HOMEOWNER WILLINGNESS TO PAY FOR A PRE-FLOOD BUYOUT AGREEMENT

BY

COLLIN REESER

THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Science in Agricultural and Applied Economics
in the Graduate College of the
University of Illinois at Urbana-Champaign, 2016

Urbana, Illinois

Adviser:

Professor Amy Ando

Abstract

Flood events are expected to increase in frequency and severity as climate change raises sea levels and intensifies regional precipitation events. The only permanent means of removing high risk homes from flood prone areas is through homeowner buyout programs. Using an online contingent valuation survey we evaluate homeowner willingness to pay for a pre-flood buyout agreement where the owner is paid pre-flood market value for their home and must relocate following a flood damaging greater than 50% of the value of their home. Additionally, we estimate homeowners' willingness to sign up for a pre-flood buyout agreement coupled with flood insurance. We find self-reported flood risk estimates, income, the expectation of neighbors also signing up for the buyout, environmental concerns, and flood experience all significantly affect homeowners' willingness to pay for the program. When coupled with flood insurance we find self-reported flood risk estimates, income, neighborhood tenure, environmental concerns, and flood experience all significantly affect homeowners' willingness to sign up.

This research was funded in part by a grant from the National Resources Defense Council

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

Much attention has been paid to the rising public costs of the National Flood Insurance Program (NFIP). In conjunction with subsidized[1] insurance premiums, which leave the price of some policies below their risk adjusted value (Kousky & Shabman 2014; Hayes & Neal 2011), high profile flood events caused by Hurricanes Katrina, Rita, Sandy and a number of riverine inundations have highlighted the economic costs of floods[2]. Premiums collected from flood insurance policies have fallen far short of covering the losses of these major flood events; thus, the NFIP carries a $23 billion debt burden (GAO 2016). Policymakers are debating how best to manage flood risk in the future and limit taxpayer financial exposure to NFIP losses. This paper will examine a possible new kind of policy: a pre-flood buyout agreement between flood management agencies and homeowners. Under such an agreement the homeowner would remain in their home until a flood event causes damage greater than 50% of the value of the home (substantial damage). Following such an event, the homeowner would be paid the pre-flood market value of the property to move, the home would be razed, the land restored to a natural state or public space, and the property would no longer be a liability to the NFIP. We estimate the welfare effects of such a policy on flood plain homeowners by quantifying their willingness to pay to take part in such a program. We identify how preferences over such policies vary with factors such as income, race, and connection to the community; social justice issues are

[1] Subsidized policies are defined as a category of business that does not make an adequate contribution to the loss reserve pool (Hayes & Neal 2011)

[2] These major flood events have also accentuated the human, and environmental costs of development in flood prone areas (National Research Council 2014; Dalbom 2014; Gedan et al. 2011; Mcleman & Hunter 2009)

prominent concerns in flood policy design. We also develop an estimate of the fraction of flood plain homeowners who would be willing to take part in a particular buyout program, coupled with flood insurance, that has been proposed in the literature (Hayat & Moore 2015).

Flood losses have consistently imposed the highest economic costs of any natural disasters (King 2012). Eighty-eight percent of U.S. counties experienced at least one flood in the last half of the 20th century (Burby 2001). Moving forward, flood events are expected to increase in frequency and severity as climate change raises sea levels and intensifies regional precipitation events (Galloway et al. 2006; Pachauri & Meyer 2014; Mallakpour & Villarini 2015). Additionally, the U.S. population is disproportionately living in higher risk areas. Thirty-nine percent of the U.S. population lives in costal shoreline counties which represent only 10% of the U.S. land area (excluding Alaska) and the rate of population density increase is greatest for costal shoreline counties (NOAA 2013).

The high costs of disaster recovery from floods stems in part from the subsidized premium policies that have existed since the inception of the National Flood Insurance Program. These subsidized policies were intended to encourage participation in the program, but consequently boosted development in high risk areas (Wriggins 2014; Bagstad et al. 2006) by subsidizing the long term cost of development. Housing affordability concerns have countered attempts to reduce or eliminate premium subsidies.

Many other factors contribute to rising costs of flood recovery including low flood insurance market penetration rates, out of date flood maps, coastal population growth, and political issues. On average, only 50% of properties in high risk areas are covered by flood insurance (Dixon & Clancy 2006; Kriesel & Landry 2004). NFIP Flood Insurance Rate Maps

(FIRMs)[3] are commonly a decade or more out of date and are based on past flood experience rather than future flood risk, which is likely to change due to climate change (Galloway et al. 2006; Carolan 2007). Population growth within coastal counties has outpaced non-coastal counties, with shoreline counties adding 125 persons per square mile compared to 36 persons per square miles for all U.S. counties between 1970 and 2010, (NOAA 2013). Finally, policy makers receive more electoral support when directing post-disaster spending when compared to pre-disaster spending. Healy and Malhotra (2009) find elected officials are more likely to be re-elected for disaster relief spending when compared to disaster preparedness spending, even though they estimate $1 spent on preparedness is worth about $15 in future savings from mitigated floods (assuming a 4% discount rate and a 6% depreciation rate). Additionally, Conrad et al. (1998) finds a 200% return on disaster preparation spending within 5 years[4]

The role of the federal government in the flood insurance market emerged from failure of private insurers' ability to cover large spatially correlated flood events in the early 1960s (Kousky & Michel-Kerjan 2015; Kunreuther 2015). With its creation in 1976, the NFIP became the primary flood risk management tool for the U.S. government, encouraging participation by offering insurance at subsidized rates in exchange for risk mitigation requirements from participating communities. Calls for more flood insurance reform stem from a combination of unprecedented borrowing from the U.S. Treasury due to high loss ratios, a low probability of

[3] Flood Insurance Rate Maps (FIRM) delineate flood zones, provide a basis to identify properties that require flood insurance, and establish where floodplain building standards should be enforced (GAO 2015). The Technical Mapping Advisory Council (TMAC), created and funded under Biggert Waters is tasked with reviewing, updating, and maintaining rate maps

[4] Conrad et al. 1998 did not account for additional cost savings from reduced flood management services therefore is considered a conservative estimate

being able to repay that debt through premium receipts[5], and expectations of higher future flood losses.

In an effort to bring solvency back to the NFIP, the Biggert-Waters Flood Insurance Reform Act of 2012 mandated the gradual elimination of most flood insurance subsidies[6] by raising flood insurance premiums by 25% each year until full risk rates are reached (Wriggins 2014). The potential for dramatic premium increases for certain policies under Biggert-Watters raised immediate concerns of housing affordability, particularly for low income households. This criticism resulted in passage of the Homeowner Flood Insurance Affordability Act (HFIAA) of 2014, which repealed many of the mandated premium increases required under Biggert Watters. While HFIAA resulted in more affordable premiums for property owners the continuation of subsidized policies ensures the continued insolvency of the NFIP. Biggert-Waters and the HFIAA represent the perpetually conflicting policy goals of the NFIP. Subsidized premiums offer affordable protection to low income property owners and increase participation in the program, but do not fully fund the indemnity payments and cost of administering the program requiring taxpayers to cover the additional losses.

In response to the perpetual nature of the conflicting policy goals, a pre-flood homeowner buyout program has been proposed as a compromise between offering affordable flood protection and reducing total liability (Hayat & Moore 2015). A pre-flood buyout program could take a number of proposed forms including a legal agreement between homeowner and local flood management agencies to move in exchange for insurance premium reductions, or agencies could purchase a conservation easement on the property. In one form it would allow low income

[5] Biggert-Waters required FEMA to issue a report to congress with options to repay all NFIP debt within 10 years of the bills implementation (GAO 2015)

[6] Properties subject to the 25% premium increase include secondary residences, businesses, and severe repetitive loss properties. See (GAO 2015) for premium status of all property types

homeowners to maintain their affordable insurance policy in exchange for agreeing to relocate in the event of a flood damaging greater than 50% of the value of their home. This would also prevent demolition of otherwise suitable undamaged homes before the next flood event. Other risk mitigation tools like elevating homes or building levies may reduce risk but fall short of a permanent solution as extraordinary events can still damage mitigated homes and base flood levels can vacillate over time with climate change (Pachauri & Meyer 2014).

Homeowner buyout programs have been employed for decades as a permanent means of reducing future flood risk exposure in flood zones (Binder & Binder 2013; Zavar 2015; de Vries, D.H., Fraser 2012). Buyout programs have the capacity to further reduce flood risk for properties not involved in the agreement. As coastal and riverine communities have expanded over the decades, the natural flood protections of swamps, forests, mangroves, and other natural barriers were drained and developed. Consequently, properties further from bodies of water were at increased risk of flood. (Kerr, 2007; Costanza, 2006; Snohomish County 2013). After a buyout, land that had once served as a protective barrier to other development can be restored to its natural state (or otherwise protective state) to help prevent damage to other homes. Other research has estimated possible benefits of buyout programs that permit restoration of costal and riverine flood plains. Shepart et al. (2011) compiled 75 publications in a meta-analysis with many showing costal marshes provide valuable hazard mitigation properties through wave attenuation and shoreline stabilization. Additionally, floodplains in their natural state are home to more species of plants and animals than in any other landscape unit in most regions of the world (Tockner & Stanford 2002).

Homeowner buyout programs of the past have primarily focused on contracting to buy out properties after they have been damaged by flooding (Binder, 2013; Dalbom, 2013; de Vries,

D.H., Fraser, 2007). It is not uncommon however, for homeowners to receive indemnity payment, rebuild, and then participate in a buyout program; an unfortunate consequence of the length of time it can take to complete the process and cause of increased costs. The proposed buyout program analyzed in this paper takes a new approach. Homeowners in flood zones are able to sign up for a guaranteed buyout for the full market value of their home before a flood event occurs. Such a program could have both desirable and undesirable features for homeowners. The homeowner would have peace of mind knowing what will occur after a major flood event. Property value in surrounding areas can be increased by restored coastline or open space created through buyouts (Bolitzer and Netusil 2000; Dale-Johnson and Yim 1990; Irwin 2015). Homeowners and communities can more effectively plan for flood events and their aftermath which may include a tax base changes (GAO 2004), infrastructure modification (Dalbom 2014) or in some cases relocation of entire communities (Brown 1996). Completing the buyout paperwork before the flood event (benefit-cost analysis, appraisals, and conservation planning) could greatly reduce post flood legal processes and thus reduce the time needed to complete the buyout. On the other hand, the homeowner would be giving up the option to change their mind and rebuild their home in the same location after a flood occurred; that loss of option value may represent a significant disutility to individuals with strong attachments to the location of their current home. Given these possible benefits and costs, how much would a homeowner be willing to pay (WTP) for the certainty of a guaranteed buyout or how much would they have to be paid to be willing to accept (WTA) it? We have carefully crafted a survey to measure just that. Results of this study can inform policy makers of the propensities of homeowners in our sample communities and communities of similar characteristics (see Figure 1 for the spatial distribution of survey respondents).

This paper makes multiple contributions to the body of flood risk mitigation literature. As of the writing there is no known analysis of homeowners' willingness to participate in pre-flood buyout agreement programs. Employing a payment card contingent valuation survey we value homeowners' WTP for a guarantee their home will be bought out following a major flood event. The model allows us to quantify the effects and significance of having recent flood experience, self-estimates of flood risk, income, home value, and other demographic variables. The second part of our analysis measures the effect of the same variables on homeowners' willingness to sign up for a buyout program that is coupled with mandated purchase of flood insurance.

CHAPTER 2

METHODS

2.1 Contingent Valuation Methodology

To investigate (WTP) for a guaranteed buyout, this study uses an online payment card contingent valuation survey design.[7] Contingent valuation (CV) is a common valuation method for goods that are not currently traded in a marketplace (Lindhjem & Mitani 2012; Carson 2012; Champ et al. 2011; Carson & Mitchell 1989; Bateman 2002). In the absence of market research, practitioners in this field often rely on stated preference methods to value goods. The CV method uses a survey instrument to describe a good, and then elicit information from survey participants about their WTP for that good. The technique is especially useful when other indirect non-market valuation methods like travel cost or hedonic are not technically feasible (Smith 1993; Bateman 2002).

This paper employs the CV payment card elicitation format which presents an ordered series of dollar values from which respondents reveal their willingness to pay each amount by checking yes or no. This response format is used a balance between efficiency and reliability. Relative to dichotomous choice, the payment card format provides narrower intervals to estimate efficiently (Brown et al. 1996). Additionally, it provides more reliable responses when compared to open ended formats. Cameron and Huppert (1989) note that using the center of the intervals as a point estimate of WTP can bias the parameter estimates. Additionally, range and centering bias are found to be a concern with early payment card studies (Carson & Mitchell 1989). Rowe, Schulze and Breffle (1996) however, use an exponential response scale and find no evidence of

[7] For a more extensive review of tradeoffs between the payment card and other elicitation formats see (Champ & Bishop 2006; Bateman 2002)

range or centering bias as long as respondents were able to select values on the upper end of the value distribution. They find the inclusion of exceptionally high bids may influence welfare estimates; this study uses focus groups to determine the maximum bid to minimize both truncating and excessively large bids.

Exponential response scales display values to respondents with increasing interval distances between values. This approach has a number of features. First, exponential response scales allow practitioners to include larger ranges of values without including a cumbersome number of choices (Rowe et al. 1996). Secondly, it assumes individuals have the ability to quickly distinguish between two values increases proportionally to the value of the good (Rowe, Schulze, and Breffle 1996). For example, one may consider the cents when purchasing a pencil but would not if purchasing a car. Rowe et al. (1996) use Weber's law[8] as a base for the interval distances of the payment card. This is the method used to construct the payment card in this paper.

Many efforts were made to increase the precision of the WTP responses. As Mitchell and Carson (1989) and the NOAA panel on contingent valuation (Arrow et al. 1993) recommend, the background information and new pre-flood buyout sections are designed to encourage respondents to think in depth about their personal budget and how the proposed buyout would affect them. Flood risk, budget, community, and how much they value the security of knowing they would be paid the full value of their home following a major flood event are all brought to their attention through the background information. Care was taken when framing the new guaranteed buyout policy to provide what Carson and Hanemann (2005) call face validity.

[8] Weber's law quantifies the distance necessary to perceive changes between two stimuli. The next noticeably different value is calculated using the exponential function: $B_n = B_1 \times (1+k)^{n+1}$ Where B_n is the bid value n units from the initial bid, B_1 is the initial Bid, and k is a positive constant. (Rowe et al. 1996)

Respondents should believe in the plausibility of the non-market good transaction. This study uses feedback from focus groups to tailor and refine the survey language to match the experience and language commonly used by homeowners when communicating about flood risk and mitigation. The good must be clearly and fully described to the respondent to elicit a precise estimate of WTP, but the description must be neutral and not so long as to bore or encourage skimming by the respondent. In cases where the respondent is unfamiliar with the good, they will make their own assumptions thus including unintended elements into the good being valued (Champ et al. 2011). Bateman and Mawby (2004) show survey respondents can become tired, bored, or even annoyed with excessive information. This survey is carefully crafted to provide pertinent elements of the proposed policy while avoiding participant overload. Answer choices are randomized when possible to avoid ordering effects (Champ et al. 2011; Bateman 2002).

A common concern regarding contingent valuation studies is hypothetical bias (Loomis 2011; Murphy et al. 2005). Hypothetical bias occurs when survey respondents express they are WTP more than what they would actually pay in a market transaction. Although not universally accepted, (Krosnick et al. 1996) hypothetical bias has been noted in a number of meta analyses (Loomis 2011; Murphy et al. 2005) indicating care should be taken to minimize its effects. One method employed to reduce hypothetical bias is through the use of cheap talk scripts within the survey (Tonsor & Shupp 2011; Taylor et al. 1999). These scripts inform respondents of the possible tendency of survey takers to misstate their actual WTP and encourages them to be more cognizant of their actual WTP. We include a short cheap talk script in the key valuation questions to minimize hypothetical bias.

2.2 Survey Design and Data Collection

Prior to survey administration, three focus groups of homeowners in flood prone areas were held to refine the survey instrument. The primary goal was to ensure respondents understand the language of the buyout scenario as there are numerous unique terms and acronyms in the flood risk and mitigation domain. Additionally, the focus groups sought to identify languages or concepts that clarified the valuation process or could be cause for response bias. We also review the qualitative responses from the focus groups sessions to ensure the content is not unduly influencing respondents' answers.

In March of 2016, an online survey was distributed to a Qualtrics participant panel which collected 491 responses. Respondents were recruited from zip codes containing flood zones within the 100 year floodplain. To be eligible, respondents must own their own home and verify their flood zone code through FEMAs National Flood Hazard Layer tool. This respondent panel was chosen as a sample of the target demographic of homeowner buyout programs. The online platform Qualtrics was selected to administer the survey because of its large national panel, ability to quickly screen thousands of panel members on specific criteria, and cost of administration.

The survey is presented in Appendix A. It begins with a series of eligibility screens to ensure respondents are homeowners, living within the 100 year floodplain, and over the age of 18. Floodplain status was determined by incorporating the National Flood Hazard Layer (NFHL)[9] into the online platform. Each respondent is asked to enter their address into the Federal Emergency Management Agency NFHL tool. Once entered, the tool displays the flood zone information respondents enter into the screening question.

[9] The National Flood Hazard Layer (NFHL) is a digital database that contains flood hazard mapping data from FEMA's National Flood Insurance Program (NFIP). fema.gov/national-flood-hazard-layer-nfhl

The second section of the survey provides the respondent with background information on flood risk and describes what homeowners can currently do if their house is severely damaged in a flood, including brief information about the nature of conventional post-flood buyout programs. Section three describes the features of a hypothetical pre-flood guaranteed buyout program. In short, this program is a pre-flood agreement that guarantees homeowners their home would be bought out after a flood causing substantial damage. In exchange, the homeowners are required to relocate. Respondents are then presented with an ordered series of hypothetical payment values, and asked to mark yes or no for each to indicate whether they would be willing to pay that amount of money for the program. The payment values are 11 exponentially ascending dollar amounts ranging from $0 to $3,500. If a respondent is not willing to pay any amount of money to participate (they will check "no" for all dollar amounts) the survey takes them to another payment card asking respondents how much they would need to be paid to participate in the program. The survey has both WTA and WTP sections as some focus group participants indicated they had a negative value for the program. However, we present the WTP card first to avoid incentive compatibility problems associated with people declaring they would need to be paid to accept the program if payment is presented as an option.

The fourth section of the survey asks homeowners if they would be willing to sign up for a different kind of program. This hypothetical program is only available to homeowners with flood insurance. Homeowners with flood insurance who sign up for the hypothetical program would be allowed to pay the old subsidized insurance rates. Insurance rates are increasing to be actuarially fair, so in the absence of such a program insurance will be much more expensive. The survey instrument calculates and explains the annual savings from signing up for this hypothetical program. For a person who currently has insurance, savings are found by using the

homeowner's reported premium and FEMA's own estimate that subsidized premiums are 40-45% of full risk rates (Hayes and Neal 2011; GAO 2013). For survey respondents who do not currently have insurance, full risk and subsidized rates are calculated using their home value and assumes a 1% annual chance of substantial flood.

The last survey section gathers demographic, risk perception, home characteristics, flood experience, and other information to be used as controls. Socioeconomic factors are important components of many flood risk mitigation programs so estimating relationships among these variables is important. Additionally flood experience and risk perceptions have been shown to affect risk mitigation decisions (Atreya, Ferreira, and Michel-Kerjan 2015; Browne and Hoyt 2000).

Instrument reliability is enhanced through a number of pre-survey launch validity checks. The survey was distributed to multiple municipal and regional floodplain managers to ensure content validity and plausible implementation of the proposed buyout program. Two soft launches were conducted to verify respondents were being ushered through the survey as intended and to identify screening questions. Following the soft launches multiple attention filter and logical validation questions[10] were added to ensure data quality.

Some individuals respond to contingent valuation questions by reporting they are not willing to pay anything for the proposed good. Such a respondent may truly have WTP equal to zero for that good, but such responses may instead be serving as expressions of protest over the good or an element of the valuation context (Carson & Mitchell 1989). The inclusion of protest responses in a CV analysis can bias WTP estimates. We identify and remove protest votes that

[10] Attention filters are simple questions that ensure respondents are reading the questions and typically require a specific response to pass. Logical filters remove respondents who fail to provide logically consistent answers throughout the survey.

meet two conditions. First, they are unwilling to participate in the program for any amount of money. Secondly, they indicate through other survey responses that they are including spurious elements in their value expression.

2.3 Conceptual Model and Data Analysis

In this paper, we will value and model homeowners' WTP to sign up for the pre-flood buyout agreement previously described. The buyout agreement can be thought of as a bundle of goods (both positive and negative) for which the homeowner reveals a value. The purpose here is not to disentangle the values that homeowners place on the different components but rather the combined value of the entire buyout agreement. This is achieved by developing a theoretical model representing the value change between the baseline level of utility without the buyout program and the level of utility with the buyout program.

The indirect utility functions (v) represented in equation (1) are used to derive the compensating welfare measure (c) necessary to equate homeowners' utility with and without the buyout agreement. In other words, c represents how much the homeowner would be WTP for the guaranteed buyout program Q^1 at price vector p^1 to achieve the same level of utility as they would have without the buyout program (Q^0, p^0) (Champ, Boyle, and Brown 2011).

$$(1) \quad v(p^0, Q^0, y) = v(p^1, Q^1, y - c)$$

To estimate WTP, we elicit preference information from respondents through a payment card contingent valuation survey. Preference information selected by each respondents is recorded as a bid interval containing the true WTP. This interval represents the dependent

variable in our analysis as we model the true WTP. To build a framework to estimate respondents WTP, we rely on an efficient maximum likelihood interval regression developed by Cameron and Huppert (1989). In performing this analysis, we estimate coefficients for a number of explanatory variables (see Table 1). Individual WTP values can be estimated as:

$$(2) \quad c_i = z_i'\beta + u_i$$

where c_i represents *WTP* for respondent i, u_i is the random error term with mean zero and standard deviation σ, z_i' is a vector of independent variables that explain response variation, and β is the vector of coefficients. See Table 1 for a full list of variables included in the function $z_i'\beta$. We cannot directly observe c_i as a consequence of the payment card elicitation format, but rather we observe the interval within which it falls. Therefore, the probability that the true WTP c_i falls within the interval chosen by respondent i is:

$$(3) \ \Pr(c_i \subseteq (\$B_{li}, \$B_{ui}) = \Pr[\frac{(\$B_{li} - z_i'\beta)}{\sigma} < t_i < \frac{\$B_{lu} - z_i'\beta}{\sigma}]$$

where t_i is a standard normal variable $\$B_{li}$ and $\$B_{ui}$ represent the upper and lower bounds of the interval containing c_i, and $z_i'\beta$ is the function representing the solution to equation (1) defining the value being estimated (Champ, Boyle, and Brown 2011). As an alternative specification we take the log transformation of the upper and lower bounds ($\$B_{li}, \$B_{ui}$); Cameron and Huppert (1989) show this transformation is a better fit for the expected skewness of the value distribution, but it also bottom-censors negative valuations at zero.

This paper uses a second regression to examine homeowners' willingness to participate in a buyout program coupled with flood insurance. That hypothetical program is similar to the one proposed in Hayat and Moore (2014); a homeowner in a high risk areas would receive subsidized flood insurance premiums in exchange for agreeing to accept a buyout in the event that their house is damaged and flood and losses are more than 50% of its value. The survey asks homeowners only a single question about whether they would be willing to sign up for the program given the savings on insurance payments they would realistically obtain from such a program; thus, we analyze that single dichotomous choice with a maximum likelihood logit regression. We estimate the effect of explanatory variables x_j on the probability of the homeowner signing up for the program. $P(y = 1|x_j) = \frac{\exp(x_j\beta)}{1+\exp(x_j\beta)}$ In this model, y is the binary response variable that takes a value of 1 if the respondent will sign up for the program and 0 if they decline. The explanatory variables x_j include factors such as income, flood experience, community attachment, and whether or not the homeowner already has flood insurance.

2.4 Hypotheses

A number of papers have shown that homeowners base their flood mitigation decisions on a number of economic, social, and political factors (Browne & Hoyt 2000; Fraser et al. 2003; de Vries, D.H., Fraser 2012; FEMA 1998). From these papers, we derive the following hypotheses for the effects of the factors in equation (2).

Brown and Hoyt (2000) study demand for flood insurance and find the likelihood that a household has flood insurance increases with income and flood experience and decreases with price. Fraser et al. (2003) surveyed residents and flood management officials in communities that had recently participated in a post-flood buyout to examine factors contributing to success and

failure of buyout programs. They find risk, neighborhood attachment, and buyout process factors such as trust, communication, and timing to be important predictors. Fraser found 37% of their sample indicated future flood risk was very important in their decision to participate in the buyout program. Furthermore, Atreya, Ferreira, and Michel-Kerjan (2015) and Browne and Hoyt (2000) find previous flood experience to be a driver of current risk expectations. Studies of post flood buyout programs have found that financial considerations, land development pressures, connection to neighborhood, perceived risks, and the quality of relationships between residents and local officials influence a homeowner's willingness to accept a buyout (de Vries, D.H., Fraser 2012; Fraser et al. 2003). Over 50% of residents surveyed by Fraser (2003) expressed an aversion to losing neighborhood based social networks, while others voiced an eagerness to leave as they perceived the neighborhood to be in decline. FEMA's Flood Acquisition Manual from 1998 also identifies size of household and opinions of family and friends as influential over property owners' decision to participate in a buyout.

From these findings, we hypothesize WTP for the pre-flood buyout program will increase with self-reported flood risk estimates, number of insurance claims, size of the largest claim, income, and flood insurance premium. We hypothesize homeowners will pay less for the guaranteed buyout if they have lived in the community longer, communicate with their neighbors more frequently, have family in the community or believe a higher proportion of their neighbors will move after a flood. In addition to these hypotheses, we estimate the effect on WTP for homeowners that believed the buyout would be good for the environment. We hypothesize this effect to be positive. See Table 2 for a summary of hypotheses.

CHAPTER 3

RESULTS AND DISCUSSION

3.1 Summary Statistics

In total, our survey yielded 491 useable responses after filtering respondents that are deemed incomplete or made logically incongruent responses. All respondents are homeowners living within the 100 year floodplain. Nearly all respondents are primary homeowners (97% are owner occupiers) which is important as they are the focus of hazard mitigation grant programs. Forty-six percent currently are covered by flood insurance and 11% live in designated V-zones which are subject to wave action. Forty-six percent of our sample have flood insurance which matched the latest market penetration estimates of around 50% and suggests no self-selection by insured households. We do however, find insurance rates in the middle and high income categories (57% and 53% respectively) are much higher than the low income category (38%). Table 4 contains results of the motivations our respondents expressed in their decision to purchase flood insurance. In terms of flood experience 33% of respondents have experienced at least one flood and 34 homeowners are in designated repetitive loss properties, of which 89% are in the low or middle income category (see Table 3 for the complete distribution). Fifty-two percent of respondents were female and the average household size is 2.75. Thirty percent have some college and 59% have a bachelors or advanced degree. For a more detailed description of respondent characteristics see Figure 2 and Table 5.

3.2 Regression Results

We run two different samples through our linear and log model specifications. The full sample (n=491) and a conservative sample (n=447) where we filter out individuals that spent less than 7 minutes on the survey or left some answers blank. Only conservative sample results are shown in this paper as the two specifications are not meaningfully different. To elicit preference information for the pre-flood buyout program, participants are presented with a payment card consisting of a series of yes-no response options to corresponding dollar values. Respondents are asked to indicate whether or not they would be willing to pay each amount. Through interval regression analysis we estimate the effects of 20 potential explanatory variables. We find self-reported flood risk estimates, the expectation of neighbors also signing up for the buyout, environmental concerns, flood experience, and income all significantly affect homeowners' WTP to sign up for the pre-flood buyout program. The average homeowner WTP is $605. A summary of WTP interval observations can be seen in Figure 3.

Table 6 displays parameter estimates for the two model specifications. The first is the linear specification, flowed by the log specification where we log transform the dependent variable. The linear form allows negative values from respondents that express a disutility from the program and would need to be paid to participate but assumes a normal distribution of WTP values. Additionally, the linear functional form allows us to interpret the coefficients as marginal effects. The log transformed specification transforms of the interval bounds as specified in Cameron and Huppert (1989). This specification censors the few observed intervals lower than zero, but follow a right skewed distribution common to valuation distributions.

Consistent with previous flood mitigation literature homeowners that have a higher self-estimated flood risk are willing to pay more for a guaranteed buyout. We find as a homeowner's

estimate of the probability of flood in the next 30 years increases by one percentage point their WTP for the program increases by $6.24. If two neighbors have a 50 percentage point difference in expectation of flood in the next 30 years the difference in their WTP would be $324.

We ask respondents to estimate the proportion of their neighbors that would accept a pre-flood buyout program as it is presented to them. We hypothesize that increasing the proportion of neighbors accepting the agreement would positively affect other homeowners own WTP for the program. Our analysis shows for every percentage point increase of neighbors signing up for the program, homeowners are willing to pay an additional $4.69. If one homeowner believes 3 of their 10 neighbors would take the pre-buyout and another believes 7 of 10, the difference in their WTP would be $235.

Environmental literature notes multiple environmental benefits of removing development and restoring the most vulnerable flood prone areas to a natural or otherwise protective state. Two of the four model specifications indicated a significant effect from environmental concern. Respondents who believe buyouts have environmental benefits were willing to pay $215 (full sample) more to participate in the pre-flood buyout. This effect could be due to homeowners holding positive values for the land being restored to its natural state.

We hypothesize homeowners that have previously made a claim to be willing to pay more for the program. We find that only those that had made a claim of $25,000 or more had WTP values that are statistically significantly higher than other homeowners. Homeowners in this category (n=44) are found to be willing to pay an additional $590 to sign up. These homeowners are intimately aware of the risk they face and the hassles of rebuilding and may be keen to participate in a buyout after the next substantial flood event.

Examining respondents who currently have flood insurance we find each additional dollar a spent on flood insurance premiums increases their WTP by $0.09. Therefore, our findings imply that one homeowner facing an additional $1,000 in annual premiums would be willing to pay an additional $90 to sign up. A buyout agreement could decrease the future spending on flood protection for these households so they would be willing to pay more.

Consistent with economic theory, households with greater income are willing to pay more for normal goods. We find the average WTP for households making under $70,000 per year to be $446. Households in the $70,000 to $150,000 range would pay $691 ($245 more than low-income category) and those making more than $150,000 were willing to pay $1,202 ($756 more than low-income category). We find homeowners with home values between $100,000 and $250,000 were willing to pay more but only in the log transformed conservative sample.

A dummy variable indicating whether or not the respondent was African American indicated a negative and significant willingness to pay but only at the 10% level and only for the log transformed conservative sample.

3.3 Buyout Coupled With Insurance Decision Factors

Our second objective is to evaluate homeowners' willingness to participate in a similar buyout program coupled with mandatory purchase of flood insurance. Respondents are presented with the option to sign up for the program with reduced insurance premiums and a guaranteed buyout agreement or face full rate premiums. Within our panel 68% of respondents indicated they would sign up. To explain the factors that significantly contribute to the likelihood a homeowner will sign up we employ a logit regression maximum likelihood estimation model. Our results (Table 7) show that homeowners' self-reported flood risk, premium savings, size of

household, time spent in community, environmental concern, income, and race affect homeowners' willingness to sign up for coupled program.

Regression coefficients from logistic regressions are helpful in determining the sign and significance of partial effects but interpreting the magnitude of the effect can be difficult. The difficulty stems from the non-linear marginal effects, where the marginal effect depends on the values the levels of all of the other variable in the regression. We use an average partial effect (APE) method (sometimes called the average marginal effect) to express probabilities homeowners will sign up at different levels of the explanatory variables (Wooldridge J. M. 2011). For binary explanatory variables we estimate the discrete difference in probability of sign up between both levels of the binary variable using the observed values of the other predictors for individual respondents. This difference in values is averaged for all respondents to produce the APE (Wooldridge J. M. 2011). This method allows us to express intuitive probability of sign up differences for the two groups or between discrete levels of continuous variables.

Our analysis shows homeowners' self-reported estimate of flood risk varies positively with probability of sign up. We estimate a homeowner who believes their home will be flooded with 100% certainty in the next 30 years is 10% more likely to sign up for the buyout program when compared to a homeowner that believes there is a 50/50 chance, and 21% more likely than one who is certain no flood will occur. This is consistent within the flood risk mitigation literature that says higher risk homeowners are more likely to take steps to mitigate their flood risk.

We hypothesized premium savings from signing up would increase the probability of sign up but we found the effect to be negative. This negative effect included all homeowners with and without insurance. When we subtract out the effect for homeowners that currently have

insurance the overall effect becomes insignificant. This makes intuitive sense as currently uninsured homeowners would be forced to purchase insurance to sign up for this program, an action they have already revealed through their behavior they are unable or unwilling to do. Thirty-nine percent of uninsured respondents express they could not afford the premium and 45% said they don't worry about their home being flooded (Table 4)

Our analysis shows income to be a factor in sign up rates. The predicted sign-up rate of households making under $70,000 is 63.6%, compared to 74.7% for the middle income group, and 80% for the top income group of $150,000 and above.

For each additional member of a household, we find the probability of signing up increases. The predicted probability of a household with 2 inhabitants signing up for the program is 66.4%. This probability increases to 83.2% for households with 6 occupants. This relationship can also be seen in Table 8, showing the observed sign up rates across number of inhabitants.

We hypothesized a longer neighborhood tenure would decrease willingness to sign up but found the relationship to be positive. This effect may be due to some long term low income households wanting to leave the neighborhood but not having the means. Our data show lower income households have a longer neighborhood tenure. We also find homeowners with family in town less willing to participate in the buyout program.

We find environmental concerns to increase signups for the pre-flood buyout program coupled with insurance. Homeowners that believe buyouts are good for the environment are 14% more likely to sign up when compared to those that did not hold that belief. Twenty-five percent of respondents express this belief (Table 9).

CHAPTER 4

CONCLUSIONS AND LIMITATIONS

4.1 Conclusion

This study was designed to improve understanding of homeowner preferences towards pre-flood buyout programs. We tested the effects of flood experience, risk estimates, community attachment, income and other demographic variables on homeowners' WTP for a guaranteed buyout in the event of substantial flood damage to their home. We also tested homeowners' willingness to participate in a buyout program that is coupled with insurance. Results of these two analyses can be used by policymakers and local flood officials in designing and pursuing buyout policies to reduce community and national flood risk.

Our results imply that a free policy offering pre-flood buyout agreements would improve the welfare of homeowners by an average of $605. We find self-estimated flood risk, income, flood experience, and environmental concern to vary positively with how much the homeowner is willing to pay. A homeowner who believes their home will flood with almost certainty in the next 30 years would have an average welfare gain of $929 over a homeowner that believed there is a 50% probability of flood. Those who have experienced flood damage over $25,000 have a welfare benefit of $590 over those who have never had a claim. We also find a significant neighbor effect indicating homeowners who believe a larger percentage of their neighbors would leave following a flood have a larger welfare benefit from the program. For each percentage point increase in neighbors leaving, the welfare effect increases by $4.69. Welfare effects estimated here do not include externalities.

When offered the chance to sign up for a program that combines this guaranteed buyout with mandatory purchase of flood insurance with a subsidized rate, 68% of respondents indicated they would sign up. We find self-estimated risk, income, flood experience, neighborhood tenure, and environmental concern to vary positively with the probability a homeowner would sign up for the program.

With limited hazard mitigation grant funds and other appropriations, national and regional planners must target not only high risk areas but also areas that show a higher propensity to participate in mitigation programs. The results of this study indicate that planners might do well to prioritize communities with high flood risk, recent flood experience, and where residents are aware of the environmental benefits of floodplain restoration. Additionally, the results indicate that homeowners may be more willing to participate in buyout programs if their neighbors are also participating as was the case for Valmeyer, Illinois and Pattonsburg, Missouri, two towns relocated in their entirety after a flood (Brown 1996).

Our results show homeowners have more value for a guaranteed buyout and are more likely to sign up for the coupled program if they believe the end result will be better for the environment. These findings suggest homeowners would be more inclined to participate in buyout programs if environmental/sustainability components are included in the structure of post-buyout planning and the environmental benefits of land restoration are included in educational material used to inform property-owners.

Much of the risk mitigation literature examines flood mitigation at a local or regional level (Brody et al. 2008; Calil et al. 2015; Kick et al. 2011; de Vries, D.H., Fraser 2012). Furthermore, most published case studies involve recently flooded communities. While recently

flooded communities are often included in high risk zones targeted by mitigation programs, the national sample our data allows us to make much wider inferences.

Policy makers and floodplain managers can gain insight from these results across various geographies and flood experience. Many of the factors we find to significantly contribute to homeowners willingness to participate in buyout programs are robust across other mitigation strategies in the literature. These include risk estimates, income, and flood experience. Caution should, however, be exercised in applying our results to a program evaluation if details of the different proposed buyout program stray far from those presented to our survey respondents. Furthermore, actual participation rates in buyout programs may be lower than stated due to transaction costs.

Through our regression analyses we were able to measure factors that affect homeowners' willingness to participate in the pre flood buyout program proposed by Hayat and Moore (2015). These types of programs however, can be constructed to suit the many idiosyncrasies of different flood prone communities by modifying the selection criteria, terms of the buyout or level of mitigation assistance provided to homeowners. To further floodplain managers' ability to match buyout program structure to suitable communities, a better understanding of what components of buyout programs are valued by homeowners would be of great worth. These insights could come from a choice experiment analysis examining which buyout program components homeowners value, which they hold little or negative value for, and how those components vary across homeowner characteristics.

Since its inception, the NFIP has been a program designed to provide affordable flood insurance that assists homeowners in rebuilding after flood events. While NFIP policies mandate smarter building codes, homes re-built in flood zones to the highest current standards will still be

subject to unknown conditions in the future. The quickly developing literature on climate change paints a concerning picture of homes subject to rising sea levels and changing precipitation patterns. Furthermore, communicating flood risk to homeowners through full risk rate insurance premiums has been difficult due to housing affordability concerns. Previous buyout research has shown buyouts can permanently absolve the threat of flood and reduce the national flood risk exposure while accommodating those concerns. Our findings add pre-flood buyout agreements to the portfolio of viable risk mitigation strategies with the added benefit of allowing homeowners and communities to plan for more desirable outcomes while also addressing the affordable housing disparity.

REFERENCES

Arrow, K. et al., 1993. Report of the NOAA Panel on Contingent Valuation. , pp.4601–4614.

Atreya, A., Ferreira, S. & Michel-Kerjan, E., 2015. What drives households to buy flood insurance? New evidence from Georgia. *Ecological Economics*, 117, pp.153–161.

Bagstad, K.J., Stapleton, K. & D 'agostino, J.R., 2006. Taxes, subsidies, and insurance as drivers of United States coastal development. *Ecological Economics*, (63), pp.285–298.

Bateman, I.J. et al., 2002. *Economic Valuation with States Preference Techniques*, Northampton Massachusetts: Edward Elgar Publishing.

Bateman, I.J. & Mawby, J., 2003. First impressions count: interviewer appearance and information effects in stated preference studies. *Ecological Economics*, (49), pp.47–55.

Binder, S.B. & Binder, S.B., 2013. *Quick Response Grant Final Report: New York's Home Buyout Plan after Hurricane Sandy*, Boulder Colorado.

Bolitzer, B. & Netusil, N.R., 2000. The impact of open spaces on property values in Portland, Oregon. *Journal of Environmental Management*, 59(June 1998), pp.185–193.

Brody, S.D. et al., 2008. Identifying the impact of the built environment on flood damage in Texas. *Disasters*, 32(1), pp.1–18.

Brown, P.L., 1996. Higher and Drier, Illinois Town Is Reborn. *New York Times*. Available at: http://www.nytimes.com/1996/05/06/us/higher-and-drier-illinois-town-is-reborn.html?pagewanted=all.

Brown, T.C. et al., 1996. Which Response Format Reveals the Truth about Donations to a public Good? *Land Economics*, 72(May).

Browne, M.J. & Hoyt, R.E., 2000. The Demand for Flood Insurance : Empirical Evidence. *Journal of Risk and Uncertainty*, 20(3), pp.291–306.

Burby, R.J., 2001. Flood insurance and floodplain management: the US experience. *Environmental Hazards*, 3, pp.111–122.

Calil, J. et al., 2015. Aligning natural resource conservation and flood hazard mitigation in California. *PLoS ONE*, 10(7), pp.1–15.

Cameron, T.A. & Huppert, D.D., 1989. OLS versus ML estimation of non-market resource values with payment card interval data. *Journal of Environmental Economics and Management*, 17(3), pp.230–246.

Carolan, M.S., 2007. One step forward, two steps back: Flood management policy in the United States. *Environmental Politics*, 16(1), pp.36–51.

Carson, R.T., 2012. Contingent Valuation: A Practical Alternative When Prices Aren't Available. *Journal of Economic Perspectives*, 26(4), pp.27–42.

Carson, R.T. & Hanemann, W.M., 2005. The Handbook of Environmental Economics. *Federal Register 58*, pp.821–936.

Carson, R.T. & Mitchell, R.C., 1989. *Using Surveys to Value Public Goods; The Contingent Valuation Methon*, Washington DC: Resources for the Future.

Champ, P.A. & Bishop, R.C., 2006. Is Willingness to Pay for a Public Good Sensitive to the Elicitation Format? *Land Economics*, 82(2), pp.162–173.

Champ, P.A., Boyle, kevin J. & Brown, T.C., 2011. *A Primer on Nonmarket Valuation* 3rd ed., Dordrecht, The Netherlands: Kluwer Academic Publishers.

Conrad, D. et al., 1998. *Higher Ground A Report on Voluntary Property Buyouts in the Nation's Floodplains*, Vienna, Virginia.

Costanza, R., Mitsch, W.J. & Day, J.W., 2006. A new vision for New Orleans and the Mississippi delta: applying ecological economics and ecological engineering. *Frontiers in Ecology and the Environment*, 4(9), pp.465–472.

County, S., 2013. Home Buyout Program: Guidelines for Property Owners. , pp.1–2.

Dalbom, C., 2014. *Community Resettlement Prospects in Southeast Louisiana A Multidisciplinary Exploration of Legal, Cultural, and Demographic Aspects of Moving Individuals and Communities*, Tulane.

Dale-Johnson, D. & Yim, H.K., 1990. Coastal development moratoria and housing prices. *The Journal of Real Estate Finance and Economics*, 3(2), pp.165–184.

Dixon, L. & Clancy, N., 2006. *The National Flood Insurance Program ' s Market Penetration Rate : Estimates and Policy Implications*,

FEMA, 1998. *Property Acquisition Handbook for Local Communities*,

Fraser, J. et al., 2003. *Implementing floodplain land acquisition programs in urban localities*, Available at: http://jamescfraser.com/storage/publications/Floddplain Project Report.Final.pdf.

Galloway, G.E. et al., 2006. *Assessing the Adequacy of the National Flood Insurance Program's 1 Percent Flood Standard*,

GAO, 2016. *Continued Progress Needed to Fully Address Prior GAO Recommendations on Rate - Setting Methods*,

GAO, 2015. *Flood Insurance: Status of FEMA's Implementation of the Biggert-Waters Act, as Amended*,

GAO, 2013a. *High-Risk Series: An Update*,

GAO, 2013b. *More Information Needed on Subsidized Properties Estimated Remaining Subsidized Policies and Percentage of Policies by State They Represent*,

GAO, 2004. *National Flood Insurance Program: Actions to Address Repetitive Loss Properties*,

Gedan, K.B. et al., 2011. The present and future role of coastal wetland vegetation in protecting shorelines: Answering recent challenges to the paradigm. *Climatic Change*, 106(1), pp.7–29.

Hayat, B. & Moore, R., 2015. Addressing Affordability and Resiliency Through the National Flood Insurance Program. *Environmental Law Reporter*, 576(90).

Hayes, T.L. & Neal, D.A., 2011. *Actuarial Rate Review: In Support of the Recommended October 1*,

2011, Rate and Rule Changes,

Healy, A. & Malhotra, N., 2009. Myopic Voters and Natural Disaster Policy. *American Political Science Review*, 103(3), p.387.

Irwin, E.G., 2015. *The Effects of Open Space on Residential Property Values*,

Kerr, A.M. & Baird, A.H., 2007. Natural Barriers to Natural Disasters. *BioScience*, 57(2), p.102.

Kick, E.L. et al., 2011. Repetitive flood victims and acceptance of FEMA mitigation offers: An analysis with community-system policy implications. *Disasters*, 35(3), pp.510–539.

King, R.O., 2012. *National Flood Insurance Program: Background, Challenges, and Financial Status*,

Kousky, C. & Michel-Kerjan, E., 2015. Examining Flood Insurance Claims in the United States: Six Key Findings. *Journal of Risk and Insurance*, pp.1–32.

Kousky, C. & Shabman, L., 2014. *Pricing Flood Insurance: How and Why the NFIP Differs from a Private Insurance Company*,

Kriesel, W. & Landry, C., 2004. Participation in the National flood Insurance Program: An Empirical Analysis for Costal Properties. *The Journal of Risk and Insurance*, 71(3), pp.405–420.

Krosnick, J.A. et al., 1996. *Was the NOAA Panel Correct about Contingent Valuation*,

Kunreuther, H., 2015. The Role of Insurance in Reducing Losses from Extreme Events The Need for Public-Private Partnerships. , 40(4), pp.741–762.

Lindhjem, H. & Mitani, Y., 2012. Forest owners' willingness to accept compensation for voluntary conservation: A contingent valuation approach. *Journal of Forest Economics*, 18(4), pp.290–302.

Loomis, J., 2011. What's to know about hypothetical bias in stated preference valuation studies? *Journal of Economic Surveys*, 25(2), pp.363–370.

Mallakpour, I. & Villarini, G., 2015. The changing nature of flooding across the central United States. *Nature Climate Change*, 5(3), pp.250–254.

Mcleman, R.A. & Hunter, L.M., 2009. *Migration and Adaptation to Climate Change*,

Murphy, J.J. et al., 2005. A meta-analysis of hypothetical bias in stated preference valuation. *Environmental and Resource Economics*, 30(3), pp.313–325.

National Research Council, 2014. *Reducing Coastal Risk on the East and Gulf Coasts*,

NOAA, 2013. National Coastal Population Report. *NOAA's State of the Coast*.

Pachauri, R.K. & Meyer, L.A., 2014. *IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*,

Rowe, R.D., Schulze, W.D. & Breffle, W.S., 1996. A Test for Payment Card Biases. *Journal of Environmental Economics and Management*, 31, pp.178–185.

Shepard, C.C., Crain, C.M. & Beck, M.W., 2011. The protective role of coastal marshes: A

systematic review and meta-analysis. *PLoS ONE*, 6(11).

Smith, V.K., 1993. Nonmarket Valuation of Environmental Resources: An Interpretive Appraisal. *Land Economics*, 69(February).

Taylor et al., 1999. Unbiased Value Estimates for Environmental Goods: A Cheap Talk Design for the Contingent Valuation Method. *American Economic Review*, 89(3), pp.649–666.

Tockner, K. & Stanford, J.A., 2002. Riverine flood plains : present state and future trends. , 29(3), pp.308–330.

Tonsor, G.T. & Shupp, R.S., 2011. Cheap talk scripts and online choice experiments: "Looking beyond the mean." *American Journal of Agricultural Economics*, 93(4), pp.1015–1031.

de Vries, D.H., Fraser, J.C., 2012. Citizenship Rights and Voluntary Decision Making in Post-Disaster U.S. Floodplain Buyout Mitigation Programs. *International Journal of Mass Emergencies and Disasters*, 30(1), pp.1–33.

Wooldridge J. M., 2011. *Introductory Econometrics* 5th ed., Mason Ohio.

Wriggins, J., 2014. *Flood Money : The Challenge of U . S . Flood Insurance Reform in a Warming World*, Penn State Law Review.

Zavar, E., 2015. Residential perspectives: The value of Floodplain- buyout open space. *Geographical Review*, 105(1), pp.78–95.

FIGURES AND TABLES

Table 1. Variable names and descriptions

Variable Name	Description
RiskEstimate	How likely do you think your home will be hit by a flood in the next 30 years?
NeighborsEstimate	Estimate: Percent of neighbors taking buyout
Inhabitants	Number of people living in household
YearsInTown	How many years have you lived in your town?
FamilyInTown	Do you have family in town? Yes or No
NeighborComDaily	I communicate with my neighbors daily
EnvironmentalConcern	Buyouts are good for the environment: Yes or No
Ocean	Home in V zone: Subject to wave action
EverClaim	Have you ever made a flood insurance claim on your home? Yes or No
ClaimOver$25000	Have you made a claim for more than $25,000? Yes or No
HVUnder100k Ł	Home Value is less than $100,000
HV100to250k	Home Value is $100,000 to $250,000
HVOver250k	Home Value is $250,000 and above
InsuranceCurrent	Home is currently covered by flood insurance
Premium	Flood insurance premium
InsuranceCurrentByPremium	Current premium
HomeRaised	Has your home ever been elevated?
IncomeUnder70k Ł	Income Under $70,000
Income70to149K	Income $70,000 to 149,000
IncomeAbove150K	Income Above $150,000
Age18to34 Ł	Age 18 to 34
Age35to54	Age 35 to 54
Age55AndOlder	Age 55+
NoCollege Ł	College degree not completed
College	College degree completed
AdvancedDegree	Advanced degree completed (Masters, PhD, MBA…)
White	White
AfricanAmerican	African American
RaceOtherwiseSpecifeid Ł	Hispanic, Latino, Asian, Native American, Pacific Islander, Otherwise Specified

Ł Indicates omitted category

Table 2. Hypothesized effects

Factor	Hypothesized Sign	WTP for buyout	Probability of sign-up for coupled buyout
Estimated Risk	+	+	+
Income	+	+	+
Flood Experience (Ever Claim)	+	Not Significant	+
Flood Experience (Largest Claim)	+	+	Not Significant
Neighbor decision to move	+	+	Not Significant
Premium	+	+	NA
Premium Savings	+	NA	-
Neighborhood Tenure	-	Not Significant	+
Neighbor Communication	-	Not Significant	Not Significant
Family in Community	-	Not Significant	-
Environmental Concern	+	+	+

Column 3 shows the sign of the effect of the corresponding factor on willingness to pay for a guaranteed pre-flood buyout agreement. Column 4 displays the sign of the effect of the corresponding factor on homeowners probability of signing up for a pre-flood buyout agreement coupled with mandatory purchase of flood insurance.

Table 3. Summary characteristics of households

	Insurance Current		
Income	Yes	Total	Percentage
IncomeUnder70K	90	238	38%
Income70to149K	122	215	57%
IncomeAbove150K	20	38	53%
Total	232	491	47%

	Insurance Current		
Home Value	Yes	Total	Percentage
HVUnder100k	27	90	30%
HV100to250k	121	255	47%
HVOver250k	84	146	58%
Total	232	491	47%

	Home Value			
Income	HVUnder100k	HV100to250k	HVOver250k	N
IncomeUnder70K	70	128	40	238
Income70to149K	20	113	82	215
IncomeAbove150K	0	14	24	38
Total	90	255	146	491

	Repetitive Loss Properties	
Income	RLP Count	Percentage
IncomeUnder70K	10	29%
Income70to149K	21	60%
IncomeAbove150K	4	11%
Total	35	

Table 4: insurance purchase decision factors

What factors lead you not to have flood insurance? Check each that applies	Obs	Affirmative	%
I can't afford to pay the premium along with all my other bills.	259	100	39%
I don't really worry about having my house flooded.	259	116	45%
I think the government will help me if my house is damaged in a flood even if I don't have insurance.	259	17	7%
I am not required to have flood insurance	259	99	38%
My bank made me buy flood insurance when I bought my home but I dropped it after a few years.	259	16	6%

What factors lead you to have flood insurance? Check each that applies	Obs	Affirmative	%
My bank required me to purchase flood insurance in order to get a mortgage.	232	134	58%
I worry about my house getting flooded.	232	90	39%
My house has already been flooded.	232	40	17%
I decided I can afford the premium.	232	62	27%
I do not think anyone will help me rebuild if my house is damaged by a flood and I am uninsured.	232	53	23%

Note: Panel members were asked which factors were important when deciding to purchase insurance

Table 5 Summary statistics for continuous variables

	Obs	Mean	Std. Dev.	Min	Max
RiskEstimate	491	0.50	0.29	0	1
NeighborsEstimate	491	60.25	25.68	0	100
Premium	232	1282.98	1600.44	0	12000

Table 6 Interval regression estimates (1 of 2)

	Linear Interval Regression	Log Interval Regression
RiskEstimate	6.240***	0.010***
	(1.726)	(0.003)
NeighborsEstimate	4.692***	0.007**
	(1.811)	(0.003)
Inhabitants	40.048	0.049
	(34.405)	(0.06)
YearInTown	3.859	0.011**
	(3.135)	(0.005)
FamilyInTown	-26.775	-0.097
	(89.14)	(0.156)
NeighborComDaily	70.422	-0.129
	(98.698)	(0.174)
EnvironmentalConcern	139.523	0.285*
	(93.763)	(0.164)
Ocean	-62.068	0.042
	(139.84)	(0.248)
EverClaim	-256.211**	-0.159
	(121.276)	(0.213)
Claim over $25,000	590.497***	0.417
	(167.658)	(0.293)
HV100to250k	66.909	0.343*
	(115.426)	(0.204)
HVOver250k	73.344	-0.021
	(132.082)	(0.233)
InsuranceCurrent	-150.678	-0.062
	(100.242)	(0.177)
Premium (Hundreds)	9.377**	0.005
	(3.964)	(0.007)
Elevated Home	125.383	0.087
	(111.207)	(0.195)
N	447	447

Note: Standard errors are in parentheses.

***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively

Table 6 cont. Interval regression estimates (2 of 2)

	Linear Interval Regression	Log Interval Regression
Income70to149K	245.166***	0.388* *
	(95.034)	(0.166)
IncomeAbove150K	755.660***	0.940***
	(177.546)	(0.309)
Age35to54	-173.281	-0.405**
	(108.585)	(0.19)
Age55AndOlder	-83.045	-0.297
	(118.411)	(0.207)
CollegeDegree	233.406	0.139
	(146.068)	(0.255)
AdvancedDegree	96.784	-0.086
	(139.192)	(0.243)
White	24.702	-0.051
	(132.411)	(0.231)
AfricanAmerican	-135.556	-0.538*
	(176.946)	(0.309)
_cons	-457.615*	0.965**
	(253.501)	(0.444)
N	447	447

Note: Standard errors are in parentheses.

***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively

Table 7 Logistic regression estimates (1 of 2)

	Logistic
RiskEstimate	0.020***
	(0.005)
NeighborsEstimate	0.005
	(0.005)
Inhabitants	0.306***
	(0.111)
YearInTown	0.022**
	(0.01)
FamilyInTown	-0.471*
	(0.28)
NeighborComDaily	-0.337
	(0.302)
EnvironmentalConcern	0.957***
	(0.301)
Ocean	-0.131
	(0.434)
EverClaim	0.792
	(0.409)
Claim over $25,000	-0.064
	(0.632)
HV100to250k	0.503
	(0.428)
HVOver250k	0.279
	(0.553)
N	447

Note: Standard errors are in parentheses.

***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively

Table 7 cont. Logistic regression estimates (2 of 2)

	Logistic
InsuranceCurrent	0.292
	(0.638)
PremiumSavingAll (In Hundreds)	-0.130**
	(0.063)
InsCurrent#PremSavingsAll	0.106*
	(0.064)
Elevated Home	0.455
	(0.373)
Income70to149K	0.715**
	(0.293)
IncomeAbove150K	1.111*
	(0.587)
Age35to54	-0.473
	(0.332)
Age55AndOlder	0.435
	(0.35)
CollegeDegree	-0.272
	(0.442)
AdvancedDegree	-0.209
	(0.415)
White	0.057
	(0.387)
AfricanAmerican	3.142***
	(1.103)
_cons	-1.801**
	(0.837)
N	447

Note: Standard errors are in parentheses.
***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively

Table 8: Cross-tabulations of respondent features with survey response to sign-up question

	Would you sign up for the pre-flood buyout program with insurance?		
Race	Yes	Total	Percentage
Otherwise Specified	36	61	59%
White	249	379	66%
African American	50	51	98%
Total	335	491	68%

Inhabitants	Yes	Total	Percentage
1	42	80	53%
2	121	186	65%
3	66	85	78%
4	61	85	72%
5	27	34	79%
6	11	13	85%
7	5	6	83%
8	1	1	100%
Total	334	490	68%

Environmental Concern	Yes	Total	Percentage
Yes	96	122	79%
No	239	369	65%
Total	239	369	65%

Claims last 20 years	Yes	Total	Percentage
0	219	354	62%
1	52	66	79%
2	43	47	91%
3	11	12	92%
4+	10	12	83%
Total	335	491	68%

Table 9: Panel decision factors

What thoughts below affected your thinking about whether or not you would accept this guaranteed buyout program? Check each one that applies	N	Yes responses	%
I am worried about floods.	491	107	22%
I don't really think flood risks are a big deal.	491	69	14%
I would not want to abandon my neighbors.	491	42	9%
My neighbors are likely to leave after a flood, so I might as well accept a buyout.	491	75	15%
My neighbors are likely to leave after a flood, so I will like living here even more.	491	32	7%
A buyout might hurt my community.	491	52	11%
Getting my house out of the flood plain might help my community manage floods.	491	76	15%
I have confidence in the federal government administering a buyout program.	491	69	14%
I want to stay near the water.	491	85	17%
This place is my home.	491	193	39%
I don't like interacting with the federal government.	491	70	14%
Allowing my house to be bought and the lot to be restored will be good for nature.	491	122	25%
I like the security of knowing I will be bought out quickly.	491	222	45%
I would be very happy to be paid the full value of my house after a flood.	491	241	49%
I don't believe that I would really receive the full value of my house if I accepted a buyout.	491	155	32%

Figure 1: Spatial distribution of survey respondents by zip codes

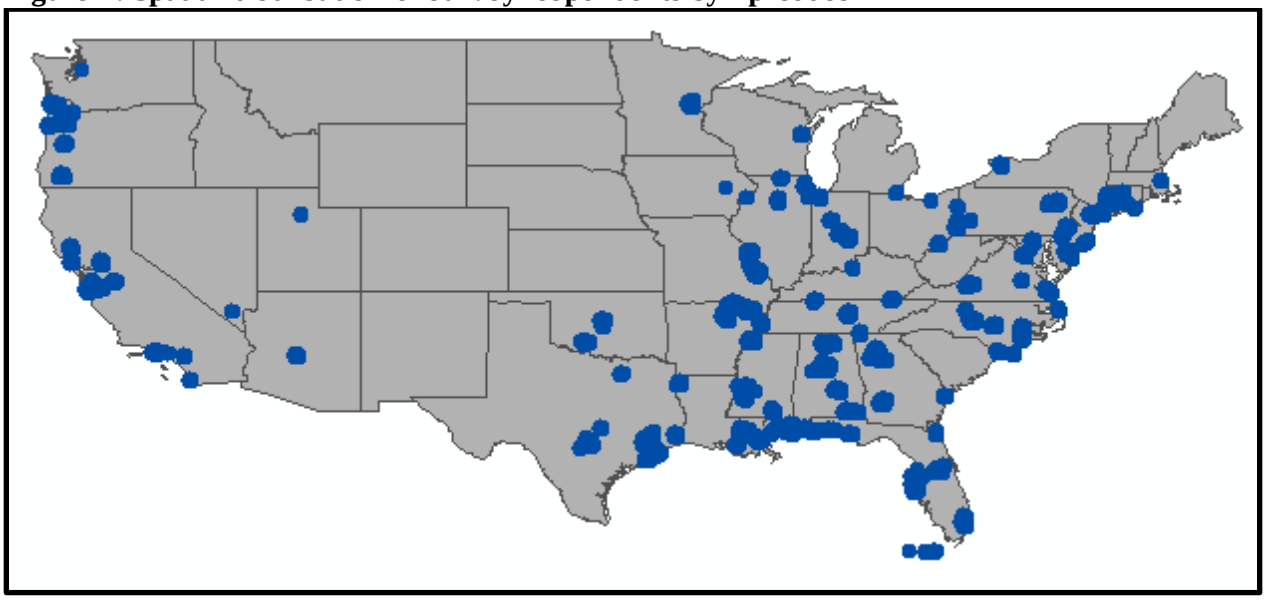


Figure 2: Panel characteristics (frequencies) 1 of 4

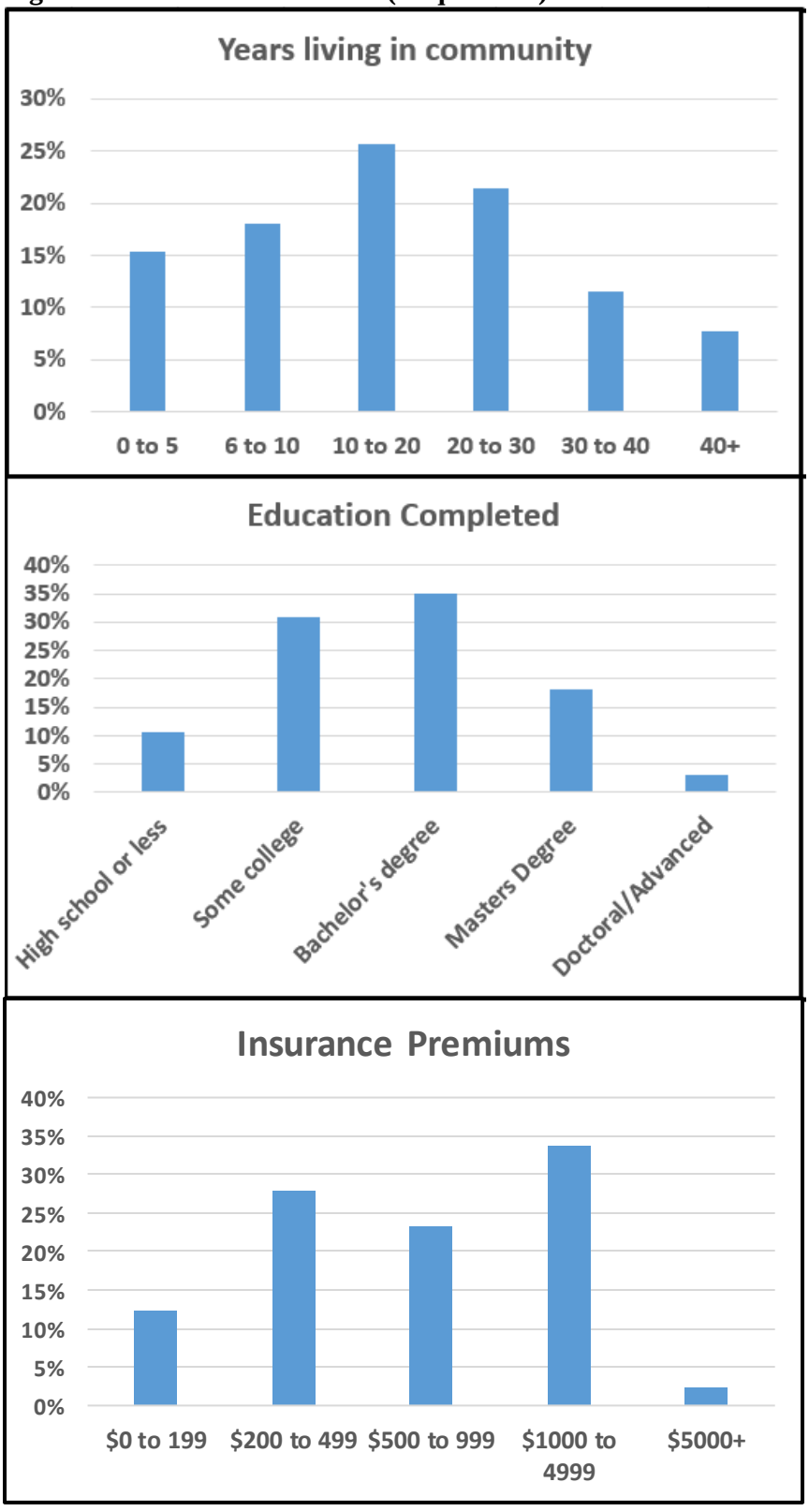


Figure 2 cont: Panel characteristics (frequencies) 2 of 4

Figure 2 cont: Panel characteristics (frequencies) 3 of 4

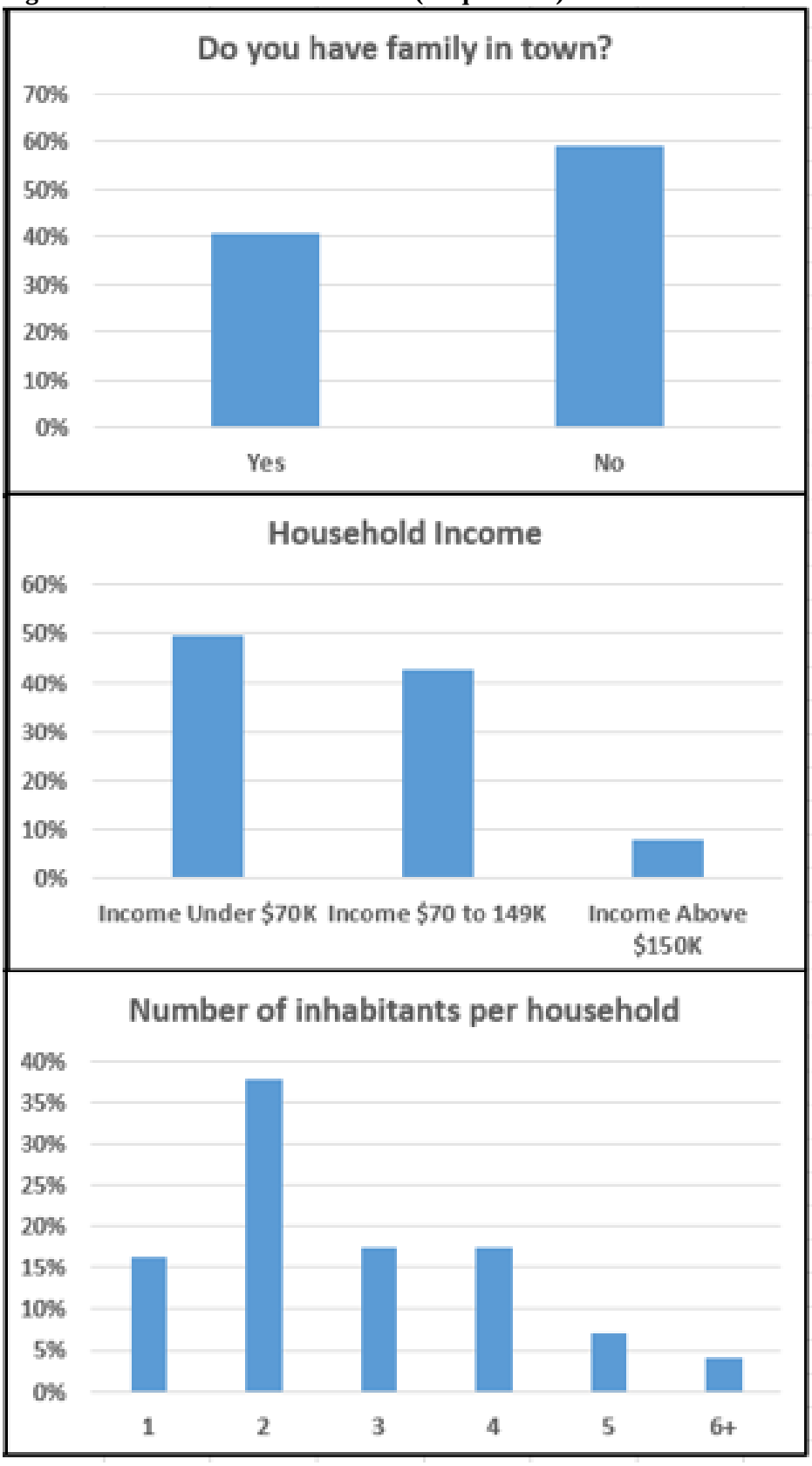


Figure 2 cont: Panel characteristics (frequencies) 4 of 4

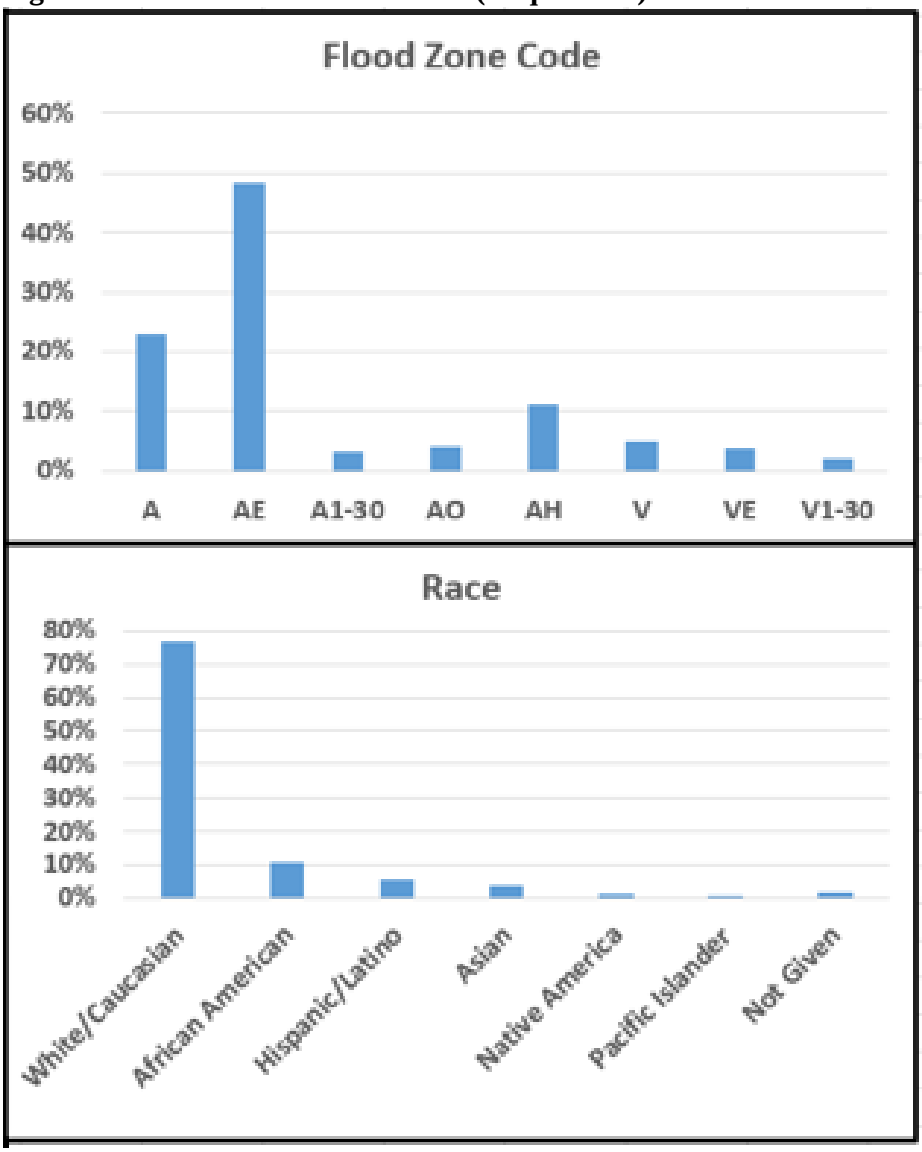
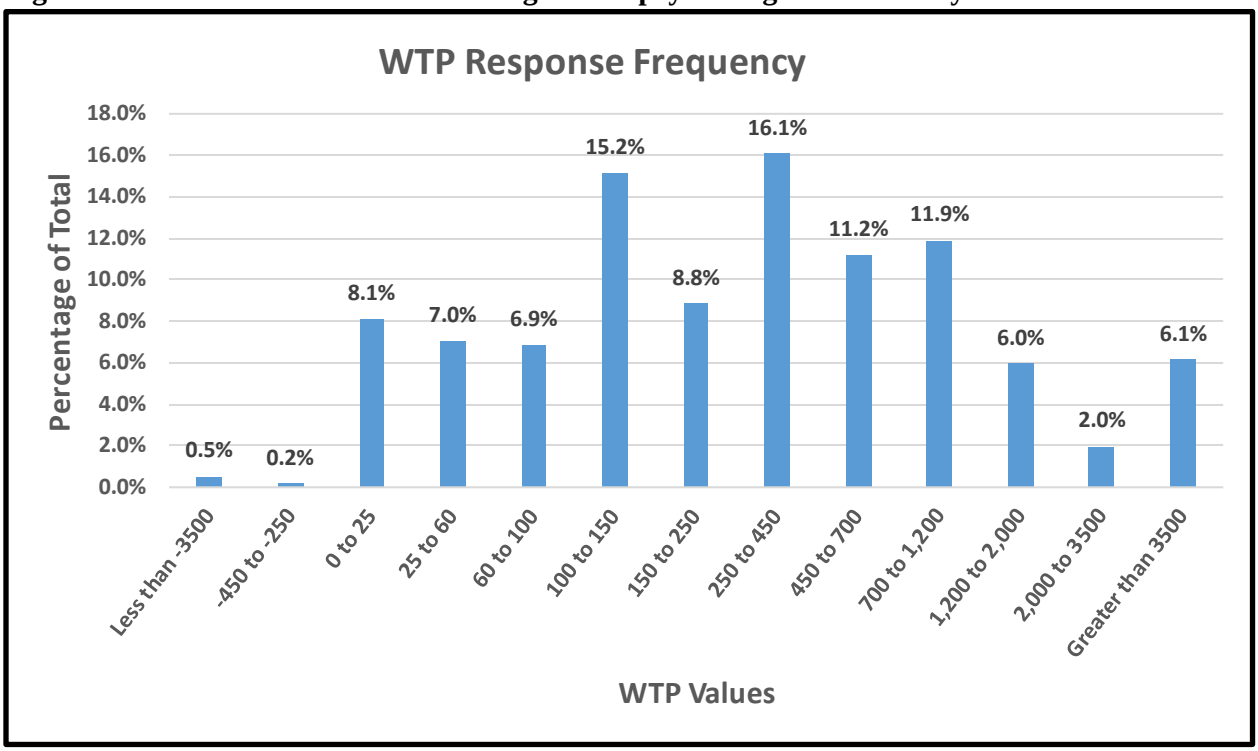


Figure 3: Interval observations of willingness to pay for a guaranteed buyout



APPENDIX A

Flood Policy Survey

This online survey is research being done by Professor Amy W. Ando and Graduate Student Collin Reeser of the Department of Agricultural and Consumer Economics at the University of Illinois. This survey is designed to evaluate people's willingness to take part in possible new policies related to flood prone homes.

Participation is voluntary and will take approximately 30 minutes. You will not be asked to give your name or address, and the online survey tool does not link any identifying information about you to your responses.

You should only complete this survey if you are over 18 years old and own a home that is in a flood zone. Please complete it to the best of your ability. You may choose not to answer specific questions and can stop taking the survey at any time.

Your input is very important for us. You may not benefit directly from participating, but the results of this research may help design better flood policies in the future. We are happy to provide you with a copy of the final report at your request.

Will my study-related information be kept confidential?

Yes, but not always. In general, we will not tell anyone any information about you. When this research is discussed or published, no one will know that you were in the study. However, laws and university rules might require us to disclose study data. For example, if required by laws or University Policy, study data may be seen or copied by the following people or groups:

- The university committee and office that reviews and approves research studies, the Institutional Review Board (IRB) and Office for Protection of Research Subjects;
- University and state auditors, and Departments of the university responsible for oversight of research;
- Federal government regulatory agencies such as the Office of Human Research Protections in the Department of Health and Human Services;
- The financial sponsor of the research, The Natural Resource Defense Council

If you have any questions about this survey research or its results please contact:

Professor Amy Ando, amyando@illinois.edu, 217- 333-5130

Graduate Student Collin Reeser, creeser2@illinois.edu

If you have any questions, concerns or complaints about your rights as a participant in this study, please contact the University of Illinois Institutional Review Board at 217-333-2670 or via email at irb@illinois.edu.

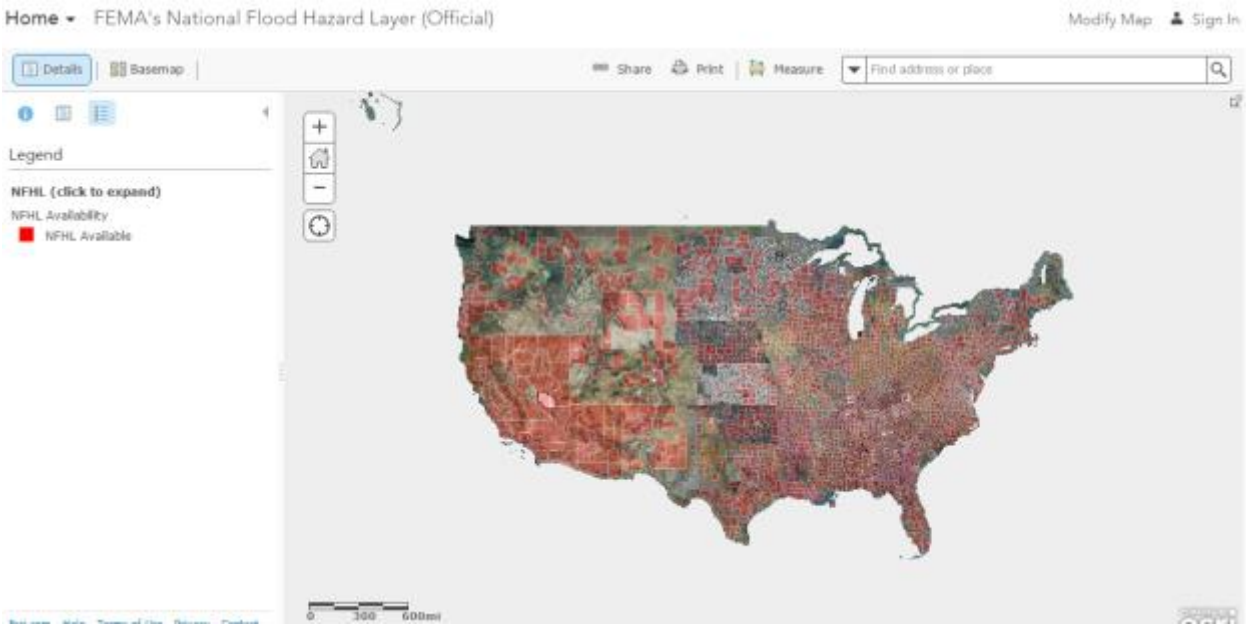
You should print this information sheet for your future reference. If you agree with the above terms select "I Agree" below.

- ❍ I agree
- ❍ I do not wish to participate in this survey

4) Here you will look up the flood zone that your house is in and enter the flood zone information into the survey. Please note that information about your address will not be stored anywhere – it just helps the flood map tool to give you correct flood zone information.

1. Type your address into the Search Bar.
2. Left click on your home. This will open an information box that lists flood zone information for the area.

3. Click the right arrow (Circled above) at the top of the box until you see "Flood Zone"
4. Select the indicated flood zone from the list below



Part 1: Preliminary Questions

We will be asking several questions about your home. If you have multiple homes in different locations, please think about the address you entered in the previous question.

1) Do you own your home?

- Yes
- No

2) How much do you think your home is worth?

- Under $49,999
- $50,000 to 99,999
- $100,000 to 149,999
- $150,000 to 199,999
- $200,000 to 249,999
- $250,000 to 299,999
- Over $300,000

3) Is this your main home or a second home (like a vacation house or a rental property)?

- Main home
- Second home

Part 2: General background information

- Floods can cause a great deal of damage and flood risks are getting worse. Coastal towns are expected to see a 55% increase in the size of areas at high risk for flood (defined as areas with a 1 in 100 chance every year of a major flood) by the year 2100. The number of homes in high-risk flood areas along U.S. rivers is also expected to increase by 45% by the year 2100, with increases as high as 100% in some river areas of the Northwest and along small streams and rivers near the Great Lakes.

- Communities can try to reduce the risk of future flood damage in several ways, including buying out houses in areas at serious risk of flood and restoring natural areas which will protect the remaining properties nearby. Communities can also turn this land into public parks.

In the event of a buyout, homes in flood plains can be restored to natural flood barriers as shown here. Source: Land Conservancy of NJ: http://www.tlc-nj.org/index.php/pr-pompton-39.

- If homeowners do not have flood insurance, the government makes no promise that it will help them at all to pay for damage to their houses caused by a flood. Those people may rebuild their houses in the same locations, but that is likely to be at their own expense.

- Currently the owner of a severely damaged house who does have insurance through the National Flood Insurance Program might be able to do two things:
    - Place a claim to get paid for at least some of the damage, and then rebuild their house in the same location (if permitted by local regulations).
    - Participate in a homeowner buyout program instead of rebuilding in the same location if a buyout program is made locally available. Under current policy:
        - The homeowner would be paid the pre-flood market value
        - The buyout process, if allowed, can take from 1-4 years after a flood because a lot of paperwork must be completed.

Part 3

Possible new guaranteed buyout program policy – version A

Consider a possible new kind of program for houses that are at risk of severe damage by floods – a guaranteed buyout program. If you were to sign up for it, it would work like this:

- You would sign a permanent legal agreement promising that if a flood damages your house such that half its value (or more) is lost, then you will let the government buy your house and you will move.

    - The government would pay you the value of the house on the market before it was damaged.
    - Some of the required paperwork would be completed before a flood to make the process much faster should it be needed. The buyout, if needed, would be completed in less than three months after a bad flood.
- This arrangement gives you certainty that you will be able to sell your house for its full value quickly after a flood.
- This arrangement takes away your option to rebuild your house in the same location after severe flood damage.

5) Suppose the new policy were put in place, and you were offered the opportunity to pay to sign up for the new guaranteed buyout program. In exchange for having the certainty that you will be able to sell your house for its full value quickly after a flood (but giving up the option to rebuild after a major flood) you will pay a one-time fee.

Please think about the **largest amount of money you would be willing to pay** this year in order to be able to sign up for the guaranteed buyout program, considering your financial situation and the flood risk you face. Remember, in your location, updated flood maps say that we can expect a flood at least once every 100 years (or a 1 in 4 chance of flood over the course of a 30 year mortgage).

Consider the dollar amounts listed below. For <u>each</u> amount, check whether you would sign up (Yes or No) for the buyout program if that amount of money were your cost. Previous studies have found that some people overstate how much they are willing to pay. Therefore, consider thoroughly how the one-time cost will affect your budget so that you are really certain that you actually are willing to pay the money associated with each alternative that you say you would sign up.

One Time Cost for You	Yes, I would sign up	No, I would not sign up
$0		
$15		
$35		
$60		
$150		
$250		
$450		
$700		
$1200		
$2000		
$3500		

If respondent answers "No" to all amounts, go on to question 6.

If answers "Yes" to any, skip question 6.

6) You answered "No" to all dollar amounts, indicating that you are not willing to sign up for this program even if it were free.

Suppose now that you would actually be paid money to sign up for the new guaranteed buyout program. In exchange for giving up the option to rebuild in the same location after a major flood you will receive a single one-time payment. This policy will only be put in place if payments to homeowners aren't too expensive. Please think about the **smallest** amount of money you would really need to be paid in order to agree to sign up for the guaranteed buyout program, considering your financial situation and the flood risk you face.

Remember, in your location, updated flood maps say that we can expect a flood at least once every 100 years (or a 1 in 4 chance of flood over the course of a 30 year mortgage)

Consider the dollar amounts listed below. **For <u>each</u> amount, check whether you would sign up (Yes or No) for the buyout program if that amount of money were the one time payment you receive.** Previous studies have found that some people overstate how much they would need to be paid to accept a change they don't want. Therefore, consider thoroughly how the one-time payment will affect your budget so that you are really certain of your answers.

One Time Payment to You	Yes, I would sign up	No, I would not sign up
$0		
$15		
$35		
$60		
$150		
$250		
$450		
$700		
$1200		
$2000		
$3500		

7) **With this new guaranteed buyout program in place**, what percent of your neighbors do you think would sell their homes and move following a very damaging flood? Mark an X on the line below

|---|---|---|---|---|

Percent:	0	25%	50%	75%	1
	NONE		Half of them		ALL

8) How likely do you really think it is that your home will be hit in the next 30 years by a flood so bad that the house loses more than half its value? Mark an X on the line below

|---|---|---|---|---|

Probability:	0	.25	.50	.75	1
	NO	not very	flip a coin	probably	YES
	It certainly won't happen		50/50		It will certainly happen

9) What thoughts below affected your thinking about whether or not you would accept this guaranteed buyout program? **Check each one that applies**

	Yes
I am worried about floods.	
I don't really think flood risks are a big deal.	
I would not want to abandon my neighbors.	
My neighbors are likely to leave after a flood, so I might as well accept a buyout.	
My neighbors are likely to leave after a flood, so I will like living here even more.	
A buyout might hurt my community.	
Getting my house out of the flood plain might help my community manage floods.	
I don't like interacting with the federal government.	
I have confidence in the federal government administering a buyout program.	
I want to stay near the water.	
This place is my home.	
Allowing my house to be bought and the lot to be restored will be good for nature.	
I like the security of knowing I will be bought out quickly.	
I would be very happy to be paid the full value of my house after a flood.	
I don't believe that I would really receive the full value of my house if I accepted a buyout.	
Other:	

Part 4:

11) Have you **ever** had a flood insurance policy on your home? (This is a separate policy from your homeowners policy.)

- Yes
- No

12) Do you **currently** have a flood insurance policy on your home?

- Yes
- No

13) Does your flood insurance policy cover the full value of your home?

- Yes
- No

If you answered No to Question 12 Please answer Question 13 and then skip to Question 20.

If you answered Yes to Question 12 Please skip to Question 14

14) What factors lead you **not** to have flood insurance? Check each that applies.

- I can't afford to pay the premium along with all my other bills.
- I don't really worry about having my house flooded.
- I think the government will help me if my house is damaged in a flood even if I don't have insurance.
- I am not required to have flood insurance
- My bank made me buy flood insurance when I bought my home but I dropped it after a few years.
- Other (fill in): _____

15) Approximately how much in dollars do you pay each year for flood insurance? (Does not include homeowners' insurance) **Please do not enter commas or dollar signs ("," "$")**

- $_____

16) Under the National Flood Insurance Program you can buy insurance for up to $250,000 for your property. How much of the value of your home is insured under your flood insurance? Mark an X on the line below

Percent: |----------|----------|----------|----------|

0 25% 50% 75% 100%

NONE Half of it ALL of my home

17) What factors lead you to have flood insurance? Check each that applies.

- ❍ My bank required me to purchase flood insurance in order to get a mortgage.
- ❍ I worry about my house getting flooded.
- ❍ My house has already been flooded.
- ❍ I decided I can afford the premium.
- ❍ I do not think anyone will help me rebuild if my house is damaged by a flood and I am uninsured.
- ❍ Other (fill in): _____

18) Please check all that apply to your home

	Yes
My home is built on a crawl space	
My home is a mobile home	
My home has a basement	
My home was built before 1978	
My home has more than one level of living space	

Prices for flood insurance coverage are likely to rise in the future for many homeowners. The new price will better reflect a property's actual risk of flooding. Such a homeowner can expect their premiums to increase 5-20% each year until they are approximately double the current rates in the year 2020. For example, if you are one of those households, your flood insurance premium is likely to increase from $750 a year to $1500 a year by 2020.

Possible new guaranteed buyout program - version B, combined with flood insurance

Below is a different version of the guaranteed buyout program described earlier. With this version of the policy, homeowners must have flood insurance to sign up, and "payment" is in the form of reduced flood insurance rates.

For the purposes of this question, assume if you don't sign up for the program then your insurance premium will go up from $750 to $1500

If you do sign up for this program, it works like this:

- You could buy flood insurance at your current rate for as long as the house is there (rates will not go up). That rate would be lower than the rate you would otherwise have to pay, and so saves you $1500 every year that you own your home.
- In most ways, this insurance would provide the same benefits as the current flood insurance program.
- However, you would sign a permanent legal agreement promising that if a flood damages your house such that half its value (or more) is lost, then you will let the government buy your house and you will move.
    - The government would pay the value of the house on the market before it was damaged.
    - Some of the required paperwork can be completed before a flood to make the process much faster should it be needed. The buyout would be completed in less than three months after a bad flood.

- This arrangement gives you certainty that you will be able to sell their house for its full value quickly after a flood.
- This arrangement takes away your option to rebuild your house in the same location after severe flood damage.
- This arrangement helps you to be sure your insurance stays affordable.

19) Suppose such a new policy were put in place, and you were offered the chance to sign up for this guaranteed buyout program combined with flood insurance. Think about whether you would accept that agreement starting this year, considering your financial situation and the flood risk you face.

Remember, in your location, updated flood maps say that we can expect a flood at least once every 100 years (or a 1 in 4 chance of flood over the course of a 30 year mortgage)

Assume the amount of money you save each year on flood insurance by signing up for this policy would be $1500 per year.

Would you sign up for the policy?

- ❍ Yes
- ❍ No

  Why?:_____

Prices for flood insurance coverage are likely to rise in the future for many homeowners. The new price will better reflect a property's actual risk of flooding. Such a homeowner can expect their premiums to increase 5-20% each year until they are approximately double the current rates in the year 2020. For example, a home in your area with features and a value similar to yours would likely see a flood insurance premium increase from $750 a year to $1500 a year in 2020.

Possible new guaranteed buyout program - version B, combined with flood insurance

Below is a different version of the guaranteed buyout program described earlier. With this version of the policy, homeowners must have flood insurance to sign up, and "payment" is in the form of reduced flood insurance rates.

For the purposes of this question, assume that you have flood insurance and if you don't sign up for the program then your insurance premium will be $4000 a year

If you do sign up for this program, it works like this:

- You could buy flood insurance at $2000 a year for as long as the house is there (rates will not go up). That rate would be lower than the rate you would otherwise have to pay, and so saves you $2000 every year that you own your home.
- In most ways, this insurance would provide the same benefits as the currently available flood insurance program.

- However, you would sign a permanent legal agreement promising that if a flood damages your house such that half its value (or more) is lost, then you will let the government buy your house and you will move.
    - The government would pay the value of the house on the market before it was damaged.
    - Some of the required paperwork can be completed before a flood to make the process much faster should it be needed. The buyout would be completed in less than three months after a bad flood.

- This arrangement gives you certainty that you will be able to sell their house for its full value quickly after a flood.
- This arrangement takes away your option to rebuild your house in the same location after severe flood damage.
- This arrangement helps you to be sure your insurance stays affordable.

19b) Suppose such a new policy were put in place, and you were offered the chance to sign up for this guaranteed buyout program combined with flood insurance. Think about whether you would accept that agreement starting this year, considering your financial situation and the flood risk you face.

Remember, in your location, updated flood maps say that we can expect a flood at least once every 100 years (or a 1 in 4 chance of flood over the course of a 30 year mortgage)

Assume the amount of money you save each year on flood insurance by signing up for this policy would be $2000 per year.

Would you sign up for the policy?

❍ Yes
❍ No
Why?:_____

20) With this new guaranteed buyout program in place, what percent of your neighbors do you think would sell their homes and move following a very damaging flood? Mark an X on the line below.

Percent: |----------|----------|----------|----------|

0 25% 50% 75% 100%

NONE Half of them ALL

Part 5: Follow up questions

21) Has your home ever been raised above the ground by raising its foundation, having it built on fill, or putting it on stilts or pilings? Examples are:

Figure 1 These homes have been elevated.

- ❍ Yes
- ❍ No
- ❍ Don't Know

22) What percent of homes in your town do you think have had flood damage in the last 20 years? Mark an X on the line below.

Percent: |----------|----------|----------|----------|

0 25% 50% 75% 100%

NONE half of them ALL

23) To the best of your knowledge how many flood insurance claims have you or previous owners made on your current home in the last 20 years? Pick one.

- ❍ 0
- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4+

24) In the worst flood you have experienced, how much flood damage did your home suffer? Pick one.

- ❍ None, or I have not experienced a flood
- ❍ Less than $4000
- ❍ $4000 - $24,999
- ❍ $25,000 – $99,000
- ❍ $100,000 or more
- ❍ I don't know

25) Have you made two or more flood insurance claims of at least $1,000 on your property in the last 10 years? Pick one.

❍ Yes
❍ No
❍ Not sure

26) Did you know that most flood insurance policies are provided by the federal government?

❍ Yes
❍ No

27) How many people live in your home, including children? ____

28) How many years have you lived in your town? (This includes previous homes in the same town) _____ years

29) Did you think about flood risk when you were deciding to live there? Pick one.

❍ Yes
❍ Sort of
❍ No

30) What is your combined annual household income? Check one.

___ Less than $20,000

___ $20,000 to $29,999

___ $30,000 to $39,999

___ $40,000 to $49,999

___ $50,000 to $59,999

___ $60,000 to $69,999

___ $70,000 to $79,999

___ $80,000 to $89,999

___ $90,000 to $99,999

___ $100,000 to $124,000

___ $125,000 to $149,999

___ $150,000 to $299,000

___ $300,000 to $500,000

___ $500,000 or more

31) What is your age?

- 18 to 24
- 25 to 34
- 35 to 44
- 45 to 54
- 55 to 65
- 65 and older

32) What is the highest level of education you have completed?

- Less than high school
- High school / GED
- Some college
- 2-year college degree
- Bachelor's degree
- Master's degree
- Doctoral degree
- Other advanced degree (such as JD or MD)

33) What is your gender?

- Female
- Male
- _____

34) What is your race?

- White
- African American
- Hispanic/Latino
- Asian
- Native American
- Pacific Islander
- _____

35) Do you have family living in other homes in your community?

- Yes
- No

36) How often do you talk with the people in your neighborhood? Pick one.

- Never
- Less than once a month
- Once a month
- 2 or 3 times a month
- Once a week
- Every day

37) What is your zip code?

38) How worried are you that a flood could harm each of the following (check one for each):

	Not at all	A little worried	Very worried	Don't know
a) Your household finances				
b) Your emotional well-being				
c) Your physical health				
d) Your safety				
e) The future of your community				

39) Do you have any comments for us about this survey?

THANK YOU FOR ANSWERING THE SURVEY

APPENDIX B

MONTE CARLO ANALYSIS

Supplementing the survey research, we conduct a Monte Carlo simulation to provide insights into the value flows from pre-flood buyout agreements to taxpayers. Homeowners pay flood insurance premiums, receive indemnity payments after flood damage, and incur temporary relocation costs during reconstruction or while searching for a new home. Taxpayers (FEMA) receive premiums, pay out indemnity payments, incur administrative costs, and receive use and non-use values from bought out properties repurposed as public spaces.

This simulation is an abstract representation that measures and contrasts a full insurance policy, a subsidized flood insurance policy similar to that of some policies currently in force, and a subsidized insurance policy coupled with a buyout guarantee much like the program analyzed in the body of this paper. We calculate the net present value (NPV) of each policy for taxpayers while varying the levels of current flood risk, rate of flood risk increase, and premium subsidies.

Results (Appendix Table 1) show the NPV results for a base case scenario to which we compare all other variant scenarios. In the second scenario we decrease the insurance subsidy from 50% to 20%. The third scenario increases the rate of flood risk from the base level to three times the base level over 100 years. The final scenario increases the overall factor of risk by a factor of two. The resulting NPVs provide insights to the sign of the effect on NPV from shift between any of the three policies. All NPV values are averaged over 5,000 iterations of each scenario.

Results show net present values for the full insurance policy are negative but around zero for all scenarios. We expect this to be the case as homeowners are paying the expected annual loss as a premium. The negative values stem from temporary relocation and administration costs.

Taxpayers have negative net present values for the subsidized insurance policy and the buyout coupled with insurance. These are negative values because premiums do not fully cover indemnity payments. The buyout coupled with insurance does however have a higher relative net present value for taxpayers than the subsidized insurance policy. Taxpayer are relatively better off with the coupled policy under higher risk scenarios when compared to the subsidized insurance policy.

In this simulation a buyout is triggered when the sum of all past and current flood claims are greater than 50% of the value of the home. Therefore higher flood risk scenarios trigger more buyouts as can be seen in the bottom of Appendix Table 1.

These results suggest the buyout coupled with insurance reduces the financial burden on taxpayers relative to the subsidized insurance policy while still providing a positive net present value for homeowners.

Appendix B Monte Carlo Results

	Base case	Increase insurance subsidy from 50% to 80%	Increase risk 3x by year 2116	Increase overall risk by a factor of 2
Home value	$100,000	$100,000	$100,000	$100,000
Discount rate	3%	3%	3%	3%
Up front admin costs: insurance	$1,000	$1,000	$1,000	$1,000
Up front admin costs: buyout	$2,000	$2,000	$2,000	$2,000
Insurance premium	100%	100%	100%	100%
Buyout premium subsidy	50%	80%	50%	50%
Marginal open space benefit	$9,732	$9,732	$9,732	$9,732
Cumulative buyout trigger	50%	50%	50%	50%
Flood risk factor increase Yr. 0 to 100	2	2	3	2
Current probability of 25% loss	1.00%	1.00%	1.00%	2.00%
Current probability of 50% loss	0.50%	0.50%	0.50%	1.00%
Current probability of 100% loss	0.50%	0.50%	0.50%	1.00%
Year 2116 probability of 25% loss	2.00%	2.00%	3.00%	4.00%
Year 2116 probability of 50% loss	1.00%	1.00%	1.50%	2.00%
Year 2116 probability of 100% loss	1.00%	1.00%	1.50%	2.00%
Taxpayer				
NPV full insurance	$53	($326)	($4,727)	($407)
NPV subsidized insurance	($134,941)	($96,375)	($206,375)	($266,871)
NPV buyout with insurance	($91,213)	($68,795)	($113,813)	($102,422)
Taxpayer gain from buyout program vs subsidized insurance	$43,729	$27,580	$92,562	$164,449
Change from base case		($16,149)	$48,834	$120,721
Percentage of buyouts after 10 years	6%	6%	6%	12%
Percentage of buyouts after 30 years	22%	22%	23%	43%
Percentage of buyouts after 100 years	74%	74%	86%	97%