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ORIGINAL PAPER

Preferences for earthquake insurance in rural China: factors influencing individuals' willingness to pay

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Abstract In 2014, China piloted its first earthquake insurance program, and the inhabitants' demand for earthquake insurance is significant for the implementation of this plan. This study aims to identify the willingness to insure (WTI) and willingness to pay (WTP) for earthquake insurance and their influencing factors. A field survey was carried out in 2013 in pilot area, and total of 681 people were interviewed face to face. By using the contingent valuation method, we elicited people's WTI and WTP for insurance, and the results were 88 % and 160 Yuan. We also analyzed their influencing factors using Probit and Tobit model. Regression results showed that risk perception was the leading factor associated with insurance demand, followed by risk exposure, sociodemographic elements and personal characteristics. Only one aspect of disaster experience—escape experience—had positive effect on WTI. People living in the reinforced house showed lower WTP, which verifies the adverse selection did exist. The findings pointed that rich ones and village cadres were more willing to pay for insurance, and the government propaganda for earthquake mitigation could increase ones' WTP. In addition, some personal characteristics could also affect the WTI and WTP.

Keywords Earthquake insurance demand · China · Contingent valuation method · Willingness to pay · Risk perception

1 Introduction

Nature's hazards—earthquakes, volcanoes, landslides, tsunamis, flooding, hurricanes and tornadoes—directly affect hundreds of millions of people each year. Worldwide natural hazard damage exceeded $100 billion during the 1990s (IFRC 2000). China is located

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between two of the world's largest seismic zones—the circum-Pacific seismic belt and the Eurasian seismic zone. Under the effect of the extrusion of the Pacific, Indian and Philippine Sea plates, earthquakes frequently occur near the rupture zone. According to Munich reinsurance (2013) company statistics, in the past 20 years, natural hazards had resulted in 13 million deaths and $404 billion lost. Recent earthquakes, including the one in Wenchuan in 2008 ($136 billion property loss, 69,227 deaths), the one in Yushu Qinghai in 2009 ($48.3 million property loss, 2698 deaths), the one in Yingjiang, Yunnan in 2011 ($0.28 billion, 25 deaths) and the one in Yaan in 2013 ($28.23 billion, 196 deaths), resulted in loss of lives and property in China.

With the development of earthquake risk mitigation technology, the prediction and post-rescue efficiencies have been greatly improved. However, individual awareness of seismic risk prevention remains weak. In terms of Wenchuan earthquake in 2008, because the pre-event insurance coverage was very low, insurance did not play a large role in compensation afterward, and less than 2 % of the total economic loss was compensated by insurance companies (Wei 2008). Although the low coverage rate was determined by both the demand and supply, it still reflected a serious lack of awareness of Chinese residents concerning catastrophe insurance.

The Chinese government proposed earthquake insurance products in Shenzhen and Yunnan in 2014. To promote earthquake insurance among residents, the government decided to pay the full premium for residents in the early stage and then to gradually reduce the premium subsidies to promote fee sharing and resident voluntary purchase. In the long run, the key to maintaining the earthquake insurance system is to ensure significant demand for catastrophe insurance. Only when the demand reaches certain standards can the "law of large numbers" be satisfied, which can diversify the risk to ensure the normal operation of the earthquake insurance system. To ensure the success of the catastrophe insurance pilot projects, it is necessary for the government to study the potential demand level for catastrophe insurance and the key factors that may affect the demand level in China. We hypothesized that hazard experience, risk perception, risk exposure and personal characteristics would be associated with willingness to pay (WTP) for earthquake insurance.

The findings of present study not only has practical significance for China, but can also serve as a reference for those countries (developing and developed) that have not adopted earthquake insurance in earthquake risk management.

2 Background

The "small probability and huge loss" characteristic of catastrophe risk make people's demand toward catastrophe insurance differ from the attitude toward general insurance. Slovic and Fischhoff (1977) suggested that people always tend to purchase insurance for risks with relatively high possibilities and take an evasive attitude toward catastrophic risks such as earthquake and flood. In analyzing the data from the American National Flood Insurance Program (NFIP), Dixon et al. (2006) observed that the insurance penetration rate was only 1 % outside the special flood hazard area (SFHA).

Many empirical studies concerning the demand for catastrophe insurance and influencing factors focus primarily on SFHA. The paper published by Browne and Hoyt in 2000, a panel data regression study of factors affecting flood insurance, is cited relatively frequently as a reference. Browne and Hoyt (2000) suggested that the reasons for the severe shortage of flood insurance demand were as follows: (1) The individual flood insurance

demand was positively correlated with one's income, resulting in individuals with relatively low income not using insurance as a way to manage risks; (2) the insurance price was negatively correlated with demand, which means that if the government offered subsidies for insurance fees, the total demand level would increase to a certain extent; and (3) the experience of disaster loss would affect one's demand for insurance, in a similar manner to the demand for insurance being correspondingly increased in areas where flood loss had occurred recently. Through field study, Pynn and Ljung (1999) observed 18 reasons that people are not buying flood insurance. Among those reasons, the most important two were that government flood control projects would prevent flood invasion and that the national weather service expected no flood in the near future. Therefore, Dixon et al. (2006) suggested that the government's coercive measure was the only effective way to increase the flood insurance demand.

Recently, several empirical studies concerning earthquake insurance have been published. The 2011 paper by Athavale and Avila was one of the few papers about the demand for earthquake insurance. Athavale and Avila suggested that the demand for earthquake insurance was almost inelastic in terms of income and price and that the reason house owners bought earthquake insurance was to manage risk. Athavale and Avila also mentioned that those who lacked the awareness to purchase insurance always thought that the government, rather than insurance companies, would provide post-disaster compensation (Athavale and Avila 2011). Landry and Jahan-Parvar, though an empirical study of NFIP in 2011, observed that the erosion risk that an individual faced was positively correlated with the demand for flood insurance. Landry and Jahan-Parvar suggested that the construction of government flood control projects would not eliminate the demand for insurance and that the insurance coverage rates in high-flood-hazard areas (V-zone) were generally higher than those in moderate-flood-hazard areas (B/C/X-zones).

A growing number of studies have examined the subjective factors that drive people's mitigation behavior, and in particular risk perceptions. Solberg et al. (2010) pointed out that the positive correlations between risk perceptions and mitigation behavior reported in the literature on seismic hazards are often small. Thieken et al. (2007)'s results showed no statistically significant relation between risk perception and flood mitigation behavior in five of six possible cases. A small-to-medium correlation is reported in one case. Knocke and Kolivras (2007) examined the influence of two aspects of risk perception (i.e., perceived risk to life and perceived risk to property) on tracking flash flood developments. Results showed that the former is found to be significantly related to a higher frequency of tracking flash floods; no significant relation was observed for the variable perceived risk to property. Lindell and Perry (2012), however, suggested that higher risk perceptions tend to lead to precautionary behavior, and they developed a framework-protective action decision model (PADM) to interpret the mechanism between risk perception and mitigation behavior. According to PADM, awareness of a threat is initiated by environmental cues (sights or sounds), observations of others or messages from informal, news media, or official sources that are perceived primarily in terms of expertise and trustworthiness. Threat perception motivates a search for an appropriate response to protect persons and property without unnecessarily disrupting normal activities (Lindell and Perry 2000). Insurance demand is also a category of risk mitigation; many researchers used field research to study the relationship between subjective factors and demand for catastrophic insurance in countries such as China that lack the catastrophe insurance. Demand is always measured by willingness to pay (WTP) and willingness to insure (WTI). Ganderton et al. (2000) used an experimental test to measure individual WTP for catastrophic insurance and observed that the cost of insurance, loss size estimation and probability of loss occurrence

were the key factors affecting WTP. The paper published by Botzen and Bergh (2012) was one example of a study with relatively complete survey results relating to the demand for catastrophic insurance. Botzen and Bergh (2012) used a payment card to measure residents' WTP in Holland flood zones. These authors observed that the respondents' average WTP was higher than the actuarial premium fee and that the WTP was strongly affected by the respondents' flood risk perception, levels of risk aversion and risk levels of the respondents' houses.

What is the demand for catastrophic insurance in China? And what factors would affect people's demand for catastrophic insurance? Because China currently has no clear catastrophic insurance or corresponding products, research concerning the demand for catastrophic insurance can only be performed using field research or the experimental evidence approach. Currently, few literature studies have used this method in China. Wang et al. (2012) were the first to publish a paper in which a survey was used as the study method. These authors obtained 7459 questionnaires nationwide and observed that the average WTP for disaster house insurance is approximately 0.55 % (median 0.20 %) of the insured amount for an all-in-one policy. This implies that the acceptable average premium rate for the buyer's share was approximately 0.55 % of the insured amount, with a median of 0.20 %. And they also observed that elements such as the individual's experience of the disaster, the insurance experience and the level of trust toward insurance were the key factors affecting WTP. Because their survey was a nationwide survey, given the practical constraints (time, costs, etc.), the questionnaire design was inevitably brief and the influencing factors were not entirely clear. Therefore, certain key issues were not analyzed in detail.

Based on a review of the existing literature, we observed that the current studies have the following problems. First, most of the studies were empirical studies that were performed by analyzing historical data. This study method could not be applied in countries without catastrophe insurance; second, studies performed by analyzing historical data lack the discussion of individual subjective elements due to the constraint of the method; third, most studies have focused on the relationship of flood hazard and insurance, while only a few studies have focused on the relationship between earthquake risk perception and the demand for earthquake insurance; finally, limited detailed discussion has been performed concerning the demand level of catastrophic insurance in China and influencing factors.

Thus, the present study adopted the Probit and Tobit methods to research individual's WTI and WTP toward earthquake insurance from the viewpoint of microeconomics, using the data from Wuhan University's "rural residents' catastrophic risk perception and demand for catastrophic insurance" survey in 2013. We also investigated the effect of factors that included risk perception, disaster experience, risk exposure, individual socioeconomic condition and personal characteristics on the demand for earthquake insurance.

3 Methods

3.1 Study design

The contingent valuation method (CVM) is a typical stated preference method with which research groups perform surveys under hypothetical market conditions. CVM investigates people's WTP for specific environmental improvements or for resource protection, as well as people's willingness to accept (WTA) compensation for the loss of environment or resource conditions. CVM is usually applied in the evaluation of environments and resources. At present, most foreign studies about WTP for catastrophic insurance have used

CVM. The present study measured two types of farmers' willingness to spend on earthquake insurance: WTI and WTP for the premium fee.

The measurement of WTI is relatively easy. By offering specific scenario and hypothetical products, we asked farmers whether they were willing to insure. There are now four ways to measure WTP: bidding game (BD), payment cards (PC), open ended (OE) and dichotomous choices (DC). Wang et al. (2012) used OE to measure individual WTP for catastrophic insurance. Botzen and Bergh (2012) adopted PC to measure WTP. Most of the existing studies on resources and environments have adopted DC to measure WTP (Buzby et al. 1995; Hammitt and Haninger 2010; Vásquez et al. 2009). We observed that due to the respondents' low education level and limited communication with the outside world, combining PC and BD resulted in a relatively good approach to measure WTP for policy-based earthquake insurance. The bidding game is the oldest elicitation technique among all the techniques (Venkatachalam 2004). The details of bidding game approach are as follows: The respondents in a CVM study would be assigned a particular bid from a range of predetermined bids randomly. The bid assigned may be either a lower- or higher-level bid. The respondents would then be asked to say "yes" or "no" to that particular bid, and the process would continue until "the highest positive response is reached" (Randall et al. 1974). The payment card is another one of the oldest elicitation techniques, which is introduced by Mitchell and Carson (1984). The payment card would contain a range of WTP values in a card for the public good under question from which the individuals have to choose their maximum WTP value. The detailed method used in our survey is described in the following paragraph.

Under the condition that respondents could understand the scenarios, we offered PC and asked them "what was the highest insurance fee respondents were willing to pay?" If respondents were able to answer the question with the guidance of PC, the questioning part would end. If, however, the respondents were not able to make a selection after several trials, we used BD to guide the respondents. We first asked each farmer whether he/she was willing to buy earthquake insurance at the initial price (P0). If the answer was "yes," then the researchers asked the farmer again with a higher price (PU) than P0. The process continued until the answer was "no," and that price was considered the final WTP price of the respondent. If the farmer answered "no" at an initial price P0, we asked the farmer again with a lower price (PD) than P0. The process continued until the answer was "yes" and that price was determined as the final WTP price of the respondent. P0 and Pi were randomly selected in payment cards.

To ensure that the prices on payment cards were within the acceptance range, we performed a pre-survey before the actual survey. Based on the outcome of pre-survey, we decided to set PC between RMB 5 to RMB 1000.

3.2 Samples

The main data resource of the present study came from the survey "rural residents' catastrophe risk perception and catastrophic insurance demand" organized by Wuhan University. The survey lasted from September 2013 to October 2013. The survey area in this study is the state of Chuxiong, located in the middle of Yunnan Province, China. Over 90 % of this territory is mountainous, making it predisposed to earthquakes (Fig. 1). We chose Chuxiong as the survey area for several reasons. First, the Chinese government will introduce an earthquake insurance pilot program in Chuxiong. This study will focus on a high-risk-exposure group—native farmers, who are always the hardest hit after an earthquake, for their locations are nestling against mountains and their houses were vulnerable.

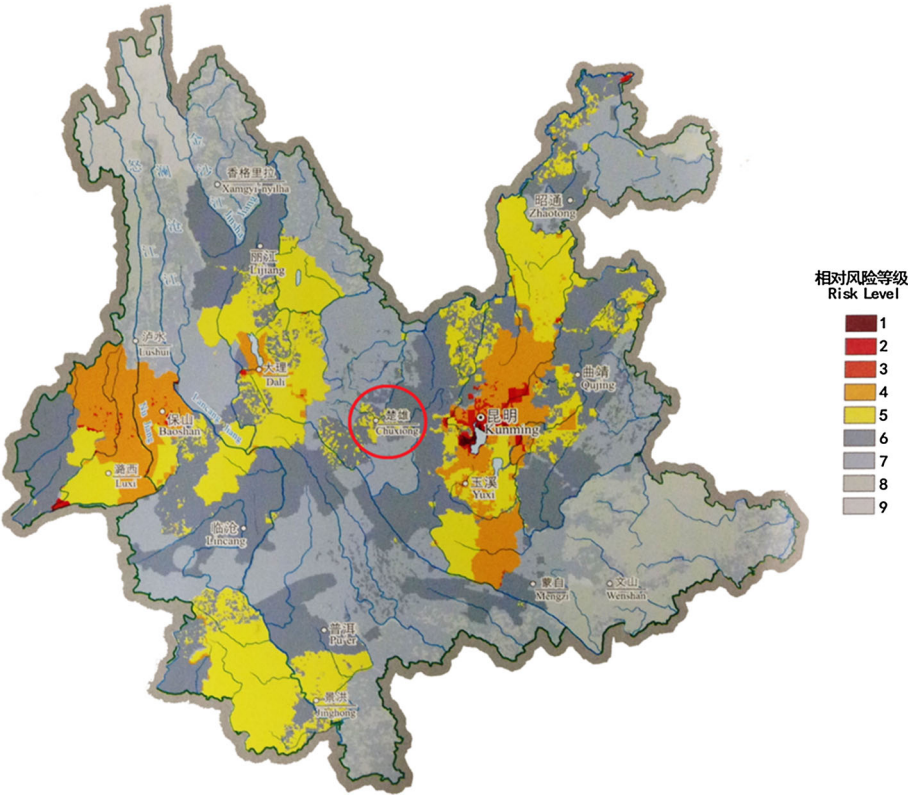

Fig. 1 Study area: earthquake-prone area—Chuxiong

Therefore, they most need earthquake insurance and enjoy full governmental subsidies. Second, according to Terpstra et al. (2006), limited knowledge of risk perception of flood hazards may lead to difficulties in communicating these risks. Habitants in Chuxiong are very familiar with earthquake risk, which greatly facilities communication in the survey and makes our argument more convincing. Thirdly, research in this area would be of both practical value and policy value. At the beginning of the earthquake insurance pilot project, the government plans to use an urban–rural difference policy under which the government offers insurance subsidies similar to agricultural insurance subsidies to rural residents. The reasons for urban–rural difference policy in China are as follows: (1) The big gap between rural and urban area is a basic condition in China, and their extent of demand for earthquake insurance are different. (2) Housing condition between both also remains. Rural people usually lived in high-risk area, and their houses are vulnerable, while urban people's housing is much stronger. (3) Insurance conditions in these two areas are different. In rural China, people owned the majority of insurance that are policy insurance, which are supported by government, such as agriculture insurance, health insurance. On the contrary, city dwellers owned insurance that are almost commercial insurance such as car insurance, accident insurance ran by company. Based on the above reasons, urban people should hold commercial earthquake insurance, which is market driven, while rural people hold government-supported earthquake insurance, which includes subsidies given by the

Table 1 Main characteristics of survey areas

County	Number of earthquake in the last 20 years (≥5.0 magnitude)	Farmers' per capita income in 2009	Locations in this pilot area	Sample size
Yaoan	4	3344	West	180
Dayao	3	3267	Northwest	161
Shuangbai	1	2804	East	160
Lufeng	0	4071	South	180

government. As farmers have relatively high agricultural insurance rates, they are relatively familiar with policy-based insurance (subsidized insurance). Thus, the present study chose a rural area of Chuxiong as the research site.

In consideration of both research purpose and operability, we selected four typical research sites in Chuxiong (Yaoan, Dayao, Shuangbai and Lufeng). In Table 1, we could see that these four areas provide different features in terms of earthquake frequencies, income and location. In accordance with the research design, we distributed 200 questionnaires to each of the four sites. Among the total of 800 questionnaires, 681 effective questionnaires were collected (the samples are shown in Table 1). Because all questionnaires were performed during in-person interviews with researchers and the researchers were properly compensated for their time and work, we obtained relatively good control concerning the quality of questionnaires. The key contents in the present research included the individual's socioeconomic characteristics, earthquake risk perception level and disaster experience and the earthquake insurance demand.

4 Variables and empirical method

4.1 Variables

4.1.1 Dependent variables

The present study used two steps to analyze an individual's demand for earthquake insurance. In the first step, we investigated participants' WTI, that is, whether they would buy earthquake insurance. The variable used in this step was binominal: 0 or 1. If the respondent was willing to purchase earthquake insurance, 1 would be selected. Otherwise, 0 would be selected. In the second step, we investigated individual's WTP for earthquake insurance, that is, how much people were willing to pay for earthquake insurance. If a participant was willing to purchase earthquake insurance, we would then determine how much he or she was willing to pay for earthquake insurance with coverage RMB 20,000 in the second step. For comparison between different individuals, we used the fix coverage (RMB 20,000).

4.1.2 Independent variables

4.1.2.1 Farmers' risk perception Lindell and Hwang (2008) suggested that an individual's risk perception was a key factor affecting people's risk prevention behavior. High risk perception led to serious risk prevention behavior. Kunreuther (1996) also suggested risk perception was always the key factor affecting earthquake insurance demand. The empirical studies conducted by Wang et al. (2012) and Botzen and Bergh (2012) confirmed

this conclusion. In the present study, Ho et al. (2008)'s paper was used as a reference; three questions that reflected the farmers' earthquake risk perception were designed, and regression analysis was performed. Using the pre-survey, we observed that farmers had difficulty understanding the five-point Likert scale.[1] After multiple tests, we added a textual description for each scale to help farmers make choices (Table 3).

4.1.2.2 Earthquake experience Viscusi and O'Connor (1984) proposed the learning model and believed that an individual's behavior of risk prevention was decided by recent experience. Viscusi and O'Connor suggested that an individual would exhibit positive risk prevention behavior if that individual had recently experienced a disaster. Browne and Hoyt (2000) confirmed that flood loss experience would positively affect the demand for flood insurance, and a higher demand level would be present for more serious flood losses experienced recently. Earthquakes occur frequently in Chuxiong. The sample's average number of earthquake experience was 1.79. Therefore, it was necessary to verify whether an individual's disaster experience would affect disaster insurance demand. In the present study, we applied virtual variables—the respondents' number of earthquake experiences (Exp_Num) and whether the respondent had experienced an earthquake evacuation (Exp_Escape) as explanatory variables.

4.1.2.3 Degree of risk exposure When a building is elevated, the flood's threaten will be decreased, then the WTP for flood insurance is also decreased. The present study included three variables—whether the house had been reinforced (Expo_Reinforced), the type of house (Expo_HouseType) and the number of houses owned (Expo_HouseNum)—into the model to test the relationship between the degree of risk exposure and the risk insurance demand. The "Shockproof reinforcement" project was a measure adopted by the Yunnan local government to increase farmers' level of disaster prevention and mitigation, under which the government provided free reinforcement for those whose houses had high risk exposure. Some of the respondents had reinforced their houses by themselves. We hypothesize that people living in the reinforced houses have relatively lower WTP. Meanwhile, we believed that the farmers' house type would affect the WTP for earthquake insurance. The difference in seismic resistance is significant between different types of houses. Higher seismic resistance of one's house should correspond with lower WTP for earthquake insurance. Table 2 reflects the basic information, seismic resistance and percentage of different types of houses given by the respondents.

4.1.2.4 Farmer's socioeconomic elements Three specific indicators—the log of the total gross household income (Socio_Income), whether the respondent worked in the office of the village (Socio_Leader) and whether the respondent had heard about earthquake propaganda from the government (Socio_Propaganda)—characterized the socioeconomic status of the farmers in the present study. First, according to consumer theory, the higher the one's income is, the greater the probability of buying earthquake insurance and the higher the corresponding WTP. Because the income of farmers mainly comes from harvests, the "annual gross household income" is more suitable than "monthly income" to reflect farmers' household financial situation. We used "Socio_Leader" to measure

[1] A Likert scale is a psychometric scale commonly involved in research that employs questionnaires. It is the most widely used approach to scaling responses in survey research. The core composition of Likert scale is rating scale, which is a set of categories designed to elicit information about a quantitative or a qualitative attribute.

Table 2 Basic information concerning house type and seismic resistance in rural area

House type	Basic information	Seismic resistance	Percentage
Soil beam structure	Use rammed earth wall as the main bearing structure and enclosure	Severe damage under VI degree of intensity	3.5
Soil wood construction	Use wood column as the main bearing structure; may use rammed earth wall as enclosure but not bearing structure	Can only withstand VI–VII degrees of intensity	58.7
Brick wood structure	Two types: use wood frame as the main bearing structure and use brick column or brick wall as the bearing structure	Will not be seriously damaged under VI degree of intensity	24.4
Brick concrete structure	Use rubble foundation, brick wall, concrete beam and slab as the main bearing structure		
Frame structure	Use reinforced concrete frame as the main bearing structure	Strong seismic resistance	13.4

Data source China Insurance Regulatory Commission

whether the social status would affect the demand for insurance. "Socio_Leader" could also be used to test whether the leaders had demonstration effects, resulting in relatively high WTP. "Socio_Propaganda" was used to test whether government propaganda on earthquakes would increase individual's awareness of risks and insurance.

4.1.2.5 Personal characteristics Based on previous studies, in the present study, gender, age, age squared (Personal_Age2) and education level (Personal_Edu) were selected as indicators of personal characteristics. The education level of rural residents was generally low. Many farmers left school for farming. We used school years to represent the level of education (Personal_Edu). "Personal_Edu" was assumed to be positively correlated with WTP. Duker (1969) suggested that the demand for insurance and age was not linearly related. Thus, the present study applied both "Personal_Age" and "Personal_Age2" as explanatory variables in the model. "Personal_Age" and "Personal_Age2" were assumed to be positively correlated with the demand for insurance.

The definition and statistical description of all variables are as follows (Table 3):

4.2 Empirical method

We investigated WTI in the first step using the Probit model. The detailed form was as follows:

$$\mathrm{WTI} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon.$$

WTI was a binominal 0–1 virtual variable, representing whether the respondent would join the earthquake insurance project. This Probit model was used to estimate the individual's likelihood of participating in earthquake insurance projects. Explanatory variables included personal risk perception X_1, earthquake experience X_2, degree of risk exposure X_3, farmer's socioeconomic elements X_4 and personal characteristics X_5.

Then, we estimated the farmers' WTP in the second step using the Tobit model. The detailed model was as follows:

Table 3 Definition and statistical description of all variables

Items	Variables	Definition	Description
Insurance demand	WTI	Are farmers willingness to insure against earthquake risk?	0: 11.31 % 1: 88.69 %
	WTP	Willingness to pay for earthquake insurance with coverage of 20,000 Yuan	Mean: 160.0338 S.D.: 214.1727
Risk perception	RiskPerception_1	In general, how afraid are you of an earthquake? 1 = not afraid at all; 2 = a little afraid; 3 = afraid; 4 = very afraid; 5 = extremely afraid	1: 0 % 2: 11.6 % 3: 9.25 % 4: 9.1 % 5: 70.04 %
	RiskPerception_2	How much do you think your property will be threatened in the event of six-magnitude earthquake occurs? 1 = impossible; 2 = possible but only a little destroyed; 3 = petty destroyed; 4 = moderate destroyed; 5 = completely destroyed	1: 12.78 % 2: 6.31 % 3: 12.33 % 4: 28.49 % 5: 40.09 %
	RiskPerception_3	In this area, how likely is it that an earthquake will occur in 1 year? 1 = impossible; 2 = the possibility is very small; 3 = possible; 4 = very possible; 5 = certain to occur	1: 31.86 % 2: 42.44 % 3: 9.4 % 4: 7.05 % 5: 9.25 %
Disaster experience	Exp_Num	How many times have you ever experienced an earthquake in 5 years?	Mean: 1.7944 S.D.: 1.3769
	Exp_Escape	Have you escaped and lived outside at the night of last earthquake? 1 = yes, 0 = no	0: 50.07 % 1: 49.97 %
Risk exposure	Expo_Reinforced	Have your ever pre-reinforced your house by yourself of government for earthquake? 1 = yes, 0 = no	0: 59.18 % 1: 40.82 %
	Expo_HouseType	What are the types of walls, beams and pillars of your living house? 1 = mud walls; wooden beams; no pillars 2 = mud walls; wooden beams; wooden pillars 3 = brick walls; wooden beams; wooden pillars 4 = brick walls; concrete beams (not convex); concrete pillars (not convex) 5 = brick walls; concrete beams (convex); concrete pillars (convex)	1: 3.52 % 2: 58.74 % 3: 8.08 % 4: 16.45 % 5: 13.22 %
	Expo_HouseNum	How many houses do you own?	Mean: 1.3642 S.D.: 0.6878

Table 3 continued

Items	Variables	Definition	Description
Sociodemographics elements	Socio_Income	Ln (family yearly gross income)	Mean: 1.3642 S.D.: 0.6878
	Socio_Leader	Have your held a post in your village? 1 = yes, 0 = no	0: 83.7 % 1: 16.3 %
	Socio_Propaganda	Have you heard of government earthquake propaganda? 1 = yes, 0 = no	0: 30.69 % 1: 69.31 %
Personal characteristics	Personal_Gender	1 = female, 0 = male	0: 42.58 % 1: 57.42 %
	Personal_Age	Age	Mean: 45.1674 S.D.: 10.0879
	Personal_Age2	Square of age	Mean: 2141.711 S.D.: 907.3705
	Personal_Edu	Numbers of education year	Mean: 6.8502 S.D.: 3.2816
Simple area (Controlled)	Riskarea_YAOAN	Sample area in Yaoan 1 = yes, 0 = no	1: 26.43 %
	Riskarea_DAYAO	Sample area in Dayao 1 = yes, 0 = no	1: 23.64 %
	Riskarea_SHAUNGBAI	Sample area in Shuangbai 1 = yes, 0 = no	1: 23.49 %
	Riskarea_LUFENG	Sample area in Lufeng 1 = yes, 0 = no	1: 26.43 %

$$\mathrm{WTP} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon.$$

WTP is the individual's willingness to pay for earthquake insurance. Because the WTP of those who did not want to join the earthquake insurance project was 0, the sample then had the problem of "Truncation." The usage of the Tobit model helped to solve this problem.

5 Results

5.1 Risk perception

Using the Probit and Tobit models, the present study performed regression analysis to investigate farmers' demand for earthquake insurance at the pilot site. Tables 4 and 5 present the regression outcomes. Models 1–3 provide the regression results of WTI for earthquake insurance. RiskPerception_1 and RiskPerception_2 were positive at the 90 and 99 % confidence intervals. This outcome is consistent with the outcome of theory analysis (i.e., higher risk perception is associated with a greater probability that one purchases earthquake insurance). Marginal effects showed that for each additional unit of the RiskPerception_1 and RiskPerception_2, probability of WTI will increase 0.0174 and 0.0234. Models 4–6 indicate that the regression results of WTP. RiskPerception_1 and RiskPerception_3 were positive at the 95 and 99 % confidence intervals. This outcome means that higher risk perception led to a higher WTP for earthquake insurance, which supported the theoretical positive correlation relationship between risk perception and risk prevention behavior (Lindell and Hwang 2008). This result is also consistent with the research results of Wang et al. (2012) and Botzen and Bergh (2012). The above results suggest that earthquake risk perception has positive effects on the demand for earthquake insurance.

5.2 Disaster experience

Viscusi and O'Connor (1984) proposed that people change their risk judgments as they obtain new information, which would further affect one's risk decision. Barnett and Breakwell (2001) also suggested that a higher frequency of disaster experience (frequency), degree of final loss (impact) and one's perception of loss degree (outcome) would result in a higher likelihood that one was to participate in risk prevention. Among all the models, only model 3 indicated that the experience of earthquake evacuation (Exp_Escape) had a positive effect on WTI (marginal effect is 0.0422). Exp_Num did not exhibit a significant correlation with either WTI or WTP. There are two possible reasons for this outcome: First, the frequency of earthquake experience (Frequency) might lead to two different effects—one may have relatively high risk perception after an earthquake experience and correspondingly have a strong willingness to take risk prevention measures; one may also become insensitive to earthquakes after several occurrences and correspondingly lack the willingness to take risk prevention measures (Benthin et al. 1993; Baan and Klijn 2004). These two different effects might lead to the insignificance of the "Exp_Num" variable.

5.3 Degree of risk exposure

In models 1–3, the "Expo_Reinforced" variable was negative at the 5 % confidence interval (marginal effect is −0.0614, −0.0564 and −0.0577). This result shows that

Table 4 Probit analysis on WTI

Items	Variables	Probit—WTI					
		Model 1		Model 2		Model 3	
		Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx
Constant	Cons	−0.9601		−1.7679		−0.6994	
Risk perception	RiskPerception_1	0.1140*	0.0174*				
	RiskPerception_2			0.1563***	0.0234***		
	RiskPerception_3					0.0152	0.0076
Disaster experience	Exp_Num	−0.0669	−0.0102	−0.0579	−0.0087	−0.0651	−0.0096
	Exp_Escape	0.2534	0.0388	0.2621	0.0392	0.2823*	0.0422*
Risk exposure	Expo_Reinforced	−0.3807**	−0.0614**	−0.3585**	−0.0564**	−0.3668**	−0.0577**
	Expo_HouseType	−0.0146	−0.0022	0.0493	0.0074	−0.0196	−0.0001
	Expo_HouseNum	0.2238*	0.0342*	0.2222*	0.0332*	0.2436**	0.0358**
Sociodemographics elements	Socio_Income	0.1272	0.0195	0.1573*	0.0235*	0.1239	0.0189
	Socio_Leader	0.0651	0.0097	0.0652	0.0095	0.0513	0.0101
	Socio_Propaganda	0.5268***	0.0930***	0.5470***	0.0951***	0.5310***	0.0954***
Personal characteristics	Personal_Gender	0.0151	0.0023	0.0086	0.0013	−0.0193	−0.0017
	Personal_Age	0.0093	0.0014	0.0204	0.0031	0.0158	0.0026
	Personal_Age2	−0.0001	0.0000	−0.0002	0.0000	−0.0002	0.0000
	Personal_Edu	0.0356	0.0054	0.0299	0.0045	0.0309	0.0049
Simple area (controlled)	Control variables	(Controlled)	(Controlled)	(Controlled)	(Controlled)	(Controlled)	(Controlled)
Test	Observations	681	681	681	681	681	681
	Prob > χ^2	0.0000	–	0.0000	–	0.0000	–
	Log likelihood	−211.0022	–	−208.4148	–	−212.5193	–
	Pseudo R2	0.1220	–	0.1327	–	0.1178	–

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$

Table 5 Tobit analysis on WTP

Items	Variables	Tobit—WTP					
		Model 4		Model 5		Model 6	
		Coef.	*p* value	Coef.	*p* value	Coef.	*p* value
Constant	Cons	−77.6371	0.669	−62.2045	0.740	−53.1408	
Risk perception	RiskPerception_1	18.2150**	0.035				
	RiskPerception_2			5.9042	0.410		
	RiskPerception_3					18.7558***	0.010
Disaster experience	Exp_Num	−6.9593	0.309	−6.2549	0.362	−7.5922	0.267
	Exp_Escape	3.3550	0.861	6.3724	0.740	4.9806	0.794
Risk exposure	Expo_Reinforced	−6.1120	0.750	−4.3746	0.820	−4.4912	0.814
	Expo_HouseType	−17.0429**	0.040	−14.2432	0.114	−17.7647**	0.032
	Expo_HouseNum	19.3131	0.134	20.6990	0.109	20.7790	0.105
Sociodemographics elements	Socio_Income	40.1988***	0.001	39.5330***	0.001	41.1744***	0.000
	Socio_Leader	57.8349**	0.023	58.6545**	0.022	59.3399**	0.020
	Socio_Propaganda	1.8911	0.925	2.5615	0.898	−0.7697	0.969
Personal characteristics	Personal_Gender	−5.5243	0.778	−9.4731	0.628	−10.1511	0.602
	Personal_Age	−13.0284**	0.046	−11.8013*	0.071	−13.0585**	0.045
	Personal_Age2	0.1503**	0.038	0.1368*	0.059	0.1484**	0.040
	Personal_Edu	8.1239**	0.013	7.4098**	0.023	7.5144**	0.020
Simple area (Controlled)	Control variables	(Controlled)	(Controlled)	(Controlled)	(Controlled)	(Controlled)	(Controlled)
Test	Observations	681		681		681	
	Prob > χ^2	0.0002		0.0000		0.0000	
	Log likelihood	−4192.7196		−4194.616		−4191.6684	
	Pseudo R2	0.0072		0.0067		0.0074	

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$

respondents had low intention to buy earthquake insurance if their houses had been reinforced to mitigate earthquake (Expo_Reinforced = 1). The variable "Expo_HouseType" was negatively correlated with WTI in model 4 and model 6, which means that people whose houses exhibited stronger earthquake resistance had lower WTP for earthquake insurance. "Expo_HouseNum" was positively correlated with WTI in models 1–3, which means that the more houses one owns, the more likely one is to purchase earthquake insurance (marginal effect is 0.0342, 0.0332 and 0.0358). These results suggest certain adverse selection problems in the earthquake insurance market. Individuals whose houses had not been reinforced, whose houses had relatively low earthquake resistance and who owned a larger number of houses had relatively high willingness to obtain earthquake insurance. This outcome is consistent with the result of Botzen and Bergh (2012).

5.4 Farmer's socioeconomic elements

We made several observations about the effects of socioeconomic elements: First, models 1–3 show that government propaganda related to earthquake prevention significantly increased the probability of individuals purchasing earthquake insurance (marginal effect is 0.0930, 0.0951 and 0.0954). This result suggests that the government should extend its propaganda power with respect to earthquake hazards and earthquake insurance when building up the catastrophic insurance system such that people will have a relatively high acceptance toward catastrophic insurance. Second, personal income had a significant positive effect on both WTI (Model 2) and WTP (Models 4–6) for earthquake insurance. Individuals with high income had a corresponding high WTP, which is consistent with other studies. Finally, individuals who work in the office of the village had relatively high WTP for earthquake insurance, which suggested that respondents with relatively high social status had a relatively high demand for earthquake insurance.

5.5 Personal characteristics

The variable "personal characteristics" was not proved true in the Probit model, meaning that personal characteristics were not significantly correlated with WTI. However, these personal characteristic elements were proved significant in the Tobit model. In models 4–6, both age elements, Personal_Age and Personal_Age2, had a significant effect on the farmers' WTP for earthquake insurance. Personal_Age and Personal_Age2 had contradictory effects on WTP, which suggest that WTP and age were not linearly related. The middle-aged had the lowest WTP, while older and younger individuals had relatively high WTP. The variable "Personal_Edu" was significantly positive, and one additional school year increased WTP by RMB 6.3. The low marginal effect of education may be due to income which is indeed correlated with higher education and thus affects the WTP. "Personal_Gender" had no significant effect on the demand for earthquake insurance in the present study.

6 Conclusions

The present study obtained 681 rural residents' WTI and WTP for earthquake insurance using a field survey. Through microdata statistical analysis, we investigated the effects of five variables—risk perception, disaster experience, risk exposure, individual

socioeconomic status and personal characteristics, on the demand for earthquake insurance. The results indicated that the average maximal WTP for earthquake insurance was RMB 160.0338 (median 100), and the WTP to the insurance coverage was 0.8 % (median 0.5 %), which was higher than the result reported by Wang et al. (2012). Our main conclusions were as follows: First, risk perception had a significant effect on the demand for earthquake insurance. Individuals with relatively high risk perception would have relatively high demand for earthquake insurance. Boosting the earthquake risk perception would be an effective approach to extend the demand for earthquake insurance. Second, individuals with a relatively high degree of risk exposure would have a relatively high demand for earthquake insurance. There was a problem of adverse selection in the earthquake insurance market. Third, individuals with higher social and economic status would have a higher demand for earthquake insurance than other individuals, which means that the development of the earthquake insurance industry was inseparable from the improvement in residents' social and economic status. Fourth, the middle-aged had a lower demand for earthquake insurance than the elderly and young. In addition, individuals with a relatively high level of education had a relatively higher demand for earthquake insurance.

Overall, we suggest that the construction of China's catastrophic insurance system should focus on the following issues. First, the earthquake insurance system should be gradually constructed. The present study indicates that improving risk perception among farmers would help increase their willingness to purchase earthquake insurance. For the purpose of risk communication, various types of earthquake communication interventions, such as entertainment education or narrative-based persuasion, could be provided by the government or other institutions to help individuals perceive more realistic levels of risk conducive to protective action against earthquake (Kreuter et al. 2007; Moyer-Gusé 2008). Second, earthquake insurance products should be priced using differentiated rates. In reality, residents with reinforced houses have a relatively low demand for earthquake insurance. Thus, to reduce the adverse selection issue, we should use the principle of differential pricing. With differentiated rates, the premium fees for those who have a relatively high degree of risk exposure would be relatively high, which means that the risk and price would be matched accordingly. Third, the insurance system should be gradually transitioned into an integrated risk management system. A society that is known to provide care for its members in case of catastrophic events usually has problems in motivating its individuals to take voluntary insurance for catastrophic events. But even if it could motivate its members to do so, it will still have to allocate some extra funds for the worst off victims ex post (Prettenthaler 2008). The government should always be considering the role that catastrophic insurance plays in the catastrophic risk management system when vigorously encouraging acceptance of catastrophic insurance in China. It is important to design the catastrophic insurance system in the interest of general social benefit. Otherwise, the catastrophic insurance system may play a negative effect.

Risk perception and other subjective factors are a complex issue, which is influenced by many social, personal, economic, cultural and environmental factors. Our research focuses only on one aspect of effects of subjective and objective factors on insurance demand; the interaction mechanism among these factors was omitted in our survey. In addition, because the target state is a mountainous city and the villagers are scattered extremely, we only choose four typical areas based on the geographical distribution instead of random sampling. These limitations require further study in the future.

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References

Athavale M, Avila SM (2011) An analysis of the demand for earthquake insurance. Risk Manag Insur Rev 14(2):233–246. doi:10.1111/j.1540-6296.2011.01205.x

Baan PJ, Klijn F (2004) Flood risk perception and implications for flood risk management in the Netherlands. Int J River Basin Manag 2(2):113–122. doi:10.1080/15715124.2004.9635226

Barnett J, Breakwell GM (2001) Risk perception and experience: hazard personality profiles and individual differences. Risk Anal 21(1):171–178. doi:10.1111/0272-4332.211099

Benthin A, Slovic P, Severson H (1993) A psychometric study of adolescent risk perception. J Adolesc 16(2):153–168. doi:10.1006/jado.1993.1014

Botzen W, van den Bergh J (2012) Risk attitudes to low-probability climate change risks: WTP for flood insurance. J Econ Behav Organ 82(1):151–166. doi:10.1016/j.jebo.2012.01.005

Browne MJ, Hoyt RE (2000) The demand for flood insurance: empirical evidence. J Risk Uncertain 20(3):291–306. doi:10.1023/A:1007823631497

Buzby JC, Skees JR, Ready RC (1995) Using contingent valuation to value food safety: a case study of grapefruit and pesticide residues. Valuing Food Safety and Nutrition: Westview Press, Boulder

Dixon LS, Turner S, Clancy N et al (2006) The National Flood Insurance Program's market penetration rate: estimates and policy implication. RAND, Santa Monica

Duker JM (1969) Expenditures for life insurance among working-wife families. J Risk and Insur 36:525–533

Ganderton PT, Brookshire DS, Mckee M et al (2000) Buying insurance for disaster-type risks: experimental evidence. J Risk Uncertain 20(3):271–289. doi:10.1023/A:1007871514658

Hammitt JK, Haninger K (2010) Valuing fatal risks to children and adults: effects of disease, latency, and risk aversion. J Risk Uncertain 40(1):57–83. doi:10.1007/s11166-009-9086-9

Ho M, Shaw D, Lin S et al (2008) How do disaster characteristics influence risk perception? Risk Anal 28(3):635–643. doi:10.1111/j.1539-6924.2008.01040.x

IFRC (2000) World disasters report. Kumarian Press, West Hartford

Knocke ET, Kolivras KN (2007) Flash flood awareness in southwest Virginia. Risk Anal 27(1):155–169. doi:10.1111/j.1539-6924.2006.00866.x

Kreuter MW, Green MC, Cappella JN, Slater MD, Wise ME, Storey D, Woolley S (2007) Narrative communication in cancer prevention and control: a framework to guide research and application. Ann Behav Med 33:221–235. doi:10.1007/BF02879904

Kunreuther H (1996) Mitigating disaster losses through insurance. J Risk Uncertain 12(2–3):171–187. doi:10.1007/BF00055792

Landry CE, Jahan-Parvar MR (2011) Flood insurance coverage in the coastal zone. J Risk Insur 78(2):361–388. doi:10.1111/j.1539-6975.2010.01380.x

Lindell MK, Hwang SN (2008) Households' perceived personal risk and responses in a multihazard environment. Risk Anal 28(2):539–556. doi:10.1111/j.1539-6924.2008.01032.x

Lindell MK, Perry RW (2000) Household adjustment to earthquake hazard a review of research. Environ Behav 32(4):461–501. doi:10.1177/00139160021972621

Lindell MK, Perry RW (2012) The protective action decision model: theoretical modifications and additional evidence. Risk Anal 32(4):616–632. doi:10.1111/j.1539-6924.2011.01647.x

Mitchell RC, Carson RT (1984) Willingness to pay for national freshwater quality improvements. Draft report prepared for US Environmental Protection Agency, Washington, DC: Resources for the Future

Moyer-Gusé E (2008) Toward a theory of entertainment persuasion: explaining the persuasive effects of entertainment-education messages. Commun Theory 18:407–425. doi:10.1111/j.1468-2885.2008.00328.x

Munich RE (2013) Natural catastrophe year in review. Munich Re, Germany

Prettenthaler FE (2008) Catastrophic risk and egalitarian principles for risk transfer mechanisms. J Appl Soc Sci Stud 128(4):549–560. doi:10.1623/hysj.52.5.1016

Pynn R, Ljung GM (1999) Flood insurance: a survey of grand forks, north dakota, homeowners. Appl Behav Sci Rev 7(2):171–180

Randall A, Ives B, Eastman C (1974) Bidding games for valuation of aesthetic environmental improvements. J Environ Econ Manag 1(2):132–149. doi:10.1016/0095-0696(74)90010-2

Slovic P, Fischhoff B, Lichtenstein S (1977) Cognitive processes and societal risk taking. Springer, Newyork

Solberg C, Rossetto T, Joffe H (2010) The social psychology of seismic hazard adjustment: re-evaluating the international literature. Nat Hazards Earth Syst Sci 10(8):1663–1677. doi:10.5194/nhess-10-1663-2010

Terpstra T, Gutteling JM, Geldof GD, Kappe LJ (2006) The perception of flood risk and water nuisance. Water Sci Technol 54(6):431–439

Thieken AH, Kreibich H, Muller M et al (2007) Coping with floods: preparedness, response and recovery of flood-affected residents in Germany in 2002. Hydrol Sci J 52(5):1016–1037

Vásquez WF, Mozumder P, Hernandez-Arce J et al (2009) Willingness to pay for safe drinking water: evidence from Parral, Mexico. J Environ Manage 90(11):3391–3400

Venkatachalam L (2004) The contingent valuation method: a review. Environ Impact Assess Rev 24(1):89–124. doi:10.1016/S0195-9255(03)00138-0

Viscusi WK, O'Connor CJ (1984) Adaptive responses to chemical labeling: Are workers Bayesian decision makers? Am Econ Rev 74:942–956

Wang M, Liao C, Yang S, Zhao W, Liu M, Shi P (2012) Are people willing to buy natural disaster insurance in China? Risk awareness, insurance acceptance, and willingness to pay. Risk Anal 32(10):1717–1740. doi:10.1111/j.1539-6924.2012.01797.x

Wei Z (2008) Earthquake insurance: international experience and China solution. Insur Stud 6:9–14