return envelope, and a $1 bill incentive. Two weeks later, a postcard was mailed to respondents to serve as a reminder. A final reminder was sent out two weeks after that. To ensure personalization, the survey begins with a personalized note from two of the project's principal investigators. As of April 2017, the total surveys returned were 233. Using the American Association for Public Opinion Research's (AAPOR) metrics for survey response rates (AAPOR 2018) and factoring

out refusals and undeliverable surveys, our minimum response rate is 10% (AAPOR 1). After accounting for missing values, a total of 152 responses were used in our regression analysis.

The state of North Carolina is divided into three geographic regions—the Appalachian Region, Piedmont Region, and the Coastal Plain Region (Lecce 2000). The eastern part of North Carolina is the Coastal Plain Region, and it extends from the coastline to the Piedmont boundary. Eastern North Carolina has experienced devastating hurricane-related flood events in recent decades (e.g., Hurricanes Fran and Floyd in 1999). As recently as 2016, Hurricane Matthew made land fall as a category 1 hurricane, damaging about 100,000 structures and killing 26 people in the eastern part of North Carolina (North Carolina 2017a). The after-Mathew rebuilding strategy for 50 counties in eastern North Carolina includes offering acquisition contracts to selected properties (North Carolina 2017b). Additional flood damage occurred in September of 2018 due to Hurricane Florence. Figure 2.2 presents the distribution of respondents' property in the study area. The dots represent respondent property locations and the red boundary line shows the coastline.

The table below shows some made up options a government property acquisition (buyout) program could offer. For each option below, if the government made you an offer to purchase your home at the value listed, would you take it?

The government would pay you…	I would accept the buyout.	
	Yes	No
75% of market value for your home.	☐	☐
90% of market value for your home.	☐	☐
100% of market value for your home.	☐	☐
110% of market value for your home.	☐	☐
125% of market value for your home.	☐	☐

Now imagine a hurricane has seriously damaged your home and you have not started repairing it yet. In that situation, if the government made you an offer to purchase your home at the value listed below would you take it?

The government would pay you…	I would accept the buyout.	
	Yes	No
75% of market value for your home.	☐	☐
90% of market value for your home.	☐	☐
100% of market value for your home.	☐	☐
110% of market value for your home.	☐	☐
125% of market value for your home.	☐	☐

Figure 2.1: Survey questions used to capture homeowner acquisition decision.

Table 2.1: Summary of variables

Variable	Description
	Acquisition
Choice (dependent variable)	= 1 if homeowner is willing to accept acquisition at a given pre-damage fair market value of property (Price), and 0 otherwise
Before hurricane event	= 1 if homeowner response of accepting acquisition is observed before hurricane event, and 0 otherwise (after hurricane event)
After hurricane event	= 1 if homeowner response of accepting acquisition is observed after hurricane event, and 0 otherwise (before hurricane event)
Price	Percentage of home value government is willing to offer to homeowner in exchange for homeowner's house. These are hypothetical and include 75%, 90%, 100%, 110%, 125%
	Environmental factors
Floodplain	= 1 if property is in a 100-year floodplain, and 0 otherwise
Distance to coastline	Measured in kilometers as the straight line distance from the North Carolina coastline to the homeowner property location
	Property Characteristic
Lot size	Homeowner's lot size is measured in acres
	Socio-demographics
Tenure in home	Number of years a homeowner has lived in the current house
Race	=1 if homeowner is White, and 0 otherwise
Income	Income represents annual household income and is in three categories. Lower = 1 if income is < $50,000, and 0 otherwise. Middle = 1 if income > $49,999 and less than $100,000, and 0 otherwise. Higher = 1 if income > $99,999, and 0 otherwise.
Education	=1 if homeowner has at least 2 years of college or higher education, and 0 otherwise.

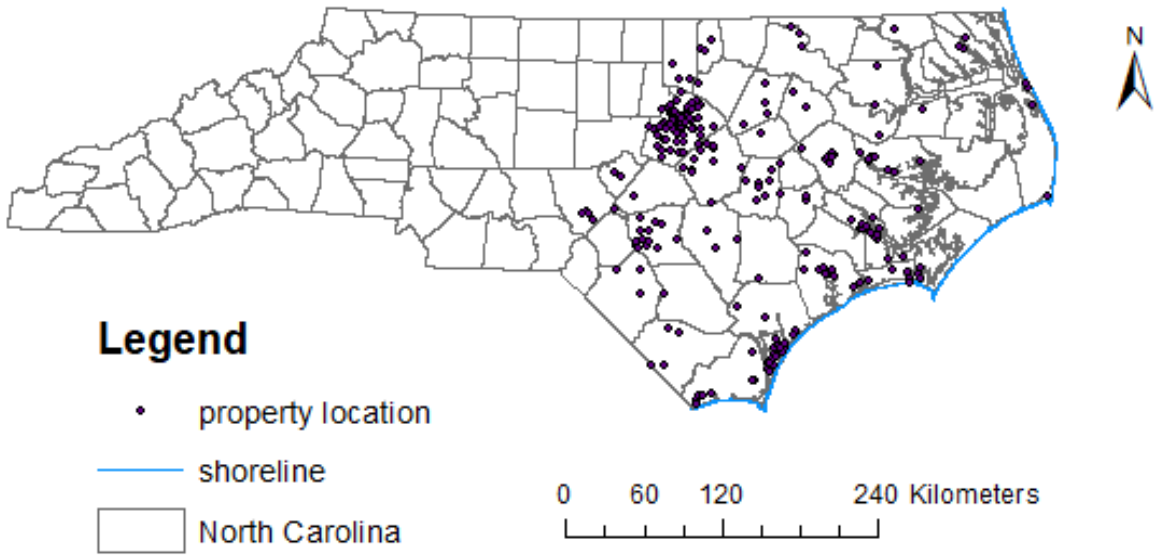


Figure 2.2: Geographic distribution of respondents' properties in eastern North Carolina

Empirical Model

Econometrics

Each homeowner makes a total of 10 choices, so we may describe our data as a panel. We specify the econometric model as

$$y_{it} = \boldsymbol{X_i\beta} + \boldsymbol{P_{it}\theta} + \varepsilon_{it}, \qquad (2.1)$$

where y_{it} is the dependent variable (*choice*) for the i^{th} homeowner in choice situation t; $\boldsymbol{X_i}$ is a vector of respondent- and property-level covariates: *Floodplain, Distance to coastline, Lot size, Tenure in home, Race, Income, and Education*; $\boldsymbol{P_{it}}$ is a vector of choice-specific covariates, which include an indicator for whether the contract is offered before or after the house has sustained damage from a hurricane as well as price variables; $\boldsymbol{\beta}$ and $\boldsymbol{\theta}$ are vectors of parameters to be estimated; and ε_{it} is the random error component. Our choice-specific covariates contain variables that have within-decision-maker variation while our respondent- and property-level covariates exhibit between-decision-maker variation but lack within-decision-maker variation.

Panel models are categorized as pooled, random effects, or fixed effects based on assumptions regarding the error term (Wooldridge 2002; Greene 2012). Pooled models assume no individual unobserved effects (i.e., homeowners are homogeneous beyond what can be captured in covariates), and that the random error component is uncorrelated with the covariates (Wooldridge 2002; Greene 2012). The fixed effects model assumes unobserved effects, and that the unobserved effects and random error component are correlated with the covariates. A disadvantage of the fixed-effects model is the inability to estimate variables that lack within-decision-maker variation (in our case *Distance to coastline and Lot size*). Unlike the fixed-effects, random-effects models assume no correlation between the unobserved effects or the random error component and the covariates (Wooldridge 2002; Greene 2012). We utilize a pooled model. Given that our dependent variable is binary, we link the dependent variable to the covariates via the probit link function:

$$\Phi^{-1}[\Pr(y_{it}=1|\,\boldsymbol{x}_i)] = \boldsymbol{X}_i\boldsymbol{\beta} + \mathbf{P_{it}}\boldsymbol{\theta} + \varepsilon_{it}. \qquad (12.2)$$

We acknowledge the possibility that the random error component may be correlated within units (individual homeowners' responses), thereby underestimating true standard errors (Cameron, Gelbach, and Miller 2008). As such we correct for this by computing the cluster-robust standard errors as recommended in the literature (Cameron, Gelbach, and Miller 2008), clustering at the respondent level.

With the goal of estimating price effects on homeowner willingness to participate in buyout programs, and further to examine whether price effects exhibit heterogeneity on demographics and other observables, we estimate the following models:

$$\Phi^{-1}[\Pr(y_{it}=1|x_i] = \boldsymbol{X_i\beta} + \ Before_{it}\theta_{Before} + \quad (2.2a)$$

$$(Before \times Price_{it})\theta_{Before\times Price} + (After \times Price_{it})\theta_{After\times Price}$$

$$\Phi^{-1}[\Pr(y_{it}=1|x_i] = \boldsymbol{X_i\beta} + [Before \times I(Z=1)]_{it}\theta_{Before\times I(Z=1)} + \quad (2.2b)$$
$$[After \times I(Z=1)]_{it}\theta_{After\times I(Z=1)} +$$
$$\left[Before \times \left(1 - I(Z=1)\right)\right]_{it}\theta_{Before\times\left(1-I(Z=1)\right)} +$$
$$[Before \times I(Z=1) \times Price]_{it}\theta_{Before\times I(Z=1)\times Price} +$$
$$[After \times I(Z=1) \times Price_{it}]\theta_{After\times I(Z=1)\times Price} +$$
$$[Before \times \left(1 - I(Z=1)\right) \times Price_{it}]\theta_{Before\times(1-I(Z=1))Price} +$$
$$[After \times \left(1 - I(Z=1)\right) \times Price_{it}]\theta_{After\times(1-I(Z=1))\times Price}.$$

Equation (2.2a) represents our simplest model. This model includes the entire list of individual- and property-level covariates (including a constant), an indicator for whether the choice concerned the house before a hurricane had damaged the property (*Before*), and two price-timing interaction variables. These interactions allow for different price effects based on whether the acquisition contract is offered immediately following damage from a hurricane event. Thus, this model allows for heterogeneity in willingness-to-accept (WTA) based on timing of the offer and allows for the construction of separate homeowner supply curves, one for pre-damage houses and one for post-damage houses. However, this model assumes that price effect heterogeneity is not linked to underlying property and property owner characteristics.

Equation (2.2b) broadly describes our more complicated models, which allow for further heterogeneity. In addition to timing (pre- and post-damage), these models allow for heterogeneity in price sensitivity by homeowner or home characteristics. The characteristics we examine in these models include race (white vs. nonwhite), homeowner tenure in the property (less than 10 years vs. 10 years or more), education level (less than college degree vs. college degree or more) flood risk to the property (located in the 100-year flood plain vs. not located in the 100-year flood plain), and income level (low, medium and high income, as defined in Table

2.1). Each version of Equation (2b) identifies one covariate, denoted *Z*, from the covariate vector ***X***. This covariate is removed and instead is included with two-way (Z and timing dummies) and three-way (Z, timing dummies and price) interactions in the model[6]. This methodology allows us to test for heterogeneous WTA values and to estimate different homeowner supply curves for each covariate-timing combination. Most covariates are indicator variables, which result in four supply curves representing each component of the 2x2 covariate-timing matrix.[7] For estimates of interest that include nonlinear combinations of coefficients (i.e., marginal effects and the probability of accepting acquisition contracts for various hypothetical property price offers), we use block bootstrapping to estimate standard errors (Efron and Tibshirani 1985; Efron and Tibshirani 1986; Hounkannounon 2008; Cameron, Gelbach, and Miller 2008; Kilian and Jung Kim 2011).

Bootstrapping

Bootstrap methodology is a well-known resampling method used to determine how accurate an estimate is an estimator of the true parameter (Efron and Tibshirani 1985; Efron and Tibshirani 1986). The approach involves randomly sampling (with replacement) from available data set to estimate the probability distribution of a statistic of interest (Efron and Efron and Tibshirani 1993). As the bootstrap samples approach infinity, the estimate approaches the true parameter of interest. Several bootstrap approaches exist, and the preferred approach depends on the kind of data set in-use (Hounkannounon 2008). For time series and panel data, the block bootstrap (or cluster bootstrap) is recommended because it allows for correlation of errors within clusters or

[6] Thus, the notation $\boldsymbol{X_i\beta}$ in Equation (2.2b) represents the full vector **X** less the heterogeneous covariate Z.
[7] The one exception to this is income, which has three categories, leading to a 3x2 matrix of income-timing combinations and a total of six supply curves.

groups but not across groups (Hounkannounon 2008; Cameron, Gelbach, and Miller 2008; Kilian and Jung Kim 2011). Bootstrap standard errors obtained from the bootstrap estimates are useful for constructing bootstrap confidence intervals for parameters of interest (Efron and Tibshirani 1985; Efron and Tibshirani 1986).

To estimate the marginal effects and the probability of accepting acquisition contracts for various hypothetical property price offers, we first estimate a pool probit model (correcting for error correlation) and obtain predicted probabilities for each price offer. We then sum these probabilities across homeowners and obtain a mean value (scalar) for each price offer. We perform the cluster bootstrap to estimate the true standard errors for the means. We use 1000 bootstrap replications in this chapter. This number of replications is considered to be more than adequate (Efron and Tibshirani 1985). The bootstrap is performed using Stata software. The confidence intervals obtained from the bootstrap are normal-base. That is the confidence intervals are based on the assumption that bootstrap sampling distribution approximates a Gaussian distribution. We also test for differences between bootstrap probability estimates. The predictive probabilities are used to plot supply curves that indicate the likelihood a homeowner will give up property in exchange for the price offered.

It is noteworthy that the econometric methodology utilized here differs from the standard in the literature for our payment card-style elicitation question. Typically, this data would be modeled using interval regression approaches (Cameron and Hupper 1989; Welsh and Poe 1998). While we acknowledge this deviation from standard practice in the literature, our modeling methods are consistent with the methods used in discrete choice modeling for similar stated preference surveys, and similar (though not identical) methods have been used when the payment card method is combined with an uncertainty response scale (Vossler et al. 2004; Wang

and Whittington 2005). Our primary reason for utilizing the probit instead of interval regression approach is due to the increased flexibility possible in the probit. In this context, interval regressions can estimate how home and homeowner characteristics influence homeowner WTA for the buyout program. A similar estimation is possible using the probit model, but the probit model allows for the estimation of price sensitivities by the said home and homeowner characteristics in a more flexible way. More specifically, the interval regression estimates how different characteristics influence the estimated payment needed to elicit agreement to the buyout offer. By contrast, the probit model can estimate both how these characteristics alter the utility of an offer (i.e., heterogeneous intercepts) and how the marginal utility of changing the buyout payment can differ by characteristics (i.e., heterogeneous slopes related to payment).

To the best of our knowledge, these two distinct effects cannot be separated using the interval regression. As a robustness check, we also show that the results of our probit model largely mirror those of an interval regression model.

Hypotheses

We split our hypotheses into two groups: those pertaining to raw likelihood of accepting buyout contracts (holding offered price constant) and those pertaining to price sensitivity to buyout contracts (how changing price alters the probability of contract acceptance).

Hypothesis 1: Buyout acceptance will be higher among homeowners who

i. *Are high-income*
ii. *Live in the floodplain*
iii. *Have had shorter tenure in the home*
iv. *Are closer to the coastline*

v. *Are offered the contract post-damage*

These hypotheses largely follow the findings of previous work. De Vries and Fraser (2012) and Reeser (2016) both found higher-income individuals are more likely to accept buyout contracts. Homeowners in floodplains more frequently experience flooding events and have a higher perception of flood risk, leading us to hypothesize that they are more likely to accept acquisition offers. Numerous studies find long tenure in the home reduces buyout acceptance rates (Fraser, Dodyle, and Young 2006; Fraser, De Vries, and Young 2006; and Kick, et al. 2011), while Zavar, Hagelman, and Rugeley (2012) note that homeowners who are distant from the river are less likely to relocate. We also expect that the prospect of avoiding costly repair to post-damage houses will make homeowners more likely to accept offers post-damage than pre-damage.

Alternate Hypothesis: Sensitivity to buyout price will be higher among homeowners who

i. *Are low-income*

ii. *Are on larger lots*

iii. *Are offered the contract pre-damage*

iv. *Live outside the floodplain*

v. *Have had longer tenure in the home*

vi. *Are further from the coastline*

Possible explanation why low-income homeowners will be more responsive to price changes would be that a 10% increase in the offered price represents a larger portion of the net assets of a low-income household than a similar percentage increase offered to a high-income household. Similarly, a 10% increase in the offer on a larger lot may represent a larger absolute increase in money offered, and therefore be more persuasive, than a similar increase on a smaller lot. Lastly, we reason that groups who are generally disposed toward accepting a buyout contract

will be less sensitive to price changes than a similar group who is, on average, disposed to reject a buyout contract. Presented in Table 2.2 are summary statistics of the variables.

Table 2.2: Summary statistics

Variable	Category	Mean	Std. Dev.	Min	Max
Choice	binary	0.49	0.50	0	1
Before hurricane event	binary	0.50	0.50	0	1
After hurricane event	binary	0.50	0.50	0	1
Price	percent	100	17.03	75	125
Floodplain	binary	0.10	0.30	0	1
Distance to Shore line [a]	continuous	99.59	69.48	0.09	196.41
Lot size[a]	continuous	1.16	2.9	0.03	33.75
Tenure in home	continuous	17.24	15.17	1	93
Race	binary	0.81	0.39	0	1
Income	binary				
Lower		0.27	0.44	0	1
Middle		0.29	0.45	0	1
Higher		0.39	0.49	0	1
Education	Binary	0.77	0.42	0	1

[a] In the econometric analysis, the variable is log transformed

Results and Discussion

Price Effects and Heterogeneity by Timing

Results from the base regression estimation outlined in Equation (2.2a) are presented in table 2.3.[8] As predicted, results show a negative and significant relationship between *Before hurricane event* and the decision to accept acquisition. Specifically, we find that homeowners are 51% less likely to accept acquisition contracts presented to them before a hurricane event compared to after, *ceteris paribus.* This is intuitive because households' decision to relocate from flood risk areas are mostly triggered after experiencing a damaging event. This preference can be translated

[8] Logit gives similar results in this case.

to dollar values by calculating homeowner WTA values[9] before and after a damaging event for the average respondent in the sample. Homeowners being less likely to accept a buyout offer before damage occurs suggests that WTA values should be higher before a flood event, and this is borne out in the data. WTA for the mean respondent is 100.35% of the value of the home if the offer is made after damage to the home (with a 95% confidence interval of 92.66–108.04) compared with 113.43% if the offer is made before damage to the home (with a 95% confidence interval of 107.52–119.34). Standard errors for these estimates are generated using bootstrapping with 1000 replications.

As one would expect, both price variables indicate that higher payments lead to higher acceptance rates. We further find respondents are more sensitive to price changes before hurricane events than after. The marginal effect for price before a hurricane event indicates that a 1% increase in price increases the likelihood of accepting acquisition contracts offered before a hurricane event by 2% while the marginal effect of a 1% price increase after a hurricane event increases the likelihood of acceptance by 1%.

Regarding homeowner and property characteristics, surprisingly, the coefficient on *Floodplain* is negative and significant. We hypothesized a positive relationship. That is, homeowners in a floodplain are 17% less likely to accept an acquisition offer compared to homeowners located outside floodplain. Robinson, et al. (2018) found a positive relationship between location of a property in floodplain and acquisition acceptance. This result may be due to moral hazard where homes in floodplains are required to carry flood insurance if financed by a

[9] Using notation from Equation 2.2a, the formula for estimating WTA is as follows:
Before a hurricane event: WTA = $\frac{\boldsymbol{X_i\beta} + Before_{it}\,\theta_{Before}}{\theta Before \times Price}$
After a hurricane event: WTA = $\frac{\boldsymbol{X_i\beta}}{\theta_{After \times Price}}$
:

federally backed mortgage. As hypothesized, the coefficient on *Distance to coastline* is negative and significant. Specifically, we find that for a 1% increase in the *Distance to coastline*, homeowners are 4% less likely to accept acquisition, *ceteris paribus*. This finding lends support to that of Zavar, Hagelman, and Rugeley (2012) who also find a negative relationship. The coefficient on *Lot size* is negative and significant, with a 1% increase in *Lot size* reducing homeowner acceptance probability by 6%. Our results on *Lot size* differ from those of Zavar, Hagelman, and Rugeley (2012), who find no relationship between total area of parcel and decision to relocate.

We find the relationship between *Tenure in home* and the likelihood of accepting acquisition is negative as hypothesized. For every additional year of *Tenure in home*, homeowners are 1% less likely to accept acquisition. Fraser, Dodyle, and Young (2006), Fraser, De Vries, and Young (2006), and Kick, et al. (2011) also find a negative relationship between attachment to place and decision to relocate. Contrary to our expectations, and to Fraser, De Vries, and Young (2006), who find a negative relationship, we find no significant effect of income on the likelihood of accepting acquisition. The coefficient on *Race* is positive and significant. That is, *ceteris paribus*, white homeowners are 12% more likely to accept acquisition offers. Our result on *Race* is consistent with that of Robinson, et al. (2018) who also found that non-white homeowners are less likely to accept acquisition contracts compared to white homeowners.

Using the model from Table 2.3, we take the following steps to construct homeowner supply curves. First, for each observation we generate a predicted probability of accepting the buyout contract. We then calculate the average probability of acceptance in the data at different price levels. Our econometric design allows for the specification of two different supply curves,

one pertaining to offers made before hurricane damage occurs and one pertaining to offers made after the property suffers hurricane damage. Figure 2.3 displays these supply curves. As indicated in the model, both curves are upward sloping, and the quantity supplied is greater after a hurricane event for all offered prices.

Table 2.3: Probit regression results

Variables	Coefficients	Standard Errors	Marginal effects
Before hurricane event	-2.16***	0.42	-0.51
Before hurricane event × price	0.06***	0.004	0.02
After hurricane event × price	0.04***	0.004	0.01
Floodplain	-0.62**	0.29	-0.17
log (Distance)	-0.21**	0.06	-0.04
log (Lot size)	-0.20**	0.08	-0.06
Tenure in home	-0.01*	0.01	-0.003
Race	0.43**	0.22	0.12
Income			
Lower	-0.09	0.19	-0.03
Higher	-0.20	0.34	-0.06
Education	0.28	0.20	0.08
Constant	-3.66***	0.57	
Pseudo R^2	0.29		

Note: ***, **, and * shows significance at 1%, 5%, and 10% levels of significance. Standard errors are robust clustered for 172 clusters in identifier (id), and number of observations = 1519. For binary variables, marginal effects are calculated as the discrete change from the base. For continuous variables, marginal effects are calculated as a unit change in the variable.

To test for whether these differences are statistically significant, we take the difference in quantity supplied (i.e., average probability of acceptance in the data) at a given price point. We then estimate standard errors and calculate *P* values for this difference using bootstrapping with

1,000 replications. In this formulation, the null hypothesis is that quantity supplied is equal for the two groups (before- and after-hurricane) at a given price point. *P* values for each price point, presented in Table 2.4, indicate the supply curves are different from each other at all price points.

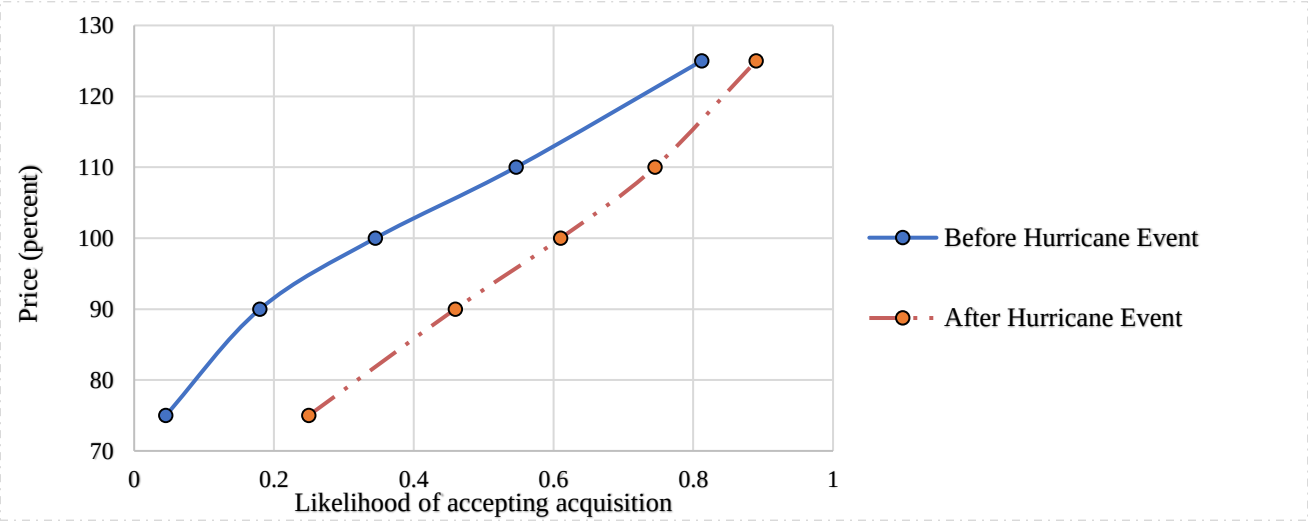


Figure 2.3: Likelihood of accepting acquisition, by timing (Damage State)

Table 2.4: Differences in quantity supplied, by timing

Price	75	90	100	110	125
Before = After	**0.000**	**0.000**	**0.000**	**0.000**	**0.002**

Notes: Reported values are p values for a test of equality between the two quantities. Bolded values indicated *P* values of 0.05 or less. Price is measured as a percentage of pre-damage fair market value for the home. Before stands for individuals considering their house before any damage. After stands for individuals considering their house after damage has occurred.

Heterogeneity by Homeowner and Property Characteristics

We next turn to our models that allow for heterogeneity by both timing and other homeowner and property characteristics, outlined by Equation (2.2b). Coefficient estimates for all five models are presented in the appendix. Figures 2.4-2.7 accompanied by Tables 2.5-2.8 display

property supply curves differentiated by race, tenure, education, and floodplain, respectively and whether these curves exhibit heterogeneity. We also explored income heterogeneity, finding mixed results that indicated no clear-cut relationship (see Figure 2.8 and Table 2.9). Each figure is matched with a table presenting *P* values for tests of equality between supply curves at different payment offers. As with the previous model, all standard errors are generated using bootstrapping with 1,000 replications.

Figure 2.4 and Table 2.5 demonstrate that we find no statistical difference in supply curves by race for contracts offered before a hurricane event. For contracts offered after a hurricane event, we find no difference in supply curves at payment offers of 75% and 90% of pre-damage property value, but at offers of 100% or more we find higher supply values for whites than non-whites. We also note that whites are more likely to accept contracts after a hurricane event at all prices compared to before a hurricane event. On the other hand, for non-whites, we find that the before and after event supply curves tend to converge at higher prices with no significant difference in the before-after comparison for the highest price level of 125% of pre-damage market value.

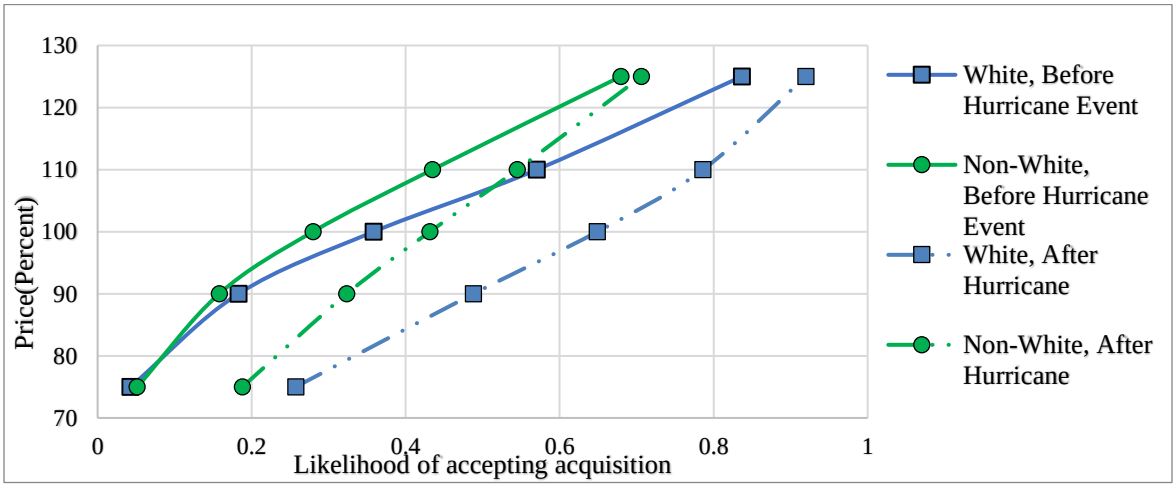


Figure 2.4: Likelihood of accepting acquisition, by race and timing

Table 2.5: Differences in quantity supplied, by race and timing

Price	W_B = W_A	W_B = NW_B	W_B = NW_A	W_A = NW_B	W_A = NW_A	NW_B = NW_A
75	**0.000**	0.804	**0.029**	**0.000**	0.366	**0.005**
90	**0.000**	0.697	0.075	**0.000**	0.055	**0.003**
100	**0.000**	0.336	0.412	**0.000**	**0.017**	**0.016**
110	**0.000**	0.165	0.803	**0.000**	**0.015**	**0.019**
125	**0.001**	0.125	0.218	**0.014**	**0.037**	0.680

Notes: Reported values are *P* values for a test of equality between the two quantities. Bolded values indicated *P* values of 0.05 or less. Price is measured as a percentage of pre-damage fair market value for the home. W_B stands for white individuals, considering their house before any damage. W_A stands for white individuals, considering their house after damage has occurred. NW_B stands for non-white individuals, considering their house before any damage. NW_A stands for nonwhite individuals, considering their house after damage has occurred.

Concerning home tenure (Figure 2.5 and Table 2.6), results show that heterogeneity exists, and further that the type of heterogeneity differs at low and high price offers. At low price levels, the heterogeneity is entirely driven by timing, with long- and short-tenure homeowners exhibiting similar behaviors. At higher offers, however, the heterogeneity changes. Specifically, we find that long-tenured homeowners receiving an offer before damage occurs are more hesitant to agree to contracts, while long-tenured owners after damage and all short-tenure homeowners (both before and after damage) all behave relatively similarly. It appears that short tenure homeowners are more price sensitive and willing to extract capital gains at 125% of market value without the added incentive to abandon a damaged home.

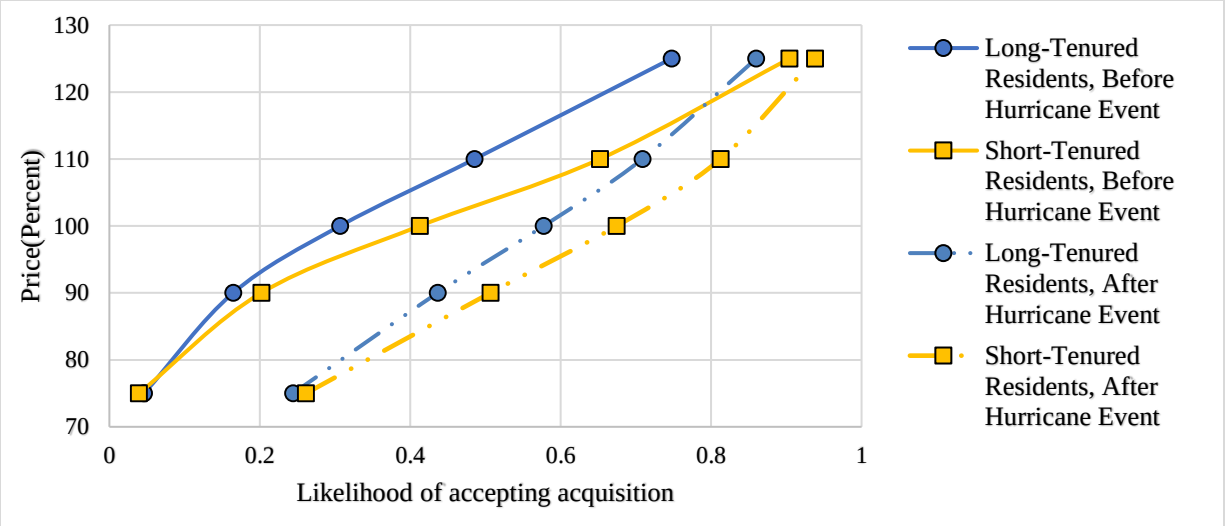


Figure 2.5: Likelihood of accepting acquisition, by tenure and timing

Table 2.6: Differences in quantity supplied, by tenure and timing

Price	10+_B = +10_A	10+_B = <10_B	10+_B = <10_A	10+_A = <10_B	10+_A = <10_A	<10_B = <10_A
75	**0.000**	0.743	**0.000**	**0.000**	0.787	**0.000**
90	**0.000**	0.407	**0.000**	**0.000**	0.284	**0.000**
100	**0.000**	0.086	**0.000**	**0.012**	0.137	**0.000**
110	**0.000**	**0.022**	**0.000**	0.442	0.095	**0.001**
125	**0.001**	**0.009**	**0.000**	0.413	0.094	0.297

Notes: Reported values are *P* values for a test of equality between the two quantities. Bolded values indicated *P* values of 0.05 or less. Price is measured as a percentage of pre-damage fair market value for the home. 10+_B stands for individuals who have lived in their home for ten years or more, considering their house before any damage. 10+_A stands for individuals who have lived in their home for ten years or more, considering their house after damage has occurred. <10_B stands for individuals who have lived in their home for less than ten years, considering their house before any damage. <10_A stands for individuals who have lived in their home for less than ten years, considering their house after damage has occurred.

Figure 2.6 and Table 2.7 show the likelihood of accepting acquisition offers by education level and timing. By and large, individuals with less than a college education are less willing to

accept offers than individuals with at least a college degree. However, further accounting for timing heterogeneity leads to an interesting pattern. At low offer levels, more educated homeowners receiving offers after damage occurs are far more likely to accept, with other groups (all non-college graduates and college graduates receiving offers before damage occurs) behaving similarly. As prices rise, we find two groups – college graduates being offered buyouts before damage and non-college graduates being offered after damage – are much more responsive to price increases than their counterparts. As a result, at highest offers we find the group of non-college graduates being offered before damage becomes an outlier, with substantially lower likelihood of accepting offers compared with the other three groups.

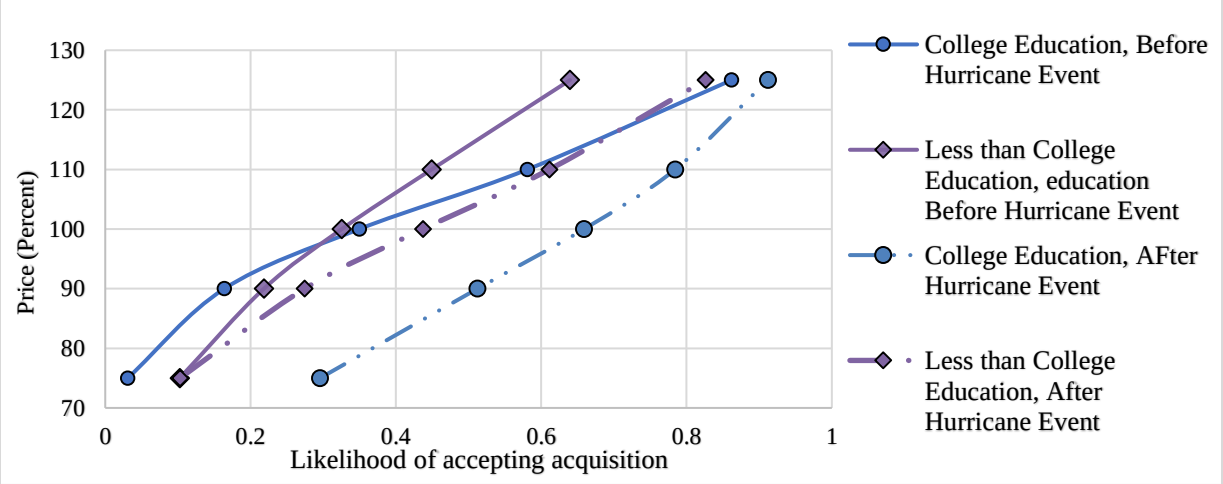


Figure 2.6: Likelihood of accepting acquisition, by education and timing

Table 2.7: Differences in quantity supplied, by education and timing

Price	C_Before = C_After	C_Before = NC_Before	C_Before = NC_After	C_After = NC_Before	C_After = NC_After	NC_Before = NC_After
75	**0.000**	0.088	0.084	**0.001**	**0.001**	0.991
90	**0.000**	0.374	0.105	**0.000**	**0.001**	0.230
100	**0.000**	0.744	0.278	**0.000**	**0.006**	**0.025**
110	**0.000**	0.127	0.734	**0.000**	**0.043**	**0.004**
125	**0.040**	**0.017**	0.620	**0.003**	0.218	**0.005**

Notes: Reported values are *P* values for a test of equality between the two quantities. Bolded values indicated *P* values of 0.05 or less. Price is measured as a percentage of pre-damage fair market value for the home. C_Before stands for individuals with educational attainment of a college degree or higher, considering their house before any damage. C_After stands for individuals with educational attainment of a college degree or higher, considering their house after damage has occurred. NC_Before stands for individuals with educational attainment of less than a college degree, considering their house before any damage. NC_After stands for individuals with educational attainment of less than a college degree, considering their house after damage has occurred.

Figure 2.7 and Table 2.8 present supply curves differentiated by presence in the floodplain and timing. We find no significant difference in quantity supplied by homeowners in floodplain and those outside floodplain after hurricane damage occurs. Indeed, the supply curves are almost identical. Referring back to wording of the survey question, homeowners are asked to imagine that their home has been seriously damaged by a hurricane. In this case, perceived risk associated with residing in a floodplain may be overshadowed by the added information that damage has occurred. This may be interpreted as base rate neglect where respondents contemplate recent evidence and ignore the underlying probability of damage (Kahneman and Tversky, 1973). We similarly find no difference by floodplain before damage occurs, though it

appears that homeowners outside the floodplain are more responsive to price changes than homeowners in the floodplain.

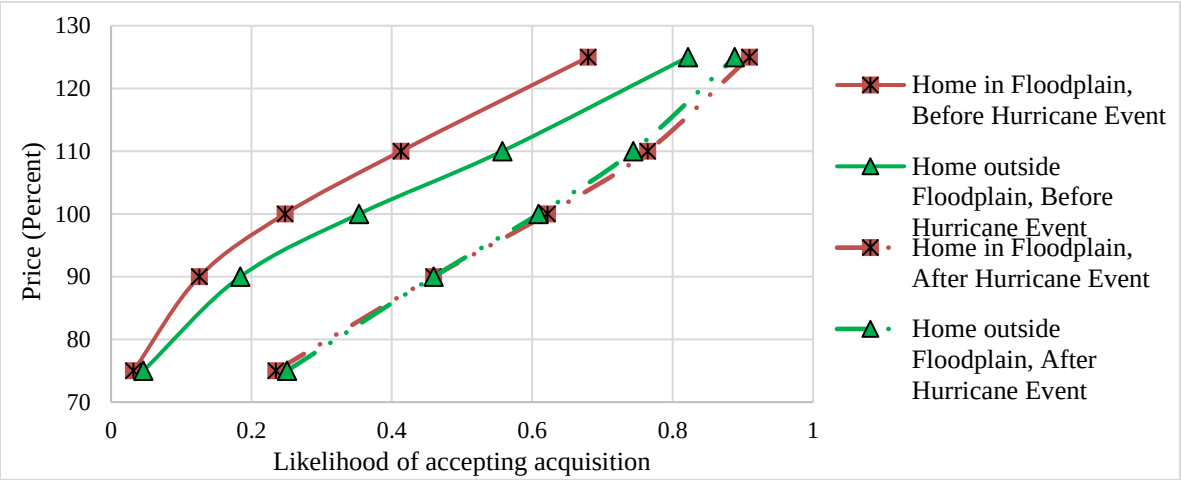


Figure 2.7: Likelihood of accepting acquisition, by floodplain and timing

Table 2.8: Differences in quantity supplied, by floodplain and timing

Price	F_Before = F_After	F_Before = NF_Before	F_Before = NF_After	F_After = NF_Before	F_After = NF_After	NF_Before = NF_After
75	**0.045**	0.442	**0.000**	0.059	0.877	**0.000**
90	**0.008**	0.219	**0.000**	**0.036**	1.000	**0.000**
100	**0.003**	0.284	**0.000**	0.066	0.932	**0.000**
110	**0.003**	0.284	**0.014**	0.144	0.884	**0.000**
125	0.075	0.385	0.199	0.420	0.847	**0.010**

Notes: Reported values are *P* values for a test of equality between the two quantities. Bolded values indicated *P* values of 0.05 or less. Price is measured as a percentage of pre-damage fair market value for the home. F_Before stands for individuals with homes in floodplain, considering their house before any damage. F_After stands for individuals with homes in floodplain, considering their house after damage has occurred. NF_Before stands for individuals with homes in floodplain, considering their house before any damage. NF_After stands for individuals with homes in floodplain, considering their house after damage has occurred.

Figure 2.8 and Table 2.9 present supply curves differentiated by income categories. The supply curves are almost identical. That is, we find no significant difference between quantity supplied income categories. However, interacting income categories with timing heterogeneity, we find significant difference in quantity supplied for homeowners with low income before and after a damaging event. The significant difference is also observed for middle income homeowners and higher income homeowners. Nevertheless, across income categories and timing heterogeneity, the difference in quantity supplied is limited. Table 2.10A presents estimated coefficients for the various models considered in this chapter.

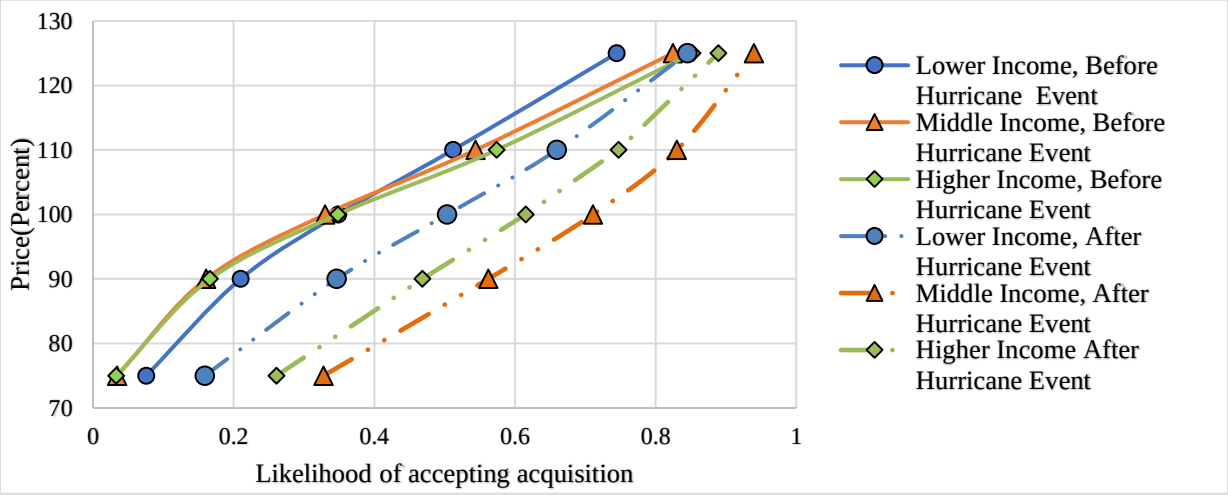


Figure 2.8: Likelihood of accepting acquisition, by income category and timing

Table 2.9: Differences in quantity supplied, by income category and timing

Price	L_Before = L_After	L_Before = M_Before	L_Before = H_Before	L_Before = M_After	L_Before = H_After	L_After = M_After	L_After = H_After	M_After = H_After	M_Before = M_After
75	0.061	0.206	0.208	**0.001**	**0.000**	0.043	0.078	0.457	**0.000**
90	**0.004**	0.395	0.447	**0.000**	**0.000**	**0.012**	0.093	0.215	**0.000**
100	**0.001**	0.784	0.915	**0.000**	**0.000**	**0.014**	0.174	0.176	**0.000**
110	**0.001**	**0.000**	**0.008**	**0.000**	**0.008**	**0.036**	0.352	0.192	**0.000**
125	**0.043**	0.429	0.259	**0.011**	0.104	0.136	0.654	0.257	**0.025**

Table 2.9 Continued

Price	H_Before = H_After	M_Before = H_Before	M_Before = H_After	L_After = M_Before	L_After = H_Before	M_After = H_Before
75	**0.000**	0.985	**0.000**	**0.019**	**0.020**	**0.000**
90	**0.000**	0.914	**0.000**	**0.008**	**0.010**	**0.000**
100	**0.000**	0.843	**0.000**	**0.031**	**0.034**	**0.000**
110	**0.000**	**0.021**	**0.021**	0.203	0.225	**0.000**
125	0.274	0.816	0.451	0.750	0.906	0.062

Notes: Reported values are *P* values for a test of equality between the two quantities. Bolded values indicated *P* values of 0.05 or less. Price is measured as a percentage of pre-damage fair market value for the home. L_Before stands for individuals with annual income less than $50,000, considering their house before damage. L_After stands for individuals with annual income less than $50,000, considering their house after damage has occurred. M_Before stands for individuals with annual income greater than $49,999 but less than $100,000, considering their house before damage. M_After stands for individuals with annual income greater than $49,999 but less than $100,000, considering their house after damage has occurred. H_Before stands for individuals with annual income greater than $99,999, considering their house before damage. H_After stands for individuals with annual income greater than $99,999, considering their house after damage has occurred.

Robustness Check: Interval Regression

To this point, our analysis has considered data in long format, where each observation is a binary choice between accepting and rejecting a specific buyout offer. It is often the case that analyses, such as this one, relying on small samples can be prone to narrow results that fail to hold up to robustness checks. To test whether our results exhibit this tendency, we consider an alternative modeling procedure. We use the bid value at which respondents first say they will accept a buyout offer to construct an interval for respondent WTA. This results in a wide data

format where five binary yes/no decisions are condensed into a single WTA interval observation. We follow the payment card literature (Welsh and Poe 1998; Cameron and Hupper 1989) and estimate a series of panel[10] interval regressions that mirror the probit regressions in Table 2.10A. Table 2.11A shows these results. These results appear less statistically significant than their probit counterparts, but in terms of the major contribution of this article they are remarkably similar. Specifically, the primary takeaways from our probit models are (i) offered price matters and (ii) there is substantial heterogeneity in willingness to accept an offer as well as price sensitivity by timing of the offer and home- and homeowner characteristics. As the dependent variable in the interval regression is WTA, it is not possible to include price as an explanatory variable. As such, takeaway (i) cannot be directly tested using the interval regression model. Our finding of substantial heterogeneity, however, is directly testable and is confirmed in the interval regression models. As with the probit models, each interval regression model beyond the base model generates four[11] potentially heterogeneous groups, and comparing these groups allows for six unique comparisons. In all models included in Table 2.11A, we reject the null hypothesis that the groups are the same at the 90% confidence level in at least four of the six comparisons. This is clear evidence of preference heterogeneity and suggests that our probit findings are robust to other model specifications. It is also noteworthy that the interval regression generates similar estimates of household WTA for a buyout program (108.22% after damage; 118.70% before damage) to the 100.35% and 113.43% values generated by the probit models.

[10] The data is still a panel in this setting, as each respondent will have a WTA interval for before damage and after damage occurrences.

[11] As an example, in the second column of table 2.10A, we allow for heterogeneity by race. The four groups generated are white homeowners being offered a buyout before damage, white homeowners being offered a buyout after damage, nonwhite homeowners being offered a buyout before damage, and nonwhite homeowners being offered a buyout after damage.

Conclusion

While numerous previous studies examine what factors make homeowners more willing to accept government acquisition contracts for at-risk properties, the role of price has been largely ignored and no studies exist that account for heterogeneous price impacts. We present an empirical analysis of home price compensation effects on willingness to accept government acquisition contracts using a mail survey of homeowners in eastern North Carolina. We estimate pooled probit models to link hypothetical home price offers to a homeowner's acquisition decision while controlling for a host of other covariates. Using these models, we derive probabilities of accepting acquisition contracts for various compensation levels, allowing us to construct property buyout supply curves. We then use a block bootstrap methodology to estimate standard errors, which allow us to test whether supply heterogeneity exists along multiple homeowner and property characteristics.

Results show the expected positive relationship between price and homeowners' decision to accept a government acquisition contract. We also find that non-price characteristics influence buyout acceptance in two ways. First, they influence *ceteris paribus* willingness to accept offers. This effect is emphasized in the literature. Additionally, we find that price responsiveness varies based on these non-price characteristics. We detail how non-price characteristics lead to heterogeneous willingness to accept buyout offers, with the timing of the offer (before or after damage to the house has occurred) exhibiting the sharpest heterogeneity.

Our findings suggest that acquisition programs may want to consider increasing home price incentives to motivate more homeowners to sell their at-risk houses and relocate to lower-risk areas. Additionally, implementation of buyout programs on a continuous basis instead of an episodic basis warrants further study. The findings indicate that at higher home price offers, it

may not matter whether acquisition contracts are presented to homeowners before or after a hurricane event. Removing property and residents from high flood risk areas prior to a catastrophic flood event can save lives and reduce government expenditure on recovery. Further, damaging hurricanes that destroy a portion of a region's housing stock create a supply side shock that can temporally inflate prices of the existing undamaged stock making relocation difficult. For these reasons, it may be welfare improving if acquisition offers are made before a hurricane event, barring perverse location incentive effects. What is clear is that stakeholders and policy makers should consider prices as key determinants of homeowner decision-making when designing acquisition contracts.

It is important to note that our study's focus on coastal North Carolina, combined with the small sample used in our analysis and low response rates to the survey, suggests that further work in this area would be useful to increase confidence in the generalizability of our findings. Future research should expand our survey sample to encompass a wider study area to test the generalizability of our results to other flood-prone regions.[12] Furthermore, future work would benefit from explicitly accounting for issues of consequentiality of the survey responses. These findings can also be embedded in larger integrated models that include homeowners, insurers, reinsurance, and government as stakeholders. Similar integrated models have been used to study

[12] A referee noted that it is possible for consequentiality to vary by respondent characteristics. For example, homeowners who live in the floodplain may find acquisition questions more consequential than those that live outside the floodplain. While this is certainly possible and our lack of consequentiality questions leaves us unable to definitively rule it out, we would suggest anecdotally that in a study area like the coastal plain of North Carolina, which has experienced multiple large-scale flood events in recent decades, the recognition of flood risk is high even among homeowners who do not live in the 100-year flood zone (partly due to the fact that damage is not restricted to this zone during catastrophic flood events). More empirically, it is difficult to argue that the pattern we find in the data (differences between before- and after-damage supply curves for those within the floodplain, differences between within- and outside-floodplain supply curves for offers before damage, and no difference between without- and outside-floodplain supply curves for offers after damage) would be driven by respondents outside the flood plain viewing the survey as largely inconsequential or less consequential than those inside the floodplain. Such an explanation is, to the authors, difficult to construct.

the effect on all stakeholders of a private voluntary market for catastrophe insurance, insurer competition, insurance affordability, and retrofit choices (Kesete et al. 2014; Peng et al. 2014; Gao et al. 2016; Shan et al. 2017; Jasour et al. 2018; Xu et al. 2018). This wider perspective would allow researchers to analyze the combined effects of acquisition, retrofit, and insurance actions on regional risk.

CHAPTER 3 : HOMEOWNER PREFERENCE FOR HOUSEHOLD-LEVEL FLOOD MITIGATION IN US: ANALYSIS OF A DISCRETE CHOICE EXPERIMENT[13]

Abstract

For decades the Federal Emergency Management Agency (FEMA), which manages the National Flood Insurance Program (NFIP), has offered a portfolio of flood risk mitigation options to high-risk homeowners to choose from, hoping to reduce flood damages or better still remove the most —at-risk properties from the housing stock. Buyout (home acquisition) and home retrofit (e.g., home elevation) are potential candidates available to homeowners. In recent times, FEMA has increased its buyout efforts, including proposing to allow homeowners to rebuild on the same lot after the buyout. While studies exist on factors affecting homeowners' decisions to participate in buyouts, no study has examined how proposed changes coupled with availability of alternative mitigation options like home elevation will affect participation. This chapter fills the gap by examining homeowners' stated preference for buyout and home elevation contract attributes using data from a discrete choice experiment. Results indicate that factors that influence the decision to participate in home acquisition include the price offered for home acquisition, whether the homeowner is permitted to rebuild on the same lot after the current home is torn down, the number of days that will elapse between the signing of the contract and when the homeowner can expect to be paid, and number of days the homeowner is given to vacate the property. Factors that influence the elevation decision include the cost of elevating the home, the size of elevation subsidies, and future insurance premium rate appreciation. Overall, we also find

[13] With Gregory Howard and Jamie Kruse. This work was supported by the National Science Foundation under collaborative awards #1433622 and #1856256. The statements, findings, and conclusions are those of the authors and do not necessarily reflect the views of the National Science Foundation.

that the effects vary with the timing (whether the contract is offered before or after a damage event) of the contract offered.

Introduction

The National Flood Insurance Program (NFIP) is the most subscribed public disaster program tasked with disaster preparedness and recovery in the US. Yet, the program is challenged with solvency issues partly due to program design.[14] Currently, the program has accumulated debt exceeding $20 billion (Congressional Research Service 2019) and efforts to achieve solvency through risk-based premium rate structures have met public resistance, rolling back proposed rates increases (Frimpong, et al. 2019). Consequently, this has raised concerns about program performance and sustainability.

In lieu of risk-based premium rate structures, and after it became clear that sea walls, levees, dams and the like can and should not be used in all cases to reduce risk exposure (Fan and Davlasheridze, 2016), the Federal Emergency Management Agency (FEMA) is increasingly using government buyouts (home acquisition) to address NFIP's solvency challenges. Buyouts are government efforts to buy and retire severely (about 50%) damaged or repetitive loss properties or relocate said properties to areas with lower flood risk. The program is partly (75%) funded by FEMA's Hazard Mitigation Grant Program (HMGP), with the remaining 25% supported by either local government, non-governmental agencies or the homeowners themselves (FEMA 2015). Buyouts are usually initiated after a presidential disaster declaration and homeowner participation in the program is voluntary. Alternatively, homeowners may

[14] NFIP is not actuarially sound for several reasons. The program, for example is not structured to build a capital surplus; cannot deny policies to high-risk applicants, neither can it deny insurance because of frequent losses. It is also subject to statutory limits on rate increases and its premium rates do not reflect actual flood risk (GAO 2010).

benefit from programs such as the Hazard Mitigation Assistance (HMA) program, which subsidizes home elevation. Home elevation involves raising structures on either stilts, mounds, concrete pillars or foundations to an elevation at Base Flood Elevation or higher (FEMA 2015).

To encourage buyout program participation, policy makers are considering programmatic changes. The proposed changes will potentially allow homeowners to retain ownership of the deed-restricted lot and build new structures so long as they meet current local building codes (Flavelle 2018). Also, the program may potentially be allowed to run on a continuous basis and not only after a presidential disaster declaration in an area. While these proposed changes could impact buyout participation, there are no empirical studies evaluating the impact of such policy changes.

This chapter investigates predominantly coastal US residential homeowners' stated preferences for buyout and home elevation contract attributes, and estimates the average willingness to accept values for buyout and home elevation contracts. Given the proposed changes to buyout programs, this study examines attributes including property pricing, retained ownership of the deed-restricted lot, timing of the transaction, and contract options that include future flood insurance pricing, home elevation cost, and subsidies.

Within the flood risk mitigation literature, relatively few studies have examined factors that influence an individual's decision to participate in buyouts, and have mostly focused on the effects of demographic and geospatial factors on participation decision (Fraser, et al. 2003; Fraser, Doyle, and Young 2006; Fraser, De Vries, and Young 2006; Kick et al. 2011; De Vries and Fraser 2012; Zavar, Hagelman, and Rugeley 2012; Bukvic, et al. 2015; Robinson, et al. 2018; Frimpong, et al 2019). Frimpong, et al. (2019) examined the effect of offered price on homeowners' decision to participate in buyouts using a contingent valuation survey of 123

homeowners in Eastern North Carolina. Other studies have also focused on the effect of demographic and geospatial factors on individual's decisions to buy flood insurance (Baumann and Sims 1978; Browne and Hoyt 2000; Michel-Kerjan and Kousky 2010; Kousky 2010; Gallagher 2014; Kriesel and Landry 2004; Landry and Jahan-Parver 2011; Petrolia, Landry, and Coble 2013), , or elevate their homes (Botzen, Aerts, and van den Bergh 2012). In this chapter, I use a much larger national sample of coastal properties and builds on past studies by expanding the list of attributes related to buyout and home elevation contracts. I additionally examine the impact of future insurance premium pricing on homeowners' decision to engage in mitigation options. This analysis further allows for the quantification of tradeoffs between different subsidized risk mitigation activities.

Results indicate that homeowners prefer buyout contracts that offer larger payments, give homeowners more time before they must vacate the property, and reduce the lag time between signing of the contract and payment to the homeowner. Perhaps surprisingly, homeowners do not put a premium on being able to retain the lot. Regarding elevation, homeowners unsurprisingly prefer contracts with lower elevation costs and higher elevation subsidies. I also ask respondents to consider their house as-is (pre-damage) in some choices, while in other choices I ask respondents to imagine their house was recently damaged by a flood event. I find not only that general preferences for buyout contracts vary with the timing of the contract (whether it is offered before or after a flood damage event), but further that preferences for specific attributes also vary with timing of the contract offered.

The next section presents policy background with details on the NFIP, buyouts, and structure elevation. The third section describes the survey and experimental design and data used for the discrete choice analysis. Section four presents the theoretical foundation and econometric

model used in the analysis. Regression results and discussion are presented in the fifth section, while section six concludes the chapter.

Policy Background

National Flood Insurance Program

To provide access to affordable federally backed flood insurance and to encourage community-level flood risk mitigation, the US congress passed the National Flood Insurance Act of 1969 that created the NFIP (FEMA 2019a). Community-level participation in NFIP is voluntary and only residents and businesses of participating communities can buy flood insurance policies. Participating communities adopt floodplain management ordinances and are encouraged to exceed minimum mitigation efforts.

Currently, the NFIP is the most widely used adaptation strategy among residents (Thomas and Leichencko 2011) with over 22,000 participating communities and over 5 million policies-in-force (Congressional Research Service 2019). Private insurance companies write policies, but the federal government is responsible for paying damage claims. NFIP's policy coverage is limited to structure and contents, with limits of $250,000 and $100,000, respectively for single-family building and up to 500,000 for other residential or non-residential building (FEMA 2020). Flood insurance premium rates are determined mainly by Flood Insurance Rate Maps (FIRMs) which are updated periodically. Other factors that affect premiums are, whether the structure is elevated above historic flood-levels and the extent to which the community participate in the community rating system (Frimpong et al. 2020). As such, the assessed flood-risk level for a structure can change when new FIRMs take effect. However, policy holders with continuous coverage whose flood risk-levels have increased are not affected by the post-FIRM

insurance premium rates. This rule is also referred to as grandfathering (FEMA 2016). As a result, premiums may not reflect current flood risk.

Since its inception, NFIP has seen several reforms to bolster the effectiveness of the program. The Flood Insurance Protection Act of 1973 and The National Flood Insurance Reform Act of 1994 were enacted to encourage NFIP enrollment, and The Flood Insurance Reform Act of 2004 was intended to encourage flood risk reduction. In 2012, the Biggert-Waters Flood Insurance Reform Act was introduced to bolster the financial health of NFIP by increasing premium rates but was later repealed and replaced with The Homeowner Flood Insurance Affordability Act of 2014 (FEMA 2019b). To date, the program has borrowed over $20 billion dollars from the US Treasury to meet its claim payments obligations (Congressional Research Service 2019), making it a financially "high risk" public disaster program.

To complement community-level flood risk mitigation efforts, FEMA has introduced Hazard Mitigation Grant Program (HMGP) to assist states and local communities in reducing community-level flood risk by reducing the risk to individual properties.

Buyouts

Among the host of potential risk mitigation measures that homeowners could pursue for natural disasters, buyout is by far the most effective way of eliminating future flood risk. Buyout programs pay homeowners to sell high-risk property to the government for demolishing or relocating the structure to an area with lower flood risk. The program is funded through FEMA's Hazard Mitigation Grant Program (HMGP), a component of the Hazard Mitigation Assistance (HMA) and is authorized by Section 404 of the Stafford Act, 42 U. S. C.5170c (FEMA 2015). Local governments (states and territories), and federally recognized tribes may apply for

FEMA's HMGP funds to be used for buyouts (FEMA 2015), but only after there is a presidential disaster declaration. Prior to local authorities implementing buyouts, a benefit–cost analysis is used to assess the advantages and disadvantages of the acquisition (FEMA 2005). Contracts are voluntary, so individual homeowners may choose to accept or reject offers made by local authorities. Once a contract is agreed upon, the said structure is demolished or relocated if possible and the cleared lot is typically left as open space or converted to a recreational area (FEMA 2005).

Buyouts gained popularity after the Great Midwest Floods in 1993, where communities like Cherokee and Story County in Iowa acquired 157 and 28 properties, respectively (FEMA 2011). Since then several other communities have benefitted from the HMGP. After the 1997 floods, Grand Forks, North Dakota bought approximately 800 properties. A year later, San Antonio, Texas, acquired 400 properties to reduce future flood risk, and after Hurricanes Fran and Floyd in 1999, about 1,150 properties were bought in Greenville and Kinston, North Carolina (De Vries and Fraser 2012; Frimpong, et al. 2019).

In addition to eliminating future flood risk to properties and lives, buyouts have several other advantages. Barnhizer (2003) mentions that for every $1 the government invests in the buyout, homeowners who participate save $2 in future flood insurance premia. This makes the buyout program a win-win for both parties. Again, the program provides an opportunity for homeowners to financially protect against decreased home values in the wake of a flood event (Greer and Binder 2017; Frimpong, et al. 2019). Federal and local governments, on the other hand, could potentially save on future flood related expenditures when an area is cleared of flood-prone structures (Barnhizer 2003). Buyout benefits could accrue to society as the resulting open space could serve as recreational grounds (e.g., fishing and hunting, boating, and hiking)

(Barnhizer 2003). Further, the open space could potentially help mitigate future floods (Brody and Highfield 2013) which may in turn increase adjacent property values Barnhizer (2003).

Structure/ Home Elevation

For communities participating in NFIP, potential policy holders with structures at risk of flood damage are required to raise their structure above the Base Flood Elevation (BFE) (100-year flood elevation) (FEMA 2015). Homeowners are also encouraged to incorporate freeboard requirements into elevation. Freeboard is an additional height (usually 1 foot) above the BFE. There are three basic ways to elevate a house: raising the structure on piers or piles; on a mound; and on a tall foundation (FEMA 2015). Location, size, quality of materials and construction, complexity of details, site constraints, utility requirements, systems requirements, development and permitting fees, and general market and economic conditions are all factors that influence whether a structure can be elevated. The cost of elevating structures varies based on the size of the structure. For a medium-sized brick or concreate slab house, the cost of elevating the house is estimated at $30,000 (FEMA 2005).

Elevation incentives are available to homeowners through mitigation grant programs such as the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA)) and Pre-Disaster Mitigation Program (PDM). As elevation reduces flood risk, homeowners with elevated houses often benefit from lower flood insurance premiums (FEMA 2015).

Survey and Data

The survey is in five sections. The first section presents respondents with a consent form, followed by screening questions. The third section collects data on homeowners' history in the

community, experiences on flooding and thoughts on flood risk. The fourth section comprise a series of hypothetical choice scenarios regarding flood risk mitigation and the final section collects household-level data on homeowner demographic characteristics and property address information. Property address information are used to access characteristics of the property and location in, for example, floodplain. I explain the choice experiment design next. Sample of the survey instrument is relegated to the appendix of the dissertation.

Choice Experiment Design

I use a discrete choice experiment[15] to elicit homeowners' preference for *buyout, house elevation, and a status quo depicting flood insurance premium appreciation*. The flood mitigation scenarios are hypothetical and vary along several attributes as shown in Table 3.1. For the buyout contract, attributes include what is being sold (either the structure and the lot or just the structure), the price the homeowner will receive (as a percentage of the pre-damage fair market value of the property being sold[16]), how long it will take for the government to make the payment to the homeowner, and how long the homeowner has before they must vacate the property.

For home elevation contracts, attributes include the cost of elevating the house and the subsidy they will receive. The cost of elevating the house is measured as a percentage of the home's value, while the size of the subsidy is measured as the percentage of the total cost of

[15] Discrete choice experiment is an attribute-based approach to gather stated preference data (Ryan, Gerard, and Amaya-Amaya 2008). With this approach, respondents are presented with a series of hypothetical scenarios that comprise two or more competing alternatives that vary along several attributes (Ryan, Gerard, and Amaya-Amaya 2008), in addition to a status quo. The attribute levels are assumed to determine the value (utility) the alternative provides (Lancaster 1966). Given the attributes of interest and their levels, a choice set design method (e.g. Full factorial, Fractional factorial or Efficient design) is used to generate choice set scenarios (Louviere, Hensher, and Swait 2000).

[16] If the homeowner is selling only the house, this is measured as the value of only the house. If homeowner is selling both the house and the lot, this is measured as the value of the house and the lot combined.

elevating the house. Lastly, I also specify a value for how much the homeowner can expect their flood insurance premiums to rise. This attribute is expressed as a percentage increase relative to their current premium and is given different levels for the elevation contract and the status-quo[17] option of neither contract.

As many of these attributes are presented as percentages and may be confusing for some respondents, in the section of the survey that outlines the attributes respondents were presented with numeric examples to illustrate how different percentages would translate to dollar amounts (see Figures 3.1 and 3.2).

Table 3.1: Program attributes and levels

Attribute	Level
Buyout	
What will you sell to the government	1=house and lot, 0=house only
Price you will receive if you sell property	75%, 90%, 100%, 110%, and 125%
How long it will take the government to pay	15 days, 45 days, 75 days, and 120 days
You must vacate the house within this period	30 days, 60 days, 90 days, and 120 days
Home elevation	
Cost to raise the house above ground	20%, 30%, 40%, and 50%
Subsidy you will receive to raise house above ground	25%, 50%, 75%, and 100%
How much your flood insurance premium will increase	20%, 30%, 40%, and 50%

[17] Subjects were given the same status-quo premium increase in all choices, while premium increases varied for different elevation policies. There was between-subject variation in status-quo premium increases, meaning different subjects were given different expected premium increases in the status-quo.

Programs that involve government purchases of at-risk houses are called *Buyout Programs*. These programs involve the following components:

What Parts of the Property are Sold: A coastal property includes the house or structure as well as the land or lot on which the house is built. Some buyout programs require the owner sell both the house and the lot, while others require sale of the house but allow the current homeowner to retain ownership of the lot. In this case, the house will be destroyed, but you are allowed to rebuild on the lot so long as the new house meets current safety codes.

Price you will receive if you sell the property: This is the amount of money you will receive, as a percentage (%) of the property's value. This value is the pre-damage fair market value of what you are selling. If you are selling only the house, this is measured as the value of only the house. If you are selling both the house and the lot, this is measured as the value of the house and the lot combined. Fair market prices are determined by a licensed appraiser. For example, if the value of your property before the flood damage is $100,000, and the government offers to pay you 90% of the property value, accepting the offer means you will receive $90,000.

How long it will take the government to pay you if you sell: This is the number of days it will take government officials to pay you for the sale of your house after the buyout contract has been agreed-to and signed.

Time you have to vacate your home: After a buyout agreement has been agreed-to and signed, you are given a grace period (number of days) to vacate the house. This is true for all contracts, including those that allow the property owner to keep ownership of the lot.

Figure 3.1:Description of the buyout contract attributes

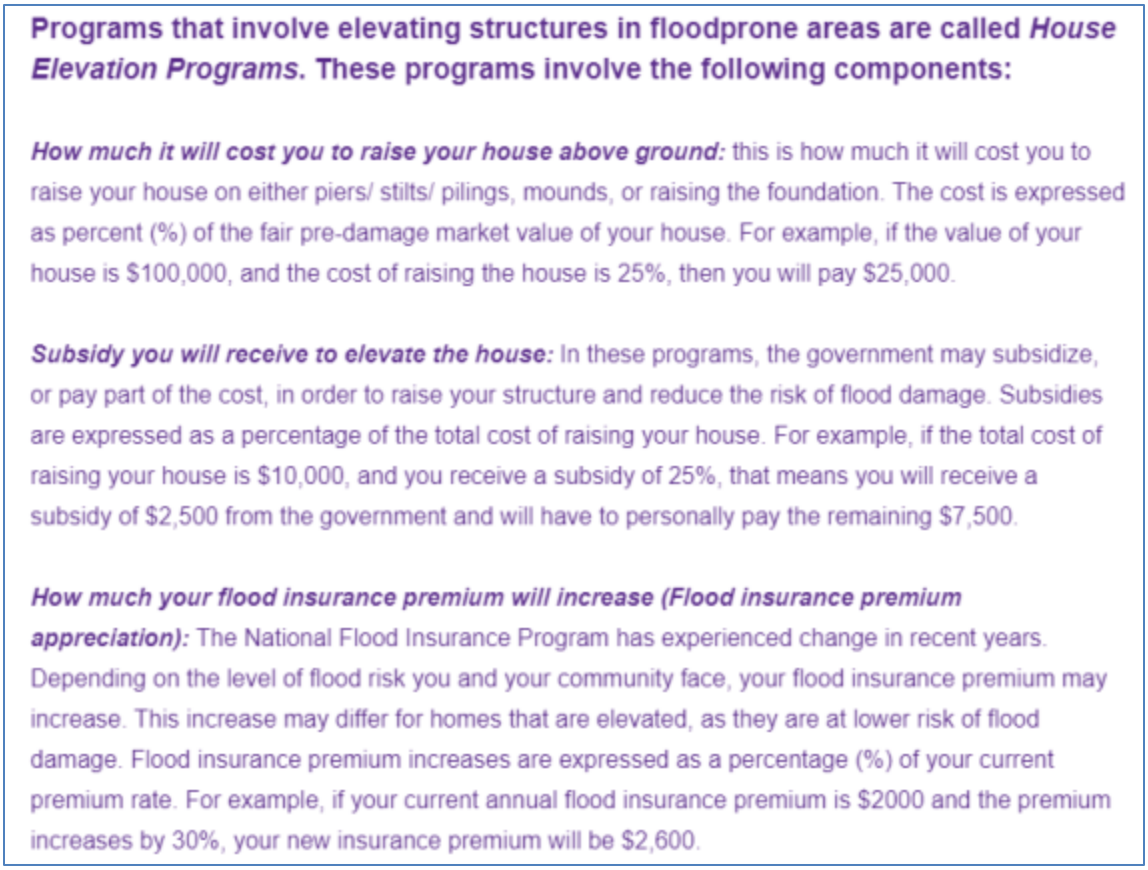
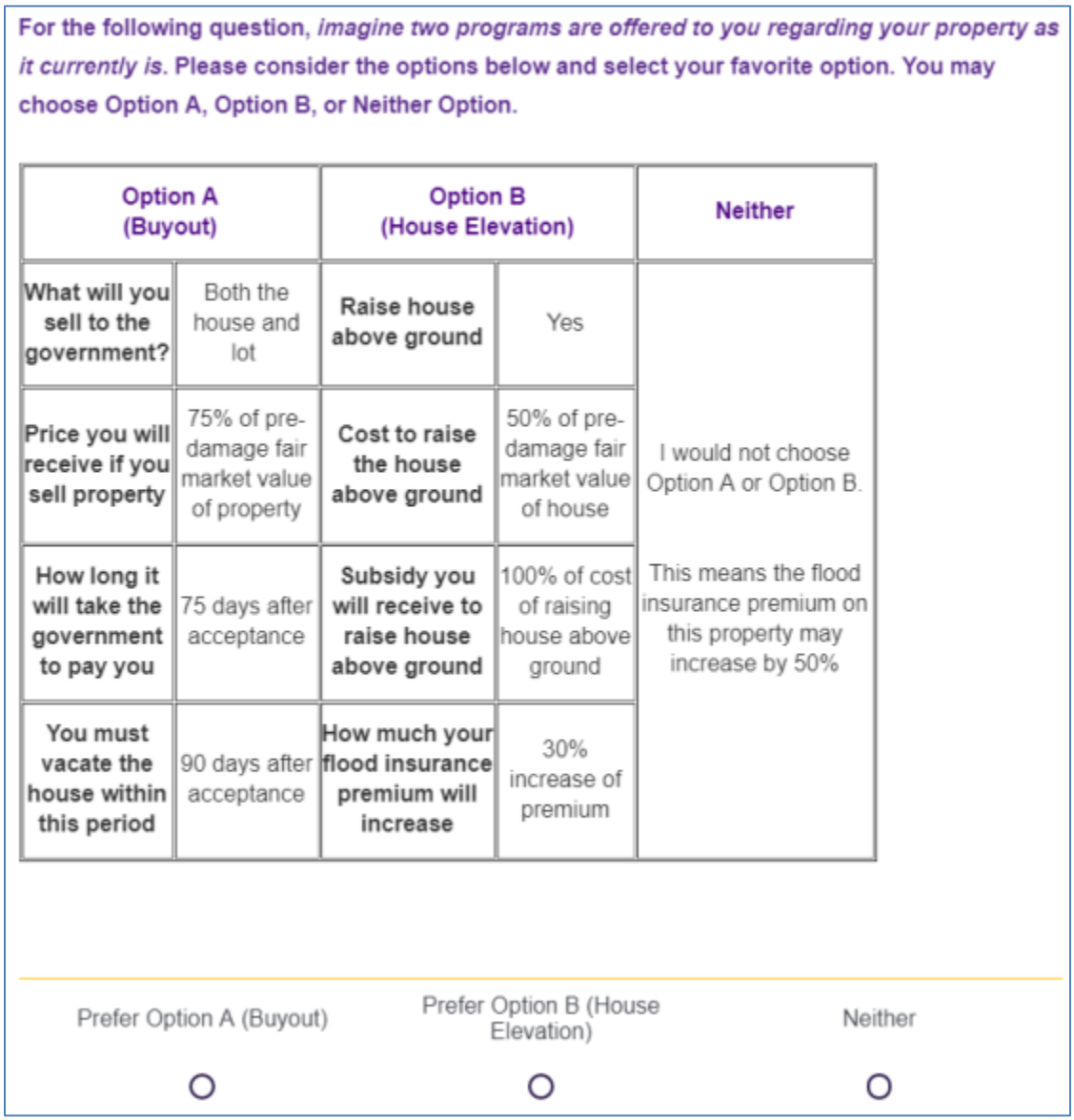


Figure 3.2: Description of the house elevation contract attributes

The choice experiment design is determined using SAS 9.3 experimental design macros (Kuhfeld 2010).[18] The resulting design of 30 choice sets maximizes the D-efficiency (Scarpa and Rose 2008). I group the 30 choice sets into 15 blocks, each block containing two choice sets to limit cognitive strain on respondents, as there is evidence that hypothetical bias mitigation techniques can show reduced effectiveness after 4-5 choices (Howard, et al. 2017). Homeowners are shown four choice sets in a randomized fashion (2 of the 15 blocks). In this way, the order of choice set is not confounded with specific attribute levels in our analysis. In two choice sets, respondents are prompted to consider their house as it currently is, without damage from a flood

[18] They include %*mktruns*, %*mktex*, %*mktroll*, %*choiceff*, %*mktdups*, and %*mktblock*.

event. In the other two choice sets, homeowners are asked to assume a recent flood event has damaged their property when making their choice. The order of damaged scenarios is randomized. Figures 3.3 and 3.4 shows an example of the choice sets.

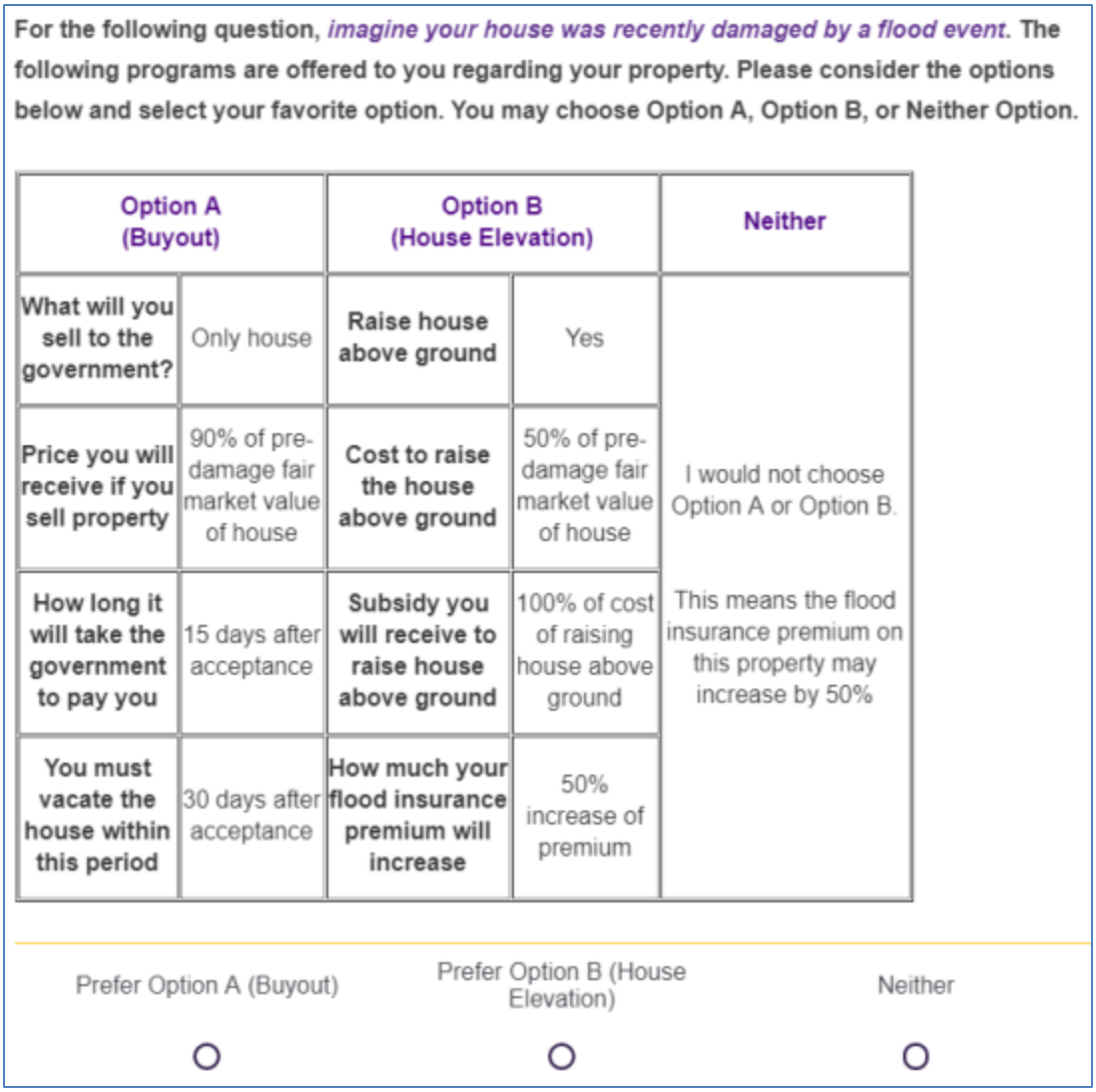


For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		Option B (House Elevation)		Neither
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	75% of pre-damage fair market value of property	**Cost to raise the house above ground**	50% of pre-damage fair market value of house	
How long it will take the government to pay you	75 days after acceptance	**Subsidy you will receive to raise house above ground**	100% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	30% increase of premium	

Prefer Option A (Buyout) ○ Prefer Option B (House Elevation) ○ Neither ○

Figure 3.3: Example of choice set homeowner evaluates assuming property condition is as it currently is.



For the following question, *imagine your house was recently damaged by a flood event.* The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		Option B (House Elevation)		Neither
What will you sell to the government?	Only house	Raise house above ground	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	90% of pre-damage fair market value of house	Cost to raise the house above ground	50% of pre-damage fair market value of house	
How long it will take the government to pay you	15 days after acceptance	Subsidy you will receive to raise house above ground	100% of cost of raising house above ground	
You must vacate the house within this period	30 days after acceptance	How much your flood insurance premium will increase	50% increase of premium	

Figure 3.4: Example of choice set homeowner evaluates assuming property is damaged by flood.

Survey Administration

A total of 1,366 residential homeowners responded to an online survey administered between August 2018 and April 2019. Figure 3.5 shows the distribution of respondents' properties in the study area. Based on respondents' address information, majority (577 (42.24%)) have properties in the East Coast states (excluding Florida samples), 206 (15.08%) have properties in the Gulf Coast states (excluding Florida samples), 401 (29.36%) are in Florida, 99 (7.25%) are in West

Coast states, 43 (3.15%) are in the Great Lakes area, and 9 (0.66%) are in other places such as Hawaii. A total of 31 respondents' addresses were not available for verification.

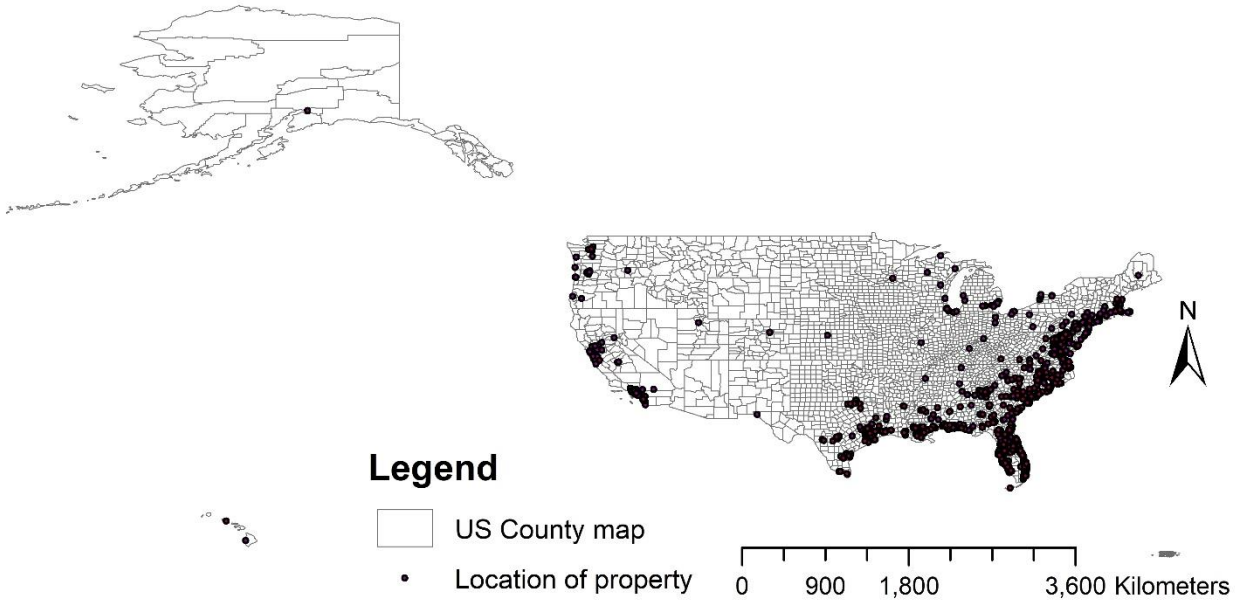


Figure 3.5: A map of U.S. showing distribution of respondents' property location

First, respondents provide consent to participate in the survey, followed by answering screening questions - homeowners who are at least 18 years old and have property within 150 kilometers (about 93.2 miles) from the shoreline. This is followed by answering questions on their history in the community, experience with floods and perceptions of flood risk. Respondents were then presented a series of hypothetical choice scenarios regarding flood risk mitigation options for their coastal property to be evaluated. Each choice offered three options: a buyout contract, a home elevation contract, and a status-quo option of choosing neither contract (see Figures 3.3 and 3.4 for example of the choice set or scenarios). The survey ends with questions on a host of demographics.

Prior to evaluating the choice scenarios, respondents were introduced to the flood

mitigation programs with detailed description of the program attributes. First, respondents were told that, "The federal government through the Federal Emergency Management Agency (FEMA) has taken steps to reduce or eliminate the impacts of flood hazards on residents and their property. These efforts *include buying or relocating houses* found in floodprone areas, *elevating houses* in floodprone areas, and *making opportunities available to purchase flood insurance*." This statement is followed by the description of the buyout and home elevation contract attributes (see Figures 3.1 and 3.2) as well as image of a property bought and torn down by local government (Buyout) and image of a property being elevated above ground (see Figures 3.6 and 3.7). Finally, respondents were informed that, "Changes to the National Flood Insurance Program indicate that in the future flood insurance premiums in your area may increase by 100%. Suppose your local government official has offered contracts to help reduce or eliminate flood risk in your community. In the next questions we would like to know whether you would be willing to enter into flood risk reduction programs". Because respondents are known to respond to hypothetical questions differently than when faced with real life choices, we resort to using cheap talk technique[19] to further mitigate hypothetical bias. Specifically, we mention in the survey that "We are interested in your true preferences. There are no right or wrong answers only what you would actually prefer. The questions are hypothetical, and research has shown that some people commit to actions in hypothetical situations that they would not actually commit to in real life. Please keep this in mind and do your best to answer the questions that follow as if they were real options being offered to you."

[19] Cheap talk is an ex-ante approach to address hypothetical bias in the survey design stage where respondents are told that hypothetical bias is a significant problem and asked not to submit to this type of respondent error (Cummings and Taylor 1999; Whitehead and Cherry 2007; Howard, et al. 2017; Penn and Hu 2019).

Figure 3.6: Example of a house bought and torn down by local government (Buyout). Source: FEMA 2018c

Figure 3.7: Example of a house being elevated above ground (House elevation program). Source: Courtesy Jamie Kruse

Empirical Model

I begin the analysis with a random utility framework[20] where utility is a function of a vector of contract attributes X_{ijk} :

$$U_{ij} = \beta X_{ijk} + e_{ij}. \qquad (3.1)$$

Where U_{ij} is utility individual i derives for *jth* alternative contract, β is vector of parameters associated with *k* contract attributes, X_{ijk} , and e_{ij} is the error term. With the assumption that the errors, e_{ij} , are independent and identically distributed and follow an extreme value type 1 distribution, we utilize the standard conditional logit model.

Of particular interest is evaluating whether preferences are substantially different when considering houses that are not currently damaged from a flood event. To explore any potential differences between damaged and undamaged houses, an indicator variable for whether a choice is made assuming the house is not damaged by a flood event (*Before*) or damaged by flood event (*After*) is interacted with the attributes and alternative specific constants (ASC) for *Buyout* and *Elevation*:

$$\begin{aligned} U_{ij} = & \left[\sum_{k=1}^{K} \beta_k X_{ijk} + \eta Buyout_{ij} + \varphi Elevation_{ij} \right] \times Before \\ & + \left[\sum_{k=1}^{K} \delta_k X_{ijk} + \alpha Buyout_{ij} + \gamma Elevation_{ij} \right] \times After + e_{ij} \end{aligned} \qquad (3.2)$$

where *X* is a vector of *k* attributes. β_k , η, φ, δ_k , α , and γ are parameters to be estimated. Table 3.2 presents a description of the variables used in the regression analysis.

As a robustness check, I also estimate a random parameters model that accounts for

[20] See appendix for details on random utility theory.

potential heterogeneity in homeowner preferences. Further, I estimate a series of conditional logit models that considers (1) subsamples of the data -respondents with property within 49 kilometers (about 30 miles) from the shoreline, homeowners in East and Gulf Coast states, permanent residents, and single-family homes, (2) interaction terms - interacting respondents sociodemographic characteristic with attributes. Except for the results on the random parameters logit, the rest of the robustness check results are presented in the appendix of this chapter.

Table 3.2: Variable definition

Variable	Definition
	Buyout
Price × Before	Price (% of pre-damage value of property) for buyout contracts offered before a flood event
Price × After	Price (% of pre-damage value of property) for buyout contracts offered before a flood event
Sell both house and lot × Before	Dummy equal to 1 if contract offered before flood event requires selling both house and lot
Sell both house and lot × After	Dummy equal to 1 if contract offered after flood event requires selling both house and lot
Acquisition pay period × Before	Number of days to pay buyout participant for contract offered before flood event
Acquisition pay period × After	Number of days to pay buyout participant for contract offered after flood event
Vacate × Before	Number of days to vacate property after contract offered before flood event is agreed upon
Vacate × After	Number of days to vacate property after contract offered before flood event is agreed upon
	Home elevation
Elevation cost × Before	Cost (% of pre damage value of property) to elevate a home for elevation contract offered before flood event
Elevation cost × After	Cost (% of pre damage value of property) to elevate a home for elevation contract offered after flood event
Elevation subsidy × Before	Subsidy (% of cost of elevation) to elevate home for elevation contract offered before flood event
Elevation subsidy × After	Subsidy (% of cost of elevation) to elevate home for elevation contract offered after flood event
Insurance appreciation × Before	% increase in insurance premium for elevation contract offered before flood event
Insurance appreciation × After	% increase in insurance premium for elevation contract offered after flood event

Table 3.2 Continued

	Alternative Specific Constants (ASC)
Buyout × Before	Dummy equal 1 if alternative is buyout and contract is offered before flood event
Buyout × After	Dummy equal 1 if alternative is buyout and contract is offered after flood event
Elevation × Before	Dummy equal 1 if alternative is elevation and contract is offered before flood event
Elevation × After	Dummy equal 1 if alternative is elevation and contract is offered after flood event

Policy Simulation: Average Compensating Variation (CV)

Next, I adopt Hanemann's (1984) average compensating variation (CV) framework to estimate the minimum willingness to accept (WTA) for a buyout and home elevation contract for the average homeowner in our sample. For each contract type, we generate two WTA estimates: one for a contract offered prior to damage and one for a contract offered after damage. The buyout contract, requires the homeowner to sell both house and lot, pay the homeowner in 365 days, and require the homeowner to vacate the property after 60 days. Home elevation contract would cost 30% of the property's value to elevate home. In all cases, the respondent has the option of choosing the status quo option, which carries with it an insurance premium rate increase of 50%. Conversely, choosing the elevation contract leads to a smaller premium increase of 30%. I repeat the policy simulation exercise while varying the attributes levels of the buyout contract to examine the welfare implications of different buyout contracts and present results in the appendix of the chapter. The CV framework is defined as follows:

$$\mathrm{CV} = -\frac{1}{\beta_{price}}\left(V_1 - V_0\right), \qquad (3.3)$$

where V_1 is the estimated utility of the contract, V_0 is the estimated utility of the status-quo option, and β_{price} is the coefficient associated with the buyout transaction price. If a contract is offered after a house is damaged, we use δ_{price} instead of β_{price}. When estimating the CV for buyout contract, I replace *Elevation* in Equation 3.2 with Status-quo ASC to measure the estimated utility for the status-quo. Likewise, I replace *Buyout* in Equation 3.2 with Status-quo ASC when estimating CV for elevation contract.[21]

Results

Descriptive Statistics

Table 3.3 describes the demographics of our sample. The mean age of respondents is 48.76 and majority have at least bachelor's degree, are in the $50,000 - $99,999 income bracket, are white, are permanent residents, live in a single-family house, report their properties are in very good condition, have mortgage, and insurance. About 32% of the sample have experienced various degrees of property damage due to floods, 54% expect flooding in the next 10 years, and 14% are in 100-year floodplain.

Presented in Table 3.4 are the counts of respondents' preference for buyout, home elevation, and status quo (flood insurance appreciation). Regardless of the timing of the contracts (i.e., contracts offered before damage and after damage), majority of the respondents prefer

[21] Buyout contract offered before flood damage, $V = \left[\sum_{k=1}^{K} \beta_k X_{ijk} + \eta Buyout_{ij} + \lambda Status - quo_{ij} \right] \times Before$

Elevation contract offered before flood damage, $V = \left[\sum_{k=1}^{K} \beta_k X_{ijk} + \varphi Elevation_{ij} + \lambda Status - quo_{ij} \right] \times Before$

For contracts offered after flood damage I interact with *After* instead of *Before.*

buyout to the status quo, prefer home elevation to the status quo, and prefer buyout to home elevation contract. Although not reported, this is true across demographics.

Table 3.3: Demographics of sample (N = 1,366 unless noted otherwise)

Variable	N	Freq.	%	Mean	Std. Dev	Min	Max
Age	1,363			48.76	17.09	18	92
Education							
Non formal		7	0.51				
High school		378	27.67				
Associate		292	21.38				
Bachelors		464	33.97				
Post-graduate		225	16.47				
Income	1,365						
Lower (<$50,000)		490	35.87				
Middle ($50,000 - $99,999)		592	43.34				
Upper (>$99,999)		283	20.72				
Male		627	45.90				
White		1,022	74.82				
Residence type							
Permanent		1,213	88.80				
Seasonal		97	7.10				
Other (own rental property)		56	4.10				
House type							
Manufactured		100	7.32				
Single family		1,075	78.70				
Duplex/ townhouse		84	6.15				
Apartment/condominium		97	7.10				
Don’t know		10	0.73				
House Condition	1,365						
Poor		10	0.73				
Fair		100	7.33				
Good		408	29.89				
Very good		561	41.10				
Excellent		286	20.95				
Attachment to place (%)							
Personal	1,364			73.94	23.07	0	100
Family	1,361			75.54	24.32	0	100
Tenure (years)	1,360			12.90	10.98	0	69
Mortgage		791	57.91				
Flood Insurance	1,304	679	52.07				
Property damage experience		435	31.84				

Table 3.3 Continued

Percent damage	435		
Less than 20%		109	25.06
20-39%		146	33.56
40-59%		114	26.21
60-79%		40	9.20
80-100%		26	5.98
Expected % future damage	435		
Less than 20%		95	21.84
20-39%		131	30.11
40-59%		111	25.52
60-79%		70	16.09
80-100%		28	6.44
Next flooding within the next			
5 years or less		485	35.51
10 years or less		254	18.59
25 years or less		110	8.05
100 years or more		115	8.42
I don't know		402	29.43
100-year floodplain	1,264	173	13.69

Table 3.4: Summary of the respondents' choices.

	Buyout	Home Elevation	Neither
Before	1,372	764	592
After	1,442	776	513

Estimated Coefficients of Conditional logit model

Results from our estimated conditional logit model in Equation 3.2 are presented in Table 3.5. As one would expect, homeowners prefer buyout contracts that offer more money in exchange for the property, pay the homeowner more quickly, and allow more time for the homeowner to vacate the property. Further, there is no premium homeowners give to being able to retain the lot; indeed, I find that they would prefer to sell the lot with the house. These findings hold for both pre-damage and post-damage offers, though a test for difference in magnitude of the coefficients finds that *Price* × *Before* and *Price* × *After* are statistically different. Specifically, I find that homeowners are more sensitive to price changes before damage occurs compared with after

damage occurs. This finding is consistent with that of Frimpong et al. (2019). I find no other differences in contract timing for buyout contracts, except for the alternative specific constant for buyout.

Turning to elevation subsidies, as one would expect homeowners prefer contracts that offer larger subsidies. The model suggests that respondents also prefer elevation contracts with a lower cost of elevation, though this attribute is not statistically significant when contracts are offered after damage is suffered. As one would expect, homeowners prefer options that deliver lower levels of insurance premium appreciation, though surprisingly this effect is not statistically significant. One possible explanation for this relates to the sample. Almost half of respondents report that they do not carry flood insurance on their property; therefore insurance premium increases may be viewed as having no consequence. The coefficients on the interaction terms *Buyout* × *Before*, *Buyout* × *After*, *Elevation* × *Before*, and *Elevation* × *After* (the alternative specific constants) should be interpreted relative the base alternative (the status-quo). Only the coefficient on *Buyout* × *Before* is significant and negative, indicating buyout contracts offered prior to a flood damage event is significantly less preferred to the current policy that comes with potential increase in future insurance premium rate (after controlling for other attributes of the alternative).

Estimated CV for Buyout and Elevation Contract Scenario

Tables 3.6 presents point estimates and confidence intervals for WTA calculations. These values can be interpreted as the minimum willingness to accept compensation or the minimum cost to officials for offering the specified buyout or elevation contract to the average person. Officials would have to pay the average homeowner 118.5% (with a 95% confidence interval of 86.229 -

150.724) of the value of the property to incentivize the homeowner to accept the buyout contract for an undamaged property. This point estimate is slightly higher than that of Frimpong, et al. (2019) who showed a point estimate of 113.43%, though this is not an apples-to-apples comparison, as the current survey includes attributes that were absent in the choice experiment in Frimpong, et al. On the other hand, for a buyout contract offered after damage has occurred, WTA is 94.862% of the pre-damage value of the property (with a confidence interval of 41.599 - 148.126). Frimpong, et al. (2019) report a similar but slightly higher point estimate (100.35%) than the current estimate (though the same caveats outlined above apply to this comparison). While the difference in WTA estimates prior to and after damage is fairly large (for a $200,000 property, the difference exceeds $37,000), we find that the standard errors around these estimates are large enough for us to be unable to reject the null hypothesis of equal WTA values at standard confidence levels[22] (p value = 0.220).

WTA for home elevation contracts are also displayed in Table 3.6. For elevation contracts offered prior to a home damaged by flood, officials will have to provide the average homeowner 40.186% of the total cost of elevating the home as a subsidy to motivate the homeowner to engage in home elevation. On the other hand, for elevation contracts offered after the home is damaged by flood the WTA is not statistically different from zero, implying that under the conditions of this contract no subsidy is needed. This may be a surprising result, but the reader must keep in mind that this contract includes the assumption that elevation will reduce premium increases from 50% to only 30%, so in this scenario elevation yields tangible rewards to the homeowner even without a subsidy.

[22] We test for differences by estimating the difference between these CV values and bootstrapping a standard error for this difference. Testing for differences between the two estimates, where the null hypothesis is $CV_{Before} = CV_{After}$ is equivalent to testing for whether their difference is equal to zero, or the null hypothesis $CV_{Difference} = 0$ where $CV_{Difference} = CV_{Before} - CV_{After}$.

Table 3.5: Conditional logit regression results

Variable	Coefficient
Price × Before	0.0179***
	(0.00222)
Price × After	0.0113***
	(0.00211)
Sell both house and lot × Before	0.189**
	(0.0768)
Sell both house and lot × After	0.227***
	(0.0756)
Acquisition pay period × Before	-0.00327***
	(0.000966)
Acquisition pay period × After	-0.00305***
	(0.000940)
Vacate × Before	0.00355***
	(0.00112)
Vacate × After	0.00388***
	(0.00110)
Elevation cost × Before	-0.0149***
	(0.00413)
Elevation cost × After	-0.00187
	(0.00408)
Elevation subsidy × Before	0.0107***
	(0.00180)
Elevation subsidy × After	0.00607***
	(0.00178)
Insurance appreciation × Before	-0.00232
	(0.00199)
Insurance appreciation × After	-8.14e-05
	(0.00204)
Buyout × Before	-1.444***
	(0.309)
Buyout × After	-0.420
	(0.303)
Elevation × Before	-0.0286
	(0.180)
Elevation × After	0.0738
	(0.179)
Pseudo R-squared	0.085
Log pseudolikelihood	-5487.2596
Observations (Cluster id)	16,377 (1,366)

Robust standard errors in parentheses. Errors are clustered by the respondent.

*** p<0.01, ** p<0.05, * p<0.1

Table 3.6: Results from the estimated compensation variation framework

	Buyout Contract		Elevation Contract	
	Min. WTA	95% Confidence Interval	Min. WTA	95% Confidence Interval
Before	118.477%***	86.229, 150.724	40.186%***	23.495, 56.876
	(16.453)		(8.516)	
After	94.862%***	41.599, 148.126	-3.206%	-104.881, 98.468
	(27.176)		(51.876)	
Test for difference	23.61%	-35.959, 83.188	43.392%	-56.964, 143.747
	(30.395)		(51.203)	

Bootstrap standard errors in parentheses

*** p<0.01

Buyout contract (for Before and After timing) comprises the following attributes (levels): Sell both house and lot (1); Acquisition pay period (365 days); Vacate (60 days). Home elevation contract: Elevation cost (50%); Insurance appreciation (30%). Replication based on 1,366 clusters in id.

Robustness Check

Random Parameter Logit Model

Following the growing literature on estimating discrete choice models that allow for unobserved heterogeneity in preferences (Revelt and Train 1998; Train 2009), I also estimate the model in Equation 2 of this chapter as a random parameter logit (RPL) model with 1,000 Halton draws and present results in Table 3.7. RPL models assume that preferences for an attribute follow a specified distribution. In our case, I model normally distributed preferences for each attribute and estimate the mean and standard deviation of the preference distribution for each attribute.

The main findings of the conditional logit model are supported by the RPL. Further, the model gives some insights regarding the more curious findings from the conditional logit. For example, one would expect insurance premium increases to have a negative impact on utility.

While the conditional logit model has the correct sign for these coefficients, they are not statistically significant. In the RPL model, however, I find mean values to be negative and statistically significant. Furthermore, I find statistically significant standard deviations, suggesting that there is evidence of a spread in preferences. This lends credence to the theory that while some homeowners dislike premium hikes, others (likely those who don't insure their home against flood events) are indifferent to these changes, leading to a spread of preferences in the sample. Lastly, there is evidence that there is greater preference heterogeneity for elevation programs than for buyout programs. While buyout programs have much larger (in absolute value) mean preference coefficients for their ASCs (-3.762 and -2.137 for buyouts compared with -0.356 and 0.113 for elevation), the ASCs for elevation have much larger estimated standard deviations, implying a greater spread of preferences.

Table 3.7: Random parameter logit regression results

Variable	Mean	Std. deviation
Price × Before	0.0313***	-0.00145
	(0.00474)	(0.00273)
Price × After	0.0215***	0.00306
	(0.00398)	(0.00454)
Sell both house and lot × Before	0.284**	-0.249
	(0.128)	(1.089)
Sell both house and lot × After	0.403***	-0.484
	(0.129)	(0.569)
Acquisition pay period × Before	-0.00415***	-0.00535
	(0.00159)	(0.0129)
Acquisition pay period × After	-0.00482***	-0.0100**
	(0.00157)	(0.00416)
Vacate × Before	0.00684***	-0.00344
	(0.00202)	(0.00453)
Vacate × After	0.00767***	-0.00495
	(0.00189)	(0.00367)
Elevation cost × Before	-0.0315***	0.0340***
	(0.00877)	(0.0130)
Elevation cost × After	-0.0189**	0.0545***
	(0.00933)	(0.0120)

Table 3.7 Continued

Elevation subsidy × Before	0.0174***	0.00562
	(0.00310)	(0.00474)
Elevation subsidy × After	0.00949***	0.00848
	(0.00312)	(0.00620)
Insurance appreciation × Before	-0.0207***	0.0335***
	(0.00392)	(0.00301)
Insurance appreciation × After	-0.0144***	-0.0296***
	(0.00404)	(0.00328)
Buyout × Before	-3.762***	0.322
	(0.617)	(0.209)
Buyout × After	-2.137***	0.0669
	(0.530)	(0.517)
Elevation × Before	-0.357	1.799***
	(0.322)	(0.271)
Elevation × After	0.113	0.746
	(0.347)	(0.863)
Log likelihood	-5146.7058	
Observations (Cluster id)	16,377 (1,366)	

Robust standard errors in parentheses. Errors are clustered by the respondent.
*** p<0.01, ** p<0.05, * p<0.1

Considering Subsets of the Full Data Set

Results in Tables 3.6 and 3.7 utilized the full data set (N = 1,366). I also considered estimating Equation 2 using subsets of the full dataset. Specifically, I estimated Equation two considering only respondents (1) with property within 30 miles from the shoreline, (2) with property in East and Gulf Coast, (3) who are permanent resident of their community, and (4) who own single-family houses. These subsets of the data were chosen for a couple of reasons. First, it is possible that respondents with properties within 30 miles of the coast and those in the East and Gulf Coast states are more prone to flooding from tropical cyclones and thus could perceive the survey as more consequential than their counterparts. Also, permanent residents experience flooding in person and this may shape their perception on flooding and hence their decision to participate in flood risk mitigation. Further, one could hypothesize that single family homeowners are more

likely to participate in flood risk mitigation compared to those with manufactured homes or commercial properties. The results, as presented in Table 3.11A in the appendix of the chapter, however, shows that overall the main empirical results (with full dataset) are robust to that of the subsets of the dataset. That is, they have the same signs but only differ slightly in terms of magnitudes and significance.

Considering Interaction Terms

Similarly, I explored further additional sensitivity analysis by interacting respondents' sociodemographic variables with program attributes and alternative specific constants. I present results in Table 3.12A through 13.15A. Specifically, I focus on whether the homeowner is white or non-white, has a bachelors or post-graduate degree or not, have mortgage or not have flood insurance or not, have experienced flood damage or not, have property in 100-year floodplain or not, and income class. As expected, some of the results are sensitive to the model specification and this somewhat confirms the results obtained from the random parameters logit model. However, it can also be claimed the overall the coefficients have the same signs as the main results.

Discussion

For the past few decades, there has been a surge in using buyouts to tackle growing flood damages in the U.S, although the program faces participation challenges (Fraser, et al. 2003; deVries 2017; Bukvic and Owen 2017). This chapter aims to provide information on the attributes of buyout contracts that are of utmost interest to homeowners and use this information to construct willingness to accept (WTA) estimates that would guide policy makers in designing

buyout contracts. The choice experiment design used in this chapter to elicit homeowner preference for risk mitigation contracts is unique because the attributes differ across alternatives while traditional designs have same attributes across alternatives.

The analysis reveals important insight concerning homeowner preference for flood risk mitigation. Descriptively, most of the homeowners prefer buyouts to home elevation and prefer home elevation to the status quo. This is true regardless of whether buyouts are offered prior to a flood damage event or after an event. This suggests that under the right contract conditions homeowners are likely to accept buyouts. Further investigation into what attributes affect preference reveals that homeowners place significant importance on price offered in order to accept acquisition contract, which is not surprising. This finding reinforces the importance of offering benefits to individuals to engage them in voluntary environmental programs as has been shown in the literature. I also find that homeowners have less support for buyout contracts that offer the opportunity to rebuild on the same lot after home is torn down. Perhaps one explanation to this is that homeowners believe rebuilding to meet current building codes or land restrictions will be costly. This is even more so if the restricted land holds less value to the homeowner. Another reason could be that homeowners do not believe the restrictions will eliminate the flood risk. Another important finding is the emphasis homeowners place on the number of days that will elapse between the signing of the contract and when they can expect to be paid. The lesser the number of days, the more likely homeowners will accept contract. Relatedly, the greater the number of days the homeowner is given to vacate the property the more likely they are to accept buyout contract. This is somewhat surprising because houses that are severely damaged during flood events are mostly uninhabitable, at least in the short run. Regarding house elevation program, as expected, I find that Factors that influence the elevation decision include the cost of

elevating the home, the size of elevation subsidies, and future insurance premium rate appreciation.

In addition to the low buyout participation, officials are concerned about the high cost associated with buyouts (Barnhizer, 2003). However, studies show that the benefits of buyouts outweigh the cost (Rose et al., 2007; Godschalk et al. 2009; Salvesen, et al. 2018). Rose et al. (2007), for example indicate that the average benefit-cost ratio for FEMA floodplain buyout grants for the period 1993 and 2003 is 5 to 1. Other analysis of buyouts show that the program has accrued avoided losses of several millions of dollars (Salvesen, et al. 2018). Currently the federal government funds 75% of the acquisition process while additional funds (25%) are sourced from the local government, non-governmental agencies, and the homeowner. Our WTA estimates show that the average respondent in our sample is willing to accept a minimum of 118.5% (minimum of 94.86% if buyout contract is offered post-flood damage event) of the pre-damage value of their property to relinquish property at its current condition to authorities. That is, per Rose, et al. benefit-cost ratio estimate of 5 to 1 (5 to 1 suggests benefits of $375 for every $75 spent), presumably, a program that offered 125% of the value of the home (i.e. increasing cost to $125), while keeping the same benefits makes a benefit-cost ratio of 3 to 1 (i.e., $375/$125), which is still attractive.

Between the years 2000 and 2016 the federal government, through FEMA's HMGP, spent $648,421,227 in buyouts of 10, 265 damaged properties (median payout is $50,314; average is $ 63,168. per home) (Patterson, 2018). Meanwhile, NFIP policy covers up to $250,000 per structure and $100,000 for contents (for single family dwelling) and about 500,000 for other residential and commercial structures that get damaged by floods. Assuming the properties on which it pays claims are repetitive properties, then FEMA could pay claims on the

damaged property for years. Buyout contracts are mostly offered post-disaster but based on our WTA estimate (118.5% pre-damaged value of property) and the available statistics on the benefits of buyouts discussed, we posit that even offering buyouts pre-disaster will accrue larger benefits. Salvesen, et al. (2018) finds that local governments could save about $30 per year from avoided infrastructure cost such as road maintenance in flood-prone neighborhoods. Other cost that could be avoided include emergency and response costs. The National Institute of Building Sciences also finds that found that the impact of federal mitigation grants, including grants for property acquisition, resulted in an economic impact of $6 for every $1 invested (Multihazard Mitigation Council, 2017; Salvesen, et al. 2018).

Conclusion

This paper presents what is believed to be the first empirical analysis of homeowners' stated preference for household-level flood risk mitigation utilizing discrete choice data from a national survey of predominantly coastal homeowners. This study is also the first to jointly investigate homeowner stated preference for buyout and home elevation contract attributes. Buyouts and home elevation are popular household-level flood risk mitigation strategies FEMA is increasingly using to engage homeowners in flood risk mitigation with the goal of bolstering NFIP's solvency. As such, this study sheds light on which attributes of the program are most important to homeowners in an area that is of increasing interest to policy makers.

Results indicate the obvious, that price offered for buyouts is a key factor that positively influences the decision to participate. This finding is consistent with that of findings by Frimpong, et al. (2019). Interestingly, the results show that homeowners prefer not to retain the right to rebuild on the same lot after accepting a buyout, should such an option be available. This

finding is important, especially now that officials are considering allowing homeowners to rebuild on the same lot after the current home is torn down. Results further indicate that the shorter the payment period and the longer time homeowners can stay in the acquired home before vacating, the more likely homeowner will accept a buyout offer. These findings are unique in that variations in contract characteristics were not examined in previous buyout studies. As expected, the higher the elevation cost, the less likely homeowners are to elevate the structure, while increasing elevation subsidies will motivate homeowners to elevate their homes.

Another key finding of this study relates to the premium that must be paid to induce buyouts before a flood event occurs. Using average compensating variation and bootstrapping to test whether there are differences between WTA for undamaged homes and damaged homes are statistically significant, I cannot reject the null hypothesis of equal WTA values. While it is unlikely that entire communities will willingly accept buyout offers for their undamaged homes without being offered a price premium, this work suggests that offering buyouts on a rolling basis and before a storm hits is worth exploring further, especially if offers are coupled with the potential for homeowners to stay in their homes for a substantial period before vacating. Overall, the analyses suggest that buyout on a rolling basis will accrue larger benefits to federal and local governments.

CHAPTER 4 : USING SUBJECTIVE OR OBJECTIVE RISK INDICATORS IN HAZARD RISK MANAGEMENT TOOLS: WHAT ARE THE POLICY IMPLICATIONS?[23]

Abstract

This chapter evaluates the policy implications of utilizing subjective versus objective risk indicators in hazard risk management tools. To derive a single index each for subjective and objective risk, a factor analysis is used. I then integrate these indices with choice experiment survey data on households' preference for household-level flood risk mitigation and estimate conditional logit models and willingness to accept to better understand how risk indicator type affects policy recommendations. Generally, I find that the model with subjective risk performs better, as indicated by the AIC/BIC. More importantly, willingness to accept estimates shows the two risk measures yield significantly different policy outcomes, suggesting that the type of risk indicator (subjective and objective) used in empirical work matters a lot.

Introduction

Through managing climate risk, researchers have developed frameworks for conceptualizing natural hazard resilience of different social systems - household, community, and national. A core component of these resilience frameworks is the hazard risk indicator (Cutter 2008). Hazard risk indicators fall under two broad categories-- subjective and objective risk indicators. In this context, "subjective" refers to a measure based on personal judgment while "objective" refers to a measure based on external judgment and verification (Maxwell et al. 2015).

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Typically, objective risk indicators have been considered in resilience frameworks (Jones, Samman, and Vinck 2018; Frimpong, et al. 2019 and 2020). Some have argued that objective risk does not always perform satisfactorily in measuring resilience (Jones, Samman, and Vinck 2018), but there is little evidence to support the argument. Like Jones, Samman and Vinck (2018), other studies have considered subjective risk indicators in measuring resilience (Baker, et al. 2009; Jones and Tanner 2017). Still others have integrated both subjective and objective risk indicators in resilience frameworks (Petrolia, Landry, and Coble 2013; Petrolia, et al. 2015), although incorporating multiple risk indicators in resilience frameworks, especially in econometric models, may yield misleading results due to potential correlation between hazard risk indicators. Perhaps because of this lack of consensus regarding which type of risk indicator should be included in resilience frameworks, there remains a gray understanding of the implications of utilizing one risk category over another.

This chapter contributes to the hazard mitigation literature by evaluating whether and to what extent the choice of risk indicator (i.e., subjective and objective) has differential implications on hazard policy recommendations. That is, this chapter both advances the operationalization of natural hazard resilience measures and provides effective approaches to managing the impacts of climate change.

Given the longstanding limitations to incorporating multiple risk indicators in econometric models, I employ a factor analysis to create an index for subjective and objective risk categories. Each risk index category is built using several intercorrelated within-category risk indicators. I then interact these indices with attributes and alternative specific constants for buyouts and home elevation contracts and estimate conditional logit regression models. The resultant preference parameters are used to calculate minimum willingness to accept (WTA) for

a buyout and home elevation contract, which can be used to evaluate the policy implications of using subjective or objective risk indicators.

The results indicate that the model with subjective risk is preferred, as indicated by the AIC/BIC. These are information theoretic measures, indicating that there is more relevant information related to homeowner preferences for risk mitigation embedded in subjective risk measures than in their objective risk counterparts, at least in the context of this study. More importantly, willingness to accept estimates shows the two risk measures yield significantly different policy consequences, suggesting that the type of risk indicator (subjective and objective) used in empirical work has important implications.

The remainder of this chapter is organized in three sections. The first section describes the data, presents an overview of factor analysis, and outlines how it is applied in this chapter to generate the subjective and objective risk indices. This section also describes the empirical model used to measure resilience and the framework used to compute minimum willingness to accept estimates. The second section presents and discusses the results from the estimated models and framework, and the last section concludes the chapter.

Methods

Data

Three separate categories of data are used in this paper: (1) risk measures used to construct the subjective risk index, (2) risk measures used to construct the objective risk index, and (3) stated preference choice experiment data. I provide an overview of the process to construct the subjective and objective risk index and refer readers to chapter three for the detailed description of the stated choice experiment data. In this chapter, however, I use a subset of the full stated

choice experiment dataset. Specifically, I only consider respondents with valid property address information. As a robustness check, I also consider only East and Gulf Coast samples and present results in the appendix of the chapter.

I begin with the description of elements used in the subjective and objective risk indices, and then provide an overview of constructing the indices themselves. First, the subjective risk index comprises respondents' (1) *structure damage experience*, (2) *extent of structure damage*, (3) *expected structure damage from next flood*, (4) *chance of future flooding*, and (5) *flood insurance*. We measure these variables via an online survey we administer to predominantly coastal residential homeowners (IRB # UMCIRB 18-000714). Presented in figure 4.1 are the survey text for questions used to capture subjective risk perception. The wording of the questions is consistent with what has been used in the literature on hazard mitigation (Petrolia, Landry, and Coble 2013). *Structure damage experience* and *flood insurance* elements are binary and were assigned the value one (1) if the respondent has experienced flood damage to the structure and has flood insurance, respectively, and the value zero (0) otherwise. We scaled *extent of structure damage* and *expected structure damage* as the midpoint for each interval.[24] So, for example, 20-39% is scaled to 29.5%, 40-59% is scaled as 49.5% and so forth. *Chance of future flooding* is scaled as lower bound estimate, so if respondent expects the next flood within the next five years of less, we scale it as 0.2 (i.e., 1/5) 0.1 if within the next 10 years, and so forth.

Geospatial flood hazard data from several sources are used to generate measures of objective flood risk. Specifically, we consider the following elements: (1) *flood depth* (storm surge inundation), (2) *floodplain*, and (3) *distance*. *Flood depth* is measured in feet and the data, which is in a raster format (flood depth maps), is obtained from the National Weather Service's

[24] We also considered re-scaling it as ordinal (i.e., 1, 2, 3, 4, and 5, where 1 is less than 20%, 2 is 20-39%, …, and 5 is 80-100%) and outcomes are similar.

(NWS) National Hurricane Center (NHC) of the National Oceanic and Atmospheric Administration (NOAA) (NOAA 2019). NHC utilizes the hydrodynamic Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model to simulate storm surge in 27 basins along the U.S East and Gulf Coasts to generate inundation data (Jelesnianski, et al. 1992 and Zachry, et al. 2015). The SLOSH model predicts flood depth for 5 hurricane categories (i.e., categories 1, 2, 3, 4, and 5) based on the Saffir-Simpson Hurricane Wind Scale. Because residents may face different storm surge risks and these risks could be progressive (i.e., a resident facing cat 1 storm surge could potentially face cat 2, 3, 4, and 5 storm) we consider all 5 hurricane categories.[25] We note, however, that for levee areas, storm surge data are not reported and so properties in this area are excluded from the analysis.[26] The SLOSH model has over the years been used to create evacuation zones and to evaluate societal impacts from storm surge flooding (Zachry et al. 2015), hence is an appropriate indicator for objective flood risk. For the *floodplain* element, we use the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Maps (FIRM) (FEMA 2019c). For flood insurance purposes, FEMA categorizes flood zones into two broad categories -- special flood hazard area (SFHA) and non-special flood hazard area (non-SFHA). The SFHA, also referred to as "100-year floodplain" or high risk, is the land area covered by the floodwaters of the "base flood" on flood insurance rate maps (FIRMs) (Frimpong, et al., 2020).[27] SFHA comprises broadly two flood zones. Land area in A and V zones are subject to inundation

[25] Residents in north east of east coast of U.S. may face only up to category 4 hurricane. This is because coastal waters in this region are relatively cold and thus will inhibit a category 5 hurricane which requires a much warmer water.
[26] A total of 11 properties in our sample were in levee areas and were excluded from the analysis.
[27] "The "base flood" is the flood having a 1% chance of being equaled or exceeded in any given year. This is the regulatory standard, also referred to as the "100-year flood", and the SFHA is thus also referred to as the "100-year flood zone". The base flood is the national standard used by the NFIP and all federal agencies for the purposes of requiring the purchase of flood insurance and regulating new development. Base Flood Elevation (BFE), which is the computed elevation to which floodwater is anticipated to rise during the base flood, is typically shown on FIRMs." (Frimpong, et al. 2020).

by the 1-percent-annual-chance flood event. The difference is that V zones are also subject to coastal storm induced waves. That is, houses in V zones are expected to suffer greater losses from wave action compared to those in A zones. On the other hand, non-SFHA comprises the B / X flood zone (moderate risk): an area within the 0.2-percent-annual-chance floodplain; C/ X flood zone (risk is minimal): an area outside the 1-percent and 0.2-percent-annual-chance floodplains; and D (undetermined risk): the area is unstudied although flooding is possible. About 25% of all flood claims filed are for structures located within these non-SFHA zones (Floodpartners 2020). In this paper, we follow FEMA in categorizing flood zone into two: SFHA and non-SFHA and assign the value one (1) if a property is in a SFHA and zero (0) otherwise for our variable *floodplain*. Lastly, for the variable *distance*, I calculate the distance, in miles, from the respondent's property to the coastline as the shortest distance between respondent's property and the coastline. The coastline data is a polyline and is obtained from the U.S. Census Bureau, Department of Commence (Data.Gov 2019). Because data on the three objective risk indicators are georeferenced, I am able to overlay with the homeowner's property address information I collected from the online survey to ensure that objective risk data are at the property-level.[28] By doing so, I eliminate potential bias when comparing subjective and objective risk. The data extractions and calculations are performed in ArcGIS desktop. Table 4.1 presents the summary of elements used to construct the subjective and objective flood risk indices.

[28] Homeowner property address information is geocoded using the *World Geocoding Service* in ArcGIS.

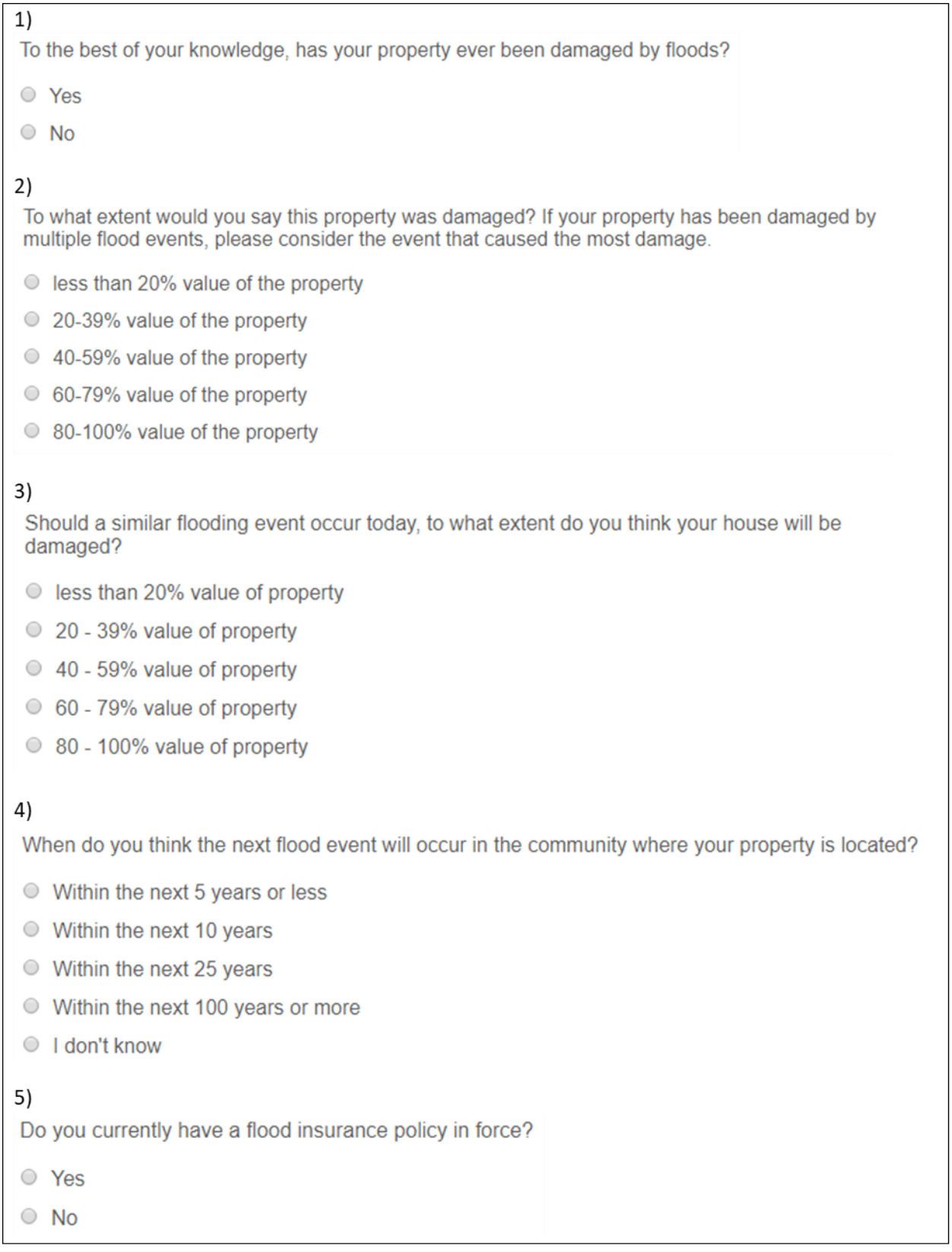

Figure 4.1: Survey questions used to capture subjective risk

Table 4.1: Summary of subjective and objective risk variables used to construct index (N=949)

Variables	Definition	Mean	Std. Dev.	Min	Max
	Subjective risk				
Structure damage experience	=1 if home is ever damaged, 0 otherwise	0.305	0.461	0	1
Extent of structure damage	Value of current home damage expressed as a %	11.079	20.366	0	90
Expected structure damage from next flood	Value of expected home damage expressed as a %	12.164	22.267	0	90
Chance of future flooding	Subjective Probability of future flood	0.096	0.087	0	0.2
Flood insurance	=1 if home has flood insurance, 0 otherwise	0.477	0.4995	0	1
	Objective risk				
Cat 1	Depth of storm surge resulting from category 1 tropical cyclone. Measured in feet.	0.202	0.961	0	10
Cat 2	Depth of storm surge resulting from category 2 tropical cyclone. Measured in feet.	0.716	2.136	0	15
Cat 3	Depth of storm surge resulting from category 3 tropical cyclone. Measured in feet.	1.614	3.678	0	21
Cat 4	Depth of storm surge resulting from category 4 tropical cyclone. Measured in feet.	2.867	5.424	0	21
Cat 5	Depth of storm surge resulting from category 5 tropical cyclone. Measured in feet.	2.912	6.056	0	21
Floodplain	=1 if home is in a 100-year floodplain, 0 otherwise	0.167	0.373	0	1
Distance	Linear distance from home to nearest coastline	58.438	88.588	0.031	476.041

Factor Analysis

Next, I employ exploratory factor analysis to create indices for subjective and objective risk.[29] Factor analysis is a data shrinking statistical technique that identifies a latent factor or factors that underlie a set of observed variables.[30] The technique has been used by researchers in both the social and natural sciences (Kim and Mueller 1978; Subbarao, Subbarao, Chandu 1996) to derive a set of uncorrelated variables for further analysis. Factor analysis assumes that there are a small number of common latent factors responsible for the covariation among a group of observed variables (Kim, et al. 1978; Kim and Mueller 1978). Those factors that are unique are assumed to be orthogonal to each other and thus do not contribute to the covariation between observed variables (Harman 1976; Kim and Mueller 1978). Equation 1 describes the factor analysis process. The goal is to find a few common factors that linearly reconstruct a set of observed variables which in our case are the elements for the respective risk categories:

$$y_{ij} = \sum_{i,r=1}^{n} l_{ir}\delta_{rj} + e_{ij} \qquad (4.1)$$

where y_{ij} is the value of the i_{th} observation on the j_{th} element, l_{ir} is the i_{th} observation on the r_{th} common factor, δ_{rj} is the set of linear coefficients called factor loadings, and e_{ij} is the j_{th} variable's unique factor (similar to a residual). The initial number of factors is equivalent to the number of elements used in the analysis. Factor loadings show the correlation between the

[29] There are two types of factor analysis - exploratory factor analysis and confirmatory factor analysis. Exploratory factor analysis examines the number of factors or how many dimensions are in a set of variables whiles confirmatory factor analysis seeks to test specific hypothesis about the structure or the number of dimensions underlying a set of variables (e.g., the number of latent factors, factor loadings, factor correlations, and factor means) (Harman 1976).

[30] Principal Component Analysis (PCA) and Factor analysis are parallel. Both aim at reducing the dimensionality of a data set (i.e., variable reduction technique). However, they require different approaches to arrive at data reduction. For factor analysis, the objective is to identify certain unobserved factors from the observed variables, whereas PCA does not directly address this objective (Tabachnick and Fidell 2001; Fabrigar, et al 1999).

elements and the factors. All except y_{ij} is to be estimated (Stata 13). There are an infinite number of solutions to Equation 1. Principal axis factor, maximum likelihood, generalized least squares, and unweighted least squares are examples of approaches that could be used to fit the data and extract the factors (Harman 1976). After the extraction of the factors, various constraints are introduced to make the model determinate (Stata 13). That is, the loadings could be rotated, and the rotations are in two forms: orthogonal and oblique. Orthogonal rotation assumes the factors are uncorrelated whiles oblique rotation assumes intercorrelated factors. Although oblique rotations are often desired, they fall short of retaining some important properties of the original solution (Stata 13). The rotation is, however, irrelevant when only one factor in a solution is desired (Grace-Martin 2020). The factor selection process has the effect of maximizing the correlation between data and the projection and is equivalent to carrying out multiple linear regression on the projected data against each variable of the original data. The first factor (Factor 1) represents the strongest correlation between variables and the latent factor.

As recommended, I begin to create our indices by examining the correlations of the elements (variables) to identify and potentially eliminate variables that correlate at less than 0.4 with all other variables within each risk category (Kim and Meuller 1978; Hinkin 1998), or variables with insignificant correlation coefficients. Presented in Table 4.2 are the correlation coefficients between elements under the risk categories. Except for *distance* in the objective risk category all other variables within each risk category fall on or exceeds the correlation coefficient benchmark (i.e., 0.4). I, however, keep distance because it significantly correlates with other objective risk elements.

Table 4.2: Correlation coefficients for subjective and objective risk variables

	Subjective risk				
	Structure damage experience	Extent of structure damage	Expected structure damage from next flood	Chance of future flooding	Flood insurance
Structure damage experience	1				
Extent of structure damage	0.821	1			
Expected structure damage from next flood	0.824	0.916	1		
Chance of future flooding	0.383	0.302	0.306	1	
Insurance	0.359	0.353	0.349	0.310	1

	Objective risk						
	Cat 1	Cat 2	Cat 3	Cat 4	Cat 5	Floodplain	Distance
Cat 1	1						
Cat 2	0.870	1					
Cat 3	0.725	0.924	1				
Cat 4	0.600	0.822	0.947	1			
Cat 5	0.441	0.609	0.695	0.788	1		
Floodplain	0.455	0.607	0.595	0.556	0.439	1	
Distance	-0.129	-0.191	-0.242	-0.289	-0.252	-0.160	1

Note: All coefficients are significant at 1% significant level

I then perform the factor analysis using the factor procedure in Stata 13.1. Because I am interested in creating only one variable (i.e., the index) for each risk category, I retain only one factor, Factor 1. Factor 1 has the highest eigenvalue, 2.9 and 4.3, and explains 100% and 90% of the total variance for subjective and objective risk, respectively. Table 4.3 presents the factor loadings, eigenvalues, and percent of total variability. I show output for Factor 1 and Factor 2 although I keep only Factor 1 for further analysis. I then generate factor scores, which are

estimates of Factor 1, for each observation in the dataset. Factor scores serve as our index for each type of risk. Finally, I normalize the scores to have mean zero and standard deviation 1 by taking the difference between the factor scores and its mean, and then divide by the standard deviation.

Table 4.3: Eigenvalues and factor loadings

Variables	Subjective risk		Objective risk	
	Factor 1	Factor 2	Factor 1	Factor 2
Structure damage experience	0.878	0.043		
Extent of structure damage	0.924	-0.158		
Expected structure damage from next flood	0.926	-0.141		
Chance of future flooding	0.385	0.326		
Insurance	0.435	0.260		
Cat 1			0.776	0.444
Cat 2			0.953	0.260
Cat 3			0.975	-0.043
Cat 4			0.937	-0.290
Cat 5			0.730	-0.333
Floodplain			0.607	0.013
Distance			-0.249	0.172
Eigenvalue	2.819	0.220	4.300	0.491
Percent of total variability accounted for by each factor	101.2	8	89.6	10.2

Note: Subjective risk: LR test: independent vs. saturated: chi2(10) = 5.9e+04 Prob>chi2 = 0.000;

Objective risk: LR test: independent vs. saturated: chi2(21) = 1.0e+05 Prob>chi2 = 0.000

Empirical Model

Econometrics

To examine the policy implications of the choice of risk indicator, I first estimate two conditional logit models. The first model includes the interaction of the subjective risk index with the

attributes and alternative specific constants (ASC) for buyout and home elevation, while the second model includes the interaction of objective risk index with the attributes and alternative specific constants (ASC) for buyout and home elevation:

$$U_{ij} = \left[\sum_{k=1}^{K} \beta_k X_{ijk} + \eta Buyout_{ij} + \varphi Elevation_{ij} \right] + \left[\sum_{k=1}^{K} \alpha_k X_{ijk} + \phi Buyout_{ij} + \delta Elevation_{ij} \right] \times R + e_{ij} \quad (4.2)$$

where U_{ij} is utility and X_{ijk} is a vector of attributes. β_k, η, φ, α_k, ϕ, and δ are parameters to be estimated. I replace *R* with *subjective risk index* when estimating Equation 2 with subjective risk index interactions and replace *R* with *objective risk index* when estimating Equation 2 with objective risk index interactions. Given this model structure, β_k estimates preferences for program attributes for an individual with the average level of risk in the sample (R=0), while α_k estimates the change in preferences for program attributes as the level of risk faced by the individual increases.

Estimating Minimum Willingness to Accept

Next, I use information from the estimated parameters in Equation 4.2 to estimate the minimum willingness to accept (WTA) for a buyout and home elevation contract for the average homeowner in our sample using Hanemann's (1984) average compensating variation framework. WTA (and willingness to pay – WTP) measures are often used to inform policy analyses (Loomis 2014). For contract type (buyout vs elevation), I generate and compare two WTA estimates: one for average level of subjective risk and one for the average level of objective risk. Both buyout contracts require the homeowner to sell both house and lot, pay the homeowner in

300 days, and require the homeowner to vacate the property after 60 days. Home elevation contracts would cost 30% of the property's value to elevate home. In all cases, the respondent has an alternative of choosing the status quo option, which carries with it an insurance premium rate increase of 50%. Choosing the elevation contract also leads to a premium increase of 50%. The CV framework is defined as follows:

$$\text{CV} = -\frac{1}{\beta_{price}}\left(V_1 - V_0\right), \qquad (4.3)$$

where V_1 is the estimated utility of the contract, V_0 is the estimated utility of the status-quo option, and β_{price} is the coefficient associated with the buyout transaction price. For elevation contract I replace β_{price} with $\beta_{subsidy}$, the subsidy for elevation.

Results and Discussion

Results from Conditional logit model Estimation

Presented in Table 4.4 are the results of the estimated conditional logit models for subjective risk and objective risk. As a robustness check, I also estimated the models with risk index computed using the principal component analysis and present results in the appendix. Generally, results are similar to what I discuss in this section. I discuss the results from the two models concurrently. On comparing the model statistics, that is, pseudo r-squared and AIC and BIC, I note that the model with subjective risk performs better compared to the objective risk model. A finding that somewhat confirms the Jones, Samman, and Vinck (2018) argument for the preference of subjective risk as a measure of resilience. Generally, considering the average respondent in the sample, except for insurance appreciation and the alternative-specific constant for the elevation

option, coefficients in the two models have the same sign and significance, with closely parallel magnitudes. For example, I note that for both models, the average respondent prefers more money in order to accept buyout contracts, assigns no premium to being able to retain the deed restricted lot, and values contracts that pay shortly after accepting contract and allow a longer stay or use of the property by the owner. The results, however, differ greatly, both in magnitude and statistical significance, if I factor in risk. For example, I find that increasing subjective risk by one standard deviation decreases sensitivity to buyout premia significantly while the same one standard deviation increases in objective risk results in no change in sensitivity to buyout premium.

Further, I find that for the two models, respondents' preference for elevation contract characteristics are very similar at the average level of risk, whether it be objective or subjective. The estimates from the two models differ significantly, as I increase risk in the two models. That is, compared to the objective risk counterpart, respondents with above average subjective risk (i.e., 1 standard deviation increase in subjective risk index) become less sensitive to the cost of elevation as well as the offered elevation subsidy. Lastly, all other contract characteristics held constant, I find that a 1 standard deviation increase in subjective risk index leads to a dramatic increase in preference for both the elevation and buyout contracts relative to the status-quo option (as shown by buyout and elevation alternative-specific constants), but I find no similar change in preference associated with an increase in the objective risk index.

Table 4.4: Results from the conditional logit model estimations

Variables	R = Subjective risk	R= Objective risk
Price	0.016***	0.017***
	(0.002)	(0.002)
Price × R	-0.005***	-0.001
	(0.002)	(0.002)
Sell both house and lot	0.186***	0.188 ***
	(0.064)	(0.064)
Sell both house and lot × R	-0.023	0.058
	(0.070)	(0.059)
Acquisition pay period	-0.003***	-0.003***
	(0.001)	(0.001)
Acquisition pay period × R	0.002*	0.001
	(0.001)	(0.001)
Vacate	0.002**	0.002**
	(0.001)	(0.001)
Vacate × R	-0.00003	-0.002*
	(0.001)	(0.001)
Elevation cost	-0.007**	-0.008**
	(0.004)	(0.003)
Elevation cost × R	0.006*	0.004
	(0.004)	(0.003)
Elevation subsidy	0.010***	0.010***
	(0.002)	(0.002)
Elevation subsidy × R	-0.004***	0.001
	(0.002)	(0.002)
Insurance appreciation	-0.004**	-0.003
	(0.002)	(0.002)
Insurance appreciation × R	-0.002	0.002
	(0.002)	(0.002)
Buyout	-1.116***	-1.179***
	(0.273)	(0.271)
Buyout × R	0.764***	0.061
	(0.290)	(0.282)
Elevation	-0.281	-0.229
	(0.172)	(0.167)
Elevation × R	0.869***	-0.146
	(0.164)	(0.153)
Pseudo R-squared	0.127	0.094
Log pseudolikelihood	-4044.208	-4198.869
AIC / BIC	8124.416 / 8258.43	8433.739 / 8567.753
Observations (Cluster id)	12,648 (949)	12,648 (949)

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Policy Implications: Minimum Willingness to Accept

As mentioned in the previous section, WTP/WTA measures are often used to inform policy analyses (Loomis 2014). In this paper, I am interested in estimating both WTA for a contract, but also in understanding what changes in the homeowner's risk index would induce a specified reduction in WTA. Presented in Table 4.5 are the WTA estimates for a specified contract for a homeowner with the average level of risk according to each index (subjective vs. objective).

Table 4.5: Results from the estimated compensating variation framework

	Subjective risk		Objective risk	
	Min. WTA	95% Confidence interval	Min. WTA	95% Confidence interval
		Buyout		
Mean risk	98.56%*** (13.50)	72.10, 125.03	106.93%*** (12.87)	81.71, 132.14
	Std dev. for subjective risk Index		Std dev. for objective risk index	
Induce 10% reduction	0.16* (0.08)	-0.003, 0.32	1.48 (1.70)	-1.85, 4.81
Induce 20% reduction	0.29** (0.15)	0.003, 0.58	2.8 (2.15)	-1.42, 7.02
		Elevation		
Mean risk	47.9%*** (12.88)	22.65, 73.15	51.69%*** (13.56)	25.11, 78.28
	Std dev. for subjective risk index		Std dev. for objective risk index	
Induce 10% reduction	0.05** (0.21)	0.01, 0.09	3.08 (2.30)	-1.43, 7.59
Induce 20% reduction	0.1** (0.04)	0.02, 0.18	8.61** (3.06)	2.61, 14.61

Bootstrap standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Buyout contract comprises the following attributes (levels): Sell both house and lot (1); Acquisition pay period (300 days); Vacate (60 days). Home elevation contract: Elevation cost (30%); Insurance appreciation (50%). Replication based on 949 clusters in id.

For buyout contracts, the minimum WTA are 98.6% fair market value of the home for a homeowner with the average level of subjective risk and 106.9% fair market value of the home for a homeowner with the average level of objective risk. Further, to induce a 10 % (20%) reduction in the WTA, standard deviation estimates show that homeowner's subjective risk index will have to be increased by 0.16 (0.29) standard deviations while objective risk index will require a much larger increase of 1.5 (2.8) standard deviations.

For elevation contracts, the minimum WTA are 47.9% of the cost of elevation for a homeowner with the average level of subjective risk and 51.7% of the cost of elevation for a homeowner with the average level of objective risk. To induce a 10% (20%) reduction in the WTA, the homeowner's subjective risk index will have to be increased by 0.05(0.1) standard deviations while the objective risk index will have to increase by 3.08 (8.6) standard deviations. It is worth mentioning that although standard deviation estimates for the objective risk index are not significant (except for elevation contract when I want to induce a 20% reduction in WTA), it provides a fair understanding of how different, especially in magnitude, it is from that of the subjective risk index.

Summary and Conclusion

A recent assessment (Jones, Samman, and Vinck 2018) of using subjective or objective risk to measure resilience indicates the two risk categories yield different outcomes, as expected. However, until now, the policy implications of using subjective or objective risk as a hazard risk management tool was lacking in the literature. This paper investigated the policy implications of using subjective or objective risk as hazard risk management tool to measure household flood risk mitigation decisions. This paper also demonstrates the use of factor analysis to create indices

for intercorrelated hazard indicator variables for further analysis.

The first discovery to emerge from this paper is that the model with subjective risk measure holds more information related to homeowner preferences for risk mitigation than objective risk counterparts. Jones, Samman, and Vinck (2018) also notes that subjective risk measures perform satisfactorily in measuring resilience. Based on willingness to accept estimates, I find that the two risk measures yield significantly different policy outcomes. This implies that officials are not any more likely to get homeowners to accept buyout contracts if they target higher risk homes based on objective risk. On the other hand, given that the factor analysis indicates that expected structure damage from next flood, extent of structure damage, and structure damage experience strongly define subjective risk index, if officials can target repetitive loss homes, the chances of increased uptake are considerable. That is, overall, findings from this study suggest that researchers and hazard risk managers need to carefully consider the choice of risk indicators used to inform hazard mitigation policies.

I have explored the policy implications of using subjective versus objective risk indicators to inform hazard mitigation policy with application to flood risk hazard and studying households. The main limitation to this work is the limited objective flood hazard data. The analyses do not account for other objective flood risk data such as precipitation. Future work should consider precipitation and other objective flood risk data at the parcel-level. The methods applied in this chapter could be extended to other risk hazards and social systems. Again, over time, subjective risk could be volatile, as such this paper should stimulate a further discussion on the topic.

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APPENDIX A: APPENDIX FOR CHAPTER 2

Table 2.10A: Coefficient estimates for all models

Variables	Base Model	Z = Race	Z = Tenure	Z = Education	Z = Flood Risk	Z = Income
Before hurricane	-2.16***	-	-	-	-	-
Floodplain	-0.62**	-0.63**	-0.61**	-0.61**	-	-0.62**
log (Distance)	-0.21**	-0.13**	-0.11*	-0.13*	-0.13**	-0.13**
log (Lot size)	-0.20**	-0.21**	-.021**	-0.21**	-0.21***	-0.20**
Tenure in home	-0.01*	-0.01*	-	-0.01*	-0.01*	-0.01*
Race	0.43**	-	0.48**	0.44**	0.43*	0.44**
Income						
Lower	-0.09	-0.10	-0.09	-0.09	-0.09	-
Higher	-0.20	-0.20	-0.19	-0.20	-0.20	-
Education	0.28	0.28	0.30	-	0.29	
Constant	-3.66***	-2.59***	-4.36***	-4.47***	-3.64***	-3.60***
Before hurricane × price	0.06***	-	-	-	-	-
After hurricane × price	0.04***	-	-	-	-	-
Before Hurricane × Z	-	-3.04***	-1.30*	-1.88**	-2.52**	-1.32
After hurricane × Z	-	-0.90	0.65	1.21	-0.91	-0.74
Before Hurricane × Z × price	-	0.06***	0.05***	0.06***	0.05***	0.05***
After hurricane × Z × price	-	0.04***	0.04***	0.40***	0.05***	0.05***
Pseudo R^2	0.29	0.29	0.29	0.30	0.29	0.29

Note: ***, **, and * shows significance at 1%, 5%, and 10% levels of significance. Standard errors are robust clustered for 172 clusters in identifier (id), and number of observations=1519. Each column represents a model, with the first column representing the base model described by Equation (2a) and the remaining columns representing models described by Equation (2b). Each of these models accounts for heterogeneity for a single covariate, denoted Z. These models omit the "Before Hurricane" variable as well as the covariate, and include two- and three-way interactions of the covariate in question, the timing dummies (Before and After hurricane), and price.

Table 2.11A: Interval regression results

Variables	Base Model	Z = Race	Z = Tenure	Z = Education	Z = Floodplain
Before hurricane	10.48*** (< 0.005)	7.50* (0.087)	12.04*** (<0.005)	−0.08 (0.980)	10.05*** (< 0.005)
Floodplain	3.09 (0.434)	3.15 (0.423)	3.17 (0.422)	3.21 (0.405)	-
Log (distance)	1.73*** (0.010)	1.73*** (0.010)	1.72*** (0.010)	1.68** (0.011)	1.77*** (0.008)
Log (lot size)	−0.27 (0.812)	−0.25 (0.823)	−0.26 (0.819)	−0.38 (0.728)	−0.34(0.759)
Tenure in home	0.04 (0.673)	0.04 (0.665)	-	0.03 (0.745)	0.04 (0.688)
Race	−1.73 (0.659)	-	−1.77 (0.652)	−1.81 (0.645)	−1.76 (0.653)
Low income	−0.88 (0.725)	−0.90 (0.719)	−0.83 (0.740)	−0.68 (0.778)	−1.04 (0.673)
High income	−0.95 (0.672)	−0.87 (0.697)	−0.90 (0.687)	−0.85 (0.704)	−1.76 (0.646)
Education	−1.20 (0.659)	−1.25 (0.657)	−1.13 (0.687)	-	−1.29 (0.648)
Constant	102.89*** (< 0.005)	104.17*** (<0.005)	102.30*** (<0.005)	107.74*** (<0.005)	103.04*** (<0.005)
Before hurricane × Z	-	0.22 (0.965)	−0.03 (0.828)	6.03* (0.061)	8.61** (0.045)
After hurricane ×Z	-	−3.15 (0.440)	0.08 (0.406)	−6.74** (0.029)	0.64 (0.886)
Differences		1/6* (3 others p < 0.1)	4/6	2/6* (3 others p < 0.1)	5/6

Notes: ***, **, and * show significance at 1%, 5%, and 10% levels of significance. Standard errors are robust clustered for 172 clusters in identifier (id). Each column represents a model, with the first column representing the interval regression that mirrors the base model described using Equation 2.2a (with price variables omitted) and the remaining columns representing models described by Equation 2.2b (also with price variables omitted). Each of these models accounts for heterogeneity for a single covariate, denoted as Z. These models include two-way interactions of the covariate in question with the timing dummies (Before and After hurricane). The models described by Equation 2.2b generate four groups, which allows for six distinct binary comparisons between groups. The bottom row of the table shows how many of these six comparisons reject the null hypothesis of no difference between groups at the 5% level of significance, as well as how many additional comparisons would be rejected at the 10% level.

APPENDIX B: APPENDIX FOR CHAPTER 3

Random Utility Theory

The random utility theory (RUT) is a well-known theory for modeling discrete choices of individuals (McFadden 1974 and Hanemann 1984). The theory assumes that individuals' utility for a good is a function of observable (deterministic/ systemic) and unobservable (stochastic/random) components (Manski 1973). The former is comprised the attributes of the good/service (Griliches 1961 and Lancaster 1966) while the latter, according to Manski (1973), arise due to omitted attributes, imperfect information, and the use of proxies (instrumental variables) which contain random errors. Since the researcher has incomplete behavioral information about the decision-maker, the researcher can only assume a probabilistic behavior of the decision-maker (Lancaster 1966).

Assume individual *i*'s utility (*U*) for flood mitigation activity (*j*) is a function of the deterministic component (V_{ij}) of the utility (U) and a stochastic component ε. We further assume the homeowner is rational and maximizes utility by choosing the mitigation program that gives the highest comparable utility subject to homeowner's budget constraint. Mathematically, we can express the homeowner's utility function as

$$U_{ij} = V_{ij} + \varepsilon_{ij} \qquad (3A1)$$

We further decompose the deterministic component to be a function of the attributes (X) of flood mitigation *j* and the homeowner' characteristics (W). That is $V_{ij} = X_j + W_i$. Substituting into Equation A1, we have $U_{ij} = X_{ij} + W_i + \varepsilon_{ij}$. For simplicity, let us assume there are two competing flood mitigation options: *j* and *k*, $\forall J$. Since we don't have complete behavioral information about the homeowner we can only make probabilistic judgments: 1 if homeowner prefers *j* and 0

otherwise. Thus, we can only compare utilities and assume homeowner *i* will choose flood mitigation *j* if the expected utility for *j* is greater than the expected utility for *k*, that is,

$EU_{ij} > EU_{ik}$.

This can further be expressed mathematically as,

$$\begin{aligned} \Pr_{ij}\left[Y=1 \middle| X_{ij}, X_{ik}, W_i\right] &= \Pr\left[U_{ij} > U_{ik}\right] \\ &= \Pr\left[\left(X_{ij} + W_i + \varepsilon_{ij}\right) - \left(X_{ik} + W_i + \varepsilon_{ik}\right) > 0 \middle| X_{ij}, X_{ik}, W_i\right] \\ &= \Pr\left[\left(X_{ij} - X_{ik} + \varepsilon_{ij} - \varepsilon_{ik}\right) > 0 \middle| X_{ij}, X_{ik}, W_i\right] \end{aligned} \quad \text{(3A2)}$$

where P_{nj} is the probability (Pr) that the difference in the observed utilities of the chosen alternative (*j*) and the other alternatives (*k*) is greater than the difference between the unobserved variation in the utility of the other alternatives (*k*) and the utility of the chosen alternative (*j*). We note that the decision-maker's specific characteristics (W) falls out of Equation A2. This is because it is invariant across the two goods and is assumed to be captured by the random component.

Several standard choice models and their econometric applications have been developed based on the specification of the distributions for the random component (McFadden 1974 and Hanemann 1984) and applied in recent studies. These discrete choice models include multinomial logit, conditional logit, random parameter logit, and latent class models (Bhat 1997; Birol, Karousakis, and Koundouri 2002; Columbo, Hanley, and Louviere 2009; Train 1998 and 2009; McFadden and Train 2000; McFadden 1973; Hanemann 1984).

From Equation 3A1, we can introduce coefficients for the attribute variables and decision maker specific characteristics as,

$$V_{ij} = \beta X_{ij} + \gamma W_i \quad \text{(3A3)}$$

Where β and γ are vector of parameters to be estimated for the observable attributes *X* and decision-maker characteristics, *W*. Assuming the random component of the utility follows a Gumbel or a Type 1 extreme value distribution,

$$F\left(\varepsilon_{ij}\right) = \exp\left(-\exp\left(-\varepsilon_{ij}\right)\right) \qquad (3A4)$$

then the probability the decision-maker *i* will choose alternative j, the best alternative, from a set of policy alternatives *J* can be specified as a function of the systematic component (*V*). That is,

$$\Pr\left(\mathrm{Y}_i = j\right) = \frac{\exp\left(\beta X_{ij} + \gamma W_{ij}\right)}{\sum_{j=1}^{J} \exp\left(\beta X_{ij} + \gamma W_{ij}\right)} \qquad (3A5)$$

Conditional Logit Model

The conditional logit model allows one to compare the utility of one alternative to the other (Greene 2012), and as such serve as the basis for modeling the random utility model. This model, customarily, does not allow for data on decision-maker characteristics (Greene 2012). From Equation 3A5, under the conditional logit model, the choice probability for the decision-maker can be expressed as,

$$\Pr\left(\mathrm{Y}_i = j\right) = \frac{\exp\left(\beta X_{ij}\right)}{\sum_{j=1}^{J} \exp\left(\beta X_{ij}\right)} \qquad (3A6)$$

To estimate the vector of preference (attributes) parameters $\left(\beta\right)$, a log-likelihood (In *L*) function is used.

$$\ln L = \sum_{i=1}^{I} \sum_{j=1}^{J} \ln \Pr\left(Y_i = j\right) \qquad (3A7)$$

The conditional logit model, however, assumes preference homogeneity (Colombo, Hanley, Louviere 2009; Howard, Roe, and Martin 2018). That is, the population share a single-parameter

estimate for each estimable choice attribute (Colombo, Hanley, Louviere 2009; Howard, Roe, and Martin 2018) which can be unrealistic. Researchers have tried to adjust the conditional model to account for heterogeneity by interacting decision-maker specific characteristics with choice attributes or with an alternative-specific constant[31] (Greene 2012; Colombo, Hanley, Louviere 2009) To formally account for heterogeneityone could use the random parameter or mixed logit model (Train 1998; McFadden and Train 2000).

Random Parameter (Mixed) Logit Model

The random parameter logit model is, perhaps, the most popular discrete choice model used by researchers (Train 1998; McFadden and Train 2000). This model shares some similarity with the latent class model in that, they both account for heterogeneity in decision-makers preference. However, the latent class model assumes a discrete preference heterogeneity while the random parameter model assumes continuous preference heterogeneity (Howard, Roe, and Martin 2018). The choice probability for a random parameter logit model is expressed as,

$$\Pr\left(\mathrm{Y}_i = j\right) = \frac{\exp\left(\boldsymbol{\beta}_i X_{ij}\right)}{\sum_{j=1}^{J} \exp\left(\boldsymbol{\beta}_i X_{ij}\right)}, \qquad \text{(3A8)}$$

We note that in Equation A8, a subscript *i* is introduced for the parameter vector $\left(\boldsymbol{\beta}_i\right)$. This indicate preference heterogeneity under the mixed logit model. That is, the model assumes that parameters are continuously distributed over decision-makers, with

$$\boldsymbol{\beta}_i = \boldsymbol{\beta} + \boldsymbol{\gamma} W_i + \boldsymbol{\delta}\varepsilon_i \qquad \text{(3A9)}$$

where *W* is a vector of decision-maker specific characteristics as defined earlier and affects the mean of the random parameter distribution (Greene and Hensher 2003). $\boldsymbol{\gamma}$ and $\boldsymbol{\delta}$ are vector of

[31] Alternative specific constants are dummy variables created for the alternative choices (Greene 2012)

coefficients and ε is a random effect or component assumed to have a mean of zero and a constant variance (Greene and Hensher 2003). The variance of the distribution of the parameter vector (β_i) is given as $\Omega = \delta \sum \delta'$. The choice probability for the decision-maker is expressed as,

$$\Pr(Y_i = j|\Omega) = \int_{\beta_i} \left[\frac{\exp(\beta_i X_{ij})}{\sum_{j=1}^{J} \exp(\beta_i X_{ij})} \right] f(\beta_i|\Omega) d\beta \qquad (3A10)$$

The parameters in Equation 3A10 are estimated by maximizing the simulated log likelihood function which is expressed as,

$$\text{In } L_{msl} = \int_{\beta_i} \Pr(Y_i = j) f(\beta_i|\Omega) d\beta \qquad (3A11)$$

Table 3.8A: SAS macro results on design

Final Results	
Design	21
Number of choice sets	30
Alternatives	2
Parameters	11
Maximum parameters	30
D-Efficiency	20.0995
Relative D-Efficiency	66.9982
D-Error	0.0498

Note: First, we use the *%mktruns* macro to determine how big a candidate sets we need. The *%mktex* macro was then used to make candidate set of alternatives (Kuhfeld 2010). Further, the *%mktroll* is used to convert the linear arrangement created with the *%mktex* into a choice design (Kuhfeld 2010). We proceed to use the %choiceEff macro to create and evaluate the choice design (Kuhfeld 2010). In all we specify the program to create 30 choice sets with two alternatives excluding the status-squo. Our final design[32] was selected to maximize relative D-efficiencyi[33] (Kuhfeld 2010). Unlike other efficiency measures (e.g., A-efficiency, G-efficiency) the D-efficiency is the most used (Kuhfeld 2010). Relative D-efficiency ranges from 0 to 100 % where values approaching 100% or equal to 100% is preferred and indicates the degree of efficiency (Kuhfeld 2010). In practice, most designs are not exactly optimal (100%) (Kuhfeld 2010). Presented in Table 2 are results from the design. Our design shows a relative D-efficiency of 67%. We use *%mktdups* macro to identify any duplicate choice set (we found no duplicate sets). Following standard practice (Kuhfeld 2010), we group the 30 choice sets into 15 blocks, each block having two choice sets. We perform this using the *%mktblock* macro (Kuhfeld 2010).

[32] An efficient design has a small variance matrix (Kuhfeld 2010).

[33] Relative D efficiency is the ratio of two D-efficiencies for two competing designs. It can be computed as D-efficiency divided by the optimal value (number of choice sets) and multiplied by 100 (Kuhfeld 2010).

Table 3.9A: Conditional logit regression results showing all three alternative specific constants

Variables	Model 1:Base model	Model 2	Model 3
Price × Before	0.0179***	0.0179***	0.0179***
	(0.00222)	(0.00222)	(0.00222)
Price × After	0.0113***	0.0113***	0.0113***
	(0.00211)	(0.00211)	(0.00211)
Sell both house and lot × Before	0.189**	0.189**	0.189**
	(0.0768)	(0.0768)	(0.0768)
Sell both house and lot × After	0.227***	0.227***	0.227***
	(0.0756)	(0.0756)	(0.0756)
Acquisition pay period × Before	-0.00327***	-0.00327***	-0.00327***
	(0.000966)	(0.000966)	(0.000966)
Acquisition pay period × After	-0.00305***	-0.00305***	-0.00305***
	(0.000940)	(0.000940)	(0.000940)
Vacate × Before	0.00355***	0.00355***	0.00355***
	(0.00112)	(0.00112)	(0.00112)
Vacate × After	0.00388***	0.00388***	0.00388***
	(0.00110)	(0.00110)	(0.00110)
Elevation cost × Before	-0.0149***	-0.0149***	-0.0149***
	(0.00413)	(0.00413)	(0.00413)
Elevation cost × After	-0.00187	-0.00187	-0.00187
	(0.00408)	(0.00408)	(0.00408)
Elevation subsidy × Before	0.0107***	0.0107***	0.0107***
	(0.00180)	(0.00180)	(0.00180)
Elevation subsidy × After	0.00607***	0.00607***	0.00607***
	(0.00178)	(0.00178)	(0.00178)
Insurance appreciation × Before	-0.00232	-0.00232	-0.00232
	(0.00199)	(0.00199)	(0.00199)
Insurance appreciation × After	-8.14e-05	-8.14e-05	-8.14e-05
	(0.00204)	(0.00204)	(0.00204)
Buyout × Before	-1.444***	-1.415***	
	(0.309)	(0.320)	
Buyout × After	-0.420	-0.493	
	(0.303)	(0.309)	
Elevation × Before	-0.0286		1.415***
	(0.180)		(0.320)
Elevation × After	0.0738		0.493
	(0.179)		(0.309)
Statusquo × Before		0.0286	1.444***
		(0.180)	(0.309)
Statusquo × After		-0.0738	0.420
		(0.179)	(0.303)
Pseudo R-Square	0.085	0.085	0.085
Log pseudolikelihood	-5487.2596	-5487.2596	-5487.2596
Observations (Cluster id)	16,377 (1,366)	16,377 (1,366)	16,377 (1,366)

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.10A: Conditional logit regression results for pooled model

Variables	Coefficient
Price	0.0144***
	(0.00160)
Sell both house and lot	0.207***
	(0.0555)
Acquisition pay period	-0.00317***
	(0.000709)
Vacate	0.00368***
	(0.000799)
Elevation cost	-0.00825***
	(0.00294)
Elevation subsidy	0.00837***
	(0.00128)
Insurance appreciation	-0.00124
	(0.00177)
Buyout	-0.914***
	(0.241)
Elevation	0.0169
	(0.140)
Pseudo R-square	0.0834
Log pseudolikelihood	-5497.3355
Observations (cluster id)	16,377 (1,366)

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3.11A: Conditional logit regression results comparing all sample with subsamples

Variables	All sample	30 miles from shoreline	East & Gulf Coast	Permanent residents	Single-family houses
Price × Before	0.0179***	0.0157***	0.0184***	0.0201***	0.0177***
	(0.00222)	(0.00273)	(0.00235)	(0.00236)	(0.00250)
Price × After	0.0113***	0.0112***	0.0118***	0.0115***	0.0101***
	(0.00211)	(0.00258)	(0.00225)	(0.00224)	(0.00237)
Sell both house and lot × Before	0.189**	0.179**	0.236***	0.207**	0.208**
	(0.0768)	(0.0914)	(0.0816)	(0.0814)	(0.0872)
Sell both house and lot × After	0.227***	0.189**	0.197**	0.214***	0.267***
	(0.0756)	(0.0915)	(0.0812)	(0.0803)	(0.0858)
Acquisition pay period × Before	-0.00327***	-0.00343***	-0.00285***	-0.00400***	-0.00367***
	(0.000966)	(0.00117)	(0.00102)	(0.00103)	(0.00109)
Acquisition pay period × After	-0.00305***	-0.00338***	-0.00332***	-0.00347***	-0.00374***
	(0.000940)	(0.00114)	(0.00100)	(0.000995)	(0.00105)
Vacate × Before	0.00355***	0.00298**	0.00328***	0.00356***	0.00456***
	(0.00112)	(0.00135)	(0.00120)	(0.00120)	(0.00127)
Vacate × After	0.00388***	0.00265**	0.00414***	0.00412***	0.00393***
	(0.00110)	(0.00134)	(0.00118)	(0.00117)	(0.00123)
Elevation cost × Before	-0.0149***	-0.0173***	-0.0148***	-0.0179***	-0.0154***
	(0.00413)	(0.00510)	(0.00449)	(0.00447)	(0.00455)
Elevation cost × After	-0.00187	-0.000221	-0.00351	-0.00262	-0.00714
	(0.00408)	(0.00500)	(0.00438)	(0.00440)	(0.00452)
Elevation subsidy × Before	0.0107***	0.0113***	0.0120***	0.0122***	0.00920***
	(0.00180)	(0.00220)	(0.00196)	(0.00194)	(0.00199)
Elevation subsidy × After	0.00607***	0.00725***	0.00690***	0.00668***	0.00758***
	(0.00178)	(0.00223)	(0.00195)	(0.00192)	(0.00198)
Insurance appreciation × Before	-0.00232	-3.03e-05	-0.00270	-0.00129	-0.00131
	(0.00199)	(0.00239)	(0.00211)	(0.00209)	(0.00224)
Insurance appreciation × After	-8.14e-05	0.00143	-0.00143	-0.000483	-0.000193
	(0.00204)	(0.00249)	(0.00219)	(0.00217)	(0.00231)
Buyout × Before	-1.444***	-0.992***	-1.587***	-1.611***	-1.408***
	(0.309)	(0.375)	(0.330)	(0.329)	(0.347)
Buyout × After	-0.420	-0.150	-0.580*	-0.488	-0.290
	(0.303)	(0.375)	(0.320)	(0.323)	(0.340)
Elevation × Before	-0.0286	0.0355	-0.228	-0.0783	0.179
	(0.180)	(0.218)	(0.198)	(0.195)	(0.202)
Elevation × After	0.0738	-0.0350	-0.0393	-0.0420	0.215
	(0.179)	(0.220)	(0.194)	(0.191)	(0.199)
Pseudo R2	0.0850	0.0862	0.0875	0.0879	0.0811
Log pseudolikelihood	-5487.2596	-3726.7046	-4744.9016	-4859.0572	-4337.7053
Observations (clusters in id)	16,377 (1,366)	11,136 (929)	14,199 (1,184)	14,547 (1,213)	12,891 (1,075)

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.12A: Conditional logit regression results: interacting sociodemographic with base model

Variables	White	Non-White	Bachelor/graduate	No bachelor/Graduate
Price × Before	0.0211***	0.00884**	0.0165***	0.0191***
	(0.00264)	(0.00421)	(0.00319)	(0.00309)
Price × After	0.0110***	0.0122***	0.0120***	0.0108***
	(0.00245)	(0.00416)	(0.00307)	(0.00293)
Sell both house and lot × Before	0.243***	0.0206	0.150	0.224**
	(0.0889)	(0.154)	(0.108)	(0.109)
Sell both house and lot × After	0.256***	0.150	0.285***	0.160
	(0.0862)	(0.157)	(0.108)	(0.108)
Acquisition pay period × Before	-0.00439***	-0.000123	-0.00300**	-0.00346**
	(0.00112)	(0.00193)	(0.00139)	(0.00135)
Acquisition pay period × After	-0.00336***	-0.00202	-0.00337**	-0.00283**
	(0.00107)	(0.00200)	(0.00140)	(0.00128)
Vacate × Before	0.00431***	0.00129	0.00382**	0.00331**
	(0.00131)	(0.00227)	(0.00159)	(0.00158)
Vacate × After	0.00302**	0.00631***	0.00432***	0.00361**
	(0.00126)	(0.00228)	(0.00158)	(0.00152)
Elevation cost × Before	-0.0144***	-0.0138*	-0.0121**	-0.0176***
	(0.00487)	(0.00817)	(0.00585)	(0.00584)
Elevation cost × After	-0.00600	0.00810	0.00242	-0.00739
	(0.00486)	(0.00790)	(0.00579)	(0.00577)
Elevation subsidy × Before	0.0128***	0.00555	0.00859***	0.0132***
	(0.00213)	(0.00350)	(0.00247)	(0.00267)
Elevation subsidy × After	0.00664***	0.00507	0.00241	0.0106***
	(0.00212)	(0.00345)	(0.00252)	(0.00254)
Insurance appreciation × Before	-0.00159	-0.00332	-0.00540*	0.000420
	(0.00226)	(0.00441)	(0.00295)	(0.00271)
Insurance appreciation × After	0.000545	-0.000119	-0.000962	0.000775
	(0.00229)	(0.00462)	(0.00294)	(0.00286)
Buyout × Before	-1.861***	-0.0598	-1.359***	-1.518***
	(0.362)	(0.631)	(0.448)	(0.428)
Buyout × After	-0.375	-0.315	-0.556	-0.309
	(0.340)	(0.668)	(0.439)	(0.417)
Elevation × Before	-0.366*	0.876**	0.154	-0.241
	(0.217)	(0.340)	(0.258)	(0.256)
Elevation × After	-0.0239	0.519	0.341	-0.232
	(0.209)	(0.365)	(0.247)	(0.260)
Pseudo R2	0.0945		0.0894	
Log pseudolikelihood	-5430.5126		-5461.1406	
Observations (Cluster id)	16,377 (1,366)		16,377 (1,366)	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3.13A: Conditional logit regression results: interacting sociodemographic with base model

Variables	Mortgage	No mortgage	Insurance	No insurance
Price × Before	0.0190***	0.0164***	0.0103***	0.0266***
	(0.00303)	(0.00331)	(0.00319)	(0.00328)
Price × After	0.0129***	0.00954***	0.00771**	0.0148***
	(0.00284)	(0.00316)	(0.00303)	(0.00311)
Sell both house and lot × Before	0.231**	0.140	0.0842	0.317***
	(0.102)	(0.117)	(0.110)	(0.114)
Sell both house and lot × After	0.257**	0.192*	0.201*	0.210*
	(0.103)	(0.112)	(0.108)	(0.113)
Acquisition pay period × Before	-0.00533***	-0.000683	-0.000991	-0.00490***
	(0.00134)	(0.00140)	(0.00142)	(0.00140)
Acquisition pay period × After	-0.00444***	-0.00145	-0.00215	-0.00294**
	(0.00127)	(0.00140)	(0.00141)	(0.00134)
Vacate × Before	0.00443***	0.00246	0.00303*	0.00388**
	(0.00153)	(0.00168)	(0.00164)	(0.00164)
Vacate × After	0.00412***	0.00364**	0.00291*	0.00329**
	(0.00144)	(0.00170)	(0.00161)	(0.00160)
Elevation cost × Before	-0.0157***	-0.0156**	-0.0115**	-0.0176**
	(0.00523)	(0.00683)	(0.00562)	(0.00698)
Elevation cost × After	-0.00727	0.00483	0.00600	-0.0110
	(0.00532)	(0.00644)	(0.00559)	(0.00686)
Elevation subsidy × Before	0.00923***	0.0149***	0.00483**	0.0174***
	(0.00228)	(0.00306)	(0.00238)	(0.00327)
Elevation subsidy × After	0.00731***	0.00484*	0.00351	0.0120***
	(0.00230)	(0.00289)	(0.00236)	(0.00322)
Insurance appreciation × Before	-0.00209	-0.00184	-0.00108	-0.00453
	(0.00274)	(0.00292)	(0.00310)	(0.00282)
Insurance appreciation × After	-0.000234	0.000330	0.000709	-0.00138
	(0.00279)	(0.00301)	(0.00322)	(0.00284)
Buyout × Before	-1.244***	-1.585***	-0.175	-2.800***
	(0.436)	(0.441)	(0.465)	(0.446)
Buyout × After	-0.385	-0.448	0.406	-1.059**
	(0.413)	(0.446)	(0.449)	(0.432)
Elevation × Before	0.503**	-0.785***	1.056***	-1.279***
	(0.233)	(0.300)	(0.248)	(0.319)
Elevation × After	0.489**	-0.480*	0.746***	-0.848***
	(0.232)	(0.285)	(0.258)	(0.290)
Pseudo R2	0.0949		0.1197	
Log pseudolikelihood	-5428.4599		-5040.6005	
Observations (Cluster id)	16,377 (1,366)		15,636 (1,303)	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3.14A: Conditional logit regression results: interacting sociodemographic with base model

Variables	Damage	No damage	100year floodplain	No 100year floodplain
Price × Before	0.00618	0.0237***	0.0146**	0.0192***
	(0.00399)	(0.00271)	(0.00608)	(0.00248)
Price × After	0.00441	0.0143***	0.0177***	0.0105***
	(0.00374)	(0.00261)	(0.00580)	(0.00242)
Sell both house and lot × Before	0.234*	0.178*	0.173	0.180**
	(0.142)	(0.0926)	(0.209)	(0.0870)
Sell both house and lot × After	0.237*	0.225**	0.421*	0.217**
	(0.143)	(0.0896)	(0.222)	(0.0845)
Acquisition pay period × Before	-0.00251	-0.00358***	-0.00185	-0.00352***
	(0.00180)	(0.00117)	(0.00252)	(0.00110)
Acquisition pay period × After	-0.00126	-0.00395***	-0.00403	-0.00333***
	(0.00185)	(0.00111)	(0.00286)	(0.00106)
Vacate × Before	0.00206	0.00424***	0.00152	0.00384***
	(0.00202)	(0.00137)	(0.00326)	(0.00125)
Vacate × After	0.00452**	0.00337***	0.000793	0.00381***
	(0.00211)	(0.00130)	(0.00329)	(0.00123)
Elevation cost × Before	-0.0132*	-0.0130**	-0.00844	-0.0167***
	(0.00711)	(0.00532)	(0.0111)	(0.00469)
Elevation cost × After	0.00899	-0.00818	0.00263	-0.00297
	(0.00692)	(0.00536)	(0.0118)	(0.00463)
Elevation subsidy × Before	0.00597**	0.0137***	0.0111**	0.0111***
	(0.00294)	(0.00242)	(0.00463)	(0.00205)
Elevation subsidy × After	0.00418	0.00757***	0.0143***	0.00526***
	(0.00303)	(0.00239)	(0.00527)	(0.00201)
Insurance appreciation × Before	-0.00265	-0.00211	-0.00513	-0.00205
	(0.00392)	(0.00235)	(0.00513)	(0.00226)
Insurance appreciation × After	-0.00300	0.000845	-0.00246	0.000335
	(0.00410)	(0.00239)	(0.00564)	(0.00230)
Buyout × Before	0.185	-2.185***	-1.438*	-1.542***
	(0.567)	(0.374)	(0.862)	(0.347)
Buyout × After	0.336	-0.691*	-1.122	-0.259
	(0.577)	(0.362)	(0.876)	(0.343)
Elevation × Before	1.068***	-0.709***	-0.494	0.0262
	(0.310)	(0.237)	(0.473)	(0.204)
Elevation × After	0.709**	-0.251	-0.798	0.182
	(0.325)	(0.224)	(0.532)	(0.201)
Pseudo R2	0.1121		0.0874	
Log pseudolikelihood	-5325.1569		-5064.3298	
Observations (Cluster id)	16,377 (1,366)		15,153 (1,264)	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3.15A: Conditional logit regression results: interacting sociodemographic with base model

Variables	Coefficients
Price × Before	0.0194***
	(0.00347)
× Lower income	-0.00318
	(0.00497)
× Higher income	-0.00137
	(0.00603)
Price × After	0.0106***
	(0.00316)
× Lower income	0.00258
	(0.00475)
× Higher income	-8.46e-05
	(0.00577)
Sell both house and lot × Before	0.307**
	(0.120)
× Lower income	-0.0847
	(0.174)
× Higher income	-0.416**
	(0.205)
Sell both house and lot × After	0.244**
	(0.118)
× Lower income	-0.123
	(0.172)
× Higher income	0.0706
	(0.202)
Acquisition pay period × Before	-0.00319**
	(0.00150)
× lower income	-0.000349
	(0.00215)
× higher income	-3.63e-05
	(0.00269)
Acquisition pay period × After	-0.00431***
	(0.00145)
× Lower income	0.00210
	(0.00211)
× Higher income	0.00208
	(0.00258)
Vacate × Before	0.00310*
	(0.00172)
× Lower income	0.000402
	(0.00251)
× Higher income	0.00124
	(0.00311)

Table 3.16A Continued

Vacate × After	0.00425**
	(0.00166)
× lower income	0.000142
	(0.00249)
× higher income	-0.00200
	(0.00298)
Elevation cost × Before	-0.0130**
	(0.00636)
× lower income	-0.00501
	(0.00951)
× higher income	-0.000773
	(0.0108)
Elevation cost × After	-0.00826
	(0.00598)
× lower income	0.00952
	(0.00945)
× higher income	0.0125
	(0.0106)
Elevation subsidy × Before	0.00850***
	(0.00267)
× lower income	0.00692
	(0.00425)
× higher income	0.000527
	(0.00465)
Elevation subsidy × After	0.00749***
	(0.00269)
× lower income	0.00113
	(0.00416)
× higher income	-0.00610
	(0.00454)
Insurance appreciation × Before	-0.00234
	(0.00300)
× lower income	-0.000410
	(0.00440)
× higher income	0.00214
	(0.00567)
Insurance appreciation × After	0.000372
	(0.00309)
× lower income	-0.000923
	(0.00459)
× higher income	-0.000741
	(0.00556)

Table 3.16A Continued

Buyout × Before	-1.620***
	(0.476)
× lower income	0.180
	(0.690)
× higher income	0.714
	(0.861)
Buyout × After	-0.218
	(0.443)
× lower income	-0.537
	(0.680)
× higher income	-0.0812
	(0.829)
Elevation × Before	0.148
	(0.270)
× lower income	-0.811*
	(0.423)
× higher income	0.478
	(0.469)
Elevation × After	0.390
	(0.271)
× lower income	-1.026**
	(0.409)
× higher income	0.0699
	(0.472)
Pseudo R2	0.0924
Log pseudolikelihood	-5442.9218
Observations (Cluster id)	16,377

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.17A: Results from the estimated compensation variation framework, varying acquisition pay period

	Buyout Contract		Elevation Contract	
	Min. WTA	95% Confidence Interval	Min. WTA	95% Confidence Interval
Before	106.602%***	80.589, 132.614	40.186%***	23.495, 56.876
	(13.272)		(8.516)	
After	77.273%***	31.478, 123.067	-3.206%	-104.881, 98.468
	(23.365)		(51.876)	
Test for difference	29.61%	-20.835, 79.493	43.392%	-56.964, 143.747
	(25.594)		(51.203)	

Bootstrap standard errors in parentheses. *** p<0.01

Buyout contract (for Before and After timing) comprises the following attributes (levels): Sell both house and lot (1); Acquisition pay period (300 days); Vacate (60 days). Home elevation contract: Elevation cost (50%); Insurance appreciation (30%)

Table 3.18 A: Results from the estimated compensation variation framework, varying vacate

	Buyout Contract		Elevation Contract	
	Min. WTA	95% Confidence Interval	Min. WTA	95% Confidence Interval
Before	112.517%***	80.541, 144.494	40.186%***	23.495, 56.876
	(16.315)		(8.516)	
After	84.549%***	29.961, 139.137	-3.206%	-104.881, 98.468
	(27.852)		(51.876)	
Test for difference	27.968%	-32.403, 88.34	43.392%	-56.964, 143.747
	(30.802)		(51.203)	

Bootstrap standard errors in parentheses. *** p<0.01.

Buyout contract (for Before and After timing) comprises the following attributes (levels): Sell both house and lot (1); Acquisition pay period (365 days); Vacate (90 days). Home elevation contract: Elevation cost (50%); Insurance appreciation (30%)

Table 3.19: Results from the estimated compensation variation framework, varying insurance appreciation

	Buyout Contract		Elevation Contract	
	Min. WTA	95% Confidence Interval	Min. WTA	95% Confidence Interval
Before	111.988%***	79.621, 144.356	40.186%***	23.495, 56.876
	(16.514)		(8.516)	
After	94.502%***	41.220, 147.784	-3.206%	-104.881, 98.468
	(27.185)		(51.876)	
Test for difference	17.486%	-40.677, 75.650	43.392%	-56.964, 143.747
	(25.676)		(51.203)	

Bootstrap standard errors in parentheses. *** p<0.01

Buyout contract (for Before and After timing) comprises the following attributes (levels): Sell both house and lot (1); Acquisition pay period (365 days); Vacate (60 days). Home elevation contract: Elevation cost (50%); Insurance appreciation (100%)

APPENDIX C: APPENDIX FOR CHAPTER 4

Table 4.6A: Correlation matrix for all risk variables

	Structure damage experience	Extent of structure damage	Expected structure damage from next flood	Chance of future flooding	Insurance	Cat 1	Cat 2	Cat 3	Cat 4	Cat 5	Floodplain	Distance
Structure damage experience	1					0.132	0.132	0.135	0.092	-0.02	0.118	0.091
Extent of structure damage	0.876	1				0.1	0.114	0.11	0.075	-0.01	0.109	0.107
Expected structure damage from next flood	0.875	0.939	1	0.327		0.089	0.1093	0.111	0.082	0.008	0.109	0.119
Chance of future flooding	0.383	0.325		1		0.082	0.101	0.119	0.120	0.058	0.065	0.034
Insurance	0.359	0.364	0.359	0.310	1	0.101	0.160	0.193	0.189	0.129	0.235	0.029
Cat 1						1						
Cat 2						0.87	1					
Cat 3						0.725	0.924	1				
Cat 4						0.600	0.822	0.947	1			
Cat 5						0.441	0.609	0.695	0.788	1		
Floodplain						0.455	0.607	0.595	0.556	0.439	1	
Distance						-0.13	-0.191	-0.24	-0.29	-0.25	-0.1599	1

Table 4.7A: Results from estimated conditional logit model for risk index obtained using pca

Variables	R = Subjective risk	R= Objective risk
Price	0.016***	0.017***
	(0.002)	(0.002)
Price × R	-0.005***	-0.001
	(0.002)	(0.002)
Sell both house and lot	0.185***	0.185 ***
	(0.065)	(0.064)
Sell both house and lot × R	-0.015	0.053
	(0.070)	(0.058)
Acquisition pay period	-0.003***	-0.003***
	(0.001)	(0.001)
Acquisition pay period × R	0.002*	0.001
	(0.001)	(0.001)
Vacate	0.002**	0.002**
	(0.001)	(0.001)
Vacate × R	-0.00003	-0.002*
	(0.001)	(0.001)
Elevation cost	-0.007**	-0.008**
	(0.004)	(0.003)
Elevation cost × R	0.008**	0.005
	(0.004)	(0.003)
Elevation subsidy	0.010***	0.009***
	(0.002)	(0.002)
Elevation subsidy × R	-0.005***	0.001
	(0.002)	(0.002)
Insurance appreciation	-0.005**	-0.003
	(0.002)	(0.002)
Insurance appreciation × R	-0.002	0.001
	(0.002)	(0.002)
Buyout	-1.087***	-1.168***
	(0.274)	(0.272)
Buyout × R	0.779***	0.056
	(0.290)	(0.263)
Elevation	-0.282	-0.227
	(0.176)	(0.168)
Elevation × R	0.959***	-0.255
	(0.164)	(0.170)
Pseudo R-squared	0.135	0.094
Log pseudolikelihood	-3975.329	-4164.537
AIC / BIC	7986.658 / 8120.535	8365.074 / 8498.952
Observations	12,552	12,552

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

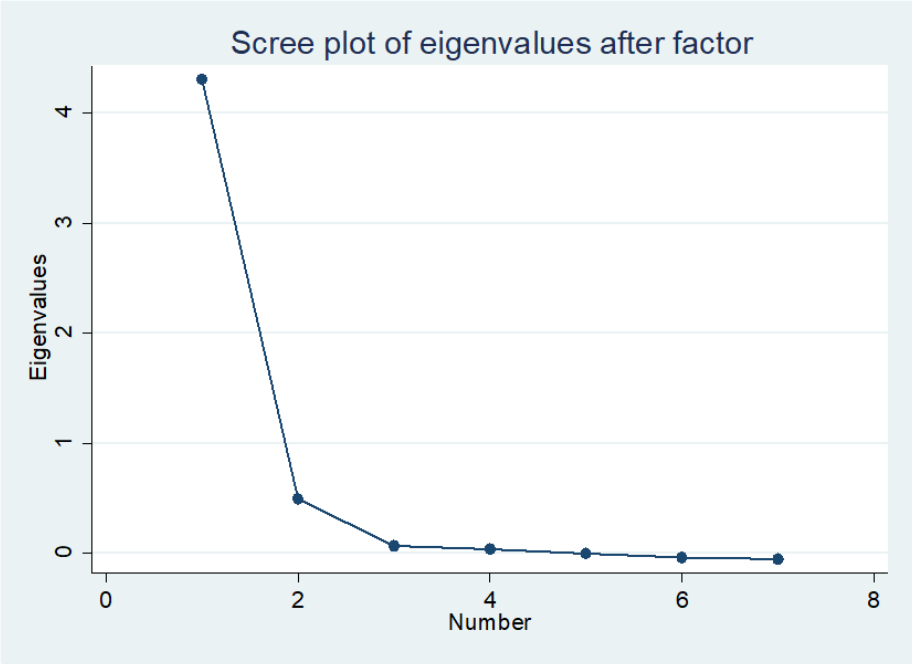
Table 4.8A: Results from the estimated compensating variation framework for risk index obtained using pca

	Subjective risk		Objective risk	
	Min. WTA	95% Confidence interval	Min. WTA	95% Confidence interval
		Buyout		
Mean risk	97.47%*** (14.3)	69.45, 125.50	107.71%*** (12.95)	82.34, 133.09
	Std dev. for subjective risk index		Std dev. for objective risk index	
Induce 10% reduction	0.15** (0.07)	0.02, 0.28	4.5* (1.95)	0.69, 8.32
Induce 20% reduction	0.28** (0.12)	0.04, 0.52	4.5** (2.45)	-0.31, 9.31
		Elevation		
Mean risk	47.34%*** (12.90)	22.07, 72.62	51.69%*** (13.74)	24.62, 78.49
	Std dev. for subjective risk index		Std dev. for objective risk index	
Induce 10% reduction	0.05** (0.20)	0.01, 0.09	-0.87 (2.16)	-5.09, 3.35
Induce 20% reduction	0.09** (0.04)	0.01, 0.17	-1.55 (2.86)	-7.15, 4.05

Bootstrap standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Buyout contract comprises the following attributes (levels): Sell both house and lot (1); Acquisition pay period (300 days); Vacate (60 days). Home elevation contract: Elevation cost (30%); Insurance appreciation (50%)



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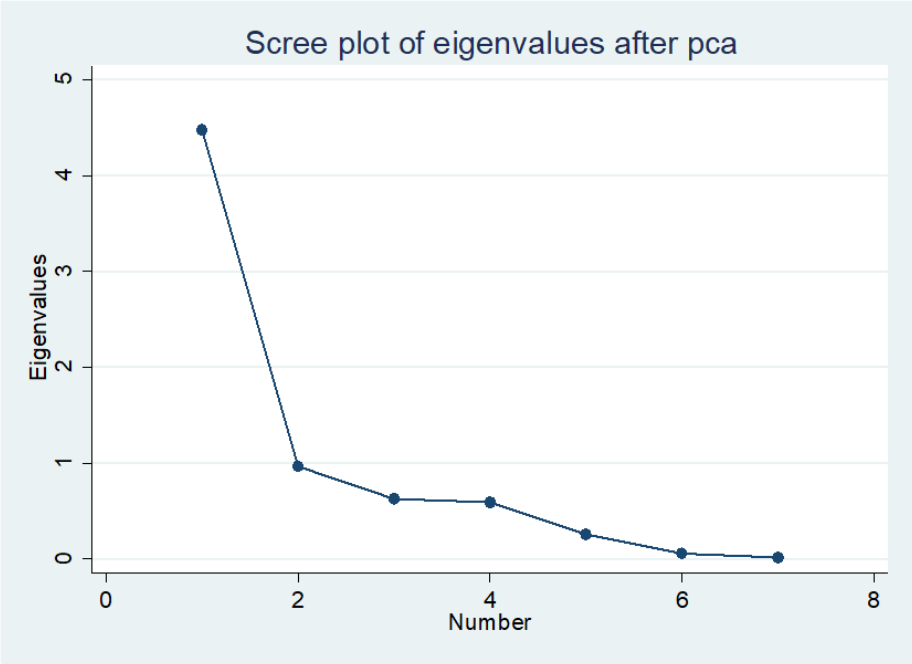
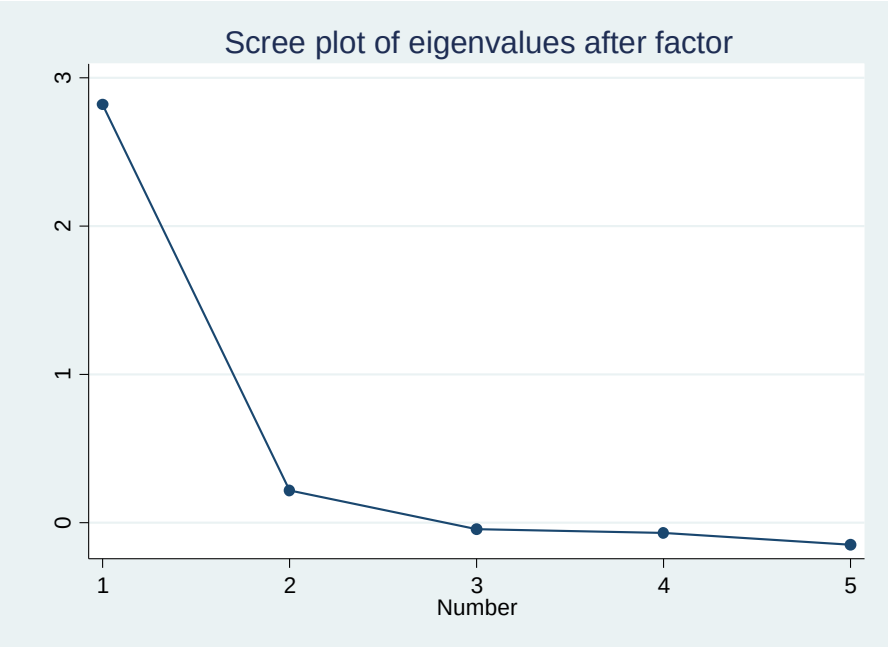


ii

Figure 4.2A: Scree plot showing eigenvalues for factor analysis (shown in i) and factor analysis (shown in ii) for objective risk



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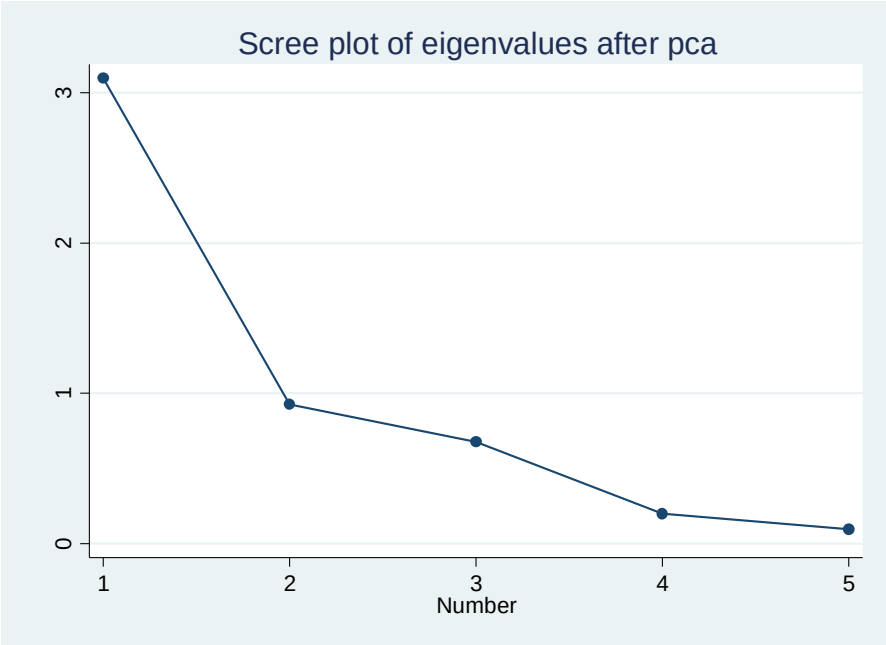


ii

Figure 4.3A: Scree plot showing eigenvalues for factor analysis (shown in i) and pca analysis (shown in ii) for subjective risk

Table 4.9A: Results from estimated conditional logit model for risk index obtained using factor analysis and considering East and Gulf Coast sample with valid addresses

Variables	R = Subjective risk	R = Objective risk
Price	0.0165***	0.0170***
	(0.00186)	(0.00186)
Price × R	-0.00545***	-0.000869
	(0.00197)	(0.00167)
Sell both house and lot	0.205***	0.207***
	(0.0650)	(0.0642)
Sell both house and lot × R	-0.0298	0.0509
	(0.0717)	(0.0597)
Acquisition pay period	-0.00327***	-0.00348***
	(0.000823)	(0.000801)
Acquisition pay period × R	0.00165*	0.00100
	(0.000936)	(0.000908)
Vacate	0.00225**	0.00237**
	(0.000939)	(0.000923)
Vacate × R	-0.000239	-0.00200*
	(0.00105)	(0.00111)
Elevation cost	-0.00726**	-0.00875**
	(0.00359)	(0.00348)
Elevation cost × R	0.00622*	0.00437
	(0.00371)	(0.00331)
Elevation subsidy	0.0100***	0.00941***
	(0.00165)	(0.00155)
Elevation subsidy × R	-0.00395**	0.000681
	(0.00165)	(0.00152)
Insurance appreciation	-0.00430**	-0.00315
	(0.00208)	(0.00202)
Insurance appreciation × R	-0.00183	0.000337
	(0.00246)	(0.00174)
Buyout	-1.140***	-1.236***
	(0.278)	(0.276)
Buyout × R	0.820***	0.0872
	(0.302)	(0.289)
Elevation	-0.294	-0.250
	(0.179)	(0.171)
Elevation × R	0.902***	-0.142
	(0.175)	(0.157)
Psuedo R2	0.131	0.095
Log pseudolikelihood	-3873.442	-4033.263
AIC/BIC	7782.883/7916.202	8102.526/8235.844
Observations (Cluster id)	12,168 (918)	12,168 (918)

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

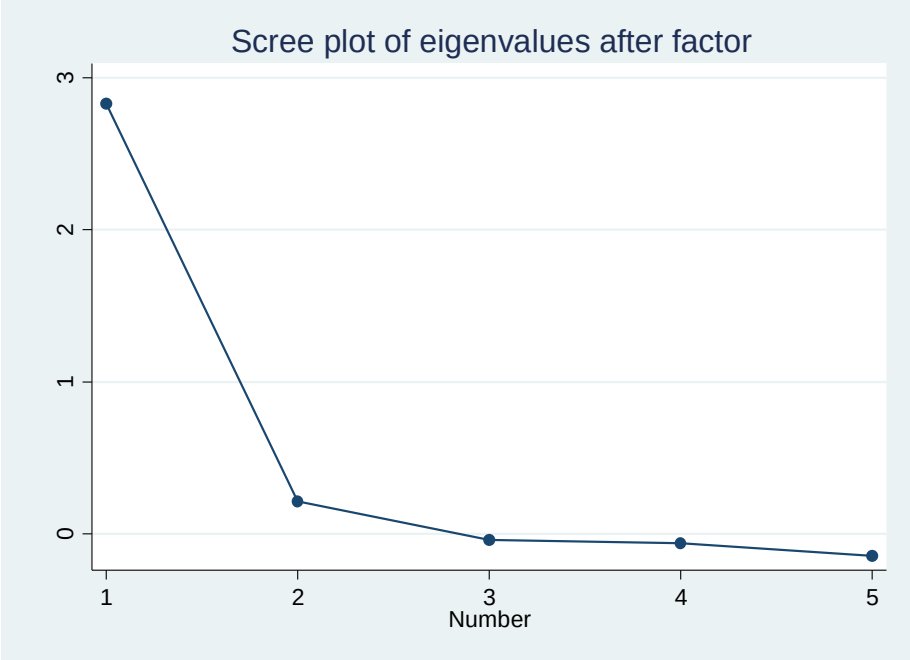
Table 4.10A: Results from the estimated compensating variation framework for risk index obtained using factor analysis and considering East and Gulf Coast sample with valid addresses

	Subjective risk		Objective risk	
	Min. WTA	95% Confidence interval	Min. WTA	95% Confidence interval
		Buyout		
Mean risk	100.50%*** (13.14)	74.74, 126.26	110.27%*** (12.53)	85.72, 134.81
	Std dev. for subjective risk index		Std dev. for objective risk index	
Induce 10% reduction	0.16 (0.11)	-0.06, 0.38	1.26 (1.69)	-2.04, 4.56
Induce 20% reduction	0.3 (0.19)	-0.06, 0.66	2.38 (2.09)	-1.72, 6.48
		Elevation		
Mean risk	48.43%*** (12.74)	23.46, 73.4	53.73%*** (13.11)	28.03, 79.42
	Std dev. for subjective risk index		Std dev. for objective risk index	
Induce 10% reduction	0.05** (0.02)	0.01, 0.09	1.96 (2.33)	-2.60, 6.52
Induce 20% reduction	0.1** (0.04)	0.02, 0.18	4.68 (3.12)	-1.44, 10.80

Bootstrap standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Buyout contract comprises the following attributes (levels): Sell both house and lot (1); Acquisition pay period (300 days); Vacate (60 days). Home elevation contract: Elevation cost (30%); Insurance appreciation (50%). Replication based on 918 clusters in id.



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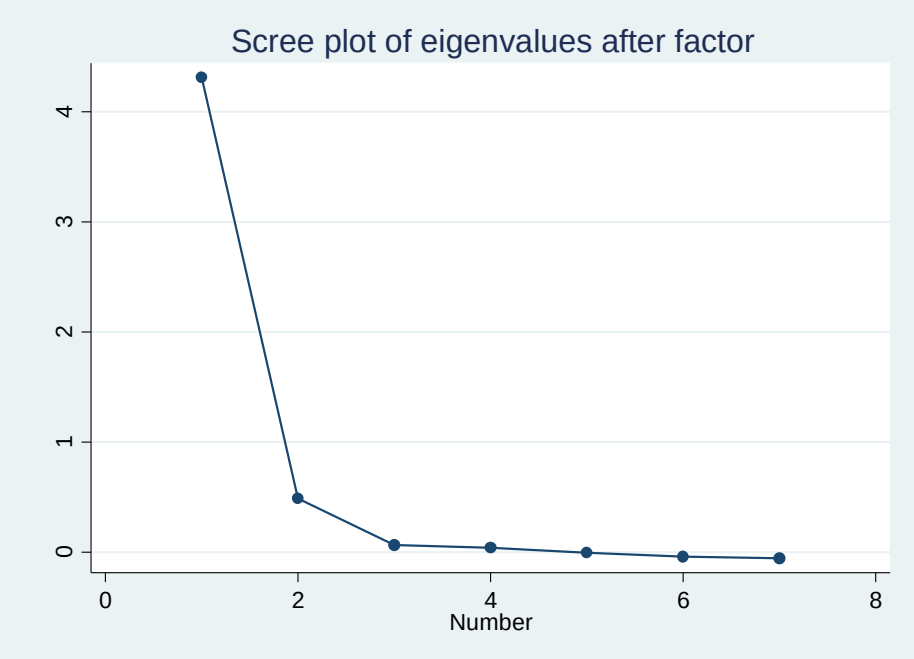


ii

Figure 4.4A: Scree plot showing eigenvalues for factor analysis (shown in i) and factor analysis (shown in ii) for objective risk and considering East and Gulf Coast sample with valid address

APPENDIX D: SURVEY INSTRUMENT FOR CHAPTERS 3 AND 4

Consent

Dear Participant,

I am a faculty member at East Carolina University in Department of Economics, and the director of the Center for Natural Hazards Research at East Carolina University. I am asking you to take part in my research study entitled, “Government Acquisition of Homes to Reduce Flood Risk; Household Willingness to participate and Implications for Acquisition Policy."

The purpose of this research is to examine the factors that affect your decision to choose flood mitigation activities. By conducting this research, I hope to understand what factors motivate your decision to participate in flood mitigation programs**.** Your participation is completely voluntary. The survey should take about 20 minutes to complete.

If you agree to take part in this survey, you will be asked questions that relate to your experience in the community, your flood risk perception, flood mitigation choice, and socioeconomic background.

This research is overseen by the University and Medical Center Institutional Review Board (UMCIRB) at East Carolina University. It is possible that members of the UMCIRB may need to review the research data. We will ask for one piece of personally identifiable information (address of your property) from you in the survey. We will use the address to identify characteristics of your parcel, such as elevation above sea level, whether the property is in a community participating in the Community Rating System (CRS), and Federal Emergency Management Agency (FEMA) flood zone designation. Please keep in mind that personally identifiable address information will be kept separately and never combined with other responses you give in this survey, thereby maintaining the confidentiality of your responses. Therefore, your responses cannot be traced back to you by anyone, including me.

If you have questions about your rights when taking part in this research, call the Office of Research Integrity & Compliance (ORIC) at 252-744-2914 (open weekdays, 8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, call the Director of ORIC, at 252-744-1971.

You do not have to take part in this research, and you can stop at any time. If you decide you are willing to take part in this study, continue with the survey by clicking "Yes I Consent" below and the research questions will appear.

Thank you for taking the time to participate in my research.

Sincerely, Jamie Kruse, Principal Investigator.

Yes I Consent

No I do not Consent

Screening questions

1. Do you have a property in a coastal zone in the United States? (Definition of coastal zone*: An area within 150 miles of the shoreline*.)

Yes

No

2. Are you 18 years or older?

Yes

No

History in Community

3. In which state is your coastal property located?

4. Are you a permanent or a seasonal resident of this community? (Please select only one)

I am a permanent resident

I am a seasonal resident

I own a rental house

5. How long have you owned the house? _____Years

6. Which of the following best describes this house?

Manufactured or Mobile house

Single family house

Duplex, or townhouse

Apartment or condominium

Some other kind of structure, please describe

I don't know

7. Which category best describes the condition of your house?

Poor

Fair

Good

Very good

Excellent

8. How strong a connection do you and your family feel to this community? (Please drag from left to right to indicate the level of connection that you personally and your family feel to the community)

Questions about experiences on flooding and thoughts on flood risk

9. To the best of your knowledge, has your property ever been damaged by floods?

Yes

No

10. To what extent would you say this property was damaged? If your property has been damaged by multiple flood events, please consider the event that caused the most damage.

less than 20% value of the property

20-39% value of the property

40-59% value of the property

60-79% value of the property

80-100% value of the property

11. In what year did this damage occur?

12. Should a similar flooding event occur today, to what extent do you think your house will be damaged?

less than 20% value of property

20 - 39% value of property

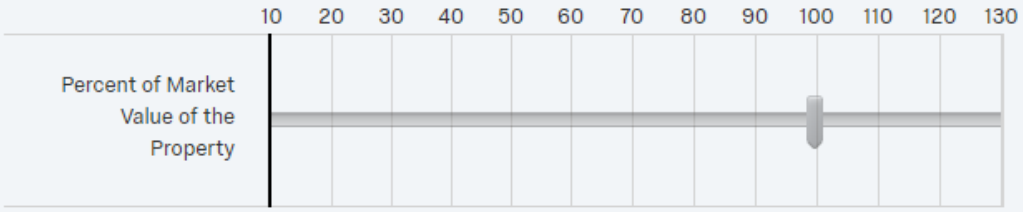
40 - 59% value of property

60 - 79% value of property

80 - 100% value of property

13. If you tried to sell your property after it was damaged by a flood event, what percentage of fair pre-damage market value do you think you could get?

If you tried to sell your property after it was damaged by a flood event, what percentage of fair pre-damage market value do you think you could get?



14. When do you think the next flood event will occur in the community where your property is located?

Within the next 5 years or less

Within the next 10 years

Within the next 25 years

Within the next 100 years or more

I don't know

15. Do you currently have a flood insurance policy in force?

Yes

No

I don't know

16. Do you have a mortgage on your house?

Yes

No

I don't know

17. Does the mortgage require you to have flood insurance policy?

Yes

No

I don't know

18. Is this house elevated by raising the bottom floor, having it built on a mound, or built on piers/ stilts/piling?

Yes

No

Introduction to flood mitigation programs

The federal government through the Federal Emergency Management Agency (FEMA) has taken steps to reduce or eliminate the impacts of flood hazards on residents and their property. These efforts include *buying or relocating houses* found in floodprone areas*, elevating houses* in floodprone areas, and *making opportunities available to purchase flood insurance*
Programs that involve government purchases of at-risk houses are called *Buyout Programs*. These programs involve the following components:
What Parts of the Property are Sold: A coastal property includes the house or structure as well as the land or lot on which the house is built. Some buyout programs require the owner sell both the house and the lot, while others require sale of the house but allow the current homeowner to retain ownership of the lot. In this case, the house will be destroyed, but you are allowed to rebuild on the lot so long as the new house meets current safety codes.
***Price you will receive if you sell the property**:* This is the amount of money you will receive, as a percentage (%) of the property's value. This value is the pre-damage fair market value of what you are selling. If you are selling only the house, this is measured as the value of only the house. If you are selling both the house and the lot, this is measured as the value of the house and the lot combined. Fair market prices are determined by a licensed appraiser. For example, if the value of your property before the flood damage is $100,000, and the government offers to pay you 90% of the property value, accepting the offer means you will receive $90,000.
How long it will take the government to pay you if you sell: This is the number of days it will take government officials to pay you for the sale of your house after the buyout contract has been agreed-to and signed.
Time you have to vacate your home: After a buyout agreement has been agreed-to and signed, you are given a grace period (number of days) to vacate the house. This is true for all contracts, including those that allow the property owner to keep ownership of the lot.

Example of a house bought and torn down by the local government (Buyout Program)

Source: FEMA 2018c

Programs that involve elevating structures in floodprone areas are called *House Elevation Programs*. These programs involve the following components:
How much it will cost you to raise your house above ground: this is how much it will cost you to raise your house on either piers/ stilts/ pilings, mounds, or raising the foundation. The cost is expressed as percent (%) of the fair pre-damage market value of your house. For example, if the value of your house is $100,000, and the cost of raising the house is 25%, then you will pay $25,000.
Subsidy you will receive to elevate the house: In these programs, the government may subsidize, or pay part of the cost, in order to raise your structure and reduce the risk of flood damage. Subsidies are expressed as a percentage of the total cost of raising your house. For example, if the total cost of raising your house is $10,000, and you receive a subsidy of 25%, that means you will receive a subsidy of $2,500 from the government and will have to personally pay the remaining $7,500.
How much your flood insurance premium will increase (Flood insurance premium appreciation): The National Flood Insurance Program has experienced change in recent years. Depending on the level of flood risk you and your community face, your flood insurance premium may increase. This increase may differ for homes that are elevated, as they are at lower risk of flood damage. Flood insurance premium increases are expressed as a percentage (%) of your current premium rate. For example, if your current annual flood insurance premium is $2000 and the premium increases by 30%, your new insurance premium will be $2,600.

Example of a house being elevated above ground (House Elevation Program)

Source: Courtesy Jamie Kruse

Choice experiment questions

[Version 1: High Premium Increase]

Changes to the National Flood Insurance Program indicate that in the future flood insurance premiums in your area may increase by 100%. Suppose your local government official has offered contracts to help reduce or eliminate flood risk in your community. In the next questions we would like to know whether you would be willing to enter into flood risk reduction programs.

We are interested in your true preferences. There are no right or wrong answers only what you would actually prefer. The questions are hypothetical and research has shown that some people commit to actions in hypothetical situations that they would not actually commit to in real life. Please keep this in mind and do your best to answer the questions that follow as if they were real options being offered to you.

[Version 1: House As-is]

Block 1 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	125% of pre-damage fair market value of property	**Cost to raise the house above ground**	50% of pre-damage fair market value of house	
How long it will take the government to pay you	120 days after acceptance	**Subsidy you will receive to raise house above ground**	75% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	30% increase of premium	

Block 1 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
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You must vacate the house within this period	120 days after acceptance	**How much your flood insurance premium will increase**	40% increase of premium	

Block 2 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	110% of pre-damage fair market value of house	**Cost to raise the house above ground**	30% of pre-damage fair market value of house	
How long it will take the government to pay you	45 days after acceptance	**Subsidy you will receive to raise house above ground**	100% of cost of raising house above ground	
You must vacate the house within this period	30 days after acceptance	**How much your flood insurance premium will increase**	30% increase of premium	

Block 2 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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Block 3 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
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Block 3 set 2

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What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
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Block 4 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
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How long it will take the government to pay you	45 days after acceptance	**Subsidy you will receive to raise house above ground**	100% of cost of raising house above ground	
You must vacate the house within this period	60 days after acceptance	**How much your flood insurance premium will increase**	20% increase of premium	

Block 4 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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Block 5 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
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You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	30% increase of premium	

Block 5 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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Block 6 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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Block 6 set 2

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Choice Block 7 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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Choice Block 7 set 2

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Block 8 set 1

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Block 10 set 1

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Block 11 set 1

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Block 12 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	125% of pre-damage fair market value of house	**Cost to raise the house above ground**	20% of pre-damage fair market value of house	
How long it will take the government to pay you	75 days after acceptance	**Subsidy you will receive to raise house above ground**	50% of cost of raising house above ground	
You must vacate the house within this period	120 days after acceptance	**How much your flood insurance premium will increase**	30% increase of premium	

Block 12 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	100% of pre-damage fair market value of property	**Cost to raise the house above ground**	30% of pre-damage fair market value of house	
How long it will take the government to pay you	120 days after acceptance	**Subsidy you will receive to raise house above ground**	75% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	20% increase of premium	

Block 13 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
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(House Elevation)</th><th>Neither</th></tr>
<tr><td>What will you sell to the government?</td><td>Only house</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

This means the flood insurance premium on this property may increase by 100%</td></tr>
<tr><td>Price you will receive if you sell property</td><td>75% of pre-damage fair market value of house</td><td>Cost to raise the house above ground</td><td>50% of pre-damage fair market value of house</td></tr>
<tr><td>How long it will take the government to pay you</td><td>120 days after acceptance</td><td>Subsidy you will receive to raise house above ground</td><td>75% of cost of raising house above ground</td></tr>
<tr><td>You must vacate the house within this period</td><td>30 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>50% increase of premium</td></tr>
</table>

Block 13 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
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<tr><td>What will you sell to the government?</td><td>Both the house and lot</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

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<tr><td>How long it will take the government to pay you</td><td>15 days after acceptance</td><td>Subsidy you will receive to raise house above ground</td><td>50% of cost of raising house above ground</td></tr>
<tr><td>You must vacate the house within this period</td><td>90 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>20% increase of premium</td></tr>
</table>

Block 14 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
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<tr><td>What will you sell to the government?</td><td>Both the house and lot</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

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<tr><td>Price you will receive if you sell property</td><td>100% of pre-damage fair market value of property</td><td>Cost to raise the house above ground</td><td>20% of pre-damage fair market value of house</td></tr>
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<tr><td>You must vacate the house within this period</td><td>120 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>20% increase of premium</td></tr>
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Block 14 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	125% of pre-damage fair market value of property	**Cost to raise the house above ground**	40% of pre-damage fair market value of house	
How long it will take the government to pay you	15 days after acceptance	**Subsidy you will receive to raise house above ground**	100% of cost of raising house above ground	
You must vacate the house within this period	60 days after acceptance	**How much your flood insurance premium will increase**	40% increase of premium	

Block 15 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	125%of pre-damage fair market value of house	**Cost to raise the house above ground**	40% of pre-damage fair market value of house	
How long it will take the government to pay you	120 days after acceptance	**Subsidy you will receive to raise house above ground**	25% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	20% increase of premium	

Block 15 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
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<tr><td>How long it will take the government to pay you</td><td>15 days after acceptance</td><td>Subsidy you will receive to raise house above ground</td><td>75% of cost of raising house above ground</td></tr>
<tr><td>You must vacate the house within this period</td><td>30 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>40% increase of premium</td></tr>
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[Version 1: House Post-damage]

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
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<tr><td>Price you will receive if you sell property</td><td>125% of pre-damage fair market value of property</td><td>Cost to raise the house above ground</td><td>50% of pre-damage fair market value of house</td></tr>
<tr><td>How long it will take the government to pay you</td><td>120 days after acceptance</td><td>Subsidy you will receive to raise house above ground</td><td>75% of cost of raising house above ground</td></tr>
<tr><td>You must vacate the house within this period</td><td>90 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>30% increase of premium</td></tr>
</table>

Block 1 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	75% of pre-damage fair market value of property	**Cost to raise the house above ground**	30% of pre-damage fair market value of house	
How long it will take the government to pay you	75 days after acceptance	**Subsidy you will receive to raise house above ground**	25% of cost of raising house above ground	
You must vacate the house within this period	912 days after acceptance	**How much your flood insurance premium will increase**	40% increase of premium	

Block 2 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	110% of pre-damage fair market value of house	**Cost to raise the house above ground**	30% of pre-damage fair market value of house	
How long it will take the government to pay you	45 days after acceptance	**Subsidy you will receive to raise house above ground**	100% of cost of raising house above ground	
You must vacate the house within this period	30 days after acceptance	**How much your flood insurance premium will increase**	30% increase of premium	

Block 2 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	100% of pre-damage fair market value of property	**Cost to raise the house above ground**	20% of pre-damage fair market value of house	
How long it will take the government to pay you	15 days after acceptance	**Subsidy you will receive to raise house above ground**	50% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	50% increase of premium	

Block 3 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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<tr><td>What will you sell to the government?</td><td>Both the house and lot</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

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<tr><td>You must vacate the house within this period</td><td>60 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>50% increase of premium</td></tr>
</table>

Block 3 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	100% of pre-damage fair market value of house	**Cost to raise the house above ground**	30% of pre-damage fair market value of house	
How long it will take the government to pay you	15 days after acceptance	**Subsidy you will receive to raise house above ground**	50% of cost of raising house above ground	
You must vacate the house within this period	120 days after acceptance	**How much your flood insurance premium will increase**	40% increase of premium	

Block 4 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	75% of pre-damage fair market value of property	**Cost to raise the house above ground**	40% of pre-damage fair market value of house	
How long it will take the government to pay you	45 days after acceptance	**Subsidy you will receive to raise house above ground**	100% of cost of raising house above ground	
You must vacate the house within this period	60 days after acceptance	**How much your flood insurance premium will increase**	20% increase of premium	

Block 4 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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<tr><td>What will you sell to the government?</td><td>Only house</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

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<tr><td>You must vacate the house within this period</td><td>60 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>50% increase of premium</td></tr>
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Block 5 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	75% of pre-damage fair market value of property	**Cost to raise the house above ground**	50% of pre-damage fair market value of house	
How long it will take the government to pay you	75 days after acceptance	**Subsidy you will receive to raise house above ground**	100% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	30% increase of premium	

Block 5 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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Block 6 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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Block 6 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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Choice Block 7 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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Choice Block 7 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	110% of pre-damage fair market value of property	**Cost to raise the house above ground**	40% of pre-damage fair market value of house	
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Block 8 set 1

For the next question, *imagine your house was recently damaged by a flood event.* The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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Block 8 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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Block 9 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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Block 9 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	90% of pre-damage fair market value of house	**Cost to raise the house above ground**	20% of pre-damage fair market value of house	
How long it will take the government to pay you	75 days after acceptance	**Subsidy you will receive to raise house above ground**	25% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	30% increase of premium	

Block 10 set 1

For the next question, *imagine your house was recently damaged by a flood event.* The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
(Buyout)</th><th colspan="2">Option B
(House Elevation)</th><th>Neither</th></tr>
<tr><td>What will you sell to the government?</td><td>Only house</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

This means the flood insurance premium on this property may increase by 100%</td></tr>
<tr><td>Price you will receive if you sell property</td><td>125% of pre-damage fair market value of house</td><td>Cost to raise the house above ground</td><td>30% of pre-damage fair market value of house</td></tr>
<tr><td>How long it will take the government to pay you</td><td>45 days after acceptance</td><td>Subsidy you will receive to raise house above ground</td><td>100% of cost of raising house above ground</td></tr>
<tr><td>You must vacate the house within this period</td><td>90 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>50% increase of premium</td></tr>
</table>

Block 10 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
(Buyout)</th><th colspan="2">Option B
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<tr><td>What will you sell to the government?</td><td>Only house</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

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<tr><td>You must vacate the house within this period</td><td>60 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>20% increase of premium</td></tr>
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Block 11 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
(Buyout)</th><th colspan="2">Option B
(House Elevation)</th><th>Neither</th></tr>
<tr><td>What will you sell to the government?</td><td>Both the house and lot</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

This means the flood insurance premium on this property may increase by 100%</td></tr>
<tr><td>Price you will receive if you sell property</td><td>125% of pre-damage fair market value of property</td><td>Cost to raise the house above ground</td><td>40% of pre-damage fair market value of house</td></tr>
<tr><td>How long it will take the government to pay you</td><td>120 days after acceptance</td><td>Subsidy you will receive to raise house above ground</td><td>50% of cost of raising house above ground</td></tr>
<tr><td>You must vacate the house within this period</td><td>30 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>40% increase of premium</td></tr>
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Block 11 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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<tr><th colspan="2">Option A
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<tr><td>What will you sell to the government?</td><td>Only house</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

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<tr><td>You must vacate the house within this period</td><td>120 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>30% increase of premium</td></tr>
</table>

Block 12 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
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<tr><td>What will you sell to the government?</td><td>Only house</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

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<tr><td>You must vacate the house within this period</td><td>120 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>30% increase of premium</td></tr>
</table>

Block 12 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	100% of pre-damage fair market value of property	**Cost to raise the house above ground**	30% of pre-damage fair market value of house	
How long it will take the government to pay you	120 days after acceptance	**Subsidy you will receive to raise house above ground**	75% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	20% increase of premium	

Block 13 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	75% of pre-damage fair market value of house	**Cost to raise the house above ground**	50% of pre-damage fair market value of house	
How long it will take the government to pay you	120 days after acceptance	**Subsidy you will receive to raise house above ground**	75% of cost of raising house above ground	
You must vacate the house within this period	30 days after acceptance	**How much your flood insurance premium will increase**	50% increase of premium	

Block 13 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	125% of pre-damage fair market value of property	**Cost to raise the house above ground**	30% of pre-damage fair market value of house	
How long it will take the government to pay you	15 days after acceptance	**Subsidy you will receive to raise house above ground**	50% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	20% increase of premium	

Block 14 set 1

For the next question, *imagine your house was recently damaged by a flood event.* The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
(Buyout)</th><th colspan="2">Option B
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<tr><td>What will you sell to the government?</td><td>Both the house and lot</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

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<tr><td>You must vacate the house within this period</td><td>120 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>20% increase of premium</td></tr>
</table>

Block 14 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
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<tr><td>What will you sell to the government?</td><td>Both the house and lot</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

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<tr><td>How long it will take the government to pay you</td><td>15 days after acceptance</td><td>Subsidy you will receive to raise house above ground</td><td>100% of cost of raising house above ground</td></tr>
<tr><td>You must vacate the house within this period</td><td>60 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>40% increase of premium</td></tr>
</table>

Block 15 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	125%of pre-damage fair market value of house	**Cost to raise the house above ground**	40% of pre-damage fair market value of house	
How long it will take the government to pay you	120 days after acceptance	**Subsidy you will receive to raise house above ground**	25% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	20% increase of premium	

Block 15 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 100%
Price you will receive if you sell property	110%of pre-damage fair market value of property	**Cost to raise the house above ground**	20% of pre-damage fair market value of house	
How long it will take the government to pay you	15 days after acceptance	**Subsidy you will receive to raise house above ground**	75% of cost of raising house above ground	
You must vacate the house within this period	30 days after acceptance	**How much your flood insurance premium will increase**	40% increase of premium	

[Version 2: Low Premium Increase]

Changes to the National Flood Insurance Program indicate that in the future flood insurance premiums in your area may increase by 50%. Suppose your local government official has offered contracts to help reduce or eliminate flood risk in your community. In the next questions, we would like to know whether you would be willing to enter into flood risk reduction programs.
We are interested in your true preferences. There are no right or wrong answers, only what you would actually prefer. The questions are hypothetical, and research has shown that some people commit to actions in hypothetical situations that they would not actually commit to in real life. Please keep this in mind and do your best to answer the questions that follow as if they were real options being offered to you.

[Version 2: House As-is]

Block 1 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	125% of pre-damage fair market value of property	**Cost to raise the house above ground**	50% of pre-damage fair market value of house	
How long it will take the government to pay you	120 days after acceptance	**Subsidy you will receive to raise house above ground**	75% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	30% increase of premium	

Block 1 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	75% of pre-damage fair market value of property	**Cost to raise the house above ground**	30% of pre-damage fair market value of house	
How long it will take the government to pay you	75 days after acceptance	**Subsidy you will receive to raise house above ground**	25% of cost of raising house above ground	
You must vacate the house within this period	912 days after acceptance	**How much your flood insurance premium will increase**	40% increase of premium	

Block 2 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	110% of pre-damage fair market value of house	**Cost to raise the house above ground**	30% of pre-damage fair market value of house	
How long it will take the government to pay you	45 days after acceptance	**Subsidy you will receive to raise house above ground**	100% of cost of raising house above ground	
You must vacate the house within this period	30 days after acceptance	**How much your flood insurance premium will increase**	30% increase of premium	

Block 2 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	100% of pre-damage fair market value of property	**Cost to raise the house above ground**	20% of pre-damage fair market value of house	
How long it will take the government to pay you	15 days after acceptance	**Subsidy you will receive to raise house above ground**	50% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	50% increase of premium	

Block 3 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	125% of pre-damage fair market value of property	**Cost to raise the house above ground**	20% of pre-damage fair market value of house	
How long it will take the government to pay you	75 days after acceptance	**Subsidy you will receive to raise house above ground**	25% of cost of raising house above ground	
You must vacate the house within this period	60 days after acceptance	**How much your flood insurance premium will increase**	50% increase of premium	

Block 3 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	100% of pre-damage fair market value of house	**Cost to raise the house above ground**	30% of pre-damage fair market value of house	
How long it will take the government to pay you	15 days after acceptance	**Subsidy you will receive to raise house above ground**	50% of cost of raising house above ground	
You must vacate the house within this period	120 days after acceptance	**How much your flood insurance premium will increase**	40% increase of premium	

Block 4 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
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<tr><td>What will you sell to the government?</td><td>Both the house and lot</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

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<tr><td>You must vacate the house within this period</td><td>60 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>20% increase of premium</td></tr>
</table>

Block 4 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	100% of pre-damage fair market value of house	**Cost to raise the house above ground**	30% of pre-damage fair market value of house	
How long it will take the government to pay you	120 days after acceptance	**Subsidy you will receive to raise house above ground**	25% of cost of raising house above ground	
You must vacate the house within this period	60 days after acceptance	**How much your flood insurance premium will increase**	50% increase of premium	

Block 5 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	75% of pre-damage fair market value of property	**Cost to raise the house above ground**	50% of pre-damage fair market value of house	
How long it will take the government to pay you	75 days after acceptance	**Subsidy you will receive to raise house above ground**	100% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	30% increase of premium	

Block 5 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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<tr><th colspan="2">Option A
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<tr><td>What will you sell to the government?</td><td>Both the house and lot</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

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Block 6 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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<tr><td>What will you sell to the government?</td><td>Only house</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

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Block 6 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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<tr><td>You must vacate the house within this period</td><td>120 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>40% increase of premium</td></tr>
</table>

Choice Block 7 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	125% of pre-damage fair market value of house	**Cost to raise the house above ground**	20% of pre-damage fair market value of house	
How long it will take the government to pay you	45 days after acceptance	**Subsidy you will receive to raise house above ground**	25% of cost of raising house above ground	
You must vacate the house within this period	60 days after acceptance	**How much your flood insurance premium will increase**	40% increase of premium	

Choice Block 7 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
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How long it will take the government to pay you	120 days after acceptance	**Subsidy you will receive to raise house above ground**	50% of cost of raising house above ground	
You must vacate the house within this period	30 days after acceptance	**How much your flood insurance premium will increase**	40% increase of premium	

Block 8 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	125% of pre-damage fair market value of house	**Cost to raise the house above ground**	50% of pre-damage fair market value of house	
How long it will take the government to pay you	120 days after acceptance	**Subsidy you will receive to raise house above ground**	75% of cost of raising house above ground	
You must vacate the house within this period	120 days after acceptance	**How much your flood insurance premium will increase**	40% increase of premium	

Block 8 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
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How long it will take the government to pay you	15 days after acceptance	**Subsidy you will receive to raise house above ground**	100% of cost of raising house above ground	
You must vacate the house within this period	30 days after acceptance	**How much your flood insurance premium will increase**	50% increase of premium	

Block 9 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	125% of pre-damage fair market value of property	**Cost to raise the house above ground**	50% of pre-damage fair market value of house	
How long it will take the government to pay you	45 days after acceptance	**Subsidy you will receive to raise house above ground**	75% of cost of raising house above ground	
You must vacate the house within this period	30 days after acceptance	**How much your flood insurance premium will increase**	50% increase of premium	

Block 9 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	90% of pre-damage fair market value of house	**Cost to raise the house above ground**	20% of pre-damage fair market value of house	
How long it will take the government to pay you	75 days after acceptance	**Subsidy you will receive to raise house above ground**	25% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	30% increase of premium	

Block 10 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
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<tr><td>What will you sell to the government?</td><td>Only house</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

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Block 10 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
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How long it will take the government to pay you	15 days after acceptance	**Subsidy you will receive to raise house above ground**	50% of cost of raising house above ground	
You must vacate the house within this period	60 days after acceptance	**How much your flood insurance premium will increase**	20% increase of premium	

Block 11 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	125% of pre-damage fair market value of property	**Cost to raise the house above ground**	40% of pre-damage fair market value of house	
How long it will take the government to pay you	120 days after acceptance	**Subsidy you will receive to raise house above ground**	50% of cost of raising house above ground	
You must vacate the house within this period	30 days after acceptance	**How much your flood insurance premium will increase**	40% increase of premium	

Block 11 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
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<tr><td>What will you sell to the government?</td><td>Only house</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

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<tr><td>You must vacate the house within this period</td><td>120 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>30% increase of premium</td></tr>
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Block 12 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	125% of pre-damage fair market value of house	**Cost to raise the house above ground**	20% of pre-damage fair market value of house	
How long it will take the government to pay you	75 days after acceptance	**Subsidy you will receive to raise house above ground**	50% of cost of raising house above ground	
You must vacate the house within this period	120 days after acceptance	**How much your flood insurance premium will increase**	30% increase of premium	

Block 12 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	100% of pre-damage fair market value of property	**Cost to raise the house above ground**	30% of pre-damage fair market value of house	
How long it will take the government to pay you	120 days after acceptance	**Subsidy you will receive to raise house above ground**	75% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	20% increase of premium	

Block 13 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	75% of pre-damage fair market value of house	**Cost to raise the house above ground**	50% of pre-damage fair market value of house	
How long it will take the government to pay you	120 days after acceptance	**Subsidy you will receive to raise house above ground**	75% of cost of raising house above ground	
You must vacate the house within this period	30 days after acceptance	**How much your flood insurance premium will increase**	50% increase of premium	

Block 13 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
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How long it will take the government to pay you	15 days after acceptance	**Subsidy you will receive to raise house above ground**	50% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	20% increase of premium	

Block 14 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
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<tr><td>What will you sell to the government?</td><td>Both the house and lot</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

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<tr><td>You must vacate the house within this period</td><td>120 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>20% increase of premium</td></tr>
</table>

Block 14 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	125% of pre-damage fair market value of property	**Cost to raise the house above ground**	40% of pre-damage fair market value of house	
How long it will take the government to pay you	15 days after acceptance	**Subsidy you will receive to raise house above ground**	100% of cost of raising house above ground	
You must vacate the house within this period	60 days after acceptance	**How much your flood insurance premium will increase**	40% increase of premium	

Block 15 set 1

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	125%of pre-damage fair market value of house	**Cost to raise the house above ground**	40% of pre-damage fair market value of house	
How long it will take the government to pay you	120 days after acceptance	**Subsidy you will receive to raise house above ground**	25% of cost of raising house above ground	
You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	20% increase of premium	

Block 15 set 2

For the following question, *imagine two programs are offered to you regarding your property as it currently is*. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	110%of pre-damage fair market value of property	**Cost to raise the house above ground**	20% of pre-damage fair market value of house	
How long it will take the government to pay you	15 days after acceptance	**Subsidy you will receive to raise house above ground**	75% of cost of raising house above ground	
You must vacate the house within this period	30 days after acceptance	**How much your flood insurance premium will increase**	40% increase of premium	

[Version 2: House Post-damage]

Block 1 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
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You must vacate the house within this period	90 days after acceptance	**How much your flood insurance premium will increase**	30% increase of premium	

Block 1 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	75% of pre-damage fair market value of property	**Cost to raise the house above ground**	30% of pre-damage fair market value of house	
How long it will take the government to pay you	75 days after acceptance	**Subsidy you will receive to raise house above ground**	25% of cost of raising house above ground	
You must vacate the house within this period	912 days after acceptance	**How much your flood insurance premium will increase**	40% increase of premium	

Block 2 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	110% of pre-damage fair market value of house	**Cost to raise the house above ground**	30% of pre-damage fair market value of house	
How long it will take the government to pay you	45 days after acceptance	**Subsidy you will receive to raise house above ground**	100% of cost of raising house above ground	
You must vacate the house within this period	30 days after acceptance	**How much your flood insurance premium will increase**	30% increase of premium	

Block 2 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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<tr><td>You must vacate the house within this period</td><td>90 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>50% increase of premium</td></tr>
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Block 3 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
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How long it will take the government to pay you	75 days after acceptance	**Subsidy you will receive to raise house above ground**	25% of cost of raising house above ground	
You must vacate the house within this period	60 days after acceptance	**How much your flood insurance premium will increase**	50% increase of premium	

Block 3 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

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<tr><td>How long it will take the government to pay you</td><td>15 days after acceptance</td><td>Subsidy you will receive to raise house above ground</td><td>50% of cost of raising house above ground</td></tr>
<tr><td>You must vacate the house within this period</td><td>120 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>40% increase of premium</td></tr>
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Block 4 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	75% of pre-damage fair market value of property	**Cost to raise the house above ground**	40% of pre-damage fair market value of house	
How long it will take the government to pay you	45 days after acceptance	**Subsidy you will receive to raise house above ground**	100% of cost of raising house above ground	
You must vacate the house within this period	60 days after acceptance	**How much your flood insurance premium will increase**	20% increase of premium	

Block 4 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Only house	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	100% of pre-damage fair market value of house	**Cost to raise the house above ground**	30% of pre-damage fair market value of house	
How long it will take the government to pay you	120 days after acceptance	**Subsidy you will receive to raise house above ground**	25% of cost of raising house above ground	
You must vacate the house within this period	60 days after acceptance	**How much your flood insurance premium will increase**	50% increase of premium	

Block 5 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
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<tr><td>You must vacate the house within this period</td><td>90 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>30% increase of premium</td></tr>
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Block 5 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	90% of pre-damage fair market value of property	**Cost to raise the house above ground**	20% of pre-damage fair market value of house	
How long it will take the government to pay you	45 days after acceptance	**Subsidy you will receive to raise house above ground**	75% of cost of raising house above ground	
You must vacate the house within this period	120 days after acceptance	**How much your flood insurance premium will increase**	30% increase of premium	

Block 6 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
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<tr><td>What will you sell to the government?</td><td>Only house</td><td>Raise house above ground</td><td>Yes</td><td rowspan="4">I would not choose Option A or Option B.

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<tr><td>You must vacate the house within this period</td><td>90 days after acceptance</td><td>How much your flood insurance premium will increase</td><td>20% increase of premium</td></tr>
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Block 6 set 2

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

Option A (Buyout)		**Option B (House Elevation)**		**Neither**
What will you sell to the government?	Both the house and lot	**Raise house above ground**	Yes	I would not choose Option A or Option B. This means the flood insurance premium on this property may increase by 50%
Price you will receive if you sell property	100% of pre-damage fair market value of property	**Cost to raise the house above ground**	50%of pre-damage fair market value of house	
How long it will take the government to pay you	75 days after acceptance	**Subsidy you will receive to raise house above ground**	100% of cost of raising house above ground	
You must vacate the house within this period	120 days after acceptance	**How much your flood insurance premium will increase**	40% increase of premium	

Choice Block 7 set 1

For the next question, *imagine your house was recently damaged by a flood event*. The following programs are offered to you regarding your property. Please consider the options below and select your favorite option. You may choose Option A, Option B, or Neither Option.

<table>
<tr><th colspan="2">Option A
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Choice Block 7 set 2

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Socioeconomics

19. What is the address of this property?

Please provide the street number and street name here

Please provide the 5-digit zip code here

20. What is your age?

21. Are you

Male

Female

Attention check question

22. There are a variety of coastal hazards facing homeowners, with some posing a greater threat than others. The designers of this survey appreciate the time and effort you devote to completing our survey. We feel it is important to reward those who give this commitment by i) differentiating them from respondents who speed through surveys without properly reading the questions and ii) rewarding thoughtful, engaged respondents accordingly. To demonstrate that you have read this question carefully, please select the Mudslides option below.

In your opinion, which of the following natural disasters poses the greatest threat to your property?

Hurricanes

Earthquakes

Mudslides

Tsunamis

Wildfires

23. Which category best describes your race?

American Indian or Alaskan Native

Asian

Black or African American

Hispanic

Latino

White

Other

24. Which category best describes the highest level of education that you have completed?

Did not complete high school

High school diploma

Associate's/ two year degree

Bachelor's/ four year degree

Graduate degree

25. Are you

Married

Widowed

Divorced

Separated

Never Married

26. Which category best describes your annual household income?

Less than $10,000

$10,000 - $24,999

$25,000 - $49,999

$50,000 - $74,999

$75,000 - $99,999

$100,000 - $124,999

$100,000 - $124,999

$150,000 - $199,999

$200,000 or over

Thank you very much for completing the survey. Your contribution to the effort is greatly appreciated.

Please direct all other inquiries to:
Jamie Kruse, PhD
East Carolina University
Department of Economics or Center for Natural Hazards Research
Greenville, NC 27858-4353
Tel: 252-328-5718

APPENDIX E: NOTE ON SURVEY INTRUMENT USED IN CHAPTER 2

Survey instrument used in chapter 2 was designed and administered by, Rachel Davidson, Joseph Trainor, Jamie Kruse, and Linda Nozick. Rachel Davidson is a professor at the Department of Civil and Environmental Engineering, University of Delaware. Joseph Trainor is an associate professor at the School of Public and Administration, University of Delaware. Jamie Kruse is a distinguished professor at the Department of Economics, East Carolina University, and Linda Nozick is a professor at the School of Civil and Environmental Engineering, Cornell University.

APPENDIX F: INSTITUTIONAL REVIEW BOARD APPROVAL LETTER FOR SURVEY USED IN CHAPTERS 3 AND 4

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board
4N-64 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office 252-744-2914 · Fax 252-744-2284 ·
www.ecu.edu/ORIC/irb

Notification of Initial Approval: Expedited

From: Social/Behavioral IRB
To: Jamie Kruse
CC:

Date: 6/25/2018
Re: UMCIRB 18-000714
Homeowner Flood Mitigation Decision: What are the Motivating Factors?

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) is for the period of 6/24/2018 to 6/23/2019. The research study is eligible for review under expedited category #7. The Chairperson (or designee) deemed this study no more than minimal risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The Investigator must adhere to all reporting requirements for this study.

Approved consent documents with the IRB approval date stamped on the document should be used to consent participants (consent documents with the IRB approval date stamp are found under the Documents tab in the study workspace).

The approval includes the following items:

Name	Description
SurveyDesign_June5 2018	Surveys and Questionnaires
1Consent _Edited_April2018	Consent Forms
1Research Protocol_April18_2018	Study Protocol or Grant Application

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418