The impact of regret and worry on the threshold level of concern for flood insurance demand: Evidence from Dutch homeowners

Peter John Robinson*   W. J. Wouter Botzen[†]

Abstract

It has been argued that individuals behave according to a threshold level of concern decision rule when considering protection against risk: if the perceived probability of the risk is below a threshold level, then the likelihood of the risk is treated as zero and protection is deemed unnecessary. Little is known about the determinants of this threshold nor about whether individual thresholds are related to risk specific emotions like worry and regret. We study threshold probabilities and factors that influence these in the context of flood insurance decision making. Based on data collected from 1,041 Dutch homeowners, we find that on average the threshold level of concern for flood insurance demand is negatively related to the expected regret an individual might feel about not purchasing flood insurance if a flood occurs, as well as to worry about flooding.

Keywords: flood insurance demand, threshold level of concern, risk perceptions, anticipated emotion, anticipatory emotion

1 Introduction

Natural disaster risks, like flood risks, are increasing as a result of climate change and socio-economic development in hazard prone areas (IPCC, 2012). One method by which individuals can protect themselves against the risk of flooding is by purchasing insurance. However individuals may ignore flood risks, thus creating difficulties for policymakers who aim to increase protection measures (Camerer & Kunreuther, 1989). Studies from the U.S. have shown that many homeowners in flood prone areas tend to forgo purchasing flood insurance (Kriesel & Landry, 2004; Dixon et al., 2006) even when premiums are subsidized (Kunreuther et al., 1978). In addition to studies of insurance purchases by homeowners in practice, experimental and survey papers report that a substantial proportion of individuals are either willing to pay nothing to protect against low probability risks or do not purchase insurance priced at actuarially fair levels (Slovic et al., 1977; McClelland et al., 1993; Schade et

al., 2012; Kunreuther & Michel-Kerjan, 2015). Despite this neglect of risk in some, others have a very high demand for insurance against low probability risks (Botzen & van den Bergh, 2012; Brouwer et al., 2014).

Individuals may be unwilling to purchase insurance because they perceive the probability of the insurable risk to be below a subjective threshold level of concern (Slovic et al., 1977). To elaborate, Kunreuther (1996) defines the threshold level as p*, which is unconsciously set by the individual. If the subjective probability of the risk, p, does not exceed p*, the likelihood of the risk is treated as zero. Kunreuther and Pauly (2004) also proposed that insurance consumers maximize expected utility, although there are search costs associated with the collecting of accurate information about insurance. Furthermore, individuals need to be convinced that the likelihood of the insurable event exceeds their threshold level of concern before they will even incur such search costs.

In an empirical examination, Botzen et al. (2015) classified individuals as threshold level of concern types if they answered yes to the following question: "Some people think that the flood probability is too low to be concerned about it. These people find that the flood probability is below their threshold level of concern. Does this apply to you?". The authors found that awareness of flood risks as well as probability and damage perceptions are lower in individuals who reported using the threshold decision rule. This result suggests that low demand for flood insurance can be expected for individuals using threshold models for decision making, in particular if they believe that the flood probability they face is below their threshold level of concern.

It is well known that individuals have difficulties comprehending low probability risks (Kunreuther et al., 2001) and seem likely to neglect these risks (Sunstein, 2003). More-

*Institute for Environmental Studies, VU University, Amsterdam, The Netherlands. Email: peter.robinson@vu.nl.

[†]Institute for Environmental Studies, VU University, Amsterdam, The Netherlands.

Utrecht University School of Economics (U.S.E.), Utrecht University, Utrecht, The Netherlands.

Risk Management and Decision Processes Center, The Wharton School, University of Pennsylvania, Philadelphia, USA.

over, feelings about specific risks, like anticipated emotion (e.g., regret), may have an important role to play in individual probability distortions (Walther, 2003). Furthermore, Baron et al. (2000) find that anticipatory emotion (e.g., worry) also affects individual risk judgments. Loewenstein and Lerner (2003) defined *anticipated* emotion as emotion expected to be experienced in the future, while *anticipatory* emotion is experienced at the moment of decision making and related to the decision in hand. Anticipated emotion may concern regret for having not purchased insurance in the event of a large loss (Braun & Muermann, 2004). Anticipated regret may be an important factor behind an individual's insurance purchase decision under low-probability/high-impact risks (Kunreuther & Pauly, 2017). Schade et al. (2012) found that the anticipatory emotion of worry is a good predictor of an individual's demand for theft and fire insurance. In addition, Botzen et al. (2015) showed that individuals who worry more about flooding perceive higher flood probabilities and damage amounts.

In the present paper, we experimentally analyze the probability at which homeowners in the Netherlands are willing to pay for flood insurance, and therefore treat the probability of flooding to be above their threshold level of concern, as well as whether this threshold is related to anticipated and anticipatory influences. We report that individuals who anticipate regret for not purchasing insurance in the event of a flood, as well as those who worry about flooding, tend to have lower threshold levels of concern.

The paper is structured as follows: Section 2 describes the experiment implementation and gives an overview of the variable elicitation and description. Section 3 provides results regarding determinants of the threshold level of concern. Section 4 discusses these results and concludes the paper.

2 Experiment implementation and variable elicitation and description

2.1 Experiment implementation

An online experiment was conducted with a sample of 1,041 Dutch homeowners. In the Netherlands flood insurance is currently unavailable, although the government may partly compensate damages caused by large floods (Botzen & van den Bergh, 2012). The homeowners were drawn from the consumer panel of Multiscope, who contacted respondents via email (http://www.multiscope.nl). All respondents were rewarded "Social Points" for participating, which can be exchanged into gifts via the Multiscope website. 48.2% of the sample live in dike-ring areas designed at standards 1/1,250, implying that dikes can withstand a 1 in 1,250 years flood event. A further 3.8% of the sample live in 1/2,000 areas, 7.8% live in 1/4,000 areas, and 18.3% reside in dike-rings

TABLE 1: Probability and loss combinations presented for the flood insurance decisions.

Decision	Probability of flooding	Potential property damage caused by flooding
1	.0001	€60,000
2	.001	€60,000
3	.01	€60,000
4	.05	€60,000
5	.25	€60,000
6	.33	€60,000
7	.5	€60,000
8	0.75	€60,000
9	0.95	€60,000

with the highest protection standard (1/10,000). Moreover, 19.4% live outside dike-ring areas in land that cannot be flooded by rivers, therefore the probability of river flooding is zero. 0.8% live outside dike-ring areas in a river bed, therefore the probability of flooding is high although there is no official safety standard. The remaining 1.7% could not be classified because they provided invalid postcodes.

Individuals were first asked to imagine purchasing a property worth €240,000 in a flood prone area.[1] Additional text stated that government compensation will not be granted for uninsured flood damages. We obtained maximum willingness-to-pay (WTP) for insurance valuations for nine two-outcome prospects of probability and loss combinations framed as €60,000 flood risks (Table 1).[2] The flood risks were presented in ascending order of flood probability. Changes to these risks were attributed to different water levels in rivers in a year, and the flood insurance decisions took place from an endowed bank balance of €60,000. Therefore, potential flood losses were never greater than the bank balance available.

Of the 1,041 sampled, 624 were randomly assigned to face real incentives, where one individual was paid according to one flood insurance decision (both selected at random). We then applied the Becker, De Groot and Marschak (1964) mechanism: a premium for which flood insurance is sold is selected at random in the chosen decision. If the selected in-

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[1]€240,000=approximate average purchase price for a home in the Netherlands in year 2016 (Statistics Netherlands, 2017).

[2]In total we obtained fourteen WTP for flood insurance valuations. Two of these were presented between decisions 5 and 6: .33 probability of a flood causing €15,000 and €30,000 property damages respectively. The other three were scenarios where individuals were flooded for certain after decision 9: .33 probability of a flood causing €30,000 (respectively €45,000, €60,000) property damages, and .67 probability of a flood causing €15,000 (respectively €15,000, €30,000) property damages. However, these decisions are purposely left out of the analysis because they contain flood damage amounts other than €60,000.

TABLE 2: Coding of the dependent variable (threshold): the number of successive times individuals accepted the flood risk and remained uninsured.

Coding	Frequency	Percentage
threshold=0	783	79.7%
threshold=1	131	13.3%
threshold=2	37	3.8%
threshold=3	18	1.8%
threshold=4	7	.7%
threshold=5	4	.4%
threshold=6	1	.1%
threshold=7	1	.1%
Total	982	100%

FIGURE 1: Distribution of Likert scale responses for anticipated regret and anticipatory worry.

dividual is willing to pay a value equal to or greater than the premium, then they have purchased insurance at the price of the premium, otherwise they face the flood risk uninsured. The individual's earnings from the selected decision were paid at a specified exchange rate of 1%. This individual was contacted in private about the outcome of the computerized flood risk for their chosen decision after data collection through Multiscope. The remaining 417 individuals did not face any performance based payment. The Appendix provides details of the incentive mechanism and the experiment instructions in English, which were presented in Dutch to the respondents.

2.2 Dependent variable

To elicit the dependent variable which shall be called "threshold", individuals faced a series of two stage decisions consisting of a payment card task and then a WTP task. First, individuals were presented with a yearly risk of flooding as well as sixteen ascending logarithmically spaced values with an additional option to accept the flood risk and remain uninsured. According to these values, individuals were asked to choose the value that represented their maximum WTP for flood insurance to fully cover the cost of property damages. Second, to obtain a more refined WTP estimate, individuals were asked what they were at most willing to pay for flood insurance between the value chosen previously and the next highest value.

The threshold variable is constructed by first eliminating 59 individuals who accepted the flood risk and remained uninsured for all nine insurance decisions. These individuals are not informative with regards to threshold models, because they are likely willing to pay for insurance only if they are flooded for certain. The threshold is then coded as the number of successive times that individuals accepted
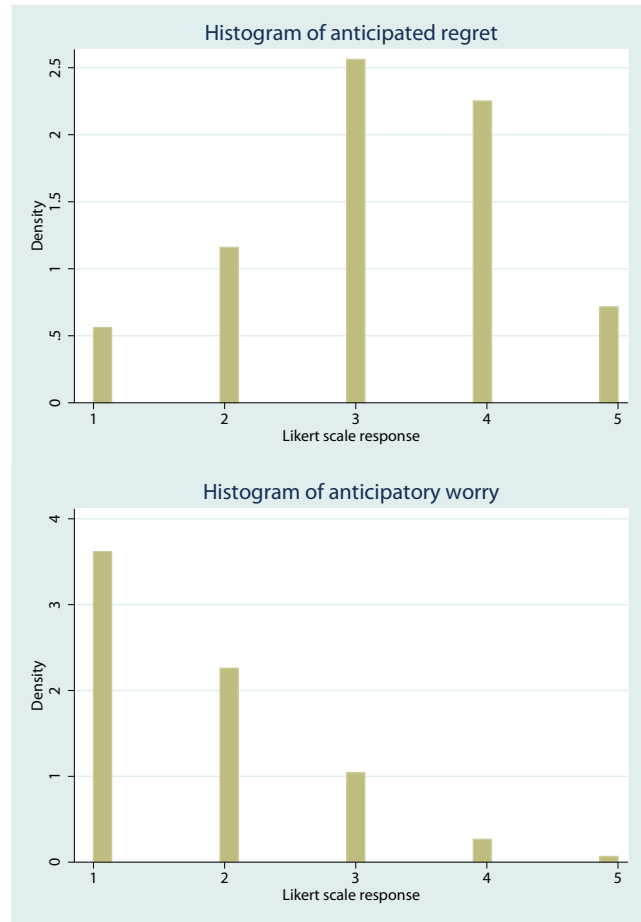
the flood risk and remained uninsured as the risk increased over the nine decisions. For example, if the individual is willing to pay for flood insurance only when the flood probability reaches .001, then their threshold is coded 1, and if the individual is willing to pay for flood insurance only when the flood probability reaches .01, the respective value is 2, etc. Table 2 provides information about the threshold variable for 982 individuals on which the proceeding analysis is based. Interestingly, for individuals who do not remain uninsured throughout the entire experiment, the majority indicate threshold levels of concern below flood probability .0001. This is shown by the 79.7% of individuals willing to pay for insurance for flood probabilities $\geq$.0001.

2.3 Independent variables

A series of Likert scale survey questions were presented following the flood insurance decisions. To derive anticipated regret, we asked individuals to indicate to what extent they agree with the following statement: "I would feel regret about not purchasing flood insurance if a flood occurs" on

a scale ranging from "Strongly disagree" (1) to "Strongly agree" (5). Moreover, anticipatory worry was elicited using the same response format, with the statement: "I am worried about the danger of flooding at my current residence".[3] Figure 1 displays histograms of the response patterns to these statements. The figure shows that most individuals are in the neutral category with regards to feeling regret about not purchasing flood insurance, however, the majority also have very low worry about flooding. The latter is not surprising given that flood protection standards in the Netherlands are high. In particular, the Dutch government has invested heavily in flood protection in a series of projects called The Delta Works, which consists of dikes, dams, sluices and storm surge barriers that protect large parts of the country (Bubeck et al., 2015). Moreover, flood risk management is widely esteemed by the Dutch population (Terpstra, 2011).

We will also assess the role of monthly household income and education levels, the former of which was measured on the following scale: income<€1,000 (1), €1,000≤income<€1,500 (2), €1,500≤income<€2,000 (3), €2,000≤income<€2,500 (4), €2,500≤income<€3,000 (5), €3,000≤income<€3,500 (6), €3,500≤income<€4,000 (7), €4,000≤income≤€5,500 (8), income>€5,500 (9). Education is coded as follows: elementary school (1), middle level applied education (2), higher general continued education (3), bachelor (4), master (5), PhD (6).

Given that stated maximum WTP for flood insurance values may be affected by worry about flooding and regret about not purchasing insurance, as well as having a direct relationship with our threshold variable, this introduces a potential for confounding. Specifically, worry and regret have been shown to influence risk aversion (Loewenstein & Lerner, 2003), and it is reasonable to assume that risk aversion relates to maximum WTP for flood insurance, which in turn could affect the WTP a positive amount for flood insurance, and therefore the threshold level of concern. There is not a single best measure for this potential confounding variable, although the maximum of all WTP values across the nine flood insurance decisions is one such measure, and will be used to examine whether the potentially problematic relationships exist in a correlation analysis in Section 3.1.[4]

3   Results

Section 3.1 reports correlations among the threshold, worry, regret, monthly household income, education and maximum WTP. Section 3.2 reports a regression analysis to investigate the impact of worry and regret on the threshold measure once other variables are included in the model.

TABLE 3: Correlation coefficients between variables.

	threshold	regret	worry	income	educ.
regret	−.12*				
worry	−.124*	.132*			
income	.020	−.026	−.059		
education	.035	.009	−.080	.330*	
max. WTP	.016	.046	−.031	.151*	.173*

Notes: Significance levels are: * p-value<.001.

3.1   Correlations

In this section we examine correlation coefficients between the threshold, worry, regret, monthly household income, education levels and the maximum WTP for flood insurance. Table 3 displays these results. The table illustrates the negative correlation between our variables of interest and the threshold measure. That is, individuals who worry more about flooding and exhibit more anticipated regret about not purchasing flood insurance should a flood occur are more likely to have a lower threshold level of concern.[5] There is also a positive relation between the measures of worry and regret, however, we will show in Section 3.2 that they both significantly influence the threshold level of concern once they are both included in a regression model.

In addition, although monthly household income and education levels correlate positively and quite strongly with each other, as one might expect, neither variable affects the threshold level of concern. Thus, these variables cannot account for the observed negative correlations of worry and regret with threshold. However, monthly income levels and education are correlated positively with the maximum that individuals were willing to pay for flood insurance across the nine decisions.

Interestingly, concerns regarding the potential confounding between maximum WTP for flood insurance and the threshold level of concern appear to be unjustified. That is, the correlation between these two variables is extremely low and even in the opposite direction from what would be predicted by the confounding. In sum, it appears that the determinants of threshold and of maximum WTP are different.

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[3]The items were presented in Dutch.

[4]Mean WTP could also be used. Nevertheless, our conclusions remain the same regardless of which variable is used.

[5]With the data used in Botzen et al. (2015), we checked the correlation coefficient between their dummy variable threshold level of concern measure (based on individuals who stated yes to the question: "Some people think that the flood probability is too low to be concerned about it. These people find that the flood probability is below their threshold level of concern. Does this apply to you?"), and the scale response of individuals with respect to their worry about flooding (which was elicited in the same way that we elicit the variable in our experiment). The correlation coefficient is negative and significant −.261 (p-value<.001), therefore, individuals who have low (high) worry about flooding levels are more (less) likely to indicate yes to the threshold level of concern question. This finding provides supportive evidence for our paper's results.

TABLE 4: OLS regression results.

	Model I: Anticipated and anticipatory emotion		Model II: Including socio-economic variables		Model III: Including maximum WTP		Model IV: Including incentives	
regret	−.079*	(.024)	−.079*	(.024)	−.08*	(.024)	−.079*	(.024)
worry	−.098*	(.028)	−.099*	(.029)	−.098*	(.029)	−.098*	(.029)
income			−.00003	(.013)	−.0004	(.013)	−.0005	(.013)
education			.018	(.023)	.017	(.023)	.017	(.023)
maximum WTP					.0000005	(.000001)	.0000005	(.000001)
hypothetical							.029	(.053)
constant	.751*	(.089)	.688*	(.132)	.689*	(.132)	.674*	(.135)
adjusted-R^2	.024		.023		.022		.022	
N	982		969		969		969	

Notes: Significance levels are: *p-value<.01 and standard errors are reported in parentheses. Dependent variable: threshold. The dummy variable, hypothetical, takes the value 1 for individuals who did not receive any performance based payment in the experiment. The number of observations decreases between Model I and Models II, III, IV due to individuals listing their education as "Other".

3.2   Regression

This section provides OLS regression results to further investigate the relationship between regret, worry and the threshold level of concern.[6] Table 4 presents an overview of the regression results. Interpreting Model I, consistent with the results from Section 3.1, anticipated regret of not purchasing flood insurance and worry about flooding are negatively related to the threshold level of concern.[7] Moreover, once socio-economic variables have been included in Model II, maximum WTP values in Model III, and performance based incentives in Model IV, the coefficient estimates for worry and regret remain stable and highly significant. Nevertheless, explanatory power for the regressions is quite low, and model fit decreases between Model I and Model IV according to the adjusted-R^2.

Strict violations of stochastic dominance may be high in online experiments where individuals are unsupervised, due to lower respondent motivation relative to what would be

expected with an experimenter present. Such violations occurred in our experiment when an individual was willing to pay more for flood insurance under a given flood risk than under another flood risk with a higher flooding probability. Upon inspection of the data, it is apparent that some of the sample violated stochastic dominance in their decisions. Notably, of the 982 individuals analyzed, stochastic dominance was violated .66 times on average. In addition, 46.4% of individuals violated at least once, although the majority of violators (69.5%) did so only once. Table 5 runs the Table 4 regression results again excluding all individuals who violated stochastic dominance. This is a check to see whether the results are robust to individuals who breach the stochastic dominance rationality requirement. The results show that the directional effects of regret and worry on the threshold level of concern become stronger. This may be the case if stochastic dominance violators displayed less attention in their responses to the survey questions in general.

4   Discussion

Using data collected from an online experiment involving 1,041 Dutch homeowners, we have shown that once individuals with no discernible threshold level of concern (those who chose to accept the flood risk and remain uninsured for each of their nine insurance decisions) are removed from the sample, threshold probabilities are <.0001 for the majority (79.7%) of individuals.[8] Nevertheless, there is still

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[6]We did not dichotomize the independent variables because that would throw away potentially useful data. Nevertheless, the results in this section are robust to dummy variable coding of regret and worry, as well as ordered Logit and ordered Probit specifications.

[7]Given the positive correlation we find between regret and worry in Table 3, one may suspect that regret and worry are not completely independent predictors of the threshold level of concern. For example, it may be the case that individuals exhibit more worry about flooding precisely because they anticipate more regret about not purchasing flood insurance if a flood occurs. The impact of worry on threshold level of concern may be sensitive to the regret level, however, we find that including an interaction between regret and worry results in an insignificant coefficient estimate on the interacting term (OLS p-value>.1). Our measure for the threshold level of concern is higher when worry and regret are low, but this is true of either regret or worry considered by itself. Note that a lot more statistical power is needed to detect interaction effects than to detect main effects.

[8]Overall, if we include those who chose to accept the flood risk and remain uninsured for each of their nine insurance decisions, a significant percentage of the sample are willing to pay zero for flood insurance, e.g.,

TABLE 5: OLS regression results excluding stochastic dominance violators.

	Model I: Anticipated and anticipatory emotion		Model II: Including socio-economic variables		Model III: Including maximum WTP		Model IV: Including incentives	
regret	−.118*	(.031)	−.120*	(.031)	−.120*	(.032)	−.119*	(.032)
worry	−.116*	(.042)	−.113*	(.042)	−.114*	(.043)	−.112*	(.043)
income			−.02	(.017)	−.02	(.017)	−.02	(.017)
education			.049	(.03)	.049	(.031)	.049	(.031)
maximum WTP					−.0000003	(.000002)	−.0000004	(.000002)
hypothetical							.025	(.071)
constant	.908*	(.12)	.849*	(.175)	.848*	(.176)	.834*	(.18)
adjusted-R^2	.041		.043		.042		.040	
N	526		520		520		520	

Notes: Significance levels are: *p-value<.01 and standard errors are reported in parentheses. Dependent variable: threshold. The dummy variable, hypothetical, takes the value 1 for individuals who did not receive any performance based payment in the experiment. The number of observations decreases between Model I and Models II, III, IV due to individuals listing their education as "Other".

a subsample of individuals using the threshold model, and anticipated and anticipatory emotions are significantly related to the associated thresholds. More specifically, our results suggest that on average, individuals who expect to feel regret about not purchasing insurance if a flood occurs, and individuals who worry about flood risk have decreased threshold levels of concern with respect to flooding. These effects cannot be accounted for by education, income, or maximum WTP.

It is also remarkable that education levels do not affect threshold levels on average. This result dispels reasonable suspicion that higher education drives thresholds down due to an increased understanding of risk and insurance demand. In addition, the failure of education to correlate with threshold does not seem to be due to poor measurement, as it did correlate with maximum WTP.

Incentives provided in the experiment according to the Becker, De Groot and Marschak (1964) mechanism do not relate to the threshold level of concern according to the analysis in Section 3.2. Therefore, this payment mechanism may not be needed in a study that is interested in examining whether individuals have a zero or non-zero WTP for insurance.

For individuals who utilize threshold models for their decision making, it is a challenge to design insurance products for risks that may fall below their thresholds. However, it has been suggested that risk perceptions can be increased by reframing yearly probability information about low likelihood events over a longer time frame. As an example, Slovic et al. (1978) found that intentions to use automobile seatbelts are larger when accident probability information is presented for 40,000 trips (a lifetime), compared to a single trip. In addition, Keller et al. (2006) showed that on average, individuals rate flood risks higher for a 33% probability of flood within 40 years, compared to a 1% probability of flood in a single year.[9] Both studies serve to show that individuals may undertake better flood preparedness measures when flood risk information is reframed.

Kunreuther and Pauly (2004) suggest another strategy for raising perceived loss probabilities above individual threshold levels, namely bundling, which consists of combining low probability risks with other risks into a single insurance policy. That way, the combined probability of loss may exceed an individual's threshold to incentivize insurance purchase. Nevertheless, the empirical evidence base is mixed and rather small, with Slovic et al. (1977) finding that bundling positively influences insurance demand, and Schoemaker and Kunreuther (1979) displaying the opposite effect. The topic would benefit from more research in the future.

25%, 13% and 10% under flood probabilities .0001, .001 and .01 respectively. Moreover, many individuals with a positive WTP for flood insurance, have very high demand, and are willing to pay more than an actuarially fair premium. Therefore, our results are not inconsistent with the statements made in the introduction.

[9]Botzen et al. (2016) find that such a framing can have different effects for subgroups of individuals, and in particular depends on political ideology in the U.S. They show that Democratic voters are more likely to invest in flood proofing measures than Republican voters when both types of voters are presented with flood probabilities over a 30 year time frame compared to a 1 year time frame.

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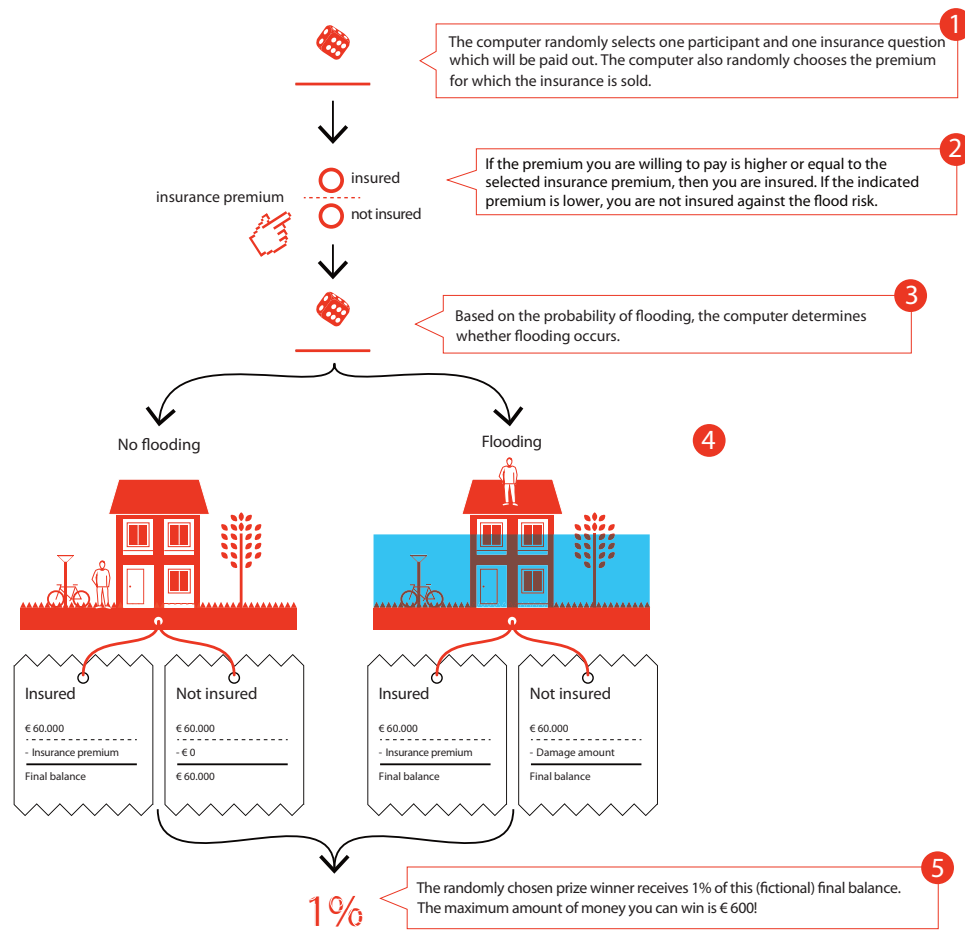
Figure A1: Payment illustration.

Appendix

(Incentivized flood insurance experiment instructions are translated from Dutch.)

First screen

Welcome to this questionnaire. This is an investigation that is part of a research project undertaken by the Institute for Environmental Issues (IVM), Vrije Universiteit (VU) Amsterdam and funded by the Netherlands Organization for Scientific Research (NWO).

The questionnaire is about your views about flood safety and flood insurance.

Flood insurance instructions

Here is a brief explanation of the next questions. Read this carefully.

Your current insurance policy for your house and contents does not cover damage caused by flooding. Imagine you recently purchased a property worth €240,000 in an area that can flood and that it is possible to buy flood insurance.

You will get 14 questions about how much you are willing to pay for flood insurance for this property. With each question: The government will not reimburse your flood damage if you are not insured. Every question is about another year with a different risk due to different water levels. Each year you have €60,000 in your bank account from which insurance premiums or flood damage can be paid.

There are no correct or incorrect answers. We are only interested in your opinion!

Payment

(The hypothetical condition is identical to the incentivized version with the following instructions omitted.)

We randomly choose one respondent to be paid.

The picture below explains a lottery that will be used to determine whether you will be paid based on your answers in the insurance questions.

[see Figure A1 for the payment illustration]

It is therefore in your best interest to answer your real willingness to pay. For example, if you state a willingness to pay higher than your real willingness, you may pay too much, while if you state a willingness to pay lower than your real willingness, you may end up without insurance and regret not stating a higher willingness.

Again, the prize winner of this research is randomly chosen by the computer.

Each participant has an equal chance of winning!

Flood insurance decisions

Year 1

Imagine that this year the chance of a flood is 1 in 10,000 causing €60,000 damage to your property.

What is the maximum premium this year that you would be willing to pay for flood insurance to fully cover the cost of damages?

[Response options, displayed top to bottom:

I accept this risk and I won't insure myself; €1; €2; €4; €9; €20; €40; €80; €170; €350; €740; €1,500; €3,200; €6,600; €13,800; €28,800; €60,000]

Follow up flood insurance decisions

You indicated that you would be willing to purchase flood insurance for [maximum willingness to pay in the previous decision] but not for [next highest value]. What is the maximum premium you are willing to pay this year in this interval?

Please enter an amount within the interval, so between the two amounts mentioned above.

(Subsequent flood insurance decisions were presented analogously.)