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

Amy W. Ando *Professor, University of Illinois, Urbana-Champaign; University Fellow, Resources for the Future, Urbana; amyando@illinois.edu*

Collin Reeser *MSc student, University of Illinois, Urbana-Champaign; Owner, Reeser Brothers Farms, Champaign; creeser2@gmail.com*

ABSTRACT *Homeowner buyout programs promote climate adaptation efforts by removing homes from floodplains. We estimate homeowner willingness to pay (WTP) for a novel agreement in which they precommit 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.* (JEL Q51, Q54)

1. Introduction

Flood events are expected to increase in frequency and severity as climate change raises sea levels and intensifies regional precipitation events (Hirabayashi 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). Federal Emergency Management Agency (FEMA) recovery programs have had to expand to help communities and households that do not have flood insurance to compensate for damaging flood events (Kousky, Erwann, Michel-Kerjan 2018). As discounts place federal insurance premiums below their risk-adjusted value (Hayes and Neal 2011; Kousky, Lingle, and Shabman 2017), 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 by 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 article 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 the home until a flood event causes damage greater than 50% of the home value (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 NFIP. We estimate the welfare effects of such a policy on floodplain homeowners by quantifying their willingness to pay (WTP) 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 develop an estimate of the fraction of floodplain homeowners who would be willing to take part in a particular buyout program coupled with flood insurance that has been

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proposed in the literature (Hayat and Moore 2015).

Flood losses have consistently imposed the highest fiscal costs of any natural disaster (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 live 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 floodplain properties from natural flooding and paved the way for them to be developed (Boustan, Kahn, and Rhode 2012). Furthermore, federal programs, such as discounted federal flood insurance and FEMA risk-mitigation and community assistance programs, have unintentionally increased 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 floodplain 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 nonactuarially fair insurance is expensive. NFIP net outlays are also high because NFIP flood insurance rate maps are commonly a decade or more out of date and are based on past flood experience rather than on future flood risk, which is shifting because of 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 et al. 2020); however, uncovered households often receive some form of disaster relief through FEMA 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 NFIP, the 2012 Biggert-Waters Flood Insurance Reform Act 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 premium increases raised immediate concerns of housing affordability, particularly for low-income households. This criticism resulted in the 2014 Homeowner Flood Insurance Affordability Act, 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 they have been used for decades as a permanent means of reducing future flood-risk exposure in flood zones (de Vries and Fraser 2012; Zavar 2015; Greer and Binder 2017). 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 et al. 2019). However, buyout programs can reduce flood risk for properties elsewhere in the community. As coastal and riverine communities have expanded, wetlands and other natural flood-protection barriers were drained and developed. Consequently, properties farther from bodies of water were at increased risk of flood (Costanza, Mitsch, and Day 2006; Kerr 2007). After a buyout, land can be restored to a protective state to help prevent damage to other homes and provide ecological benefits (Tockner and Stanford 2002; Shepard, Crain, and Beck 2011). Property values in surrounding areas can be increased by proximity to restored and protected floodplain areas (Bolitzer and Netusil 2000; Kousky and Walls 2014).

Federal spending on long-term mitigation programs, including preemptive buyouts, is limited, even though research finds that hazard mitigation has higher returns than postdisaster cleanup (Davlasheridze, Fisher-Vanden, and Klaiber 2017). Thus, most homeowner buyout programs in the past have focused on contracting to buy out properties after they have been damaged by flooding (de Vries and Fraser 2007; Dalbom, Hemmerling, and Lewis 2014; Greer and Binder 2017). 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 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 at the spatial and temporal analysis of public data on all 43,633 voluntary FEMA buyouts from 1989 to 2017 (Mach et al. 2019). Buyouts are most common in some states with high levels of flood damage (Missouri, Texas, Illinois, North Carolina, and Iowa), but there are other states (Florida, Mississippi, and Louisiana) that have low levels of buyouts despite high levels of flood damage. Even though flood damage is growing in the United States, the number of individual properties bought out has declined slightly over time (the highest number of buyouts in a single year was initiated in the wake of the massive 1993 Mississippi River flood). Mach et al. (2019) find that the likelihood a county has buyouts increases with flood risk, average income, and population density, but the neighborhoods where buyouts are concentrated are relatively poor and racially diverse. It is not possible to tell from these analyses whether the socioeconomic patterns in the observed buyouts 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 study estimates WTP 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 whole communities (Brown 1996). 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 et al. (2019) find that conventional buyouts without this kind of agreement have taken an average of 5.7 years to complete after the flood event. On the other hand, the homeowner would be giving up the option to reconsider and rebuild the home in the same location after a flood occurred; that loss of option value may represent a significant disutility to people 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 for the certainty of a guaranteed and expedited buyout, or how much would they have to be paid to be willing to accept it? No research yet exists to answer that question; this study 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 coupled with the mandated purchase of flood insurance. Those results inform likely efforts to implement a program of pre-flood contracts for post-flood buyouts given that administration of such a program would likely be coupled with 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 methods can be used to elicit values in CE surveys (Bateman et al. 2002; Champ and Bishop 2006). Dichotomous choice (DC) approaches give a dollar value and ask whether the respondent would be willing to pay that amount, and they 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. We use the payment card elicitation format, which is more reliable than open-ended questions and more efficient than DC (Brown 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 willing 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. 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 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 differentiate among the levels of the bids (Rowe, Schulze, and Breffle 1996).

We took steps in other elements of the survey 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 where possible to avoid ordering effects (Bateman 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 (Cummings and Taylor 1999; Tonsor and Shupp 2011) that informs respondents that some survey takers tend to misstate their actual WTP and encourages them to be more cognizant of this, 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

Before the online survey was administered, feedback from three focus groups of homeowners in flood-prone areas was used to ensure that respondents would 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 2016, the survey was distributed to a Qualtrics participant panel, from which we collected 491 responses. Respondents were recruited from zip codes containing flood zones in the 100-year floodplain. To be eligible to take the survey, a respondent needed to own the own home and verify the flood zone code through the FEMA National Flood Hazard Layer (NFHL) tool. [1] The Qualtrics online platform was selected because of its large national panel, ability to quickly

[1] NFHL is a database that contains flood hazard mapping data from NFIP (www.fema.gov/national-flood-hazard-layer-nfhl).

screen thousands of panel members on specific criteria, and cost of administration.

The full survey is in the Appendix. It begins with a series of eligibility screens to ensure the respondent is a homeowner, living in the 100-year floodplain, and over the age of 18. Floodplain status is determined by asking the respondent to enter their address into the NFHL tool. The tool displays information about the flood zone for that address, and the respondent enters the flood zone code into the screening question. If the code indicates presence in the 100-year floodplain, the respondent is allowed to continue the survey.

The second section of the survey provides the respondent with background information on flood risk and describes what homeowners can do if their house is severely damaged in a flood, including brief information about the nature of conventional post-flood buyout programs. This ensures that the respondent understands the status quo policy against which they should compare the hypothetical new contract to be valued.

Section 3 of the survey describes the features of a hypothetical pre-flood guaranteed buyout program. In short, this program is a pre-flood agreement that guarantees a homeowner that their home will be bought in an expedited manner if a flood causes more than 50% of the value of their house to be lost. In exchange, the homeowner is required to accept that buyout and relocate after such an event.

Respondents are then presented with an ordered series of hypothetical payment values and asked to mark "yes" or "no" for each to indicate whether they would be willing to pay that amount to be able to sign up for such a contract. The payment values are 11 exponentially ascending dollar amounts ranging from $0 to $3,500. If a respondent is not willing to pay to participate ("no" is selected for all dollar amounts), another payment card option is shown that asks how much a respondent would need to be paid to participate in the program.

The survey has both willingness to accept (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 asks homeowners if they would be willing to sign up for a slightly different kind of buyout program. This guaranteed/required post-flood buyout agreement is similar to the agreement described in the previous WTP/WTA question. However, this hypothetical buyout program is only available to homeowners with flood insurance. In the case of a minor flood, the homeowner would receive the usual insurance payments for repairs. However, in the 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 the home and need to move. No homeowner without flood insurance would be able to precontract 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 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 with insurance at the time of the survey, savings were estimated by using the homeowner's reported premium and the FEMA 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 described in the survey. We did not elicit homeowners' WTP for such a program because we focused on estimating the utility or disutility people get from a precontracted 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 precontracted buyout.

The last survey section gathers demographics, 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 (Browne and Hoyt 2000; Atreya, Ferreira, and Michel-Kerjan 2015).

Instrument reliability was enhanced through a number of presurvey 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 that 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 removed respondents who failed to provide logically consistent answers throughout the survey.

Some individuals respond to CV questions by reporting that 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). Including protest responses in a CV analysis can bias WTP estimates. We identified and removed protest votes that met two conditions. First, the respondent stated an unwillingness to participate in the program for any amount of money. Second, the respondent indicated through other survey responses that there are spurious elements in their value expression.

Conceptual Model and Data Analysis

We estimate homeowners' WTP to sign up for the pre-flood buyout agreement. 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 put on the different components but 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 $\mathbf{p}^1$ to achieve the same level of utility as they would have without the buyout program (Q^0, p^0) (Boyle 2011):

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

To estimate WTP, we elicit preference information from respondents through a payment card CV 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 this analysis, we estimate coefficients for a number of explanatory variables (see Table 1). Individual WTP values can be estimated as

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

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 β 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

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

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 $E[c] = \mathbf{z}'\hat{\boldsymbol{\beta}}$. 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 ($\$B_{li}$,$\$B_{li}$). Cameron and Huppert (1989) show that this transformation is a better fit for the expected skewness of the value distribution, but it cannot include expressions of negative value. In that model, mean WTP is found as

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

We use a second regression to examine homeowners' willingness to participate in a buyout program coupled with flood insurance. That hypothetical program is similar to that 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 if the home 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

Table 1
Variable Definitions

Variable	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 >$25k	Has made a claim for more than $25,000
Home value $100–$250k	Home value is $100,000–$250,000
Home value $250k+	Home value is $250,000 and higher
Has insurance	Home is currently covered by flood insurance
Premium ($)	Annual flood insurance premium
Premium savings ($)	Amount per year would save on premium if take coupled buyout
Home raised	Has your home ever been elevated?
Income $70k–$149k	Income $70,000–$149,000
Income $150k+	Income above $150,000
Age 35–54	Age 35–54
Age 55+	Age 55 and older
College degree	Bachelor's degree completed
Advanced degree	Advanced degree completed
White	White
Black	Black

insurance payments they would realistically obtain. 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:

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

In this model, y is the binary response variable that takes a value of one if the respondent will sign up for the program and zero if they decline. The set of explanatory variables x_j includes factors such as income, flood experience, community attachment, and whether 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 Appendix Table A1 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 who reported having insurance, and thus it only has 210 observations in total. There was insufficient variation in the dichotomous outcome variable in all 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 and find that demand for such insurance increases with income, flood experience, and risk aversion, and it decreases with price. Botzen and van den Bergh (2012) and Netusil 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 et al. (2003) surveyed residents and flood management officials in communities that had recently participated in a post-flood buyout to examine factors contributing to success and failure of buyout programs. They find risk, neighborhood attachment, and buyout process factors such as trust, communication, and timing to be important predictors, and 37% of their sample indicated that future flood risk was very important in the 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 WTA a buyout (de Vries and Fraser 2012). Over 50% of residents surveyed by Fraser et al. (2003) expressed an aversion to losing neighborhood-based social networks, whereas others voiced an eagerness to leave as they perceived the neighborhood to be in decline. The FEMA Flood Acquisition Manual from 1998 also identifies size of household and opinions of family and friends as influential over property owners' decisions to participate in a buyout.

From these findings, we hypothesize that 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 that 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 a higher WTP if they believe the buyout would be good for the environment.

3. Results

Our survey yielded 491 responses after filtering those that were incomplete, contained logically incongruent responses, or represented protest votes. If we also remove responses from individuals that spent fewer than seven 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 only features of and results from the smaller, more conservative sample. Note that

Figure 1
Spatial Distribution of Survey Respondents by Zip Codes

all respondents are homeowners living in the 100-year floodplain, and 97% of respondents are owner occupants; this is useful, as those individuals are the focus of hazard mitigation grant programs.

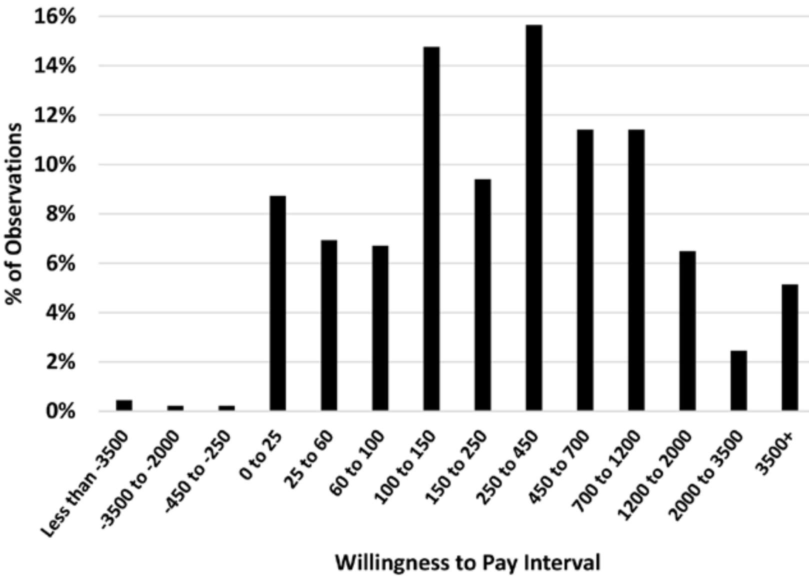
The zip codes in which our respondents reside are shown in Figure 1; they are both coastal and inland and are spread across the United States. Table 2 presents summary statistics on other characteristics of the sample (information on some qualitative responses is in Appendix Table A2). Nearly 50% of the respondents have flood insurance, which is consistent with the 50% found in previous research (Kriesel and Landry 2004; Dixon et al. 2006). We appear to not have disproportionate survey participation by insured households. About one-quarter of respondents have made a flood insurance claim, and 10% have made a claim over $25,000. The homes in our sample are highly varied; half are valued between $100,000 and $250,000, 18% are more modest, 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 risk estimates ranging from 0% (it will never happen) to 100% (it is a sure thing); the mean estimated chance is 47%. Appendix Figure A1 is a histogram of that variable; risk estimates are fairly even across the range of values but show 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%

Table 2
Summary Statistics

Variable	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
Has insurance	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 >$25k	447	0.10	0.30	0	1
Home value $100k–$250k	447	0.52	0.50	0	1
Home value $250k+	447	0.30	0.46	0	1
Income $70k–$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 35–54	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

Figure 2
Interval Observations of Willingness to Pay for a Guaranteed Buyout ($N = 447$)



of our sample live in designated V-zones that 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 option 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. Appendix Figure A2 shows a histogram of that variable; most responses are in 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% have incomes between \$70,000 and \$149,000. Respondents are evenly divided among age groups but are more homogeneous in race, with 78% White, 11% Black, and the rest in other racial and ethnic groups. The average household size is 2.7 people. Our sample is well educated: 35% have a bachelor's degree, and 23% have an advanced degree. The population relevant for our survey is just the set of people who are homeowners in floodplains, 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 percentage of observations that revealed WTP for the first simple buyout program in the dollar-value intervals on the payment card questions. Only a handful of respondents have negative WTP for this program; 99% 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 it to be \$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 \$881. The log-linear specification produces

Table 3
Interval Regression Results for Willingness to Pay

	Linear (*N*=447)		Ln (*N*=443)	
	Coefficient	SE	Coefficient	SE
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
Has insurance	−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 >$25k	618.0***	169.8	0.600**	0.269
Home value $100–$250k	59.38	114.7	0.346*	0.184
Home value $250k+	19.57	132.7	0.282	0.214
Income $70k–$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 35–54	−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	Yes		Yes	
ln(σ)	6.718***	0.036	0.262***	0.038
Σ	827.5	29.81	1.300	0.049
Log-likelihood	−1,426.0028		−961.40562	

Note: σ is calculated from the estimated ln(σ).
***, **, * Significance at the 1%, 5%, and 10% levels, respectively.

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 the 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 focus on coefficient values from the more conservative linear specification.

Consistent with previous flood-mitigation literature, homeowners with 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 1 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 who 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-flood 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 willing to accept a buyout presumes their neighbors feel the same. 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, their 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 that homeowners who have previously made a claim are 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, so they may be keen to participate in a buyout after the next substantial flood event.

Consistent with economic theory, households with higher incomes are willing to pay more for normal goods. Households in the $70,000–$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

Stated Willingness to Accept Buyout Coupled with Flood Insurance

		Willingness To Accept Buyout Coupled with Flood Insurance		
		Yes	No	Total
Currently has flood insurance	Yes	175	35	210
	No	135	102	237
	Total	310	137	447

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 (69%) respondents would be willing to accept the coupled buyout. 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 subsample of 210 respondents who 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 the net utility people would get from the buyout and their preferences over insurance. Thus, we focus our discussion on the

Table 5
Logit Regression Results

Variable	All Observations (*N*=447) Coefficient	SE	Respondents with Insurance (*N*=210) Coefficient	SE
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
Has insurance	0.744	0.657		
Premium savings	−0.095	0.064	−0.020*	0.011
Has insurance *premium savings	0.071	0.065		
Ever claim	0.732*	0.432	1.28***	0.485
Ever claim >$25k	0.245	0.693	0.181	1.07
Home value $100–$250k	0.396	0.427	0.104	0.755
Home value $250k+	−0.007	0.559	−0.445	0.778
Income $70k–$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 35–54	−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 SEs	No		Yes	
Log-likelihood	−172.09509		−72.658392	

Note: The dependent variable is a dummy variable equal to one if the respondent states they would accept the buyout program coupled with flood insurance and zero otherwise.
***, **, * Significance at the 1%, 5%, and 10% levels, respectively.

findings for the insured subsample in which at least attitudes toward 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 $150,000, 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 nonlinear 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 signup 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 APE. This method allows us to express intuitively the probability of signup 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 that environmental concerns are positively correlated with willingness to sign up for the pre-flood buyout program coupled with insurance. If a homeowner believes buyouts are good for the environment, their probability of signing up is 0.94, whereas 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 signup rates among insured respondents. The signup probability for Black respondents is 0.95, and the probabilities for White and for other respondents are 0.82 and 0.86, respectively.

4. Conclusion

This study was designed to improve the understanding of homeowner preferences toward pre-flood buyout programs. We tested the relationship between demographic factors (e.g., 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 coupled with a requirement that they maintain flood insurance. Results of these analyses can be used by policy makers 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 floodplains across the United States would gain positive value 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 precontract 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 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 after 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 floodplains—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. This is consistent with research that find households in the Gulf region with high levels of education (Landry et al. 2007) and financial resources (Davlasheridze and Fan 2017) were more likely to relocate from damaged areas after Hurricane Katrina. In contrast, Landry et al. (2007) find that high-income evacuees of Hurricane Katrina are more likely to return to their predisaster homes, and Smith et al. (2006) found that high-income households tended to rebuild rather than sell out and move after Hurricane Andrew in Florida. It could be that the multiyear delays associated with traditional ex post buyouts can make rebuilding more appealing to some high-income homeowners, and such people could be persuaded to precommit 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 it 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 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. In addition, 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 that 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 that homeowners would be more inclined to participate in buyout programs if environmental/sustainability components are included in the structure of post-buyout planning, and the environmental benefits of land restoration are included in educational material used to inform property owners.

Much of the risk-mitigation literature examines flood mitigation at a local or regional level (Brody et al. 2008; Kick et al. 2011; de Vries and Fraser 2012; Calil et al. 2015). Furthermore, most published case studies involve only recently flooded communities. Recently flooded communities are often included in high-risk zones targeted by mitigation programs, but 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 be exercised in applying our results to program evaluation if details of the proposed program stray far from those presented to our survey respondents. Furthermore, actual participation rates in buyout programs may be lower than stated owing 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 CE analysis examining which components homeowners value, which ones they hold little or negative value for, and how those components vary across homeowner characteristics.

Since its inception, NFIP was designed to provide affordable flood insurance that assists homeowners in rebuilding after flood events. While NFIP policies mandate smarter building codes, homes rebuilt 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 because of 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 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 insurance rate increases.

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References

Atreya, Ajita, Susana Ferreira, and Erwann Michel-Kerjan. 2015. "What Drives Households to Buy Flood Insurance? New Evidence from Georgia." *Ecological Economics* 117: 153–61.

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: 285–98.

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, *et al*. 2002. *Economic Valuation with Stated Preference Techniques: A Manual*. Northampton, MA: Edward Elgar.

Bateman, Ian J., and James Mawby. 2004. "First Impressions Count: Interviewer Appearance and Information Effects in Stated Preference Studies." *Ecological Economics* 49: 47–55.

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): 127–45.

Bolitzer, Benjamin, and Noelwah R. Netusil. 2000. "The Impact of Open Spaces on Property Values in Portland, Oregon." *Journal of Environmental Management* 59: 185–93.

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): 2265–77.

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): 151–66.

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." In *A Primer on Nonmarket Valuation*, edited by P. A. Champ, K. J. Boyle, and T. C. Brown. Dordrecht, The Netherlands: Kluwer.

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*, May 6. Available at http://www.nytimes.com/1996/05/06/us/higher-and-drier-illinois-town-is-reborn.html.

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* 72 (2): 152–66. https://doi.org/10.2307/3146963.

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 Nonmarket Resource Values with Payment Card Interval Data." *Journal of Environmental Economics and Management* 17 (3): 230–46.

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.

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): 162–73.

Champ, Patricia A., Kevin J. Boyle, and Thomas C. Brown. 2017. *A Primer on Nonmarket Valuation.* 2nd ed. Dordrecht, 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): 465–72.

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): 649–66.

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): 124–45.

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.

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. 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): 1125–47.

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 University of North Carolina.

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): 372–92.

Hayat, Becky, and Robert Moore. 2015. "Addressing Affordability and Resiliency through the National Flood Insurance Program." *Environmental Law Reporter* 45: 10338–49.

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: Federal Emergency Management Agency. 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.

IPCC (Intergovernmental Panel on Climate Change). 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*. Geneva.

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): 510–39.

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, 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: 150–64.

Kousky, Carolyn and Margaret Walls. 2014. "Floodplain Conservation as a Flood Mitigation Strategy: Examining Costs and Benefits." *Ecological Economics* 104: 119–28.

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): 405–20.

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: 326–43.

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): 250–54.

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

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

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

Netusil, Noelwah R., Carolyn Kousky, Shulav Neupane, Will Daniel, and Howard Kunreuther. 2020. "The Willingness to Pay for Flood Insurance." 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): 227–45.

Reeser, Collin. 2016. "Homeowner Willingness to Pay for a Pre-flood Buyout Agreement." M.S. 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: 178–85.

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): 308–30.

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): 1015–31.

USGAO (U.S. Government Accountability Office). 2004. *National Flood Insurance Program:*

Actions to Address Repetitive Loss Properties. Report GAO-04-401T. Available at https://www.gao.gov/products/gao-04-401t.
———. 2015. *Flood Insurance: Status of FEMA's Implementation of the Biggert-Waters Act, as Amended*. Report GAO-15-178. Available at https://www.gao.gov/products/gao-15-178.
———. 2016. *Continued Progress Needed to Fully Address Prior GAO Recommendations on Rate-Setting Methods.* Report GAO-16-59. Available at https://www.gao.gov/products/gao-16-59.
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, OH: 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.