Home Owners' Willingness to Buy Flood Insurance in Rural China

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Abstract: In Recent years, flood damage in rural China dramatically increased as a result of more frequent and severe floods. Although the policy-oriented agriculture insurance for natural disasters has been available in China, its coverage only applies to crops and livestock, not residents’ real estate and household property. In this paper, we investigate whether residents in rural China are willing to insure their property against flood damage and what kind of factors influence their willingness to seek insurance protection. Based on the national survey we conducted over 15 provinces in the summer of 2012, with 1322 valid observations, socio-economic, flood risks, insurance experience and region variable are analyzed using different models. The results show that there exists a strong need for flood insurance in rural China, and factors including flood experience in past 30 years, the elapsed time since the latest serious flood, income, and insurance experience influence rural residents’ willingness to participate in flood insurance. Policy suggestions for flood insurance are provided to the insurance industry and Chinese government at the end.

Key words: Flood insurance, Willingness to pay, rural property

Introduction

Around the globe, disasters caused unprecedented loss with such primary reasons as increased population and property values, concentrated assets and climate change in the past decade (Michel-Kerjan and Kunreuther, 2011). Flood is one of the most destructive hazards (Pinter, 2005) among natural disasters. During 2000 to 2011, the loss from flood accounts for 47 percentages of all natural disasters in China, and China is one of the countries in the world that

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suffered the most frequent and severe flood disasters (Manuta and Lebel 2005). About 1.07 million square kilometers land area and 6 million residents are frequently threatened by floods during the flood season annually. During 1990 to 2010, on an annual average, floods and waterlog disasters hit 13.86 million hectares of crops, of which 7.68 million hectares were inundated, leaving a human death roll of 2707, collapsed rooms of 2.04 million and a direct economic loss of 123.78 billion Yuan (Tian 2011). The rural areas suffer more than their urban counterparts because of their more vulnerable housing structure (Wang 2011).

To reduce the impact of flooding disaster, flood control measures have been taken since ancient times, including dams, levees, and reservoirs. However, White (1945) argued that relying on structural measures or hard engineering defenses alone cannot solve flood problems, and people should adjust the way to live with floods through integrated actions and non-structural methods, such as land use zoning, flood proof buildings and flood insurance, etc. There has been a worldwide significant shift in the flood management (Harvey et al. 2009; Green 2010), such as flood insurance which can compensate the loss economically. Especially, insurance and government assistance play central roles in ensuring economic and social resilience in the aftermath of catastrophes in developed countries now (Michel-Kerjan and Kunreuther 2011). The United States began flood insurance practice in the early 1950s and established the National Flood Insurance Program (NFIP) in 1968 (King 2011), which is one of the largest government disaster-insurance programs in the world (Michel-Kerjan and Kunreuther 2011). UK, Germany, France and other countries have also provided flood insurance or flood-based natural hazard insurance (Falkenhagen 2002). In china, government declared that flood disaster mitigation should shift from flood control to flood management (E 2005), which means that we should pay more attention to non-structural flood mitigation instead of structural flood defense and improve the capacity to live with floods (Cheng 2006). However, compared with developed countries, government assistance is the main instrument in

China. Chinese government paid a huge sum for disaster relief effort after each flood occurrence in 2009, but only 1 to 2 percent of the $50 billion flood losses was insured (Guy Carpenter and Co. 2010). Furthermore, the flood insurance for real estate and associated properties is not available in rural China nationwide.

Floods are not only lower-profile and persistent events but also high-impact and low-probability events, so that research results showed that the demand for flood insurance exhibits its special characteristics. The NFIP in the U.S. was aiming to higher compensation compared with government relief to individuals in 1968, but few people purchased the flood insurance (Anderson 1974). Anderson (1974) pointed out that unawareness of the program's existence, high premium rates, lack of agents to sell the program, local officials being not seeking community eligibility, loss of federal disaster assistance benefits and low flood risk as possible reasons for low participation. However, the participation rates of flood insurance were historically low despite that many mandatory flood insurance purchase requirements were imposed after great changes made in the program in 1973, 1994 and 2004 (King 2011). Many surveys of residents in flood-prone areas in the U.S. have shown that the risk perception, subjective assessment of damages, previous experience with the flood, price of the insurance, peer effect, income and education, expectation of federal relief and the length of time the habitant has resided in the community all associate with the willingness to purchase flood insurance (Baumann & Sims 1978; Kunreuther 1984, 1996; Pynn & Ljung 1999). Aggregated data and policies were used to analyze the influencing factors for flood insurance demand by Browne & Hoyt (2000), Kriesel & Landry (2004), Michel-Kerjan & Kousky (2010); Landry & Jahan-Parvar (2011) and the results showed that higher-income residents and those who experience recent flood damage are more likely to purchase insurance, and participation rates is higher in higher risk areas such as floodplain, coastal areas, and the price for flood insurance has a negative effect on its demand.

Some studies have explored the willingness to buy (WTB) in countries or regions without flood insurance supplied, like the Netherlands and Taiwan. Botzen & Bergh (2009, 2012) investigated the willingness of Dutch residents to mitigate flood risk under climate change through flood insurance and found that risk perceptions, flood experience, responsibilities for compensating flood damage and geographical characteristics were important determinants in the decision to undertake flood insurance. Chang et al. (2003) analyzed the willingness of the residents in the Shijr and Wu-doo area of Keelung River in Taiwan to pay for flood insurance and found that the flood risk perception and income level were significantly associated with the residents' willingness to insure, and flood duration was also positively related to the maximum amount they were willing to pay, and education and government involvement were important factors to increase the participation rate. Wang et al. (2012) discussed Chinese people's willingness to buy for natural disaster insurance but not flood insurance specifically and found that factors like risk, insurance experience and knowledge, and government responsibility affect people's attitude.

Chinese rural residents are extremely vulnerable to flood disasters. The policy-oriented agricultural insurance for natural disasters has been available in china since 2007, but its objects are crops and livestock, not residents' real estate or household property (Wang et al 2011, 2012). Very little research has been published in China to reveal rural residents' willingness to participate in property flood insurance so far. Therefore, our objects are to identify factors that influence rural residents' WTB for flood insurance designed for real estate and associated properties, and to analyze their decision behavior on the level of willingness to pay (WTP).

The remainder of this paper is structured as follows. Next section describes the implementation of the survey and the design of questionnaires, and gives the definitions and descriptive statistics of major variables used in our empirical analysis. In the following section, three models used in the analysis are discussed including econometric methods and alternative model settings, each addressing a specific issue. Results and conclusions are presented in the last two sections.

Data

Our survey was conducted with field visits and in-person interviews in 15 provinces in the East, Central, and West regions of China, a common division based on economic and geographic characters. Students from China Agricultural University were trained as enumerators and employed to administer the survey between June and August of 2012. In order to ensure sample selection effectiveness, stratified random sampling was used and survey objects were randomly selected in different locations, within river basin areas. The procedure can be describe as four steps: firstly, 4 to 6 provinces were randomly selected in each region; secondly, 3 to 4 counties (cities) were extracted in each selected province; then 6 to 8 administrative villages were chosen in each county (city); and finally, 10 to 15 residents were interviewed in each village. In total, the sample of 1322 effective observations was collected, which is representative of the rural resident in China with regards to geographic distribution by province, age, gender, education and income, to a certain extent. The specific sample distribution is shown in Figure 1.

The questionnaire started with questions of flood risk including the assessment of recent flood threat in their areas, numbers of flood disasters they experienced in the past 30 years, time elapsed since the most serious flood, total loss value and percentage of real estate loss value. The government relief and society donation to compensate flood loss were also inquired, such as the percentage of compensation from non-insurance accounting for loss and satisfaction level to different means of compensation after flood. Thirdly, we asked each respondent his or her insurance experience involving the numbers of insurance types bought before, the amount paid for insurance in a family last year (2011), the attitude about insurance, and peer effect on his or her decision to insure. Fourthly, the respondents' knowledge about flood insurance was inquired, using the respondents' self-rank for flood insurance knowledge with a scale 1 to 7, 1 being the least and 7 the most knowledgeable. Fifthly, the socio-economic characteristics of the respondent were collected including age, gender, education level, annual income, numbers of family members, etc.

Note: The number in parenthesis denotes the region's and the province's sample size.

Figure 1 the survey sample distribution of East, Central and West parts of China

The respondent's WTB and WTP were surveyed in the questionnaire. WTB was designed with a question whether to willing to buy flood insurance, which is a binary variable. WTP was designed with the contingent valuation method (CVM) which is one of the standard approaches for valuing nonmarketed resources, such as new product or service (Hanemann et al., 1991). A typical CVM survey includes a single bounded dichotomous choice (SBDC) setting and a double-bounded dichotomous choice (DBDC) setting.

The concrete implementing process of the CVM is as following: the respondent who is willing to buy flood insurance is asked whether to willing to pay with the highest price category, then we have a stop if the answer is "yes". Otherwise, the respondent is asked continuously the decision on the next highest price category until a yes answer is obtained. Based on our former surveys and the regional trial of household property natural disaster insurance in rural (Wang 2012), 3 situations, low, medium and high coverage, are considered which the coverage is 30,000 Yuan, 50,000 Yuan and 100,000 Yuan, respectively. Under the 30,000 Yuan coverage, the premium categories numbered from 6 to 1 are ≥60 Yuan, 30-60 Yuan, 24-30 Yuan, 18-24 Yuan, 12-18 Yuan, and <12 Yuan. The category boundaries for the 50,000 Yuan coverage insurance are 100, 50, 40, 30, 20, and 0 Yuan, respectively; and those for the 100, 000 Yuan coverage are 200, 100, 80, 60, 40, and 0 Yuan, respectively. Variables in the survey are specified in Table 1.

To calculate the amount of WTP (WTPA) of different coverage level, we use the medium value of the chosen interval up to category 5, and 75 Yuan, 125 Yuan and 250 Yuan for the category 6 of each situation, i.e., $[60, +\infty)$, $[100, +\infty)$, and $[200, +\infty)$. Assuming the premium rate of flood insurance is 0.2% (Ren et al. 2010), the premium without subsidy should be 60, 100 and 200 Yuan for each situation, so the subsidy (including central government and local government) is considered when the WTPA is less than these levels. For example, the WTPA of 30 Yuan for the 30,000 coverage situation indicates that there is a 50% subsidy (another 30 Yuan) from government.

Variables such as “Male” and “Age” are self-explained demographic variables. “Educ” shows how many years the respondent has received formal education. “IncK” is the annual after-tax household income. “Nufam” is how many people they live together and spend money together in a family. “PEEF” shows the respondent whether affected by their peer when decided and which is a dummy variable.

Variables about flood experiences are important to include. "Nuflo" shows how many times flood disaster the respondent has been suffered from during the past 30 years since 2012. “Recency” shows how many years since the respondent suffered from the serious flood till the summer (June-August) of 2012. “PeRelief” is the percentage of the relief gaining from government accounting to cover the total flood loss in the past. “NuInTyp” shows how many types of insurance the respondent bought before. “APremiu” shows how much the resident households pay for insurance on a per capita basis the year before. “NuNOpin” shows how many checks the respondent made with negative attitude to insurance by the four questions we asked “insurance being wasting money”, “insurance being no helpful to my life”, “insurance increasing my economic burden”, “insurance being easily inducing more risk”. “Knowl” is the respondent’s flood insurance knowledge degree, which is a categorical variable with the value from 1 to 7.

Based on previous literature (shown in the introduction), hypothesized signs of some variables are given in the table 1. Educ, IncK, NuFlo and Knowl have a positive expected direction on the WTB and WTP, which means these explanatory variables increase the probability of the outcome. Otherwise, PeRelief and NuOpini have a negative expected direction on the explained variable.

Table 1 Descriptive statistics of variables and means of variables

Variable name	Brief explanation	Units	Mean	Std. Dev.	Min	Max	Type	Expected direction
WTB	Willingness to buy	-	0.656	0.475	0	1	1=yes, 0=no (dependent)	-
WTPC1	Willingness to pay category of 1st situation	-	3.233	1.310	1	6		-
WTPC2	Willingness to pay category of 2nd situation	-	3.065	1.293	1	6	Dependent variable	
WTPC3	Willingness to pay category of 3rd situation	-	2.815	1.341	1	6		
WTPA1	Willingness to pay amount of 1st situation	￥Yuan	25.47	15.81	6	75	-	
WTPA1	Willingness to pay amount of 2nd situation	￥Yuan	39.69	24.92	10	125	-	
WTPA3	Willingness to pay amount of 3rd situation	￥Yuan	72.79	50.34	20	250	-	
Male	Gender	–	0.781	0.414	0	1	dummy variable (1= male)	?
Age	Years of age	Years	46.35	11.75	18	88	Continuous	?
Educ	Years of education	Years	9.139	3.563	0	17	continuous	+
NuFam	Numbers of family members	Persons	4.099	1.298	1	11	continuous	?
IncK	Annual income	￥1,000	43.84	34.47	1	260	continuous	+
NuFlo	Numbers of floods in past 30 years	Times	4.580	3.993	0	25	continuous	+
Recency	How long since the most serious flood	Years	8.519	7.867	1	58	continuous	?
PeRelief	Percentage of government relief accounting for the total flood loss	%	14.47	12.89	5	60	continuous	-
NuInTyp	Numbers of Insurance types bought before	Kinds	0.843	1.193	0	7	continuous	?
APremiu	Average paying amount for insurance of the household's each person last year(2011)	￥Yuan	72.55	135.06	0	1750	continuous	?
NuNOpin	Number of negative opinions to insurance		1.108	0.993	0	4	Continuous	-
PeEf	Peers effect	-	0.129	0.336	0	1	dummy variable (1= respondent is influenced)	?
Knowl	Knowledge of flood insurance	-	3.934	1.934	1	7	categorical variable (1=least knowing ,7=very knowing)	+
R1	East region of China	-	0.308	0.470	0	1		
R2	Central region of China	-	0.264	0.437	0	1	Dummy variable (from R1 to R3),respectively East, Central, West	?
R3	West region of China	-	0.428	0.493	0	1		

The descriptive results show that 65% of respondents are willing to buy if flood insurance is provided. The WTP is 25.47 Yuan at the 30,000 Yuan coverage level and the other two are 39.69 Yuan and 72.79 Yuan responding to 50, 000 Yuan coverage and 100,000 Yuan coverage. This implies that the premium subsidy is more and more percentage with the increasing of coverage, from 49.1% to 60.3% and 63.6%. Nevertheless, the take-up rate will increase with coverage rising at the same subsidy level (table 2). That is, the government needs to transfer more income to farmers if it wants to transfer more responsibility of disaster relief expenditure on the insurance industry.

Tables 2 Participation rate at alternative subsidy rate

variable value	subsidy percent	participation 1st level		participation 2nd level		participation 3rd level	
		Valid Percent	Cumulative Percent	Valid Percent	Cumulative Percent	Valid Percent	Cumulative Percent
1	≥80	11.7	11.7	13.4	13.4	19.6	19.6
2	≥70	13.3	24.9	16.7	30.1	20.8	40.4
3	≥60	38.0	62.9	38.9	69.1	34.9	75.3
4	≥50	19.9	82.8	16.4	85.5	12.1	87.4
5	<50	11.5	94.3	10.0	95.5	8.3	95.7
6	0	5.7	100.0	4.5	100.0	4.3	100.0

The average respondent is 46 years old, with an after-tax annual household income of approximately 43,840 RMB and a middle school degree, and has 4.01 persons each family. There is approximately 4.58 times flood disaster each family suffered in the past 30 years. The household gets government relief with 14.5% of total flood loss and bought 0.84 types insurance. The respondent has 1.1 piece of negative opinion because insurance is not good thing in Chinese cultural.

Methods

The methods used in the analysis are discussed in this section. Econometric methods, including Logit model, Ordered logit model (OLM), and Cox proportional hazard model (CPHM), used in the paper will first be introduced and then alternative models each addressing a specific issue, such as WTB Model and WTP Model are also discussed.

Logit model

Generally, we have a vector of regression ***X***, which are assumed to influence the two possible outcome ***Y***, then the probit model can be taken the form,

$$\Pr(Y=1|X)=\frac{\exp(X'\beta)}{1+\exp(X'\beta)} \qquad (1)$$

Where ***Pr*** denotes probability and ***β*** are typically estimated by maximum likelihood.

It is possible to motivate the probit model as a latent variable model. Suppose there exists an auxiliary random variable:

$$Y^*=X'\beta+\varepsilon \qquad (2)$$

Where ***ε*** is error term which account for the discrepancy between the actual observed responses and the predicted outcomes and is assumed following Logistic distribution. Then ***Y*** can be viewed as an indicator for whether this latent variable is positive:

"*Y=1*" represent respondents are willing to buy and whereas, "*Y=0*" represent respondents are

$$Y=\begin{cases}1 & \text{if} \quad Y^*>0 \;\; \text{i.e.} \;\; -\varepsilon<X'\beta, \\ 0 & \text{otherwise.}\end{cases} \qquad (3)$$

not willing to buy.

Ordered logit model and it's applied to alternative issues

When the dependent variable takes more than two values, logistic regressions are no longer valid, and the Ordered logit model is often appropriate. In this model, the dependent variable is measured on an ordinal scale, and the ordinal scale represents measurement of an underlying interval/ratio scale.

In the ordered logit model, there is an observed ordinal variable, ***Y***. ***Y***, in turn, is a function of another latent variable, ***Y****, that is the exact but unobserved dependent variable. In the ordered logit model, ***Y****, is continuous whose values determine what the observed ordinal variable ***Y*** equals. The continuous latent variable ***Y**** has various threshold points. The value on the observed variable ***Y*** depends on whether or not ***Y**** has crossed a particular threshold. For example, when ***s*** is the number of different values ***Y*** takes, the ***i***th observation should follow,

$$
\begin{aligned}
&Y = 1 \quad \text{if } \ Y_i^* \ \text{ is} < \tau_1 \\
&Y_i = k \ \text{ if } \ \tau_{\text{k-1}} \ \ Y_i^* < \tau_{\text{k}}, \text{for k} = 2, \cdots, s\text{-1} \qquad (4) \\
&Y_i = s \quad \text{if } \ Y_i^* \ \text{ is} > \tau_{\text{s-1}}
\end{aligned}
$$

The continuous latent variable ***Y**** is equal to

$$
Y_i^* = \beta_0 + \sum_{k=1}^{m} \beta_k X_{ki} + \varepsilon_i \qquad (5)
$$

The m ***β***s and the s-1 ***τ***s are parameters to be estimated. The probability that ***Y*** will take on a particular value is given below.

$$
\begin{aligned}
&\text{prob}(Y = 1 | X) = \frac{1}{1 + \exp(x\beta - \tau_1)} \\
&\text{prob}(Y = k | X) = \frac{1}{1 + \exp(x\beta - \tau_k)} - \frac{1}{1 + \exp(x\beta - \tau_{k-1})} \quad \text{for } k = 2, \cdots, s - 1 \quad (6) \\
&\text{prob}(Y = \text{s} | X) = \frac{1}{1 + \exp(x\beta - \tau_{s-1})}
\end{aligned}
$$

We will use this model to examine the factors that cause different paying interval rank for the assuming 3 coverage levels. In each level, there are 6 paying interval from low to high which value take 1 to 6. The dependent variables are WTPC1, WTPC2 and WTPC3 in table 1.

Cox proportional hazard model and it's applied to alternative issues

Cox proportional hazards model is a semi-parameter model for survival analysis, which can solve effectively the data truncation (or censoring) and interval analysis problems occurring in the DBDC method.

Firstly, we have a hazard function which means the limitation of conditional probability when a respondent are unwilling to pay ***b*** insurance but willing to pay ***b-δ*** as follows:

$$
h(b) = \lim_{\delta \to 0} \frac{prob(b - \delta \le b^* < b \,|\, b^* < b)}{\delta} \qquad (7)
$$

Assuming the vector ***X*** is the influence factors of ***i***th respondent unwillingness to pay ***b*** and ***$h_0(b)$*** is the baseline hazard function when ***X*** equals 0, then hazard function of the ***k***th influencing factor is $h_0(b)\times e^{b_k x_k}$. So the hazard function of ***i***th respondent at the payment of ***b*** can be shown:

$$h_i(b, X, \beta) = h_0(b)\cdot \exp(X\beta) \qquad (8)$$

β is the natural logarithm value which denotes that the respondent is unwillingness to pay ***b*** but willing to pay ***b-δ*** when ***X*** change one unit, and the symbol of parameter ***β*** is negative associated with the WTP. Therefore, the relative risk (RR) can be expressed by e^{β} and it implies that the probability of unwillingness to pay will increase if RR > 1. On the contrary, the probability of willingness to pay will increase if RR <1.

Another, there is a duality relation between survival function and hazard function at different payment interval, that's to say, $S(b_i^j; X) = 1 - h(b_i^j, X, \beta)$, where b_i^j indicates the WTP level with ***i***th respondent at ***j***th interval. And the survival function of ***j***th interval is given below.

$$S(b_i^j; X) = \exp\left\{1 - \int_{b_i^0}^{b_i^j} h(b, X, \beta)db\right\}; \quad (j = 1,2,\cdots,n) \qquad (9)$$

The survival probability is $S(b_i^{j-1}; X) - S(b_i^j; X)$ from the full interval ***j*** to ***j-1*** and the survival probability is $S(b_i^{j-1}; X)$ with the censoring interval. So, the probability can be calculate by function (10) which means the respondent is unwilling to pay at the interval ***j*** but willing to pay at the interval ***j-1.***

$$h(b_{j-1}^j) = 1 - \exp\left\{-\exp(\beta X)\int_{b^{j-1}}^{b^j} h_0(b)db\right\} \qquad (10)$$

Finally, we can define a scalar ***c_i*** which meaning is that the WTP of ***i***th respondent is in the full interval when **c_i** =1 and in the censoring interval when **c_i** =0, then the RR likelihood function is:

$$L = \Pi_{i=1}^{n}\left[S(b^{j-1}; X) - S(b^j; X)\right]^{c_i}\left[S(b^{j-1}; X)\right]^{1-c_i} \qquad (11)$$

And its logarithm with ***i***th respondent at the interval ***j*** is:

$$LnL = \sum_{i=1}^{n} \left\{ c_i Ln\left[1 - \exp(-\exp(\beta X + \varphi))\right] - \sum_{b=1}^{j-1} \exp(\beta X + \varphi) \right\} \quad (12)$$

where $\varphi = Ln \int_{b^{j-1}}^{b^j} h_0(b) db$.

In our question, each situation with different coverage level has a right censored data, such as [60, +∞), [100, +∞), and [200, +∞). So, CPHM can be used to analyze the influencing factor of WTP interval. The dependent variables are WTPC1, WTPC2 and WTPC3 in the table1 and the independent variables are the same with above models.

Results

The regression results are presented in Tables 3 and 4.

The results analysis of logit and ordered logit regression

In the table 3, WTB model, WTPC1 model, WTPC2 model and WTPC3 model were showed. For the WTB model, the estimated coefficient of each explanatory variable, its standard error and the corresponding marginal effect (ME) of a change in the explanatory variable are showed.

Flood risk is the one of most important factors which influencing resident's buying decision for flood insurance. The variable for number of floods experienced in past 30 years is positive and the Recency variable is negative, both of which are statistically significant at the 1% level. They indicate that the more numbers of floods experience and the shorter time elapsed since serious flood, the higher is the probability of the respondent willing to insure, indicating people understanding that buying insurance does not reduce the likelihood of the risk event occurring but it relieves the financial consequence. Furthermore, the mark of painful experience suffered from flood is clearer when there is a shorter interval, which will induce the respondent to participant in flood insurance.

Insurance experiences, UuInTyp and Apremiu, have a significant influence on the willingness to buy. When the respondents bought more types of insurance before, they tend to try this new insurance product and the WTB possibility will increase 14.6% with the UuInTyp increasing one unit. When the resident households had a higher average insurance payment, they are more willing to buy flood insurance.

Table 3 Logit and Ordered logit regression results for WTB and WTP

	WTB		WTPC1		WCP2		WCP3	
variable	β(SE)	dy/dx[b]	β(SE)	t_dy/dx[c]	β(SE)	t_dy/dx	β(SE)	t_dy/dx
Male	0.694** (0.322)[a]	0.045	0.292* (0.162)	1.06	0.408** (0.162)	2.19	0.447*** (0.161)	5.58
Age	0.044*** (0.014)	0.003	-0.004 (0.007)	-0.01	-0.013* (0.007)	-0.07	-0.005 (0.007)	-0.07
Educ	0.279*** (0.048)	0.021	0.008 (0.054)	0.03	0.031 (0.054)	0.17	0.035 (0.054)	0.44
NuFam	-0.156 (0.103)	-0.012	-0.012 (0.023)	-0.04	-0.019 (0.023)	-0.1	-0.014 (0.023)	-0.17
IncK	0.023*** (0.006)	0.002	0.059*** (0.003)	0.22	0.061*** (0.003)	0.33	0.054*** (0.003)	0.68
NuFlo	0.163*** (0.051)	0.012	0.098*** (0.018)	0.36	0.080*** (0.018)	0.43	0.050*** (0.018)	0.62
Rececy	-0.263*** (0.032)	-0.020	-0.07*** (0.022)	-0.26	-0.090*** (0.022)	-0.49	-0.082*** (0.022)	-1.03
PeRelief	-0.101*** (0.013)	-0.008	-0.005 (0.007)	-0.02	-0.009 (0.007)	-0.05	-0.003 (0.007)	-0.04
NuInTyp	1.638*** (0.208)	0.125	0.373*** (0.100)	1.38	0.335*** (0.100)	1.82	0.208** (0.097)	2.60
APremiu	0.010*** (0.002)	0.001	0.00 (0.001)	0.00	0.0 (0.001)	0.00	0.00 (0.001)	0.00
NuNOpin	-2.560*** (0.249)	-0.195	-0.205** (0.101)	-0.76	-0.246** (0.101)	-1.34	-0.116 (0.098)	-1.45
PeEf	2.662*** (0.354)	0.168	0.057 (0.135)	0.21	-0.029 (0.135)	-0.16	0.021 (0.134)	0.27
Knowl	0.559*** (0.083)	0.043	0.054 (0.038)	0.2	0.065* (0.038)	0.35	0.052 (0.038)	0.65
R1	0.236 (0.406)	0.017	0.510** (0.216)	1.93	0.358* (0.218)	1.97	0.656*** (0.215)	8.34
R3	0.994*** (0.353)	0.072	1.15*** (0.184)	4.36	1.221*** (0.186)	6.82	1.197*** (0.186)	15.26
	Pseudo R^2 = 0.755 N=1319		Pseudo R^2 =0.254 N=865		Pseudo R^2 =0.262 N=865		Pseudo R^2 =0.226 N=865	

***, **, and * indicate corresponding variable is significant at the 1%, 5% and 10% level, correspondingly.
a Number in parenthesis indicates standard error.
b The dy/dx is the marginal effect of probit model.
c The t_dy/dx is the total marginal effect which equals to the sum of the marginal effect of independent categorical variable from 1to 6 multiply its corresponding WTP value.

Other experience also has directly relation with the respondent's willingness. PeEf and Knowl have a significantly positive influencing on WTB and PeRelief negative. It indicates the respondents will ask people around them whether they buy flood insurance when making a decision, similar results as in Alex (2013). Furthermore, those who have more knowledge of insurance have a clearer picture of flood insurance in their living, thus have a lager influence. PeRelie will bring a "charity hazard" (Raschky and Weck-Hannemann 2007) to cause the WTB probability to decline. The government relief is a premium-free insurance, which is like a charity provided to individuals and induces their tendency not to insure or take any other mitigation measures, because they can rely on excepted financial assistance.

The respondent's socioeconomic characteristics also contribute in identifying the factors influencing respondents' willingness to participate in flood insurance. The variables of gender, age, education and annual income (k) all influence respondents' buying decision. Particularly, more educated people tend to buy the insurance relative to their counterparts receiving less education. Likewise, those who have more income are also more willing to buy flood insurance.

For WTP model, the estimated coefficient of each explanatory variable, its standard error and its total marginal effect (TME) on the WTP are shown in table 3. The t_dy/dx, or TME, equals

$$\sum_{j=1}^{6} dy_{ij} / dx \times WTPA_{ij} \quad (\boldsymbol{i}=1, 2 \text{ and } 3, \text{indicating 3 coverage levels})$$

Which dy_j/dx is the marginal effect of different categorical value corresponding different interval and the value of $WTPA_j$ are the same with Data section above. WTPC1, WTPC2 and WTPC3 models are significant showing by the χ^2 test.

Like WTB result, flood risk has a significant effect on WTP and the coefficient sign is the same with WTB model, also. The TME value of NuFlo is increasing with the increasing of coverage level but that of Recency is descending , such as from 0.36, 0.43 to 0.62 with NuFlo and from -0.26, -0.49 to -1.03 with Recency, which means not only WTB's probability increasing but also WTP's amount increasing with the NuFlo increasing and Recency descending. Thus, flood risk is a driver of insurance decisions.

Experience and socioeconomic characteristic have an affect on the WTP, as shown in Table 3. The numbers of Insurance types bought before (NuInTyp) is significantly positive associated with WTPC and its TME value is bigger than others almost explanatory variables, which means that the respondents are willing to pay more to this new insurance if they bought more types of insurance. Income is positive and significant at the 1% level in explaining WTPC and a 1,000 Yuan increases in income increases WTPC1, WTPC2 and WTPC3 by approximately 0.22, 0.33 and 0.68 Yuan. Furthermore, Males' WTP is higher than females' indicating they perceive flood insurance is more valuable, and is increasing with the coverage level.

Results also show that effects from both East and West regions in China are significantly positive compared with Central China (R2). Furthermore, it's worth noting that the TME of region dummy variable is the bigger than other part explanatory variables. For example, the household will pay 15.26 Yuan more if they live in West China compared with Central China and 8.34 Yuan more than who live in East China. This indicates the willingness to buy flood insurance in different region is quite different.

The results analysis of Cox proportional hazard model

The results of WTPC1, WTPC2 and WTPC3 models are shown in table 4 by Cox proportional hazard regression with a Newton-Raphson maximum likelihood iterative method, which are all significant at 1% level by χ^2 tests.

Flood risk reflected by the variable of NuFlo and Recency is still a statistical significant effect on WTP, which is same with the result of OLM. On average, when one time increase in NuFlo, the RR (relative risk) goes down approximately respectively 97.4%, 97.4% and 98% and WTP goes up respectively 2.7%, 2.6% and 2% at 3 coverage levels. Another variable, when one year increase in Recency, the RR of 3 coverage levels goes up all approximately 102% and WTP of 3 coverage levels goes down 1.8%, 2.3% and 2.3%, respectively.

Table 4 Cox proportional hazard regression results for WTB and WTP

	WTPC1		WTPC2		WTPC3	
variable	β(SE)	RR	β(SE)	RR	β(SE)	RR
Male	-0.117(0.085)[a]	0.889	-0.165(0.085)*	0.848	-0.192(0.085)**	0.825
Age	0.002(0.004)	1.002	0.005(0.004)	1.005	0.002(0.004)	1.002
Educ	-0.007(0.028)[b]	0.993	-0.016(0.028)	0.984	-0.009(0.028)	0.991
NuFam	0.002(0.013)	1.002	0.004(0.013)	1.004	0.001(0.013)	1.001
IncK	-0.021(0.001)***	0.979	-0.021(0.001)***	0.979	-0.020(0.001)***	0.980
NuFlo	-0.027(0.010)***	0.974	-0.026(0.010)***	0.974	-0.020(0.01)**	0.980
Recency	0.018(0.010)*	1.018	0.023(0.011)**	1.023	0.023(0.011)**	1.023
ReRelief	0.003(0.004)	1.003	0.006(0.004)	1.006	0.002(0.004)	1.002
NuInTyp	-0.112(0.053)**	0.894	-0.108(0.053)**	0.897	-0.083(0.052)	0.921
APremiu	0.00(0.00)	1.000	0.00(0.00)	1.000	0.00(0.00)	1.000
NuNOpin	0.090(0.048)*	1.094	0.098(0.048)**	1.104	0.081(0.05)	1.084
PeEf	-0.013(0.068)	0.987	-0.013(0.068)	0.987	-0.006(0.069)	0.994
Knowl	-0.001(0.021)	0.999	-0.014(0.020)	0.986	-0.019(0.02)	0.981
R1	0.030(0.112)	1.03	0.047(0.111)	1.048	-0.057(0.11)	0.945
R3	-0.318(0.093)**	0.728	-0.356(0.093)***	0.701	-0.358 (0.091)***	0.699

***, **, and * indicate corresponding variable is significant at the 1%, 5% and 10% level based on Wald value, correspondingly.
a Number in parenthesis indicates standard error.
b there is a positive influencing to WTP when the sign of coefficient is negative because of CPHM, vice verse.

Similar to the OLM results, residents' household income has a significantly positive effect on WTP. Generally, every 1,000 Yuan increases in income will decrease RR of WTPC1, WTPC2 and WTPC3 by all approximately 98% and increase WTP of all levels by all approximately 2%. The result shows that annual income reflects the payment ability to some extent and the high income households are more willingness to buy flood insurance with higher premium and high coverage level than lower income households, vice verse.

For regional dummy variable, R3 is significant but R1 is not significant which is slightly different to the OLM's result but is same with Logit model's result possible. The reason maybe is that the R3 household ability of resisting flood risk is lower than that of R2 as a result of R3 with lower quality house, lower income but higher flood. The RR of R3, compared with R2, decreases respectively 72.8%, 70.1% and 69.9% at low, medium and high coverage level but the WTP of R3 increases 31.8%, 35.6% and 35.8% at 3 levels, correspondingly. Our data do have the right censoring data problem and we don't expect OLM and Cox methods yield same results.

On the other hand, variables, such as Male, NuInTyp and NuNOpin, are not all significant at the three coverage levels. Male is significant with WTPC2 and WTPC3 and other two are significant with WTPC1 and WTPC2, which means that respondents have a different attitude on different coverage level. That's to say, Male are more willing to buy high coverage of insurance products compared with female but respondents with more NuInTyp and NuNOpin are willing to buy low coverage insurance.

Summary and conclusions

Climate change, long-term environmental deterioration, continued intensification of floodplain development, and the comparatively low standards of the water conservancy projects design and construction are expected to increase the frequency and severity of flooding in China. Furthermore, the rural areas of China appear to be more vulnerable than urban areas. The policy-oriented agriculture insurance for natural disasters provides insurance for crops and livestock, not for residents' household property. At the same time, experiences in various developed countries suggest that flood insurance can be an effective measure to reduce the flood damages for residents. Real estate and household property flood insurance is not available in Chinese rural areas currently. Therefore, it is necessary to investigate whether residents in rural China are willing to insure and what factors influence their willingness to insure.

The fundamental finding of this study is that willingness to participate rates of such insurance, 65.6%, are high in China rural area, and the WTPs of three coverage levels are 25.47 Yuan, 39.69 Yuan and 72.79 Yuan, respectively and the expected subsidy rates are increasing with the coverage level's increase. Compared to the low actual participation rate reported in the US (Dixon et al. 2006), it is interesting to explore further what can help to transform the high willingness to buy rate into a high actual buying rate. The second key result of this study is that risk is a driver of insurance decisions, consistent to conventional wisdom. All models show that flood risk, such as numbers of floods in past 30 years and time elapsed since the serious flood, has a significant influencing on WTB and WTP. Furthermore, the significance of regional dummy variable exists in almost models. Studies also find that annual income is a direct influencing factor when the respondents make an insurance decision, which is the same with result of Kousky (2011) who found that participation rate and coverage levels of NFIP increase with income in USA. Last but not least, insurance experience play an important role when the respondent whether to buy and pay.

Implications to the insurance industry and government policy can be derived from these results. Firstly, the flood risk, economic development and social characteristics in different areas should be taken into consideration in formulating flood insurance mode, such as low income household with high subsidy in the region of similar flood risk, high risk region with high subsidy at the same income level. It is highly possible that government subsidy will be needed for such insurance and the Chinese government should be willing to provide, because it can set aside a more predictable budget and transfer the risk of disaster relief expenditure on the insurance industry. Secondly, negative opinion has a significant negative effect on the take-up willingness and the respondents have an active demand if flood insurance provided. Therefore, the flood insurance education and promotion, such as TV, leaflet, picture, post advertisement etc., should be enhanced so that rural residents have a good and positive knowledge of flood insurance. Thirdly, both flood insurance coverage and premium should be maintained at moderate levels considering income level and government subsidy. So, the low premiums coupled with moderate insured amounts flood insurance mode should be considered, such as low premium and low coverage policy which is the same with crop insurance in China now.

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