Homeowner Willingness to Pay for a Pre-Flood Agreement for a Post-Flood Buyout

Running title: WTP for Post-Flood Buyout Commitment

Amy W. Ando
Professor, University of Illinois Urbana-Champaign
University Fellow, Resources for the Future
326 Mumford Hall
1301 W. Gregory Dr., Urbana, IL 61801
amyando@illinois.edu

Collin Reeser
Graduate Student, University of Illinois Urbana-Champaign
Owner, Reeser Brothers Farms
Champaign, IL 61820
creeser2@gmail.com

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Abstract

Homeowner buyout programs promote climate adaptation efforts by removing homes from flood plains. We estimate homeowner willingness to pay (WTP) for a novel agreement in which they pre-commit to relocating if a flood severely damages their home in exchange for an expedited buyout process. We find nearly all respondents identified positive WTP to enroll in this program, with average WTP about $600. Factors like flood risk and expectation of neighbors' responses significantly affect WTP. If the pre-flood agreement is available only if the homeowner has flood insurance, only 68% of homeowners were willing to accept the agreement.

1. Introduction

Flood events are expected to increase in frequency and severity as climate change raises sea levels and intensifies regional precipitation events (Hirabayashi, Roobavannan, Korala et al. 2013; IPCC 2014; Mallakpour and Villarini 2015). High profile flood events caused by a number of riverine inundations and events like Hurricanes Katrina, Rita, Sandy, Harvey, and Maria have highlighted several dimensions of the costs of development in flood prone areas (National Research Council 2014). Households suffer lasting economic damage in the wake of floods (Deryugina, Kawano, and Levitt 2018). FEMA recovery programs have had to expand to help communities and individual households who do not have flood insurance to compensate for damaging flood events (Kousky, Erwann, Michel-Kerjan et al. 2018). And as discounts place federal insurance premiums below their risk adjusted value (Kousky, Lingle, and Shabman 2017; Hayes and Neal 2011), premium collections have fallen far short of covering the losses of major flood events and the National Flood Insurance Program (NFIP) carries a $23 billion debt burden (USGAO 2016). Efficient flood-risk mitigation policy includes floodplain conservation (Kousky and Walls 2014) and restoration through removing homes from some flood prone areas (Kousky 2014) but how can such climate adaptation be accomplished?

Policy makers have long debated how best to reduce flood risk in the future and limit financial exposure to flood recovery expenditures. This paper examines 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, perceived flood risk, and connection to the community. 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 and Moore 2015).

Flood losses have consistently imposed the highest fiscal costs of any natural disasters (King 2012). The high government cost of disaster damage from floods has multiple sources. First, the U.S. population lives disproportionately in high 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 coastal shoreline counties (NOAA 2013). Structural projects such as dams and levees have disconnected flood plain properties from natural flooding and paved the way for them to be developed (Boustan, Kahn, and Rhode 2012). Furthermore, federal programs like discounted federal flood insurance and FEMA risk mitigation and community assistance programs have unintentionally served to increase development in high risk areas (Bagstad, Stapleton, and D'agostino 2006; Wriggins 2014; Davlasheridze and Miao 2019) by reducing the real and perceived long term cost and risk of flood plain development.

Second, features of federal flood disaster insurance and aid policy lead to high budgetary burdens. The NFIP discounts were intended to encourage participation in the program, but non-actuarially fair insurance is expensive. NFIP net outlays are also high because NFIP Flood Insurance Rate Maps (FIRMs) are commonly a decade or more out of date and are based on past flood experience rather than future flood risk, which is shifting due to climate change (Carolan

2007). Finally, only about 50% of properties in high risk areas have flood insurance (Kriesel and Landry 2004), likely because most households are willing to pay less for flood insurance than even the discounted premium cost (Netusil, Kousky, Neupane et al. 2020); however, uncovered households often receive some form of disaster relief through FEMA's Public Assistance and Individual Assistance programs regardless of whether they were individually insured (Davlasheridze and Miao 2019).

Conflicting policy goals have led to policy upheaval in the realm of flood insurance. 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 discounts by raising flood insurance premiums each year until full risk rates are reached (Wriggins 2014; USGAO 2015). However, looming flood-insurance premium increases 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 Waters. The problem remains that discounted premiums offer affordable protection to low income property owners, but do not fully fund the cost of the program or encourage residents to move to less flood prone areas.

In contrast, homeowner buyout programs allow risk-management agencies to remove homes from flood zones so they will not have to be repaired after future flood events, and have been employed for decades as a permanent means of reducing future flood risk exposure in flood zones (Greer and Binder 2017; Zavar 2015; de Vries and Fraser, 2012). Large-scale floodplain buyouts can face local opposition because they reduce the size of the municipal tax base and undermine local public finance for important services, and some research indicates that buyouts can weaken social capital and place attachment in and near target neighborhoods (Binder, Barile,

Baker et al. 2019). However, buyout programs can reduce flood risk for properties elsewhere in the community. As coastal and riverine communities have expanded, the natural flood protections of wetlands and other natural barriers were drained and developed. Consequently, properties further from bodies of water were at increased risk of flood (Kerr 2007; Costanza, Mitsch, and Day 2006). After a buyout, land can be restored to a protective state to help prevent damage to other homes and provide ecological benefits (Shepard, Crain, and Beck 2011; Tockner and Stanford 2002). Property value in surrounding areas can be increased by proximity to restored and protected floodplain area (Kousky and Walls 2014; Bolitzer and Netusil 2000).

Federal spending on long-term mitigation programs, including pre-emptive buyouts, is limited, even though research finds that hazard mitigation has higher returns than post-disaster cleanup (Davlasheridze, Fisher-Vanden, and Klaiber 2017). Thus, most homeowner buyout programs of the past have focused on contracting to buy out properties after they have been damaged by flooding (Greer and Binder 2017; Dalbom, Hemmerling, and Lewis 2014; de Vries and Fraser 2007). However, it can take so long to complete the post-flood buyout process that it is not uncommon for homeowners to just sell to a redeveloper or to receive indemnity payment and rebuild before completing participation in a buyout program (Weber and Moore 2019).

To glean clues as to who might benefit from buyout programs, we can look the spatial and temporal analysis in Mach, Kraan, Hino et al. (2017) of public data on all 43,633 voluntary FEMA buyouts from 1989 to 2017. Buyouts are most common in some of the states with high levels of flood damage (Missouri, Texas, Illinois, North Carolina, and Iowa) but there are other states (like Florida, Mississippi, and Louisiana) that have low levels of buyouts despite high levels of flood damage. Even though flood damage is growing in the U.S., the number of individual properties bought out has actually declined slightly over time (the highest number of

buyouts in a single year was initiated in the wake of the massive Mississippi River flood of 1993). They find that the likelihood a county has buyouts at all increases with flood risk, average income, and population density, but the actual neighborhoods in which buyouts are concentrated are relatively poor and racially diverse. It is not possible to tell from these analyses, however, whether the socioeconomic patterns in the buyouts observed are driven by variation in agency willingness to make buyout offers (e.g. low income areas have homes that are less expensive to buy out) or homeowner willingness to participate in the buyout program (e.g. low income homeowners are more willing to accept a buyout and move).

This paper estimates willingness-to-pay for a buyout in the context of a proposed pre-flood buyout program that takes a new approach to resolving the previously conflicting goals of reducing NFIP net outlays while protecting the financial well-being of homeowners (Hayat and Moore 2015). In such a program, homeowners in flood zones would be able to sign a binding contract for a buyout for the full market value of their home before a flood event occurs. Pre-flood contracts for post-flood buyouts are likely to help high-risk communities by empowering them to plan more effectively for flood events and their aftermath which may include tax base changes (USGAO 2004), infrastructure modification (Dalbom, Hemmerling, and Lewis 2014), or in some cases relocation of entire communities (Brown 1996). However, such pre-flood contracts could have both desirable and undesirable features for an individual homeowner. The homeowner would have peace of mind knowing with certainty what will occur after a major flood event, and completing the buyout paperwork before the flood event could greatly reduce post flood legal processes and thus reduce the time needed to complete the buyout; Mach, Kraan, Hino et al. (2017) find that conventional buyouts without this kind of pre-agreement have taken an average of 5.7 years to complete following the flood event. 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 and expedited buyout or how much would they have to be paid to be willing to accept (WTA) it? No research yet exists to answer that question; this paper fills that gap. We use a contingent valuation (CV) survey to value homeowners' WTP for a guarantee their home will be bought out following a major flood event. The model allows us to quantify how that WTP varies with factors such as 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 the mandated purchase of flood insurance. Those results inform likely efforts actually to implement a program of pre-flood contracts for post-flood buyouts given that administration of such a program would itself likely be coupled with the NFIP.

2. Methods

Stated Preference Methodology

This study uses an online choice experiment (CE) survey to estimate WTP for a guaranteed buyout contract (Carson 2012; Champ, Boyle, and Brown 2017). Several different methods can be used to elicit values in CE surveys (Champ and Bishop 2006; Bateman, Carson, Day et al. 2002). Dichotomous choice (DC) approaches give a dollar value and ask whether the respondent would be willing to pay that amount, and are viewed as more reliable than open-

ended elicitation questions. However, DC questions reveal relatively little information about the range within which the respondent's exact WTP value lies, and thus require large samples to produce accurate estimates of WTP. This paper employs the payment card elicitation format, which is more reliable than open-ended questions but more efficient than DC (Brown, Champ, Bishop et al. 1996). A payment card presents an ordered series of dollar values and asks the respondents to check yes or no for whether they would be willingness to pay each of the amounts listed.

We carefully choose the values on the payment card to optimize the validity of responses. Cameron and Huppert (1989) note that using the center of the intervals as a point estimate of WTP can bias parameter estimates in CE studies, so we use the interval-data econometric approach recommended by them to avoid such bias. Rowe, Schulze, and Breffle (1996) find no evidence of range or centering bias in payment card elicitation as long as respondents were able to select values on the upper end of the value distribution; they also find that the inclusion of exceptionally high bids may influence welfare estimates. Thus, we use focus groups to determine the maximum bid to avoid both truncation at the top and presentation of excessively large bids. Finally, we space big values below the maximum on an exponential scale; increasing interval distances between values helps respondents to differentiate among the levels of the bids (Rowe, Schulze, and Breffle 1996).

We took steps in other elements of the survey as well to increase the reliability of the WTP responses. We used 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 so that respondents would believe in the plausibility of the non-market good transaction (Carson 2012). We carefully crafted the information blocks in the survey to

provide all pertinent elements of the proposed policy (Champ, Boyle, and Brown 2017) while avoiding participant overload (Bateman and Mawby 2004). In addition, we randomized answer choices when possible to avoid ordering effects (Bateman, Carson, Day et al. 2002). Finally, we worked to mitigate hypothetical bias in the responses (in which survey respondents express a higher WTP than they would actually pay in a market transaction) by including a cheap talk script (Tonsor and Shupp 2011; Cummings and Taylor 1999) that informs respondents that some survey takers tend to misstate their actual WTP and encourages them to be more cognizant of their actual WTP, and by designing the background information and new pre-flood buyout sections to encourage respondents to think in depth about their personal budget and how the proposed buyout would affect them.

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. Feedback from these focus groups was used to ensure that respondents understand the description of the buyout scenario and to identify and eliminate language that might trigger bias in response. More details on the survey design process are provided in Reeser (2016)

In March of 2016, an online survey was distributed to a Qualtrics participant panel from which we collected 491 responses. Respondents were recruited from zip codes containing flood zones within the 100-year floodplain. To be eligible to take the survey, a respondent needed to own their own home and verify their flood zone code through FEMAs National Flood Hazard Layer tool. 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 full survey itself is in the online Appendix. It began with a series of eligibility screens to ensure the respondent is a homeowner, living within the 100-year floodplain, and over the age of 18. Floodplain status was determined by incorporating the online National Flood Hazard Layer (NFHL)[1] into the online platform. A respondent was asked to enter their address into the Federal Emergency Management Agency NFHL tool. The tool displayed information about the flood zone for that address, and the respondent entered the flood zone code into the screening question. If the code indicated presence in the 100-year floodplain, the respondent was allowed to continue in the survey.

The second section of the survey provided the respondent with background information on flood risk and described what homeowners can currently do if their house were severely damaged in a flood, including brief information about the nature of conventional post-flood buyout programs. This ensured that the respondent understood the status quo policy against which they should compare the hypothetical new contract to be valued. Section three described the features of a hypothetical pre-flood guaranteed buyout program. In short, this program is a pre-flood agreement that would guarantee a homeowner their home would be bought out in an expedited manner if a flood causes more than 50% of the value of their house to be lost; in exchange, the homeowner would be required to accept that buyout and relocate following such an event. Respondents were 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 to be able to sign up for such a contract. The payment values were 11 exponentially ascending dollar amounts ranging from $0 to $3,500. If a respondent was not willing to pay any amount of money to participate (they check “no” for all dollar amounts) the survey took them to another payment card asking respondents how much they would need to be

paid to participate in the program. The survey had both WTA and WTP sections as some focus group participants indicated they had a negative value for the program. However, we presented 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 asked homeowners if they would be willing to sign up for a slightly different kind of buyout program. This guaranteed/required post-flood buyout agreement was similar to the agreement described in the previous WTP/WTA question. However, this hypothetical buyout program would only be available to homeowners with flood insurance. In case of a minor flood, the homeowner would receive the usual insurance payments for repairs. However, in case of a flood that caused more than 50% of the value of the house to be lost, the homeowner would receive an expedited buyout equal to the fair market value of their home and need to move. No homeowner without flood insurance would be able to pre-contract for a guaranteed buyout.

At the time of the survey, insurance rates were increasing to be actuarially fair, so in the absence of such a program insurance would become much more expensive. Homeowners with flood insurance who signed up for the hypothetical program would be allowed to pay the old discounted insurance rates. Hayat and Moore (2015) proposed such a program to provide positive incentives for insured homeowners to agree to a buyout in case of severe flood damage, and to make sure that homeowners who agreed to a buyout in case of catastrophe would remain insured to cover damages from less severe floods.

The survey instrument calculated and explained the estimated annual savings on the cost of flood insurance to that particular homeowner from signing up for this hypothetical program. For a person who had insurance at the time of the survey, savings were estimated by using the

homeowner's reported premium and FEMA's own estimate that discounted premiums were 40-45% of full risk rates (Hayes and Neal 2011). For survey respondents who did not have insurance at the time of the survey, full risk insurance rates and discounted insurance rates were estimated for that homeowner using their home value and assuming a 1% annual chance of substantial flood. There was only a single dichotomous choice question asking whether the respondent would sign up for a guaranteed post-flood buyout contract if they would need to have flood insurance to do so and if having the contract would mean that the cost of flood insurance would be reduced by the amount of money described by the survey. We did not elicit homeowners' WTP for such a program because this paper is focused on estimating the utility or disutility people get from a pre-contracted buyout, and expressed WTP (or WTA) for the coupled contract commingles people's utility or disutility for insurance with the value they would have for a pre-contracted buyout.

The last survey section gathered demographic, risk perception, home characteristics, flood experience, and other information to be used as explanatory variables. These questions permit us to estimate how socioeconomic factors influence WTP for the program. In particular, flood experience and risk perceptions have been shown by previous research to affect risk mitigation decisions (Atreya, Ferreira, and Michel-Kerjan 2015; Browne and Hoyt 2000).

Instrument reliability was 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 validity screening questions. Following the soft launches multiple attention filter and logical validation questions were added to ensure data quality (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.

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 (Mitchell and Carson 1989). The inclusion of protest responses in a CV analysis can bias WTP estimates. We identified and removed protest votes that met two conditions. First, the respondent stated they were unwilling to participate in the program for any amount of money. Second, they also indicated through other survey responses that they are including spurious elements in their value expression.

Conceptual Model and Data Analysis

In this paper, we estimate 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 willing to pay 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) (Boyle 2011).

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

To estimate WTP, we elicit preference information from respondents through a payment card contingent valuation survey. Preference information selected by each respondent 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:

$$c_i = \mathbf{z}_i'\boldsymbol{\beta} + u_i \quad [2]$$

where c_i represents *WTP* for respondent *i,* u_i is the random error term with mean zero and standard deviation σ, $\mathbf{z}_i'$ is a vector of independent variables that explain response variation, and $\boldsymbol{\beta}$ is the vector of coefficients. See Table 1 for a full list of variables included in $\mathbf{z}_i'\boldsymbol{\beta}$. We cannot directly observe c_i as a consequence of the payment card elicitation format; 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:

$$\Pr(c_i \subseteq (\$B_{li}, \$B_{ui}) = \Pr\left[\frac{(\$B_{li} - \mathbf{z}_i'\boldsymbol{\beta})}{\sigma} < t_i < \frac{\$B_{lu} - \mathbf{z}_i'\boldsymbol{\beta}}{\sigma}\right] \quad [3]$$

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 $\mathbf{z}_i'\boldsymbol{\beta}$ is the function representing the solution to Equation (1) defining the value being estimated (Boyle 2011).

One specification (linear) estimates this interval regression with the actual dollar values of the interval bounds, assuming that c_i is normally distributed. In that model, mean WTP is found as $E[c] = \mathbf{z}'\widehat{\boldsymbol{\beta}}$. It can include negative expressed values for WTP. A second specification

assumes that WTP is log-normally distributed, and is estimated by taking the natural-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 cannot include expressions of negative value. In that model, mean WTP is found as

$$E[c] = \exp\left(\mathbf{z}'\widehat{\boldsymbol{\beta}}\right) \exp\left(\frac{\widehat{\sigma^2}}{2}\right). \quad [4]$$

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 area would receive discounted flood insurance premiums in exchange for agreeing to accept a buyout in the event that their house is damaged by a flood and losses are more than 50% of its value. The survey asked 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 a given explanatory variable x_j on the probability of the homeowner signing up for the program:

$$P\left(y = 1 \middle| x_j\right) = \frac{\exp\left(x_j\beta\right)}{1+\exp\left(x_j\beta\right)}. \quad [5]$$

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 set of explanatory variables x_j includes factors such as income, flood experience, community attachment, and whether or not the homeowner already has flood insurance.

Respondents' preferences over these buyout programs might be affected by unobservable factors that are correlated across space. Our respondents are located in so many different zip codes that we cannot control for location at the zip-code level. Instead, we create a set of 16 state

or regional codes as indicated in Table A1 of the Appendix such that there are at least 15 observations per code. We carry out most of the regressions with these regional fixed effects. The one exception is an estimation of Equation 5 for respondents that reported having insurance and thus only has 210 observations in total. There was insufficient variation in the dichotomous outcome variable in all of the regions, so instead we cluster standard errors by region.

Hypotheses

Previous research has shown that homeowners base their flood mitigation decisions on a number of economic, social, and political factors. We draw on that work to derive the hypotheses regarding factors that will influence WTP for a pre-flood agreement for a post-flood buyout.

Browne and Hoyt (2000) and Petrolia, Landry, and Coble (2013) study demand for flood insurance; that work finds that demand for such insurance increases with income, flood experience, and risk aversion and decreases with price. Botzen and van den Bergh (2012) and Netusil, Kousky, Neupane et al. (2020) find that WTP for flood insurance depends on perceived flood risk, and Botzen, Aerts, and van den Bergh (2009) find that risk perception also influences homeowners' willingness to invest in measures to reduce the risk of flood damage to their homes. Fraser, Elmore, Godschalk et al. (2003) survey 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, and 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 find 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 and Fraser 2012). Over 50% of residents surveyed by Fraser, Elmore, Godschalk (2003) express an aversion to losing neighborhood based social networks, while others voice 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 be willing to 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, we hypothesize that homeowners have higher WTP if they believe the buyout would be good for the environment.

3. Results

Our survey yielded 491 responses after filtering surveys that were incomplete, contained logically incongruent responses, or represented protest votes. If we also remove responses from individuals that spent fewer than 7 minutes on the survey or left some answers blank, the sample has 447 responses. We carried out regressions on both sets of 491 and 447 responses and the two sets of results were not meaningfully different. For parsimony we present here only features of and results from the smaller, more conservative, sample. Note that all respondents are homeowners living within the 100-year floodplain, and 97% of the respondents are owner

occupants; this is useful, as those individuals are the focus of hazard mitigation grant programs.

The zip codes in which our respondents reside are shown in Figure 1; they are both coastal and inland, and spread across the entire U.S. Table 2 presents summary statistics on other characteristics of the sample (information on some qualitative responses is in Appendix Table A2.) Nearly 50% of the respondents have flood insurance, which is consistent with the 50% found in previous research (Dixon, Clancy, Seabury et al. 2006; Kriesel and Landry 2004). We appear to not have disproportionate survey participation by insured households. About a quarter of respondents have made a flood insurance claim before, and 10% have made a claim over $25,000. The homes in our sample are highly varied; half of them are valued between $100,000 and $250,000, 18% are more modest than that, and 30% are worth more than the $250,000 cutoff on insurable value.

Survey respondents vary widely in how likely they thought it was that their house would be hit by a very bad flood in the next 30 years, with a mean estimated chance of 47% but risk estimates ranging from 0% (it will never happen) to 100% (it's a sure thing). Figure A1 in the online Appendix gives a histogram of that variable; risk estimates are fairly even across the range of values but with spikes at 20-29%, 50-59%, and 90-100%. Those spikes surely reflect mental rounding, but there is no spike at zero. Homeowners might find flood risk more salient with ocean proximity; 10% of our sample live in designated V-zones which are subject to wave action. Only 20% of the homes in our sample are elevated against flood.

How varied are the depths of people's connections to the place in which they currently live? People living in floodplains have little faith that their neighbors would stay if offered the ability to take a buyout after a severe flood. On average, respondents expect that almost 60% of their neighbors would move, and while some optimistic folk believe all would stay, some believe

all would leave. Figure A2 shows a histogram of that variable; most responses are in percentage ranges of 40% and higher. While at least one respondent had lived in their community for a single year, respondents on average had lived in their current towns for 20 years, with one person having deep roots grown over 72 years. Over 40% of respondents have other family in town. Only 25% of respondents talk to their neighbors daily.

Our sample has few extremely wealthy people, but over 40% with income between $70,000 and $149,000. Respondents are evenly divided among age groups but more homogeneous in race with 78% white, 11% African American, and rest in other racial and ethnic groups. The average household size is 2.7. Our sample is well-educated (perhaps unsurprisingly given that they are all homeowners); 35% have a bachelor's degree and 23% have an additional advanced degree. The population relevant for our survey is just the set of people who are homeowners in flood plains, so there are no Census statistics for that group against which we can compare our sample to evaluate its representativeness.

Figure 2 shows a histogram of the percent of observations that revealed WTP for the first simple buyout program in each of the dollar-value intervals on the payment card questions. Only a handful of respondents have negative WTP for this program; 99% of them have positive net value for a pre-flood agreement to take a post-flood buyout. The largest numbers of respondents appear to have values between $100 and $450 but 15% of the observations are in the intervals of $1,200 and higher. We can find mean homeowner WTP for this buyout program by doing an interval regression of these data on just a constant. Assuming a linear specification, we find the mean homeowner WTP (the coefficient on the constant term) is $605. The log-linear specification produces a coefficient on the constant term of 5.6 and an estimate of $\hat{\sigma}$ equal to 1.6; thus, the estimated mean WTP is to $881. The log-linear specification produces a higher estimate

of mean WTP because it must drop the four observations of people who expressed negative values and because it is not forcing a symmetric normal distribution onto a distribution of WTP values that is skewed toward positive values.

To gain insight into factors that drive variation in this WTP, we carry out interval regressions of the payment-card responses as a function of a range of explanatory variables. We include regression results for two specifications in Table 3. The first column uses the actual dollar values bounding the WTP intervals (the linear specification), and the second column uses the natural log of those dollar values (the log-linear specification). Both regressions have regional fixed effects (regressions with no fixed effects are in Appendix Table A3). Our discussion of the results focuses on variables that are statistically significant in both specifications, and we on coefficient values from the more conservative linear specification.

Consistent with previous flood mitigation literature, homeowners that have a higher self-estimated flood risk appear to be willing to pay more for a guaranteed buyout. We find that 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 $6.67. 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 $334.

We asked 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 that for every percentage point increase of neighbors signing up for the program homeowners are willing to pay an additional $4.54. If one homeowner believes 30% of their neighbors would take the pre-buyout and another believes that

number to be 70%, the difference in their WTP would be $182. This finding could simply capture projection, as a person who is very willing to accept a buyout presumes their neighbors are as well. However, it may also reflect some of the community externalities of flood-mitigation buyouts; if a respondent thinks more homes are likely to be converted to open space and more people will move away, the respondent's own willingness to move may be increased because they expect the tax base and strength of the community to be reduced by such a program.

We hypothesize homeowners that have previously made a claim to be willing to pay more for the program. The coefficient on the variable for whether the homeowner had made any claim at all is negative and significant in the linear specification, but those that had made a large claim of $25,000 or more had WTP values that are statistically significantly higher than other homeowners in both specifications (and the net effect is positive in the linear specification). Homeowners in this category are found to be willing to pay an additional $357 to sign up. These homeowners are intimately aware of the risk they face and the hassles of rebuilding, and so they may be keen to participate in a buyout after the next substantial flood event.

Consistent with economic theory, households with greater income are willing to pay more for normal goods. Households in the $70,000 to $150,000 range would pay $236 more than those in the low-income category, and households making more than $150,000 were willing to pay $676 more than those in the low-income category. Respondents with a college degree are willing to pay $218 more than respondents in categories with less formal education.

Our second objective is to evaluate homeowners' willingness to participate in a similar buyout program when coupled with the 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; if they currently have insurance but do not sign up for a buyout,

their premiums will be much higher. If they do not have insurance and reject the coupled policy, they will still not have insurance and they will not have a buyout agreement.

Table 4 shows a cross tabulation of whether respondents indicate they would sign up for this coupled program against whether respondents currently have insurance. We find that 310 out of 447 respondents would be willing to accept the coupled buyout (69%). Of the 237 respondents who do not currently have flood insurance, 135 (57%) would be willing to accept this coupled buyout even though it would require them to pay for flood insurance. The rate of people who would take the coupled buyout is much higher among those who already have insurance, but only 83% rather than 100%. This means that many people who already have insurance would not accept the buyout agreement if they must maintain that insurance as a condition of the agreement.

To understand what factors might influence the likelihood a homeowner will sign up for a buyout program that requires concurrent enrollment in flood insurance, we do a logit regression on whether a respondent indicated they would sign up for the coupled program. Table 5 shows the results of the regression for all observations in the sample of 447 with regional fixed effects and for a sub-sample of 210 respondents that currently have flood insurance with standard errors clustered by region (regressions without regional controls are in Appendix Table A4). Interpreting the results for the full sample is complicated, as willingness to sign up for the coupled program reflects both the net utility people would get from the buyout and their preferences over insurance. Thus, we focus our discussion on the findings for the insured sub-sample in which at least attitudes towards insurance are more homogeneous. The regression in that second column finds strong evidence that homeowners' willingness to sign up for the buyout program coupled with insurance is significantly correlated with self-reported flood risk,

environmental concern, previous experience with filing a flood-damage claim, and race (Black respondents are willing to pay more than others). In fact, these factors are significant and positive in the full sample as well. Several other variables are significant at the 10% level in this regression (premium savings, income over 150 thousand dollars, and age over 55), but not also in the regression with all observations.

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 variables 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 2011). For binary explanatory variables we estimate the discrete difference in the 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. This method allows us to express intuitively the 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 is statistically significant and positive. The coefficient implies that a homeowner who believes their home will be flooded with 100% certainty in the next 30 years has a probability of 0.92 of signing up for the coupled buyout program. That probability is only 0.84 if the homeowner believes there is just a 50/50 chance they will be flooded.

We find environmental concerns are positively correlated with willingness to sign us for the pre-flood buyout program coupled with insurance. If a homeowner believes buyouts are good

for the environment they have a probability of signing up that is 0.94, while the signup probability is 0.79 if they do not hold that belief. Respondents have a signup probability of 0.92 if they have flood-insurance claim experience and 0.79 if they do not – a difference of 0.13. Finally, the results show race to be associated with stated sign up rates among insured respondents. The signup probability for Black respondents is 0.95, while the probabilities for White and for other respondents are 0.82 and 0.86, respectively.

4. Conclusion

This study was designed to improve understanding of homeowner preferences towards pre-flood buyout programs. We tested the relationship between demographic factors (such as flood experience, risk estimates, community attachment, and income) and homeowners' WTP for a guaranteed buyout in the event of substantial flood damage to their home. We also quantified homeowners' willingness to participate in a buyout program that is coupled with a requirement than homeowners maintain flood insurance. Results of these 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 suggest that a free policy offering pre-flood buyout agreements would improve the welfare of homeowners by an average of $605, and nearly all the homeowners we surveyed in flood plains across the U.S. would gain positive utility from being able to sign up for such an agreement. Previous research (Healy and Malhotra 2009; Davlasheridze, Fisher-Vanden, and Klaiber 2017) has found that FEMA expenditures on hazard mitigation have higher returns in terms of damage reduction than FEMA programs for post-flood recovery expenditures, and even find buyouts to be more cost-effective than other risk mitigation strategies. Our finding of

strong homeowner demand for the opportunity to pre-contract for a buyout further strengthens the argument for expanding FEMA funding for proactive buyouts, even though voters may reward post flood cleanup more than investments in damage reduction (Healy and Malhotra 2009). Homeowners in flood-risk areas would very broadly value the opportunity to commit to having their home bought out swiftly by FEMA after the next catastrophic flood.

We find that homeowners would gain more value from a pre-flood buyout agreement if they think their home is at high risk of flood damage and if they have previously had to file a large flood insurance claim. WTP for such a program is higher if a homeowner thinks that many of their neighbors would be likely to move following a major flood. This finding indicates that social factors could be important in shaping the effectiveness of a buyout program that aims to clear homes from high-risk flood plains – it may be easier to induce a whole neighborhood or community to accept buyouts together than to induce a single family to leave. Finally, we find that enthusiasm for a guaranteed buyout program increases with a homeowner's income and education. That is consistent with some research that find households with high levels of education (Landry, Okmyung, Hindsley, et al. 2007) and financial resources (Davlasheride and Fan, 2017) were more likely to re-locate away from damaged areas after Hurricane Katrina. In contrast, Landry, Okmyung, Hindsley, et al. (2007) find that high-income evacuees of Hurricane Katrina are more likely to return to their pre-disaster homes, and Smith, Carbone, Pope et al. (2006) found that high income households tended to re-build rather than sell out and move after Hurricane Andrew in Florida. It could be that the multi-year delays associated with traditional ex-post buyouts can make rebuilding more appealing to some high-income homeowners, and such people could be persuaded to pre-commit to an expedited buyout under the kind of program we study here.

Enthusiasm is more muted when homeowners are asked about a program that combines this guaranteed buyout with mandatory purchase of flood insurance with a discounted rate. Only 69% of respondents indicated they would sign up for such a coupled buyout program. Acceptance rates are higher among people who already have flood insurance, but even some of those state they would not accept a guaranteed buyout program if that would require them to keep their insurance. It may seem illogical to those respondents to have to pay for insurance if they are simply going to have to sell the house to be eliminated if it is badly damaged in a flood. We find the likelihood of accepting this kind of coupled buyout increases with self-estimated risk and flood insurance claim experience, and the likelihood is higher for Black homeowners than for respondents of other races. Respondents are also more likely to accept this coupled program if they think that they can help the environment by allowing their house to be purchased and transformed into green infrastructure to improve flood resilience.

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 and recent flood experience. 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 the great Mississippi River flood of 1993 (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, Zahram, Highfield et al. 2008; Calil, Beck, Gleason et al. 2015; Kick, Fraser, Fulkerson et al. 2011; de Vries and Fraser 2012). Furthermore, most published case studies involve only recently flooded communities. While recently flooded communities are often included in high risk zones targeted by mitigation programs, the national sample used in our study allows us to make much wider inferences.

Policy makers and floodplain managers can gain insight from these results about the potential value of pre-flood buyout agreements across various geographies 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.

We identified factors associated with 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 helpful. 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 literature on climate change paints a concerning picture of homes subject to rising sea levels and changing precipitation patterns. Furthermore, incentivizing homeowner migration and adaptation through full risk rate insurance premiums is problematic due to housing affordability concerns (Bakkensen and Ma 2020). Fan and Davlasheridze (2016) find with a sorting model that homeowners have significant positive WTP to live in communities with high levels of flood-risk mitigation activities associated with the Community Rating System, including a wide range of actions ranging from public information programs to acquisition/relocation programs. Our findings add evidence to that support for ex-ante flood-risk mitigation. Pre-flood buyout agreements could convey benefits to many homeowners in flood prone areas, allowing homeowners and communities to successfully mitigate flood risk without the regressive effects of flood-insurance rate increases.

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6. References

Atreya, Ajita, Susana Ferreira, and Erwann Michel-Kerjan. 2015. "What drives households to buy flood insurance? New evidence from Georgia." *Ecological Economics* 117: 153–161.

Bagstad, Kenneth J., Kevin Stapleton, and John R. D'agostino. 2006. "Taxes, subsidies, and insurance as drivers of United States coastal development." *Ecological Economics* 63: 285–298.

Bakkensen, Laura A. and Lala Ma. 2020. "Sorting over flood risk and implications for policy reform." *Journal of Environmental Economics and Management* 104: 102362.

Bateman, Ian J., Richard T. Carson, Brett Day, Michael Hanemann, Nick Hanley, Tannis Hett, Michael Jones-Lee, Graham Loomes, Susana Mourato, Ece Özdemiroglu, David Pearce, Robert Sugden, and John Swanson. 2002. *Economic Valuation with Stated Preference Techniques: A Manual*. Northampton Massachusetts: Edward Elgar Publishing.

Bateman, Ian J. and James Mawby. 2004. "First impressions count: Interviewer appearance and information effects in stated preference studies." *Ecological Economics* 49: 47–55.

Greer, Alex and Sherri B. Binder. 2017. "A historical assessment of home buyout policy: Are we learning or just failing?" *Housing Policy Debate* 27(3): 372-392.

Binder, Sherri B., John P. Barile, Charlene K. Baker, and Bethann Kulp. 2019. "Home buyouts and household recovery: Neighborhood differences three years after Hurricane Sandy." *Environmental Hazards* 18(2): 127-145.

Bolitzer, Benjamin and Noelwah R. Netusil. 2000. "The impact of open spaces on property values in Portland, Oregon." *Journal of Environmental Management* 59: 185–193.

Botzen, Wouter J., Jeroen C. Aerts, and Jeroen C. van den Bergh. 2009. “Willingness of homeowners to mitigate climate risk through insurance.” *Ecological Economics* 68(8-9): 2265-2277.

Botzen, Wouter J. and Jeroen C. van den Bergh. 2012. “Risk attitudes to low-probability climate change risks: WTP for flood insurance.” *Journal of Economic Behavior and Organization* 82(1): 151-166.

Boustan, Leah Platt, Matthew E. Kahn, and Paul W. Rhode. 2012. "Moving to higher ground: Migration response to natural disasters in the early twentieth century." *American Economic Review* 102(3): 238-44.

Boyle, Kevin J. 2011. “Contingent valuation in practice.” Chapter 5 in: *A Primer on Nonmarket Valuation*. Champ, P.A., Boyle, K. J. and Brown, T.C., eds. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Brody, Samuel D., Sammy Zahran, Wesley E. Highfield, Himanshu Grover, and Arnold Vedlit. 2008. “Identifying the impact of the built environment on flood damage in Texas.” *Disasters* 32(1): 1–18.

Brown, Patricia 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, Thomas C., Patricia A. Champ, Richard C. Bishop, and Daniel W. McCollum. 1996. “Which response format reveals the truth about donations to a public good?” *Land Economics*: 152-166.

Browne, Mark J., and Robert E. Hoyt. 2000. “The demand for flood insurance : Empirical evidence.” *Journal of Risk and Uncertainty* 20(3): 291–306.

Calil, Juliano, Michael W. Beck, Mary Gleason, Matthew Merrifield, Kirk Klausmeyer, and Sarah Newkirk. 2015. "Aligning natural resource conservation and flood hazard mitigation in California." *PLoS ONE* 10(7): 1–15.

Cameron, Trudy Ann, and Daniel D. Huppert. 1989. "OLS versus ML estimation of non-market resource values with payment card interval data." *Journal of Environmental Economics and Management* 17(3): 230–246.

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

Carson, Richard T. 2012. "Contingent valuation: A practical alternative when prices aren't available." *Journal of Economic Perspectives* 26(4): 27–42.

Mitchell, Robert C. and Richard T. Carson.1989. *Using Surveys to Value Public Goods: The Contingent Valuation Method*. Washington DC: Resources for the Future.

Champ, Patricia A., and Richard C. Bishop. 2006. "Is willingness to pay for a public good sensitive to the elicitation format?" *Land Economics* 82(2): 162–173.

Champ, Patricia A., Kevin J. Boyle, and Thomas C. Brown. 2017. *A Primer on Nonmarket Valuation*, 2nd edition. The Netherlands: Springer.

Costanza, Robert, William J. Mitsch, and John W. Day Jr. 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): 465–472.

Cummings, Ronald G., and Laura O. Taylor.1999. "Unbiased value estimates for environmental goods: A cheap talk design for the contingent valuation method." *American Economic Review* 89(3): 649–666.

Dalbom, Christopher, Scott A. Hemmerling, and Joshua A. Lewis. 2014. *Community Resettlement Prospects in Southeast Louisiana.* New Orleans, LA: Tulane Institute on Water Resources Law and Policy. Available at: https://biotech.law.lsu.edu/blog/Community-Resettlement-Prospects-in-Southeast-Louisiana.pdf.

Davlasheridze, Meri, and Qin Fan. 2017. "Household Adjustments to Hurricane Katrina." *Review of Regional Studies* 47(1): 93-112.

Davlasheridze, Meri, Karen Fisher-Vanden, and H. Allen Klaiber. 2017. "The effects of adaptation measures on hurricane induced property losses: Which FEMA investments have the highest returns*?" Journal of Environmental Economics and Management* 81: 93-114.

Davlasheridze, Meri, and Qing Miao. 2019. "Does governmental assistance affect private decisions to insure? An empirical analysis of flood insurance purchases." *Land Economics* 95(1): 124-145.

Deryugina, Tatyana, Laura Kawano, and Steven Levitt. 2018. "The economic impact of Hurricane Katrina on its victims: evidence from individual tax returns." *American Economic Journal: Applied Economics* 10(2): 202-33.

Dixon, Lloyd, Noreen Clancy, Seth A. Seabury, and Adrian Overton. 2006. *The National Flood Insurance Program's Market Penetration Rate : Estimates and Policy Implications*. Santa Monica, CA: Rand Corporation. Available at: https://pdfs.semanticscholar.org/fec0/e582248a7b7d2eaab1cf3ebd73791f27db41.pdf.

Fan, Qin, and Meri Davlasheridze. 2016. "Flood risk, flood mitigation, and location choice: evaluating the National Flood Insurance Program's Community Rating System." *Risk Analysis* 36(6): 1125-1147.

Fraser, James, Rebecca Elmore, David Godschalk, and William Rohe. 2003. *Implementing Floodplain Land Acquisition Programs in Urban Localities.* Chapel Hill, NC: Center for Urban and Regional Studies at UNC Chapel Hill.

Greer, Alex, and Sherri B. Binder 2017. "A historical assessment of home buyout policy: Are we learning of just failing?" *Housing Policy Debate* 27(3): 372-392.

Hayat, Becky, and Robert Moore. 2015. "Addressing affordability and resiliency through the National Flood Insurance Program." *Environmental Law Reporter* 45: 10338 – 10349.

Hayes, Thomas L. and D. Andrew Neal. 2011. *Actuarial Rate Review: In Support of the Recommended October 1, 2011, Rate and Rule Changes*. Washington, DC: FEMA. Available at: http://www.fema.gov/media-library-data/20130726-1809-25045-6893/actuarial_rate_review2011.pdf.

Healy, Andrew, and Neil Malhotra. 2009. "Myopic Voters and Natural Disaster Policy." *American Political Science Review* 103(3): 387.

Hirabayashi, Yukiko, Roobavannan Mahendran, Sujan Koirala, Lisako Konoshima, Dai Yamazaki, Satoshi Watanabe, Hyungjun Kim, and Shinjiro Kanae. 2013. "Global flood risk under climate change." *Nature Climate Change* 3(9): 816.

Intergovernmental Panel on Climate Change (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*, [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. Geneva, Switzerland: IPCC.

Kerr, Alexander M., and Andrew H. Baird. 2007. “Natural barriers to natural disasters.” *BioScience* 57(2): 102.

Kick, Edward L., James C. Fraser, Gregory M. Fulkerson, Laura A. McKinney, and Daniel H. De Vries. 2011. “Repetitive flood victims and acceptance of FEMA mitigation offers: An analysis with community-system policy implications.” *Disasters* 35(3): 510–539.

King, Rawle O. 2012. *National Flood Insurance Program: Background, Challenges, and Financial Status*. Washington, DC: Congressional Research Service.

Kousky, Carolyn. 2014. “Managing shoreline retreat: a U.S. perspective.” *Climatic Change* 124: 9-20.

Kousky, Carolyn and Margaret Walls. 2014. “Floodplain conservation as a flood mitigation strategy: Examining costs and benefits.” *Ecological Economics* 104: 119-128.

Kousky, Carolyn, Brett Lingle, and Leonard Shabman.2017. “The pricing of flood insurance.” *Journal of Extreme Events* 4(2): 1750001.

Kousky, Carolyn, Erwann O. Michel-Kerjan, and Paul A. Raschky. 2018. "Does federal disaster assistance crowd out flood insurance?” *Journal of Environmental Economics and Management* 87: 150-164.

Kriesel, Warren, and Craig Landry. 2004. “Participation in the National Flood Insurance Program: An empirical analysis for coastal properties.” *Journal of Risk and Insurance* 71(3): 405–420.

Landry, Craig E., Okmyung Bin, Paul Hindsley, John C. Whitehead, and Kenneth Wilson. 2007. “Going home: Evacuation-migration decisions of Hurricane Katrina survivors," *Southern Economic Journal* 74: 326-343.

Mach, Katharine J., Caroline M. Kraan, Miyuki Hino, A. R. Siders, Erica M. Johnston, and Christopher B. Field. 2019. "Managed retreat through voluntary buyouts of flood-prone properties." *Science Advances* 5(10): p.eaax8995.

Mallakpour, Iman, and Gabriele Villarini. 2015. "The changing nature of flooding across the central United States." *Nature Climate Change* 5(3): 250–254.

National Research Council, 2014. *Reducing Coastal Risk on the East and Gulf Coasts*. Washington, D.C.: National Academies Press.

National Oceanic and Atmospheric Administration (NOAA), 2013. *National Coastal Population Report: Population Trends from 1970 to 2020*. Washington, D.C.: NOAA.

Netusil, Noelwah R., Carolyn Kousky, Shulav Neupane, Will Daniel, and Howard Kunreuther. 2020. "The Willingness to Pay for Flood Insurance." Forthcoming in *Land Economics*. Wharton Risk Management and Decision Processes Center Working Paper 2020-3. Available at https://riskcenter.wharton.upenn.edu/wp-content/uploads/2020/09/Working-Paper-2020-03_Willingness-To-Pay-for-Flood-Insurance.pdf.

Petrolia, Daniel R., Craig E. Landry, and Keith H. Coble. 2013. "Risk preferences, risk perceptions, and flood insurance." *Land Economics* 89(2): 227-245.

Reeser, Collin. 2016. *Homeowner Willingness to Pay for a Pre-Flood Buyout Agreement*. MS Thesis, University of Illinois Urbana-Champaign.

Rowe, Robert D., William D. Schulze, and William S. Breffle. 1996. "A test for payment card biases." *Journal of Environmental Economics and Management* 31: 178–185.

Shepard, Christine C., Caitlin M. Crain, and Michael W. Beck. 2011. "The protective role of coastal marshes: A systematic review and meta-analysis." *PLoS ONE* 6(11): e27374.

Smith, V. Kerry, Jared C. Carbone, Jaren C. Pope, Daniel G. Hallstrom, and Michael E. Darden. 2006. "Adjusting to natural disasters." *Journal of Risk and Uncertainty* 33(1-2): 37-54.

Tockner, Klement and Jack A. Stanford. 2002. "Riverine flood plains: present state and future trends." *Environmental Conservation* 29(3): 308-330.

Tonsor, Glynn T., and Robert S. Shupp. 2011. "Cheap talk scripts and online choice experiments: 'Looking beyond the mean.'" *American Journal of Agricultural Economics* 93(4): 1015–1031.

U.S. Government Accountability Office (USGAO). 2004. *National Flood Insurance Program: Actions to Address Repetitive Loss Properties. Report No. GAO-04-401T*. https://www.gao.gov/.

U.S. Government Accountability Office (USGAO). 2015. *Flood Insurance: Status of FEMA's Implementation of the Biggert-Waters Act, as Amended. Report No. GAO-15-178*. https://www.gao.gov/.

U.S. Government Accountability Office (USGAO). 2016. *Continued Progress Needed to Fully Address Prior GAO Recommendations on Rate - Setting Methods. Report No. GAO-16-59*. https://www.gao.gov/.

de Vries, Daniel H. and James C. Fraser. 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): 1–33.

Weber, Anna and Moore, Robert. 2019. *Going Under Water: Long Wait Times for Post-Flood Buyouts Leave Homeowners Underwater*. NRDC Report 19-08-A. Chicago, IL: Natural Resources Defense Council. Available at: https://www.nrdc.org/sites/default/files/going-under-post-flood-buyouts-report.pdf.

Wooldridge, Jeffrey M. 2011. *Introductory Econometrics 5th ed*. Mason Ohio: South-Western CENGAGE Learning.

Wriggins, Jennifer. 2014. "Flood money : The challenge of U.S. flood insurance reform in a warming world." *Penn State Law Review* 119(2): 361-437.

Zavar, Elyse. 2015. "Residential perspectives: The value of floodplain-buyout open space." *Geographical Review* 105(1): 8–95.

Table 1: Variable definitions

Variable name	Definition
Estimated risk	What do you think the probability is your home will be hit by a flood in the next 30 years? (0-100)
Neighbors move %	Estimate of % of neighbors that would take a buyout (0-100)
Inhabitants	Number of people living in household
Years in town	How many years have you lived in your town?
Family in town	Has family in town
Neighbor talk daily	I communicate with my neighbors daily
Environmental concern	Agree buyouts are good for the environment
Ocean	Home in V zone: Subject to wave action
Ever claim	Has made a flood insurance claim on your home
Ever claim over $25k	Has made a claim for more than $25,000
Home value $100 to $250k	Home Value is $100,000 to $250,000
Home value $250k+	Home Value is $250,000 and above
HasInsurance	Home is currently covered by flood insurance
Premium ($)	Annual flood insurance premium
PremiumSavings ($)	Amount per year would save on premium if take coupled buyout
Home raised	Has your home ever been elevated?
Income $70K to $149K	Income $70,000 to $149,000
Income $150K+	Income Above $150,000
Age 35 to 54	Age 35 to 54
Age 55+	Age 55 and older
College degree	Bachelor's degree completed
Advanced degree	Advanced degree completed
White	White
Black	Black

Table 2: Summary statistics

Variable name	N	Mean	SD	Min	Max
Estimated risk	447	47.4	28.6	0	100
Neighbors move %	447	58.6	25.3	0	100
Years in town	447	20.0	14.3	1	72
Family in town	447	0.43	0.50	0	1
Neighbor talk daily	447	0.25	0.43	0	1
Environmental concern	447	0.26	0.44	0	1
Home raised	447	0.19	0.39	0	1
Ocean	447	0.10	0.30	0	1
HasInsurance?	447	0.47	0.50	0	1
Premium/yr ($100)	447	6.00	12.5	0	120
Ever claim	447	0.27	0.44	0	1
Ever claim over $25k	447	0.10	0.30	0	1
Home value $100k to $250k	447	0.52	0.50	0	1
Home value $250k+	447	0.30	0.46	0	1
Income $70K to $149K	447	0.43	0.50	0	1
Income $150K+	447	0.07	0.26	0	1
Inhabitants	447	2.73	1.40	0	8
Age 35 to 54	447	0.31	0.46	0	1
Age 55+	447	0.39	0.49	0	1
College degree	447	0.35	0.48	0	1
Advanced degree	447	0.23	0.42	0	1
White	447	0.78	0.42	0	1
Black	447	0.11	0.31	0	1

Table 3: Interval regression results for willingness to pay

	Linear (N=447)		Ln (N=443)	
	Coefficient	S.E.	Coefficient	S.E.
Estimated risk	6.665***	1.714	0.014***	0.003
Neighbors move %	4.542***	1.812	0.005*	0.003
Years in town	4.439	3.138	0.007	0.005
Family in town	30.80	90.26	0.137	0.144
Neighbor talk daily	46.82	99.70	0.050	0.160
Environmental concern	104.4	93.61	0.343**	0.149
Home raised	133.2	111.8	0.303*	0.179
Ocean	-51.01	142.4	-0.234	0.228
HasInsurance?	-116.6	100.2	-0.202	0.160
Premium/yr ($)	8.895**	3.985	0.002	0.006
Ever claim	-261.0**	121.8	-0.229	0.193
Ever claim over $25k	618.0***	169.8	0.600**	0.269
Home value $100 to $250k	59.38	114.7	0.346*	0.184
Home value $250k+	19.57	132.7	0.282	0.214
Income $70K to $149K	235.6**	97.10	0.621***	0.154
Income $150K+	676.2***	182.7	1.13***	0.289
Inhabitants	40.36	34.36	0.099*	0.054
Age 35 to 54	-110.0	108.5	-0.412**	0.173
Age 55+	-39.14	118.0	-0.084	0.188
College degree	218.2**	96.59	0.354**	0.152
Advanced degree	155.7	119.0	0.348*	0.191
White	111.4	134.5	0.148	0.213
Black	-113.8	179.8	-0.081	0.288
Regional fixed effects	y		y	
ln(σ)	6.718***	0.036	0.262***	0.038
Σ[a]	827.5	29.81	1.300	0.049
Log likelihood	-1426.0028		-961.40562	

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

[a] σ is calculated from the estimated ln(σ).

Table 4: Stated willingness to accept buyout coupled with flood insurance

		Willing to accept buyout coupled with flood insurance?		
		Yes	**No**	**Total**
Currently have flood insurance?	**Yes**	175	35	210
	No	135	102	237
	Total	310	137	447

Table 5: Logit regression results

Variable	All observations (N=447)		Respondents with insurance (N=210)	
	Coefficient	S.E.	Coefficient	S.E.
Estimated risk	0.022***	0.006	0.018**	0.010
Neighbors move %	0.005	0.006	0.012	0.010
Years in town	0.025**	0.010	-0.001	0.010
Family in town	-0.609**	0.292	-0.125	0.445
Neighbor talk daily	-0.274	0.315	-0.696	0.431
Environmental concern	0.973***	0.311	1.70***	0.578
Home raised	0.536	0.407	0.836	0.824
Ocean	-0.001	0.470	1.01	0.657
HasInsurance?	0.744	0.657		
PremiumSavings	-0.095	0.064	-0.020*	0.011
HasInsurance?* PremiumSavings	0.071	0.065		
Ever claim	0.732*	0.432	1.28***	0.485
Ever claim over $25k	0.245	0.693	0.181	1.07
Home value $100 to $250k	0.396	0.427	0.104	0.755
Home value $250k+	-0.007	0.559	-0.445	0.778
Income $70K to $149K	0.741**	0.308	0.537	0.393
Income $150K+	1.22**	0.630	1.55*	0.874
Inhabitants	0.264**	0.113	0.089	0.144
Age 35 to 54	-0.510	0.360	0.012	0.317
Age 55+	0.410	0.360	1.53*	0.808
College degree	-0.154	0.303	0.320	0.433
Advanced degree	-0.080	0.358	-0.239	0.406
White	0.139	0.410	-0.422	0.487
Black	3.42***	1.13	1.37***	0.441
Constant	regional fixed effects		-1.14	1.65
Clustered standard errors?	n		y	
Log likelihood	-172.09509		-72.658392	

The dependent variable is a dummy variable equal to 1 if the respondent states they would accept the buyout program coupled with flood insurance and 0 otherwise.

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

Figure 1: Spatial distribution of survey respondents by zip codes

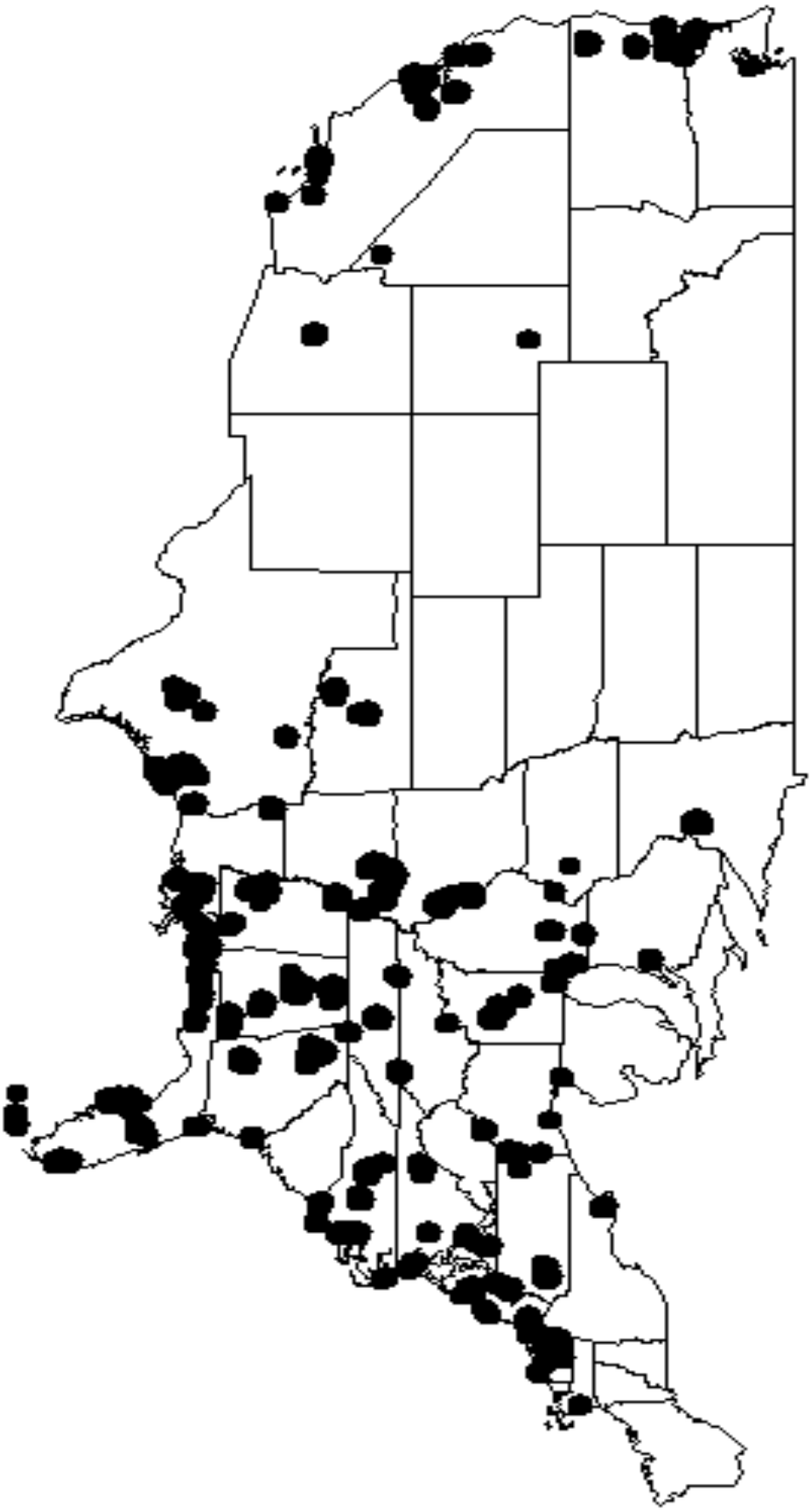
Note: Each dot indicates a zip code from which survey responses were obtained.

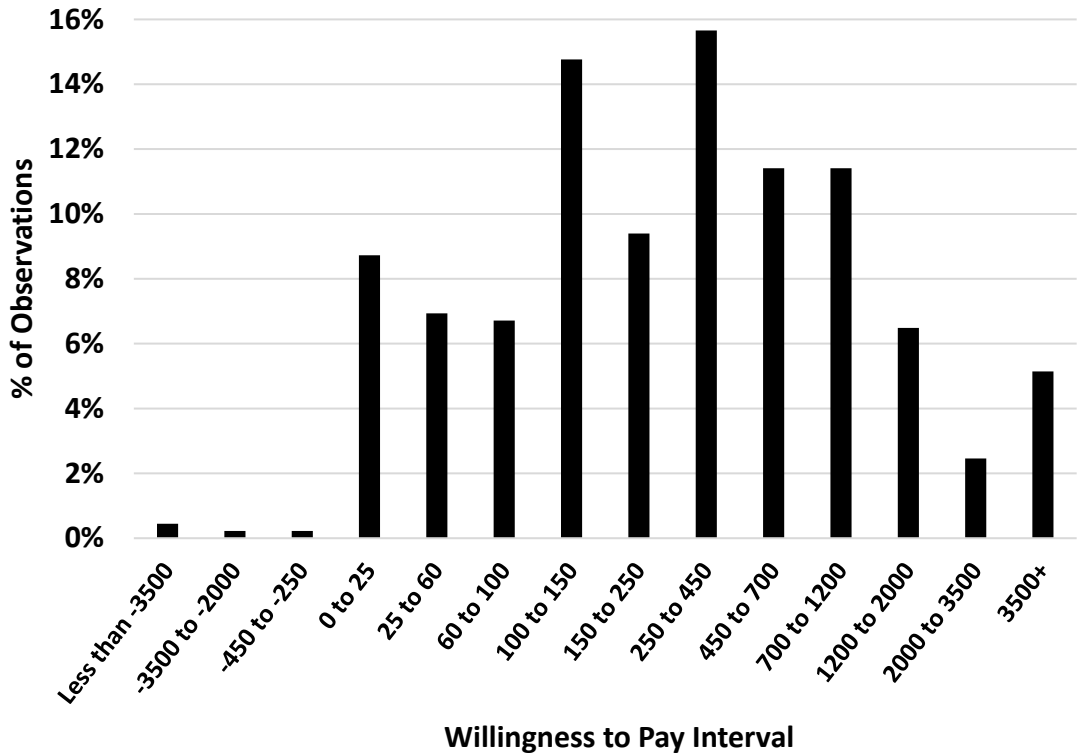
Figure 2: Interval observations of willingness to pay for a guaranteed buyout (N=447)

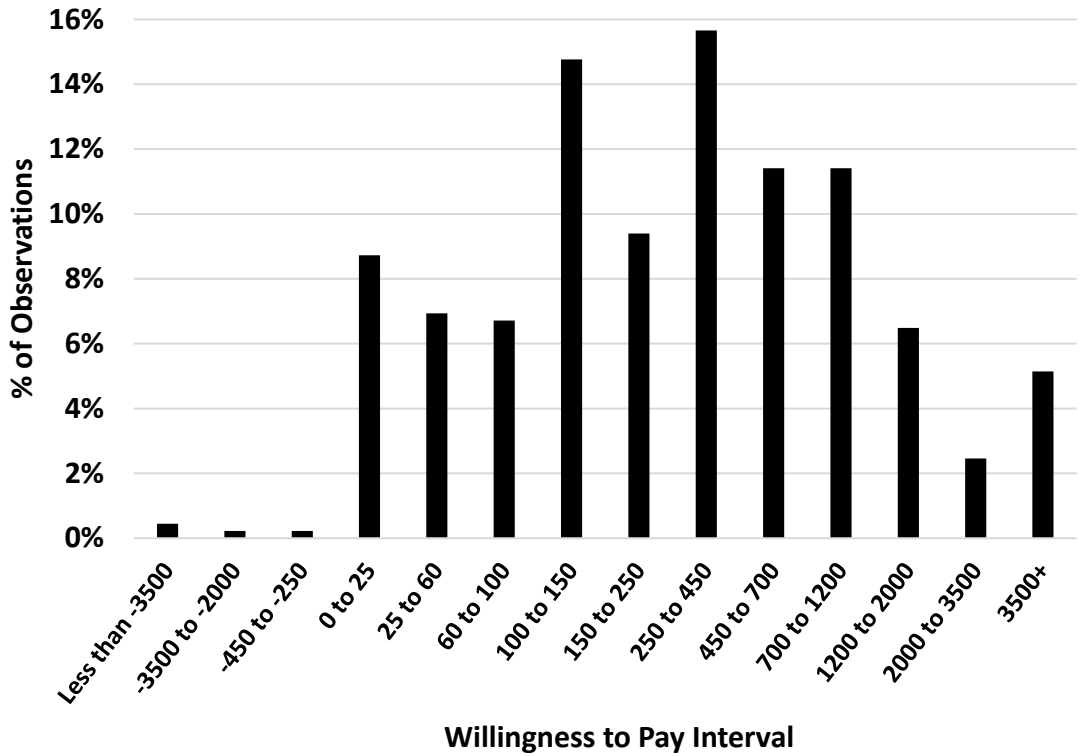
Endnotes

[1] The National Flood Hazard Layer (NFHL) is a digital database that contains flood hazard mapping data from FEMA's National Flood Insurance Program (NFIP).

www.fema.gov/national-flood-hazard-layer-nfhl







Homeowner Willingness to Pay for a Pre-Flood Agreement for a Post-Flood Buyout

Running title: WTP for Post-Flood Buyout Commitment

Amy W. Ando
Professor, University of Illinois Urbana-Champaign
University Fellow, Resources for the Future
326 Mumford Hall
1301 W. Gregory Dr., Urbana, IL 61801
amyando@illinois.edu

Collin Reeser
Graduate Student, University of Illinois Urbana-Champaign
Owner, Reeser Brothers Farms
Champaign, IL 61820
creeser2@gmail.com

Appendix materials can be accessed online at:
https://uwpress.wisc.edu/journals/pdfs/LE-98-4-Ando-app.pdf

Abstract

Homeowner buyout programs promote climate adaptation efforts by removing homes from flood plains. We estimate homeowner willingness to pay (WTP) for a novel agreement in which they pre-commit to relocating if a flood severely damages their home in exchange for an expedited buyout process. We find nearly all respondents identified positive WTP to enroll in this program, with average WTP about $600. Factors like flood risk and expectation of neighbors' responses significantly affect WTP. If the pre-flood agreement is available only if the homeowner has flood insurance, only 68% of homeowners were willing to accept the agreement.

1. Introduction

Flood events are expected to increase in frequency and severity as climate change raises sea levels and intensifies regional precipitation events (Hirabayashi, Roobavannan, Korala et al. 2013; IPCC 2014; Mallakpour and Villarini 2015). High profile flood events caused by a number of riverine inundations and events like Hurricanes Katrina, Rita, Sandy, Harvey, and Maria have highlighted several dimensions of the costs of development in flood prone areas (National Research Council 2014). Households suffer lasting economic damage in the wake of floods (Deryugina, Kawano, and Levitt 2018). FEMA recovery programs have had to expand to help communities and individual households who do not have flood insurance to compensate for damaging flood events (Kousky, Erwann, Michel-Kerjan et al. 2018). And as discounts place federal insurance premiums below their risk adjusted value (Kousky, Lingle, and Shabman 2017; Hayes and Neal 2011), premium collections have fallen far short of covering the losses of major flood events and the National Flood Insurance Program (NFIP) carries a $23 billion debt burden (USGAO 2016). Efficient flood-risk mitigation policy includes floodplain conservation (Kousky and Walls 2014) and restoration through removing homes from some flood prone areas (Kousky 2014) but how can such climate adaptation be accomplished?

Policy makers have long debated how best to reduce flood risk in the future and limit financial exposure to flood recovery expenditures. This paper examines 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, perceived flood risk, and connection to the community. 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 and Moore 2015).

Flood losses have consistently imposed the highest fiscal costs of any natural disasters (King 2012). The high government cost of disaster damage from floods has multiple sources. First, the U.S. population lives disproportionately in high 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 coastal shoreline counties (NOAA 2013). Structural projects such as dams and levees have disconnected flood plain properties from natural flooding and paved the way for them to be developed (Boustan, Kahn, and Rhode 2012). Furthermore, federal programs like discounted federal flood insurance and FEMA risk mitigation and community assistance programs have unintentionally served to increase development in high risk areas (Bagstad, Stapleton, and D'agostino 2006; Wriggins 2014; Davlasheridze and Miao 2019) by reducing the real and perceived long term cost and risk of flood plain development.

Second, features of federal flood disaster insurance and aid policy lead to high budgetary burdens. The NFIP discounts were intended to encourage participation in the program, but non-actuarially fair insurance is expensive. NFIP net outlays are also high because NFIP Flood Insurance Rate Maps (FIRMs) are commonly a decade or more out of date and are based on past flood experience rather than future flood risk, which is shifting due to climate change (Carolan

2007). Finally, only about 50% of properties in high risk areas have flood insurance (Kriesel and Landry 2004), likely because most households are willing to pay less for flood insurance than even the discounted premium cost (Netusil, Kousky, Neupane et al. 2020); however, uncovered households often receive some form of disaster relief through FEMA's Public Assistance and Individual Assistance programs regardless of whether they were individually insured (Davlasheridze and Miao 2019).

Conflicting policy goals have led to policy upheaval in the realm of flood insurance. 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 discounts by raising flood insurance premiums each year until full risk rates are reached (Wriggins 2014; USGAO 2015). However, looming flood-insurance premium increases 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 Waters. The problem remains that discounted premiums offer affordable protection to low income property owners, but do not fully fund the cost of the program or encourage residents to move to less flood prone areas.

In contrast, homeowner buyout programs allow risk-management agencies to remove homes from flood zones so they will not have to be repaired after future flood events, and have been employed for decades as a permanent means of reducing future flood risk exposure in flood zones (Greer and Binder 2017; Zavar 2015; de Vries and Fraser, 2012). Large-scale floodplain buyouts can face local opposition because they reduce the size of the municipal tax base and undermine local public finance for important services, and some research indicates that buyouts can weaken social capital and place attachment in and near target neighborhoods (Binder, Barile,

Baker et al. 2019). However, buyout programs can reduce flood risk for properties elsewhere in the community. As coastal and riverine communities have expanded, the natural flood protections of wetlands and other natural barriers were drained and developed. Consequently, properties further from bodies of water were at increased risk of flood (Kerr 2007; Costanza, Mitsch, and Day 2006). After a buyout, land can be restored to a protective state to help prevent damage to other homes and provide ecological benefits (Shepard, Crain, and Beck 2011; Tockner and Stanford 2002). Property value in surrounding areas can be increased by proximity to restored and protected floodplain area (Kousky and Walls 2014; Bolitzer and Netusil 2000).

Federal spending on long-term mitigation programs, including pre-emptive buyouts, is limited, even though research finds that hazard mitigation has higher returns than post-disaster cleanup (Davlasheridze, Fisher-Vanden, and Klaiber 2017). Thus, most homeowner buyout programs of the past have focused on contracting to buy out properties after they have been damaged by flooding (Greer and Binder 2017; Dalbom, Hemmerling, and Lewis 2014; de Vries and Fraser 2007). However, it can take so long to complete the post-flood buyout process that it is not uncommon for homeowners to just sell to a redeveloper or to receive indemnity payment and rebuild before completing participation in a buyout program (Weber and Moore 2019).

To glean clues as to who might benefit from buyout programs, we can look the spatial and temporal analysis in Mach, Kraan, Hino et al. (2017) of public data on all 43,633 voluntary FEMA buyouts from 1989 to 2017. Buyouts are most common in some of the states with high levels of flood damage (Missouri, Texas, Illinois, North Carolina, and Iowa) but there are other states (like Florida, Mississippi, and Louisiana) that have low levels of buyouts despite high levels of flood damage. Even though flood damage is growing in the U.S., the number of individual properties bought out has actually declined slightly over time (the highest number of

buyouts in a single year was initiated in the wake of the massive Mississippi River flood of 1993). They find that the likelihood a county has buyouts at all increases with flood risk, average income, and population density, but the actual neighborhoods in which buyouts are concentrated are relatively poor and racially diverse. It is not possible to tell from these analyses, however, whether the socioeconomic patterns in the buyouts observed are driven by variation in agency willingness to make buyout offers (e.g. low income areas have homes that are less expensive to buy out) or homeowner willingness to participate in the buyout program (e.g. low income homeowners are more willing to accept a buyout and move).

This paper estimates willingness-to-pay for a buyout in the context of a proposed pre-flood buyout program that takes a new approach to resolving the previously conflicting goals of reducing NFIP net outlays while protecting the financial well-being of homeowners (Hayat and Moore 2015). In such a program, homeowners in flood zones would be able to sign a binding contract for a buyout for the full market value of their home before a flood event occurs. Pre-flood contracts for post-flood buyouts are likely to help high-risk communities by empowering them to plan more effectively for flood events and their aftermath which may include tax base changes (USGAO 2004), infrastructure modification (Dalbom, Hemmerling, and Lewis 2014), or in some cases relocation of entire communities (Brown 1996). However, such pre-flood contracts could have both desirable and undesirable features for an individual homeowner. The homeowner would have peace of mind knowing with certainty what will occur after a major flood event, and completing the buyout paperwork before the flood event could greatly reduce post flood legal processes and thus reduce the time needed to complete the buyout; Mach, Kraan, Hino et al. (2017) find that conventional buyouts without this kind of pre-agreement have taken an average of 5.7 years to complete following the flood event. 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 and expedited buyout or how much would they have to be paid to be willing to accept (WTA) it? No research yet exists to answer that question; this paper fills that gap. We use a contingent valuation (CV) survey to value homeowners' WTP for a guarantee their home will be bought out following a major flood event. The model allows us to quantify how that WTP varies with factors such as 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 the mandated purchase of flood insurance. Those results inform likely efforts actually to implement a program of pre-flood contracts for post-flood buyouts given that administration of such a program would itself likely be coupled with the NFIP.

2. Methods

Stated Preference Methodology

This study uses an online choice experiment (CE) survey to estimate WTP for a guaranteed buyout contract (Carson 2012; Champ, Boyle, and Brown 2017). Several different methods can be used to elicit values in CE surveys (Champ and Bishop 2006; Bateman, Carson, Day et al. 2002). Dichotomous choice (DC) approaches give a dollar value and ask whether the respondent would be willing to pay that amount, and are viewed as more reliable than open-

ended elicitation questions. However, DC questions reveal relatively little information about the range within which the respondent's exact WTP value lies, and thus require large samples to produce accurate estimates of WTP. This paper employs the payment card elicitation format, which is more reliable than open-ended questions but more efficient than DC (Brown, Champ, Bishop et al. 1996). A payment card presents an ordered series of dollar values and asks the respondents to check yes or no for whether they would be willingness to pay each of the amounts listed.

We carefully choose the values on the payment card to optimize the validity of responses. Cameron and Huppert (1989) note that using the center of the intervals as a point estimate of WTP can bias parameter estimates in CE studies, so we use the interval-data econometric approach recommended by them to avoid such bias. Rowe, Schulze, and Breffle (1996) find no evidence of range or centering bias in payment card elicitation as long as respondents were able to select values on the upper end of the value distribution; they also find that the inclusion of exceptionally high bids may influence welfare estimates. Thus, we use focus groups to determine the maximum bid to avoid both truncation at the top and presentation of excessively large bids. Finally, we space big values below the maximum on an exponential scale; increasing interval distances between values helps respondents to differentiate among the levels of the bids (Rowe, Schulze, and Breffle 1996).

We took steps in other elements of the survey as well to increase the reliability of the WTP responses. We used 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 so that respondents would believe in the plausibility of the non-market good transaction (Carson 2012). We carefully crafted the information blocks in the survey to

provide all pertinent elements of the proposed policy (Champ, Boyle, and Brown 2017) while avoiding participant overload (Bateman and Mawby 2004). In addition, we randomized answer choices when possible to avoid ordering effects (Bateman, Carson, Day et al. 2002). Finally, we worked to mitigate hypothetical bias in the responses (in which survey respondents express a higher WTP than they would actually pay in a market transaction) by including a cheap talk script (Tonsor and Shupp 2011; Cummings and Taylor 1999) that informs respondents that some survey takers tend to misstate their actual WTP and encourages them to be more cognizant of their actual WTP, and by designing the background information and new pre-flood buyout sections to encourage respondents to think in depth about their personal budget and how the proposed buyout would affect them.

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. Feedback from these focus groups was used to ensure that respondents understand the description of the buyout scenario and to identify and eliminate language that might trigger bias in response. More details on the survey design process are provided in Reeser (2016)

In March of 2016, an online survey was distributed to a Qualtrics participant panel from which we collected 491 responses. Respondents were recruited from zip codes containing flood zones within the 100-year floodplain. To be eligible to take the survey, a respondent needed to own their own home and verify their flood zone code through FEMAs National Flood Hazard Layer tool. 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 full survey itself is in the online Appendix. It began with a series of eligibility screens to ensure the respondent is a homeowner, living within the 100-year floodplain, and over the age of 18. Floodplain status was determined by incorporating the online National Flood Hazard Layer (NFHL)[1] into the online platform. A respondent was asked to enter their address into the Federal Emergency Management Agency NFHL tool. The tool displayed information about the flood zone for that address, and the respondent entered the flood zone code into the screening question. If the code indicated presence in the 100-year floodplain, the respondent was allowed to continue in the survey.

The second section of the survey provided the respondent with background information on flood risk and described what homeowners can currently do if their house were severely damaged in a flood, including brief information about the nature of conventional post-flood buyout programs. This ensured that the respondent understood the status quo policy against which they should compare the hypothetical new contract to be valued. Section three described the features of a hypothetical pre-flood guaranteed buyout program. In short, this program is a pre-flood agreement that would guarantee a homeowner their home would be bought out in an expedited manner if a flood causes more than 50% of the value of their house to be lost; in exchange, the homeowner would be required to accept that buyout and relocate following such an event. Respondents were 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 to be able to sign up for such a contract. The payment values were 11 exponentially ascending dollar amounts ranging from $0 to $3,500. If a respondent was not willing to pay any amount of money to participate (they check “no” for all dollar amounts) the survey took them to another payment card asking respondents how much they would need to be

paid to participate in the program. The survey had both WTA and WTP sections as some focus group participants indicated they had a negative value for the program. However, we presented 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 asked homeowners if they would be willing to sign up for a slightly different kind of buyout program. This guaranteed/required post-flood buyout agreement was similar to the agreement described in the previous WTP/WTA question. However, this hypothetical buyout program would only be available to homeowners with flood insurance. In case of a minor flood, the homeowner would receive the usual insurance payments for repairs. However, in case of a flood that caused more than 50% of the value of the house to be lost, the homeowner would receive an expedited buyout equal to the fair market value of their home and need to move. No homeowner without flood insurance would be able to pre-contract for a guaranteed buyout.

At the time of the survey, insurance rates were increasing to be actuarially fair, so in the absence of such a program insurance would become much more expensive. Homeowners with flood insurance who signed up for the hypothetical program would be allowed to pay the old discounted insurance rates. Hayat and Moore (2015) proposed such a program to provide positive incentives for insured homeowners to agree to a buyout in case of severe flood damage, and to make sure that homeowners who agreed to a buyout in case of catastrophe would remain insured to cover damages from less severe floods.

The survey instrument calculated and explained the estimated annual savings on the cost of flood insurance to that particular homeowner from signing up for this hypothetical program. For a person who had insurance at the time of the survey, savings were estimated by using the

homeowner's reported premium and FEMA's own estimate that discounted premiums were 40-45% of full risk rates (Hayes and Neal 2011). For survey respondents who did not have insurance at the time of the survey, full risk insurance rates and discounted insurance rates were estimated for that homeowner using their home value and assuming a 1% annual chance of substantial flood. There was only a single dichotomous choice question asking whether the respondent would sign up for a guaranteed post-flood buyout contract if they would need to have flood insurance to do so and if having the contract would mean that the cost of flood insurance would be reduced by the amount of money described by the survey. We did not elicit homeowners' WTP for such a program because this paper is focused on estimating the utility or disutility people get from a pre-contracted buyout, and expressed WTP (or WTA) for the coupled contract commingles people's utility or disutility for insurance with the value they would have for a pre-contracted buyout.

The last survey section gathered demographic, risk perception, home characteristics, flood experience, and other information to be used as explanatory variables. These questions permit us to estimate how socioeconomic factors influence WTP for the program. In particular, flood experience and risk perceptions have been shown by previous research to affect risk mitigation decisions (Atreya, Ferreira, and Michel-Kerjan 2015; Browne and Hoyt 2000).

Instrument reliability was 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 validity screening questions. Following the soft launches multiple attention filter and logical validation questions were added to ensure data quality (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.

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 (Mitchell and Carson 1989). The inclusion of protest responses in a CV analysis can bias WTP estimates. We identified and removed protest votes that met two conditions. First, the respondent stated they were unwilling to participate in the program for any amount of money. Second, they also indicated through other survey responses that they are including spurious elements in their value expression.

Conceptual Model and Data Analysis

In this paper, we estimate 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 willing to pay 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) (Boyle 2011).

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

To estimate WTP, we elicit preference information from respondents through a payment card contingent valuation survey. Preference information selected by each respondent 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:

$$c_i = \mathbf{z}_i'\boldsymbol{\beta} + u_i \quad [2]$$

where c_i represents *WTP* for respondent *i,* u_i is the random error term with mean zero and standard deviation σ, $\mathbf{z}_i'$ is a vector of independent variables that explain response variation, and $\boldsymbol{\beta}$ is the vector of coefficients. See Table 1 for a full list of variables included in $\mathbf{z}_i'\boldsymbol{\beta}$. We cannot directly observe c_i as a consequence of the payment card elicitation format; 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:

$$\Pr(c_i \subseteq (\$B_{li}, \$B_{ui}) = \Pr\left[\frac{(\$B_{li} - \mathbf{z}_i'\boldsymbol{\beta})}{\sigma} < t_i < \frac{\$B_{lu} - \mathbf{z}_i'\boldsymbol{\beta}}{\sigma}\right] \quad [3]$$

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 $\mathbf{z}_i'\boldsymbol{\beta}$ is the function representing the solution to Equation (1) defining the value being estimated (Boyle 2011).

One specification (linear) estimates this interval regression with the actual dollar values of the interval bounds, assuming that c_i is normally distributed. In that model, mean WTP is found as $E[c] = \mathbf{z}'\widehat{\boldsymbol{\beta}}$. It can include negative expressed values for WTP. A second specification

assumes that WTP is log-normally distributed, and is estimated by taking the natural-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 cannot include expressions of negative value. In that model, mean WTP is found as

$$E[c] = \exp\left(\mathbf{z}'\widehat{\boldsymbol{\beta}}\right) \exp\left(\frac{\widehat{\sigma^2}}{2}\right). \quad [4]$$

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 area would receive discounted flood insurance premiums in exchange for agreeing to accept a buyout in the event that their house is damaged by a flood and losses are more than 50% of its value. The survey asked 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 a given explanatory variable x_j on the probability of the homeowner signing up for the program:

$$P\left(y = 1 \middle| x_j\right) = \frac{\exp\left(x_j\beta\right)}{1+\exp\left(x_j\beta\right)}. \quad [5]$$

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 set of explanatory variables x_j includes factors such as income, flood experience, community attachment, and whether or not the homeowner already has flood insurance.

Respondents' preferences over these buyout programs might be affected by unobservable factors that are correlated across space. Our respondents are located in so many different zip codes that we cannot control for location at the zip-code level. Instead, we create a set of 16 state

or regional codes as indicated in Table A1 of the Appendix such that there are at least 15 observations per code. We carry out most of the regressions with these regional fixed effects. The one exception is an estimation of Equation 5 for respondents that reported having insurance and thus only has 210 observations in total. There was insufficient variation in the dichotomous outcome variable in all of the regions, so instead we cluster standard errors by region.

Hypotheses

Previous research has shown that homeowners base their flood mitigation decisions on a number of economic, social, and political factors. We draw on that work to derive the hypotheses regarding factors that will influence WTP for a pre-flood agreement for a post-flood buyout.

Browne and Hoyt (2000) and Petrolia, Landry, and Coble (2013) study demand for flood insurance; that work finds that demand for such insurance increases with income, flood experience, and risk aversion and decreases with price. Botzen and van den Bergh (2012) and Netusil, Kousky, Neupane et al. (2020) find that WTP for flood insurance depends on perceived flood risk, and Botzen, Aerts, and van den Bergh (2009) find that risk perception also influences homeowners' willingness to invest in measures to reduce the risk of flood damage to their homes. Fraser, Elmore, Godschalk et al. (2003) survey 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, and 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 find 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 and Fraser 2012). Over 50% of residents surveyed by Fraser, Elmore, Godschalk (2003) express an aversion to losing neighborhood based social networks, while others voice 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 be willing to 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, we hypothesize that homeowners have higher WTP if they believe the buyout would be good for the environment.

3. Results

Our survey yielded 491 responses after filtering surveys that were incomplete, contained logically incongruent responses, or represented protest votes. If we also remove responses from individuals that spent fewer than 7 minutes on the survey or left some answers blank, the sample has 447 responses. We carried out regressions on both sets of 491 and 447 responses and the two sets of results were not meaningfully different. For parsimony we present here only features of and results from the smaller, more conservative, sample. Note that all respondents are homeowners living within the 100-year floodplain, and 97% of the respondents are owner

occupants; this is useful, as those individuals are the focus of hazard mitigation grant programs.

The zip codes in which our respondents reside are shown in Figure 1; they are both coastal and inland, and spread across the entire U.S. Table 2 presents summary statistics on other characteristics of the sample (information on some qualitative responses is in Appendix Table A2.) Nearly 50% of the respondents have flood insurance, which is consistent with the 50% found in previous research (Dixon, Clancy, Seabury et al. 2006; Kriesel and Landry 2004). We appear to not have disproportionate survey participation by insured households. About a quarter of respondents have made a flood insurance claim before, and 10% have made a claim over $25,000. The homes in our sample are highly varied; half of them are valued between $100,000 and $250,000, 18% are more modest than that, and 30% are worth more than the $250,000 cutoff on insurable value.

Survey respondents vary widely in how likely they thought it was that their house would be hit by a very bad flood in the next 30 years, with a mean estimated chance of 47% but risk estimates ranging from 0% (it will never happen) to 100% (it's a sure thing). Figure A1 in the online Appendix gives a histogram of that variable; risk estimates are fairly even across the range of values but with spikes at 20-29%, 50-59%, and 90-100%. Those spikes surely reflect mental rounding, but there is no spike at zero. Homeowners might find flood risk more salient with ocean proximity; 10% of our sample live in designated V-zones which are subject to wave action. Only 20% of the homes in our sample are elevated against flood.

How varied are the depths of people's connections to the place in which they currently live? People living in floodplains have little faith that their neighbors would stay if offered the ability to take a buyout after a severe flood. On average, respondents expect that almost 60% of their neighbors would move, and while some optimistic folk believe all would stay, some believe

all would leave. Figure A2 shows a histogram of that variable; most responses are in percentage ranges of 40% and higher. While at least one respondent had lived in their community for a single year, respondents on average had lived in their current towns for 20 years, with one person having deep roots grown over 72 years. Over 40% of respondents have other family in town. Only 25% of respondents talk to their neighbors daily.

Our sample has few extremely wealthy people, but over 40% with income between $70,000 and $149,000. Respondents are evenly divided among age groups but more homogeneous in race with 78% white, 11% African American, and rest in other racial and ethnic groups. The average household size is 2.7. Our sample is well-educated (perhaps unsurprisingly given that they are all homeowners); 35% have a bachelor's degree and 23% have an additional advanced degree. The population relevant for our survey is just the set of people who are homeowners in flood plains, so there are no Census statistics for that group against which we can compare our sample to evaluate its representativeness.

Figure 2 shows a histogram of the percent of observations that revealed WTP for the first simple buyout program in each of the dollar-value intervals on the payment card questions. Only a handful of respondents have negative WTP for this program; 99% of them have positive net value for a pre-flood agreement to take a post-flood buyout. The largest numbers of respondents appear to have values between $100 and $450 but 15% of the observations are in the intervals of $1,200 and higher. We can find mean homeowner WTP for this buyout program by doing an interval regression of these data on just a constant. Assuming a linear specification, we find the mean homeowner WTP (the coefficient on the constant term) is $605. The log-linear specification produces a coefficient on the constant term of 5.6 and an estimate of $\hat{\sigma}$ equal to 1.6; thus, the estimated mean WTP is to $881. The log-linear specification produces a higher estimate

of mean WTP because it must drop the four observations of people who expressed negative values and because it is not forcing a symmetric normal distribution onto a distribution of WTP values that is skewed toward positive values.

To gain insight into factors that drive variation in this WTP, we carry out interval regressions of the payment-card responses as a function of a range of explanatory variables. We include regression results for two specifications in Table 3. The first column uses the actual dollar values bounding the WTP intervals (the linear specification), and the second column uses the natural log of those dollar values (the log-linear specification). Both regressions have regional fixed effects (regressions with no fixed effects are in Appendix Table A3). Our discussion of the results focuses on variables that are statistically significant in both specifications, and we on coefficient values from the more conservative linear specification.

Consistent with previous flood mitigation literature, homeowners that have a higher self-estimated flood risk appear to be willing to pay more for a guaranteed buyout. We find that 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 $6.67. 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 $334.

We asked 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 that for every percentage point increase of neighbors signing up for the program homeowners are willing to pay an additional $4.54. If one homeowner believes 30% of their neighbors would take the pre-buyout and another believes that

number to be 70%, the difference in their WTP would be $182. This finding could simply capture projection, as a person who is very willing to accept a buyout presumes their neighbors are as well. However, it may also reflect some of the community externalities of flood-mitigation buyouts; if a respondent thinks more homes are likely to be converted to open space and more people will move away, the respondent's own willingness to move may be increased because they expect the tax base and strength of the community to be reduced by such a program.

We hypothesize homeowners that have previously made a claim to be willing to pay more for the program. The coefficient on the variable for whether the homeowner had made any claim at all is negative and significant in the linear specification, but those that had made a large claim of $25,000 or more had WTP values that are statistically significantly higher than other homeowners in both specifications (and the net effect is positive in the linear specification). Homeowners in this category are found to be willing to pay an additional $357 to sign up. These homeowners are intimately aware of the risk they face and the hassles of rebuilding, and so they may be keen to participate in a buyout after the next substantial flood event.

Consistent with economic theory, households with greater income are willing to pay more for normal goods. Households in the $70,000 to $150,000 range would pay $236 more than those in the low-income category, and households making more than $150,000 were willing to pay $676 more than those in the low-income category. Respondents with a college degree are willing to pay $218 more than respondents in categories with less formal education.

Our second objective is to evaluate homeowners' willingness to participate in a similar buyout program when coupled with the 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; if they currently have insurance but do not sign up for a buyout,

their premiums will be much higher. If they do not have insurance and reject the coupled policy, they will still not have insurance and they will not have a buyout agreement.

Table 4 shows a cross tabulation of whether respondents indicate they would sign up for this coupled program against whether respondents currently have insurance. We find that 310 out of 447 respondents would be willing to accept the coupled buyout (69%). Of the 237 respondents who do not currently have flood insurance, 135 (57%) would be willing to accept this coupled buyout even though it would require them to pay for flood insurance. The rate of people who would take the coupled buyout is much higher among those who already have insurance, but only 83% rather than 100%. This means that many people who already have insurance would not accept the buyout agreement if they must maintain that insurance as a condition of the agreement.

To understand what factors might influence the likelihood a homeowner will sign up for a buyout program that requires concurrent enrollment in flood insurance, we do a logit regression on whether a respondent indicated they would sign up for the coupled program. Table 5 shows the results of the regression for all observations in the sample of 447 with regional fixed effects and for a sub-sample of 210 respondents that currently have flood insurance with standard errors clustered by region (regressions without regional controls are in Appendix Table A4). Interpreting the results for the full sample is complicated, as willingness to sign up for the coupled program reflects both the net utility people would get from the buyout and their preferences over insurance. Thus, we focus our discussion on the findings for the insured sub-sample in which at least attitudes towards insurance are more homogeneous. The regression in that second column finds strong evidence that homeowners' willingness to sign up for the buyout program coupled with insurance is significantly correlated with self-reported flood risk,

environmental concern, previous experience with filing a flood-damage claim, and race (Black respondents are willing to pay more than others). In fact, these factors are significant and positive in the full sample as well. Several other variables are significant at the 10% level in this regression (premium savings, income over 150 thousand dollars, and age over 55), but not also in the regression with all observations.

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 variables 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 2011). For binary explanatory variables we estimate the discrete difference in the 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. This method allows us to express intuitively the 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 is statistically significant and positive. The coefficient implies that a homeowner who believes their home will be flooded with 100% certainty in the next 30 years has a probability of 0.92 of signing up for the coupled buyout program. That probability is only 0.84 if the homeowner believes there is just a 50/50 chance they will be flooded.

We find environmental concerns are positively correlated with willingness to sign us for the pre-flood buyout program coupled with insurance. If a homeowner believes buyouts are good

for the environment they have a probability of signing up that is 0.94, while the signup probability is 0.79 if they do not hold that belief. Respondents have a signup probability of 0.92 if they have flood-insurance claim experience and 0.79 if they do not – a difference of 0.13. Finally, the results show race to be associated with stated sign up rates among insured respondents. The signup probability for Black respondents is 0.95, while the probabilities for White and for other respondents are 0.82 and 0.86, respectively.

4. Conclusion

This study was designed to improve understanding of homeowner preferences towards pre-flood buyout programs. We tested the relationship between demographic factors (such as flood experience, risk estimates, community attachment, and income) and homeowners' WTP for a guaranteed buyout in the event of substantial flood damage to their home. We also quantified homeowners' willingness to participate in a buyout program that is coupled with a requirement than homeowners maintain flood insurance. Results of these 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 suggest that a free policy offering pre-flood buyout agreements would improve the welfare of homeowners by an average of $605, and nearly all the homeowners we surveyed in flood plains across the U.S. would gain positive utility from being able to sign up for such an agreement. Previous research (Healy and Malhotra 2009; Davlasheridze, Fisher-Vanden, and Klaiber 2017) has found that FEMA expenditures on hazard mitigation have higher returns in terms of damage reduction than FEMA programs for post-flood recovery expenditures, and even find buyouts to be more cost-effective than other risk mitigation strategies. Our finding of

strong homeowner demand for the opportunity to pre-contract for a buyout further strengthens the argument for expanding FEMA funding for proactive buyouts, even though voters may reward post flood cleanup more than investments in damage reduction (Healy and Malhotra 2009). Homeowners in flood-risk areas would very broadly value the opportunity to commit to having their home bought out swiftly by FEMA after the next catastrophic flood.

We find that homeowners would gain more value from a pre-flood buyout agreement if they think their home is at high risk of flood damage and if they have previously had to file a large flood insurance claim. WTP for such a program is higher if a homeowner thinks that many of their neighbors would be likely to move following a major flood. This finding indicates that social factors could be important in shaping the effectiveness of a buyout program that aims to clear homes from high-risk flood plains – it may be easier to induce a whole neighborhood or community to accept buyouts together than to induce a single family to leave. Finally, we find that enthusiasm for a guaranteed buyout program increases with a homeowner's income and education. That is consistent with some research that find households with high levels of education (Landry, Okmyung, Hindsley, et al. 2007) and financial resources (Davlasheride and Fan, 2017) were more likely to re-locate away from damaged areas after Hurricane Katrina. In contrast, Landry, Okmyung, Hindsley, et al. (2007) find that high-income evacuees of Hurricane Katrina are more likely to return to their pre-disaster homes, and Smith, Carbone, Pope et al. (2006) found that high income households tended to re-build rather than sell out and move after Hurricane Andrew in Florida. It could be that the multi-year delays associated with traditional ex-post buyouts can make rebuilding more appealing to some high-income homeowners, and such people could be persuaded to pre-commit to an expedited buyout under the kind of program we study here.

Enthusiasm is more muted when homeowners are asked about a program that combines this guaranteed buyout with mandatory purchase of flood insurance with a discounted rate. Only 69% of respondents indicated they would sign up for such a coupled buyout program. Acceptance rates are higher among people who already have flood insurance, but even some of those state they would not accept a guaranteed buyout program if that would require them to keep their insurance. It may seem illogical to those respondents to have to pay for insurance if they are simply going to have to sell the house to be eliminated if it is badly damaged in a flood. We find the likelihood of accepting this kind of coupled buyout increases with self-estimated risk and flood insurance claim experience, and the likelihood is higher for Black homeowners than for respondents of other races. Respondents are also more likely to accept this coupled program if they think that they can help the environment by allowing their house to be purchased and transformed into green infrastructure to improve flood resilience.

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 and recent flood experience. 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 the great Mississippi River flood of 1993 (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, Zahram, Highfield et al. 2008; Calil, Beck, Gleason et al. 2015; Kick, Fraser, Fulkerson et al. 2011; de Vries and Fraser 2012). Furthermore, most published case studies involve only recently flooded communities. While recently flooded communities are often included in high risk zones targeted by mitigation programs, the national sample used in our study allows us to make much wider inferences.

Policy makers and floodplain managers can gain insight from these results about the potential value of pre-flood buyout agreements across various geographies 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.

We identified factors associated with 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 helpful. 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 literature on climate change paints a concerning picture of homes subject to rising sea levels and changing precipitation patterns. Furthermore, incentivizing homeowner migration and adaptation through full risk rate insurance premiums is problematic due to housing affordability concerns (Bakkensen and Ma 2020). Fan and Davlasheridze (2016) find with a sorting model that homeowners have significant positive WTP to live in communities with high levels of flood-risk mitigation activities associated with the Community Rating System, including a wide range of actions ranging from public information programs to acquisition/relocation programs. Our findings add evidence to that support for ex-ante flood-risk mitigation. Pre-flood buyout agreements could convey benefits to many homeowners in flood prone areas, allowing homeowners and communities to successfully mitigate flood risk without the regressive effects of flood-insurance rate increases.

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6. References

Atreya, Ajita, Susana Ferreira, and Erwann Michel-Kerjan. 2015. "What drives households to buy flood insurance? New evidence from Georgia." *Ecological Economics* 117: 153–161.

Bagstad, Kenneth J., Kevin Stapleton, and John R. D'agostino. 2006. "Taxes, subsidies, and insurance as drivers of United States coastal development." *Ecological Economics* 63: 285–298.

Bakkensen, Laura A. and Lala Ma. 2020. "Sorting over flood risk and implications for policy reform." *Journal of Environmental Economics and Management* 104: 102362.

Bateman, Ian J., Richard T. Carson, Brett Day, Michael Hanemann, Nick Hanley, Tannis Hett, Michael Jones-Lee, Graham Loomes, Susana Mourato, Ece Özdemiroglu, David Pearce, Robert Sugden, and John Swanson. 2002. *Economic Valuation with Stated Preference Techniques: A Manual*. Northampton Massachusetts: Edward Elgar Publishing.

Bateman, Ian J. and James Mawby. 2004. "First impressions count: Interviewer appearance and information effects in stated preference studies." *Ecological Economics* 49: 47–55.

Greer, Alex and Sherri B. Binder. 2017. "A historical assessment of home buyout policy: Are we learning or just failing?" *Housing Policy Debate* 27(3): 372-392.

Binder, Sherri B., John P. Barile, Charlene K. Baker, and Bethann Kulp. 2019. "Home buyouts and household recovery: Neighborhood differences three years after Hurricane Sandy." *Environmental Hazards* 18(2): 127-145.

Bolitzer, Benjamin and Noelwah R. Netusil. 2000. "The impact of open spaces on property values in Portland, Oregon." *Journal of Environmental Management* 59: 185–193.

Botzen, Wouter J., Jeroen C. Aerts, and Jeroen C. van den Bergh. 2009. “Willingness of homeowners to mitigate climate risk through insurance.” *Ecological Economics* 68(8-9): 2265-2277.

Botzen, Wouter J. and Jeroen C. van den Bergh. 2012. “Risk attitudes to low-probability climate change risks: WTP for flood insurance.” *Journal of Economic Behavior and Organization* 82(1): 151-166.

Boustan, Leah Platt, Matthew E. Kahn, and Paul W. Rhode. 2012. "Moving to higher ground: Migration response to natural disasters in the early twentieth century." *American Economic Review* 102(3): 238-44.

Boyle, Kevin J. 2011. “Contingent valuation in practice.” Chapter 5 in: *A Primer on Nonmarket Valuation*. Champ, P.A., Boyle, K. J. and Brown, T.C., eds. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Brody, Samuel D., Sammy Zahran, Wesley E. Highfield, Himanshu Grover, and Arnold Vedlit. 2008. “Identifying the impact of the built environment on flood damage in Texas.” *Disasters* 32(1): 1–18.

Brown, Patricia 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, Thomas C., Patricia A. Champ, Richard C. Bishop, and Daniel W. McCollum. 1996. “Which response format reveals the truth about donations to a public good?” *Land Economics*: 152-166.

Browne, Mark J., and Robert E. Hoyt. 2000. “The demand for flood insurance : Empirical evidence.” *Journal of Risk and Uncertainty* 20(3): 291–306.

Calil, Juliano, Michael W. Beck, Mary Gleason, Matthew Merrifield, Kirk Klausmeyer, and Sarah Newkirk. 2015. "Aligning natural resource conservation and flood hazard mitigation in California." *PLoS ONE* 10(7): 1–15.

Cameron, Trudy Ann, and Daniel D. Huppert. 1989. "OLS versus ML estimation of non-market resource values with payment card interval data." *Journal of Environmental Economics and Management* 17(3): 230–246.

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

Carson, Richard T. 2012. "Contingent valuation: A practical alternative when prices aren't available." *Journal of Economic Perspectives* 26(4): 27–42.

Mitchell, Robert C. and Richard T. Carson.1989. *Using Surveys to Value Public Goods: The Contingent Valuation Method*. Washington DC: Resources for the Future.

Champ, Patricia A., and Richard C. Bishop. 2006. "Is willingness to pay for a public good sensitive to the elicitation format?" *Land Economics* 82(2): 162–173.

Champ, Patricia A., Kevin J. Boyle, and Thomas C. Brown. 2017. *A Primer on Nonmarket Valuation*, 2nd edition. The Netherlands: Springer.

Costanza, Robert, William J. Mitsch, and John W. Day Jr. 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): 465–472.

Cummings, Ronald G., and Laura O. Taylor.1999. "Unbiased value estimates for environmental goods: A cheap talk design for the contingent valuation method." *American Economic Review* 89(3): 649–666.

Dalbom, Christopher, Scott A. Hemmerling, and Joshua A. Lewis. 2014. *Community Resettlement Prospects in Southeast Louisiana.* New Orleans, LA: Tulane Institute on Water Resources Law and Policy. Available at: https://biotech.law.lsu.edu/blog/Community-Resettlement-Prospects-in-Southeast-Louisiana.pdf.

Davlasheridze, Meri, and Qin Fan. 2017. "Household Adjustments to Hurricane Katrina." *Review of Regional Studies* 47(1): 93-112.

Davlasheridze, Meri, Karen Fisher-Vanden, and H. Allen Klaiber. 2017. "The effects of adaptation measures on hurricane induced property losses: Which FEMA investments have the highest returns*?" Journal of Environmental Economics and Management* 81: 93-114.

Davlasheridze, Meri, and Qing Miao. 2019. "Does governmental assistance affect private decisions to insure? An empirical analysis of flood insurance purchases." *Land Economics* 95(1): 124-145.

Deryugina, Tatyana, Laura Kawano, and Steven Levitt. 2018. "The economic impact of Hurricane Katrina on its victims: evidence from individual tax returns." *American Economic Journal: Applied Economics* 10(2): 202-33.

Dixon, Lloyd, Noreen Clancy, Seth A. Seabury, and Adrian Overton. 2006. *The National Flood Insurance Program's Market Penetration Rate : Estimates and Policy Implications*. Santa Monica, CA: Rand Corporation. Available at: https://pdfs.semanticscholar.org/fec0/e582248a7b7d2eaab1cf3ebd73791f27db41.pdf.

Fan, Qin, and Meri Davlasheridze. 2016. "Flood risk, flood mitigation, and location choice: evaluating the National Flood Insurance Program's Community Rating System." *Risk Analysis* 36(6): 1125-1147.

Fraser, James, Rebecca Elmore, David Godschalk, and William Rohe. 2003. *Implementing Floodplain Land Acquisition Programs in Urban Localities.* Chapel Hill, NC: Center for Urban and Regional Studies at UNC Chapel Hill.

Greer, Alex, and Sherri B. Binder 2017. "A historical assessment of home buyout policy: Are we learning of just failing?" *Housing Policy Debate* 27(3): 372-392.

Hayat, Becky, and Robert Moore. 2015. "Addressing affordability and resiliency through the National Flood Insurance Program." *Environmental Law Reporter* 45: 10338 – 10349.

Hayes, Thomas L. and D. Andrew Neal. 2011. *Actuarial Rate Review: In Support of the Recommended October 1, 2011, Rate and Rule Changes*. Washington, DC: FEMA. Available at: http://www.fema.gov/media-library-data/20130726-1809-25045-6893/actuarial_rate_review2011.pdf.

Healy, Andrew, and Neil Malhotra. 2009. "Myopic Voters and Natural Disaster Policy." *American Political Science Review* 103(3): 387.

Hirabayashi, Yukiko, Roobavannan Mahendran, Sujan Koirala, Lisako Konoshima, Dai Yamazaki, Satoshi Watanabe, Hyungjun Kim, and Shinjiro Kanae. 2013. "Global flood risk under climate change." *Nature Climate Change* 3(9): 816.

Intergovernmental Panel on Climate Change (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*, [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. Geneva, Switzerland: IPCC.

Kerr, Alexander M., and Andrew H. Baird. 2007. “Natural barriers to natural disasters.” *BioScience* 57(2): 102.

Kick, Edward L., James C. Fraser, Gregory M. Fulkerson, Laura A. McKinney, and Daniel H. De Vries. 2011. “Repetitive flood victims and acceptance of FEMA mitigation offers: An analysis with community-system policy implications.” *Disasters* 35(3): 510–539.

King, Rawle O. 2012. *National Flood Insurance Program: Background, Challenges, and Financial Status*. Washington, DC: Congressional Research Service.

Kousky, Carolyn. 2014. “Managing shoreline retreat: a U.S. perspective.” *Climatic Change* 124: 9-20.

Kousky, Carolyn and Margaret Walls. 2014. “Floodplain conservation as a flood mitigation strategy: Examining costs and benefits.” *Ecological Economics* 104: 119-128.

Kousky, Carolyn, Brett Lingle, and Leonard Shabman.2017. “The pricing of flood insurance.” *Journal of Extreme Events* 4(2): 1750001.

Kousky, Carolyn, Erwann O. Michel-Kerjan, and Paul A. Raschky. 2018. "Does federal disaster assistance crowd out flood insurance?” *Journal of Environmental Economics and Management* 87: 150-164.

Kriesel, Warren, and Craig Landry. 2004. “Participation in the National Flood Insurance Program: An empirical analysis for coastal properties.” *Journal of Risk and Insurance* 71(3): 405–420.

Landry, Craig E., Okmyung Bin, Paul Hindsley, John C. Whitehead, and Kenneth Wilson. 2007. “Going home: Evacuation-migration decisions of Hurricane Katrina survivors," *Southern Economic Journal* 74: 326-343.

Mach, Katharine J., Caroline M. Kraan, Miyuki Hino, A. R. Siders, Erica M. Johnston, and Christopher B. Field. 2019. "Managed retreat through voluntary buyouts of flood-prone properties." *Science Advances* 5(10): p.eaax8995.

Mallakpour, Iman, and Gabriele Villarini. 2015. "The changing nature of flooding across the central United States." *Nature Climate Change* 5(3): 250–254.

National Research Council, 2014. *Reducing Coastal Risk on the East and Gulf Coasts*. Washington, D.C.: National Academies Press.

National Oceanic and Atmospheric Administration (NOAA), 2013. *National Coastal Population Report: Population Trends from 1970 to 2020*. Washington, D.C.: NOAA.

Netusil, Noelwah R., Carolyn Kousky, Shulav Neupane, Will Daniel, and Howard Kunreuther. 2020. "The Willingness to Pay for Flood Insurance." Forthcoming in *Land Economics*. Wharton Risk Management and Decision Processes Center Working Paper 2020-3. Available at https://riskcenter.wharton.upenn.edu/wp-content/uploads/2020/09/Working-Paper-2020-03_Willingness-To-Pay-for-Flood-Insurance.pdf.

Petrolia, Daniel R., Craig E. Landry, and Keith H. Coble. 2013. "Risk preferences, risk perceptions, and flood insurance." *Land Economics* 89(2): 227-245.

Reeser, Collin. 2016. *Homeowner Willingness to Pay for a Pre-Flood Buyout Agreement*. MS Thesis, University of Illinois Urbana-Champaign.

Rowe, Robert D., William D. Schulze, and William S. Breffle. 1996. "A test for payment card biases." *Journal of Environmental Economics and Management* 31: 178–185.

Shepard, Christine C., Caitlin M. Crain, and Michael W. Beck. 2011. "The protective role of coastal marshes: A systematic review and meta-analysis." *PLoS ONE* 6(11): e27374.

Smith, V. Kerry, Jared C. Carbone, Jaren C. Pope, Daniel G. Hallstrom, and Michael E. Darden. 2006. "Adjusting to natural disasters." *Journal of Risk and Uncertainty* 33(1-2): 37-54.

Tockner, Klement and Jack A. Stanford. 2002. "Riverine flood plains: present state and future trends." *Environmental Conservation* 29(3): 308-330.

Tonsor, Glynn T., and Robert S. Shupp. 2011. "Cheap talk scripts and online choice experiments: 'Looking beyond the mean.'" *American Journal of Agricultural Economics* 93(4): 1015–1031.

U.S. Government Accountability Office (USGAO). 2004. *National Flood Insurance Program: Actions to Address Repetitive Loss Properties. Report No. GAO-04-401T*. https://www.gao.gov/.

U.S. Government Accountability Office (USGAO). 2015. *Flood Insurance: Status of FEMA's Implementation of the Biggert-Waters Act, as Amended. Report No. GAO-15-178*. https://www.gao.gov/.

U.S. Government Accountability Office (USGAO). 2016. *Continued Progress Needed to Fully Address Prior GAO Recommendations on Rate - Setting Methods. Report No. GAO-16-59*. https://www.gao.gov/.

de Vries, Daniel H. and James C. Fraser. 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): 1–33.

Weber, Anna and Moore, Robert. 2019. *Going Under Water: Long Wait Times for Post-Flood Buyouts Leave Homeowners Underwater*. NRDC Report 19-08-A. Chicago, IL: Natural Resources Defense Council. Available at: https://www.nrdc.org/sites/default/files/going-under-post-flood-buyouts-report.pdf.

Wooldridge, Jeffrey M. 2011. *Introductory Econometrics 5th ed*. Mason Ohio: South-Western CENGAGE Learning.

Wriggins, Jennifer. 2014. "Flood money : The challenge of U.S. flood insurance reform in a warming world." *Penn State Law Review* 119(2): 361-437.

Zavar, Elyse. 2015. "Residential perspectives: The value of floodplain-buyout open space." *Geographical Review* 105(1): 8–95.

Table 1: Variable definitions

Variable name	Definition
Estimated risk	What do you think the probability is your home will be hit by a flood in the next 30 years? (0-100)
Neighbors move %	Estimate of % of neighbors that would take a buyout (0-100)
Inhabitants	Number of people living in household
Years in town	How many years have you lived in your town?
Family in town	Has family in town
Neighbor talk daily	I communicate with my neighbors daily
Environmental concern	Agree buyouts are good for the environment
Ocean	Home in V zone: Subject to wave action
Ever claim	Has made a flood insurance claim on your home
Ever claim over $25k	Has made a claim for more than $25,000
Home value $100 to $250k	Home Value is $100,000 to $250,000
Home value $250k+	Home Value is $250,000 and above
HasInsurance	Home is currently covered by flood insurance
Premium ($)	Annual flood insurance premium
PremiumSavings ($)	Amount per year would save on premium if take coupled buyout
Home raised	Has your home ever been elevated?
Income $70K to $149K	Income $70,000 to $149,000
Income $150K+	Income Above $150,000
Age 35 to 54	Age 35 to 54
Age 55+	Age 55 and older
College degree	Bachelor's degree completed
Advanced degree	Advanced degree completed
White	White
Black	Black

Table 2: Summary statistics

Variable name	N	Mean	SD	Min	Max
Estimated risk	447	47.4	28.6	0	100
Neighbors move %	447	58.6	25.3	0	100
Years in town	447	20.0	14.3	1	72
Family in town	447	0.43	0.50	0	1
Neighbor talk daily	447	0.25	0.43	0	1
Environmental concern	447	0.26	0.44	0	1
Home raised	447	0.19	0.39	0	1
Ocean	447	0.10	0.30	0	1
HasInsurance?	447	0.47	0.50	0	1
Premium/yr ($100)	447	6.00	12.5	0	120
Ever claim	447	0.27	0.44	0	1
Ever claim over $25k	447	0.10	0.30	0	1
Home value $100k to $250k	447	0.52	0.50	0	1
Home value $250k+	447	0.30	0.46	0	1
Income $70K to $149K	447	0.43	0.50	0	1
Income $150K+	447	0.07	0.26	0	1
Inhabitants	447	2.73	1.40	0	8
Age 35 to 54	447	0.31	0.46	0	1
Age 55+	447	0.39	0.49	0	1
College degree	447	0.35	0.48	0	1
Advanced degree	447	0.23	0.42	0	1
White	447	0.78	0.42	0	1
Black	447	0.11	0.31	0	1

Table 3: Interval regression results for willingness to pay

	Linear (N=447)		Ln (N=443)	
	Coefficient	S.E.	Coefficient	S.E.
Estimated risk	6.665***	1.714	0.014***	0.003
Neighbors move %	4.542***	1.812	0.005*	0.003
Years in town	4.439	3.138	0.007	0.005
Family in town	30.80	90.26	0.137	0.144
Neighbor talk daily	46.82	99.70	0.050	0.160
Environmental concern	104.4	93.61	0.343**	0.149
Home raised	133.2	111.8	0.303*	0.179
Ocean	-51.01	142.4	-0.234	0.228
HasInsurance?	-116.6	100.2	-0.202	0.160
Premium/yr ($)	8.895**	3.985	0.002	0.006
Ever claim	-261.0**	121.8	-0.229	0.193
Ever claim over $25k	618.0***	169.8	0.600**	0.269
Home value $100 to $250k	59.38	114.7	0.346*	0.184
Home value $250k+	19.57	132.7	0.282	0.214
Income $70K to $149K	235.6**	97.10	0.621***	0.154
Income $150K+	676.2***	182.7	1.13***	0.289
Inhabitants	40.36	34.36	0.099*	0.054
Age 35 to 54	-110.0	108.5	-0.412**	0.173
Age 55+	-39.14	118.0	-0.084	0.188
College degree	218.2**	96.59	0.354**	0.152
Advanced degree	155.7	119.0	0.348*	0.191
White	111.4	134.5	0.148	0.213
Black	-113.8	179.8	-0.081	0.288
Regional fixed effects	y		y	
ln(σ)	6.718***	0.036	0.262***	0.038
Σ[a]	827.5	29.81	1.300	0.049
Log likelihood	-1426.0028		-961.40562	

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

[a] σ is calculated from the estimated ln(σ).

Table 4: Stated willingness to accept buyout coupled with flood insurance

		Willing to accept buyout coupled with flood insurance?		
		Yes	**No**	**Total**
Currently have flood insurance?	**Yes**	175	35	210
	No	135	102	237
	Total	310	137	447

Table 5: Logit regression results

Variable	All observations (N=447)		Respondents with insurance (N=210)	
	Coefficient	S.E.	Coefficient	S.E.
Estimated risk	0.022***	0.006	0.018**	0.010
Neighbors move %	0.005	0.006	0.012	0.010
Years in town	0.025**	0.010	-0.001	0.010
Family in town	-0.609**	0.292	-0.125	0.445
Neighbor talk daily	-0.274	0.315	-0.696	0.431
Environmental concern	0.973***	0.311	1.70***	0.578
Home raised	0.536	0.407	0.836	0.824
Ocean	-0.001	0.470	1.01	0.657
HasInsurance?	0.744	0.657		
PremiumSavings	-0.095	0.064	-0.020*	0.011
HasInsurance?* PremiumSavings	0.071	0.065		
Ever claim	0.732*	0.432	1.28***	0.485
Ever claim over $25k	0.245	0.693	0.181	1.07
Home value $100 to $250k	0.396	0.427	0.104	0.755
Home value $250k+	-0.007	0.559	-0.445	0.778
Income $70K to $149K	0.741**	0.308	0.537	0.393
Income $150K+	1.22**	0.630	1.55*	0.874
Inhabitants	0.264**	0.113	0.089	0.144
Age 35 to 54	-0.510	0.360	0.012	0.317
Age 55+	0.410	0.360	1.53*	0.808
College degree	-0.154	0.303	0.320	0.433
Advanced degree	-0.080	0.358	-0.239	0.406
White	0.139	0.410	-0.422	0.487
Black	3.42***	1.13	1.37***	0.441
Constant	regional fixed effects		-1.14	1.65
Clustered standard errors?	n		y	
Log likelihood	-172.09509		-72.658392	

The dependent variable is a dummy variable equal to 1 if the respondent states they would accept the buyout program coupled with flood insurance and 0 otherwise.

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

Figure 1: Spatial distribution of survey respondents by zip codes

Note: Each dot indicates a zip code from which survey responses were obtained.

Figure 2: Interval observations of willingness to pay for a guaranteed buyout (N=447)

Endnotes

[1] The National Flood Hazard Layer (NFHL) is a digital database that contains flood hazard mapping data from FEMA's National Flood Insurance Program (NFIP).

www.fema.gov/national-flood-hazard-layer-nfhl