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Evaluating Farm-Level Crop Insurance Demand in China: A Double-Bounded Dichotomous Approach

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Abstract

In 2007 the Chinese Ministry of Finance (CMF) approved the pilot agricultural insurance subsidy program, which tremendously promoted the growth of the agricultural insurance market. However the insurance adoption rate is still low comparing to that of developed countries. The main objective of this paper is to investigate factors most influence growers' crop insurance adoption decisions. To this end, we adopt a double-bounded dichotomous choice (DBDC) experiment. This bidding experiment is conducted through extensive in-person interviews with over 300 rural households in west China, Szechwan province. By using the maximize likelihood method we empirically estimate the effects of factors such as landholding, income and farming experience on the farm-level crop insurance demand. Results indicate that the majority (53 per cent) of rice growers are willing to pay a high crop insurance premium above ¥10 ($ 1.7). On the other side, about 23 per cent of growers value the crop insurance below ¥2 ($ 0.34). As expected, the effects of landholding, education and income are all positive and statistically significant. However, household size and farming experience adversely affect the insurance adoption decisions.

Keywords: contingent valuation method, field survey, insurance subsidy

1. Introduction

The national agricultural insurance premium volume has been increasing steadily in China, entitling it the world's second largest agricultural insurance market (World Bank, 2010). For example, the premium volume was estimated to be $91 million in 2005, which tremendously increased to $2.89 billion in 2011. This recent expansion can partially be attributed to the pilot subsidy program approved by the Chinese Ministry of Finance (CMF) in 2007. The nation-wide program pursues high crop insurance adoption rate by subsidizing roughly 80 per cent of the premium cost for selected crop varieties. With the expenses be borne by central and local governments, the subsidy rate is substantially higher than the average rate for most countries (World Bank, 2010). Despite such efforts and progress, the insurance adoption rate has not yet achieved the expectation, with an average of 40 per cent, and as low as 10 per cent in some interior rural regions. Therefore, determining which factors most influence the farm-level demand is of critical importance. Understanding growers' insurance adoption decisions can be instrumental in assisting the design of effective subsidy programs. Meanwhile, revealing growers' preferences helps to identify the market potential and to design comprehensive indemnity schemes that can be accessible by rural households.

Demographic and production related factors can substantially influence growers' demand for crop insurance. As previously established, the level of business risk (Sherrick, Barry, Ellinger, & Schnitkey, 2004), risk attitude (Ginder, Spaulding, Tudor, & Winter, 2009), farm size (Goodwin, 1993), expected rate of return (Gardner & Kramer, 1986; Cannon & Barnett, 1995) and premium cost (Ginder et al., 2009) are all determinants in insurance adoption decisions. While in China, small landholding, low income level and large household size are particularly crucial in explaining the insufficient demand. For example, World Bank (2007) has pointed out that there may be a link between the small landholding and the low crop insurance adoption rate. However, no recent study has quantified such linkage or effects of any other aforementioned variables. This paper contributes by penetrating into the underlying barrier of crop insurance adoption, which is hypothesized to be associated with the undesirable features of China's rural economies.

Recent studies administered field survey and have found that insurance price (Kong, 2011), growers' knowledge and trust of insurance company (Boyd, Pai, Zhang, H. H. Wang, & K. Wang, 2011) matter substantially for agricultural insurance adoption in China. This paper adds to the existing literature by conducting a sophisticated contingent valuation (CV) choice experiment in west rural China, which reveals farm-level demand for crop insurance. This study contributes in conducting extensive interviews and home visiting with over 300 rural households, documenting in detail growers' production information, risk management methods, preferences and attitudes. The in-depth interview reveals the potential barrier is likely to be associated with the undesirable production features in rural China, such as small landholding, low income level and large household size.

The analysis of this study relies on the contingent valuation (CV) method. The CV method has been commonly adopted for revealing consumer's demand and the willingness to pay (WTP). Zhang, Gallardo, McCluskey, and Kupferman (2010) adopted the CV method and elicited consumer's willing to pay for Anjou pears by a dichotomous-choice designed questionnaire. McCluskey, Mittelhammer, Marin, and Wright (2007) utilized the CV method to quantify consumer's demand for Washington State Gala apples. Hobbs, Sanderson and Haghiri (2006) developed the CV method through an experimental auction to elicit consumer's choice between bison products and beef products. Yamazaki, Rust, Jennings, Lyle, and Frijlink (2013) conducted a CV study in each of two Tasmanian fisheries that estimated the value of day's recreational fishing. Since crop insurance can be viewed as financial commodity, these market-type experiments may also be applied.

In fact, several recent studies have applied the CV approach to evaluate demand and the WTP for health insurance. Dong, Kouyate, Cairns, Mugisha, and Sauerborn (2004) collected data from a household survey and studied the WTP for a proposed community-based health insurance scheme. Mathiyazhagan (1998) conducted the CV study in India and found that socio-economic factors and physical accessibility to health services were significant determinants of willingness to pay for a viable rural health insurance scheme. Asgary, Willis, Taghvaei, and Rafeian (2004) analyzed farmers' WTP for health insurance in Iran and concluded that government subsidy was necessary as the average WTP was lower than the average premium. Barnighausen, Liu, Zhang, and Sauerborn (2007) also analyzed Chinese workers' WTP for social health insurance but found the WTP is higher than the cost. To the best of our knowledge, few studies adopted the CV method to reveal rural growers' demand for crop insurance in China. This study intents to bridges this gap.

CV study can be conducted through different experimental designs, such as dynamic field experiment (Cole, Stein, & Tobacman, 2014), iterative bidding game (Asgary et al., 2004) and payment card format (Barnighausen, Liu, Zhang, & Sauerborn, 2007). Among these methods, the double-bounded dichotomous choices (DBDC) is the most commonly used. This study utilizes a DBDC experiment, for the reason that the DBDC design can easily incorporate different insurance subsidy rates. In addition, the DBDC experiment can be conveniently conducted through in-person survey and home visiting. Questions are asked where a positive response to the initial bid leads to a second valuation question in which a step-up bid amount is given. While a negative response results in a step-down bid amount in the follow-up question. By asking respondents the follow-up valuation question, the statistical efficiency of the estimates based on a single dichotomous choice question can be improved (Hanemann & Kanninen, 1991).

Having established the background and rationale for this paper, it proceeds next with structure as follows. Next section motivates the theoretical framework of double-bounded dichotomous choice (DBDC) methodology, and the corresponding econometric specifications. Then the survey and data collection methods are described. Finally empirical results are provided. The paper ends with conclusions.

2. Methodology: Double-Bounded Dichotomous Choice (DBDC)

The contingent valuation (CV) method is commonly used to elicit consumer's demand through a dichotomous-choice questioning format. Specifically, this study adopts double-bounded dichotomous choice (DBDC) approach to reveal Chinese rice growers' demand for crop insurance. Each participating grower is presented with two consecutive bids. The level of the second bid is contingent upon the response of the first bid. Specifically, the first bid provides grower an initial hypothetical insurance premium of $b2$ and asks if he would like to purchase the insurance. If the response is 'yes' then a step-up premium $b1$ (i.e. a lower subsidy) is offered in the second bid. If the response is 'no' in the first bid, a step-down premium $b3$ (i.e. a higher subsidy) is offered in the follow-up bid.

Consequently, four outcomes result according to the responses from both bids: (1) 'yes/yes' for grower whose true private value (willingness to pay) is in the interval $[b1, +\infty)$, (2) 'yes/no' for grower whose true value is in the $[b2, b1)$, (3) 'no/yes' for grower whose true value is in the $[b3, b2)$, and (4) 'no/no' for grower whose true value is in (–∞, $b3$). Let V_i denotes grower i's true willingness to pay for the crop insurance. The category of the observed responses from the two-round bidding process is represented by:

$$y_i = \begin{cases} 1, & \text{if } V_i < b3 \\ 2, & \text{if } b3 \le V_i < b2 \\ 3, & \text{if } b2 \le V_i < b1 \\ 4, & \text{if } V_i \ge b1 \end{cases} \tag{1}$$

Where, $y \in \{1,2,3,4\}$ indicates the observed discrete outcomes for 'no/no', 'no/yes', 'yes/no', 'yes/yes'. During the interview, hypothetical questions were offered in aforementioned double-bounded bidding format. Participating growers were advised that the gross premium is ¥ 20/mu and potential indemnity is ¥ 400/mu. Then the first round offered an initial bid premium of ¥ 4/mu ($0.67/mu) ($b_2$), which was at the current subsidy rate of 80 per cent. In the second round growers who answered 'yes' were offered a higher premium of ¥ 10/mu ($1.67/mu) ($b_1$), thus a lower subsidy of 50 per cent. Growers who answered 'no' were offered a lower premium of ¥ 2/mu ($0.33/mu) ($b_3$), and thus a higher subsidy of 90 per cent.

The underlying latent private value V_i is specified linearly as,

$$V_i = b_i\beta + Z_i\alpha + \varepsilon_i, \qquad \forall\, i = 1, \ldots, n \tag{2}$$

Where, Z_i is a vector of grower i's common demographic variables such as gender, education levels and income. In addition, b_i is the ultimate bidding premium offered to grower i (b_i can be b_1, b_2 or b_3). ε is a random variable accounting for noise, including possibly unobservable factors and characteristics affecting the decision. Thus unknown parameters to be estimated are β and α. Assuming the error terms are independently identically distributed (i.i.d.) and follow a logit distribution with the cumulative distribution function defined as $G(\cdot)$.

The choice probability for each individual can be expressed as:

$$\begin{cases} \Pr(y_i = 1) = G(b3\beta + Z_i\alpha) = \dfrac{e^{b3\beta + Z_i\alpha}}{1 + e^{b3\beta + Z_i\alpha}}, \\ \Pr(y_i = 2) = G(b2\beta + Z_i\alpha) - G(b3\beta + Z_i\alpha) = \dfrac{e^{b2\beta + Z_i\alpha}}{1 + e^{b2\beta + Z_i\alpha}} - \dfrac{e^{b3\beta + Z_i\alpha}}{1 + e^{b3\beta + Z_i\alpha}}, \\ \Pr(y_i = 3) = G(b1\beta + Z_i\alpha) - G(b2\beta + Z_i\alpha) = \dfrac{e^{b1\beta + Z_i\alpha}}{1 + e^{b1\beta + Z_i\alpha}} - \dfrac{e^{b2\beta + Z_i\alpha}}{1 + e^{b2\beta + Z_i\alpha}}, \\ \Pr(y_i = 4) = 1 - G(b1\beta + Z_i\alpha) = 1 - \dfrac{e^{b1\beta + Z_i\alpha}}{1 + e^{b1\beta + Z_i\alpha}} \end{cases} \tag{3}$$

Where, for example, the probability of choosing 'no/no' (observed y = 1) reveals grower's preference over all other choice categories, which is the standard logistic distribution. In this case the grower faces the ultimate bid amount ¥ 2/mu ($0.33/mu) ($b_3$). The probability of choosing 'no/yes'(y = 2) is the difference between two cumulative densities of choosing 'no/yes'(y = 2) and choosing 'no/no' (y = 1). Similarly, the probability of choosing 'yes/no'(y = 3), i.e., facing the ultimate bid amount b_1 of ¥ 10/mu ($1.67/mu), can be viewed as the difference between two cumulative densities of choosing 'yes/no'(y = 3) and choosing 'no/yes'(y = 2). Note that the probabilities in Equation (3) must sum to one.

It follows the log-likelihood function is,

$$\ln L = \sum_i \begin{cases} I_{y_i=1} \ln\left[G(b3\beta + Z_i\alpha)\right] \\ +I_{y_i=2} \ln\left[G(b2\beta + Z_i\alpha) - G(b3\beta + Z_i\alpha)\right] \\ +I_{y_i=3} \ln\left[G(b1\beta + Z_i\alpha) - G(b2\beta + Z_i\alpha)\right] \\ +I_{y_i=4} \ln\left[1 - G(b1\beta + Z_i\alpha)\right] \end{cases} \tag{4}$$

Where, $I_{Yi=j}$ is an indicator variable corresponding to the category for the observed responses. The model was estimated by maximum likelihood which is the commonly used approach. The standard errors were estimated by the robust covariance matrix to improve the consistency (Huber, 1967; White, 1982). The estimation was conducted by GAUSS using the Newton-Raphson (NR) algorithm.

The empirical specification of Equation (2) is,

$$V_{i1} = \alpha_0 + \beta Bid_i + \alpha_1 Size_i + \alpha_2 Land_i + \alpha_3 Edu_i + \alpha_4 Exp_i + \alpha_5 Inc_i + \alpha_6 Loss_i + \alpha_7 Gender_i \tag{5}$$

Where,

Bid_i = the ultimate bidding insurance premium offered to grower i;

$Size_i$ = household size, measured by the number of persons per household;

$Land_i$ = land holdings per household, in mu;

Edu_i = discrete education level of the household head;

Exp_i = farming experience of the household head, measured by years;

Inc_i = total income, including farm income and nonfarm income;

$Loss_i$ = binary discrete variable indicating the event of crop loss;

$Gender_i$ = gender of the household head.

As discussed below, the variable *bid* takes three possible values depending on growers' choices in the bidding experiment. It equals ¥ 10/mu (\$1.67/mu) (b_1), ¥ 4/mu (\$0.67/mu) (b_2), or ¥ 2/mu (\$0.33/mu) (b_3), as described in Equations (3) and (4). Similarly, the variable *loss* takes only two possible values, equaling 1 when there was crop loss within the last two years, and 0 otherwise. The variables *edu* and *gender* are discrete which are similarly defined as in other literature (Zhang et al., 2010; McCluskey et al., 2007). The variables *size*, *land* and *exp* are all continuous.

One may reasonably expect bid to be negatively associated with grower's willingness to pay. Because growers are more likely to buy the crop insurance if it is offered at a lower price, an increase in bid premium reduces the likelihood of purchase. In addition, one may reasonably assert that higher level of landholdings, education and total income would all lead to higher willingness to purchase. Moreover, if a crop loss occurred previously, grower is more likely to reveal a higher demand for the insurance. Thus the signs of α_2, α_3, α_5, α_6 are expected to be positive. However, the direct effects of farming experience (α_4) and household size (α_1) are ambiguous. In China, long years of farming activities and large rural family are more likely to reduce the incentives for insurance purchase. Possible reason could be growers are more likely to rely on their common-sense experience than scientific methods to cope with production risks. In addition, larger household size reduces the disposable income per capita, thus reduces the consumptions including crop insurance purchase.

The model was also estimated alternatively by incorporating interactive terms where,

$$\begin{aligned} V_{i1} &= \alpha_0 + \beta Bid_i + \alpha_1 Size_i + \alpha_2 Land_i + \alpha_3 Edu_i + \alpha_4 Exp_i + \alpha_5 Inc_i + \alpha_6 Loss_i \\ &+ \alpha_7 Gender_i + \alpha_8 \left(Inc_i \times Land_i\right) + \alpha_9 \left(Inc_i \times Edu_i\right) + \alpha_{10} \left(Inc_i \times Exp_i\right) \end{aligned} \tag{6}$$

In Equation (6) $Inc_i \times Land_i$ represents the interactive effect between income and land holding. We expect that growers tend to have higher demand with a high income level as landholding increases. In addition, $Inc_i \times Edu_i$ is the interactive term of income and education. The term $Inc_i \times Exp_i$ indicates that the effects of income may also depend on farming experiences.

3. Data

3.1 A Background Overview

Agricultural insurance provision is largely dominated by crop insurance. With respect to the global agricultural insurance market, for example, over 90 per cent of the agricultural insurance business by premium volume comes from crop insurance (The World Bank, 2010). In fact, China's crop insurance market remained undeveloped until the late 1970s. More attention and research were received afterwards. The first international crop insurance conference held in China in 1994 is a milestone, leading policymakers to embark on an initiative of a nation-wide subsidy program. The idea of subsidizing, however, was still not materialized until the pilot subsidy program 2007, which covers major grain and oilseed crops including corn, wheat and soybeans, and accounts for about three-quarters of the croplands. The program largely assists rural households' productions and lives.

The survey was conducted in Szechwan province which has a total population of 91 million with 51 per cent male, 48 per cent female, 71 per cent rural population and 10.95 per cent aged population (people above 65) (2014 Statistical Yearbook). Szechwan province belongs to the Southwest rice production area. Agricultural production substantially contributes to social and economic growth. In 2013 agricultural production accounted for 13 per cent of the total GDP (2014 Statistical Yearbook). As over 90 per cent of the population feed by rice, rice production accounted for 30 per cent of the total food crop production.

Since 2007, Szechwan province is assigned to be one of the agricultural insurance pilot provinces. Afterwards, the growth of agricultural insurance market have been tremendous. In 2014 the insurance premium volume increased to 2.74 billion yuan, which is 2 per cent higher than last year. A government subsidy of 2.1 billion yuan was provided to eleven crop varieties including rice, corn, hog, rapeseeds and potatoes. About 3.79 million rural households participated in the insurance program and 2.5 million have successfully received indemnity. In addition, insurance innovation such as price index insurance have been piloted in several cities in Szechwan.

3.2 The Survey

The survey instrument used in this study was a structured questionnaire which was composed of four parts: The rice growers' demographic information; the agricultural production information; the crop insurance purchase information; and the DBDC experiment.

In-depth survey was administered by home visiting in middle plains in Szechwan province in China. The pilot survey was conducted in October, 2014. The survey questionnaire was then modified and polished based on collected information. The main and the follow-up survey were administered throughout 3 months in the winter of 2014 and the beginning of 2015. A total number of 350 rural households have been visited and interviewed. These households were chosen from 8 villages in 4 selected towns. Table 1 provides general geographic attributes for each survey site. The average village population is 2,200. The average irrigated lands are 1,572 (mu) and the average annual income per capita is 7,000 yuan. The average adoption rate of agricultural insurance for each village is 72.2 per cent for wheat, 38.9 per cent for vegetables and 61.1 per cent for the corn.

Table 1. Geographic attributes for each survey site, Szechwan province, China

Town	Village	Population (1000)	Total Crop Land (mu)		Annual Income per Capita (2013) (1000 Yuan)
			Irrigated Land	Non-irrigated Land	
BL	HY	1.76	425.10	3629.50	10.84
	GY	1.57	1450.00	602.00	
ML	LH	2.16	4310.90	0.00	8.16
GY	LY	2.60	500.00	868.00	10.86
	LS	2.18	1939.00	280.00	10.20
	GY	2.60	1730.00	1200.00	10.40
SK	ZS	2.43	1057.00	745.00	2.66
	LS	2.45	1165.00	1255.00	2.86

Note. 1 mu = 0.067 hectares, ¥ 1 = $ 0.17. 'BL', 'ML', 'GY' and 'SK' denote names for each town. Similarly the second column denotes names for each village.

Source: Author's calculation based on *2014 Demographics Report*, *Szechwan Province*, Research Center of Economic Development in West China, Southwest University of Finance and Economics.

To minimize potential selection bias households were chosen with the facilitation of village leaders, local agricultural corporative and open markets. Eight graduate students from economics major were hired and trained to conduct the interviews. Each interview took 30-45 minutes. An incentive of household cleaning materials valued ¥ 12 ($2) was offered to growers upon completion. In order to control response bias participators were also instructed in advance that the information is only used confidentially for university research.

3.3 Data Descriptions and Summary Statistics

Missing key information and incompletion are resulted due to some growers' lack of cooperation. Finally 302 questionnaires were end up in the sample analyzed, with the completion rate of 86 per cent. Table 2 assembles summary statistics of the main sociodemographic variables. The average household size is 4 people, which is likely to be structured as one grandparent, two parents and one child. The majority of interviewed growers were male (76 per cent). Most of the participators finished elementary (45 per cent) or junior high degree (43 per cent). The mean of farming years is 38 years, about 75 per cent of growers have faming experience longer than 30 years. The data reveals, as it is well noted, the population aging problem and rural-urban labor immigration phenomenon are significant in rural China. The average landholdings is 3.48 mu per household. About 79 per cent of rural household have landholdings less than 3 mu (0.2 hectares) (Note 1). This again reveals that agricultural production in rural China is dominated by marginal rural households. About 40 per cent of growers indicated that they have experienced crop loss in the last two years. The mean of total per capita monthly income is ¥ 918 ($153).

Table 2. Summary statistics for demographic variables, rural household, China

Variable	Description	Percentage (%)	Mean	Std. Dev.	Mini.	Max.
Gender	= 0 if female	23.67	0.84	0.46	0.00	1.00
	= 1 if male	76.33				
Experience	Years of farming		38.22	10.52	1.00	64.00
	< 30	25.33				
	30-40	30.00				
	40-50	32.33				
	> 50	12.33				
Household size			3.97	1.21	1.00	8.00
Education	1 = no education	6.00	2.51	0.73	1.00	5.00
	2 = elementary school	44.67				
	3 = junior high	43.00				
	> 4 above high school	6.34				
Lands (mu)	Agricultural Lands perhousehold		3.48	18.24	0.30	317.00
	< 1	21.33				
	1-2	33.67				
	2-3	23.67				
	> 3	21.33				
Total Monthly Income per Capita (¥)			917.59	1201.23	14.02	17699.17
	< 650	43.00				
	650-950	16.00				
	950-1250	17.00				
	> 1250	24.00				
Event of Crop Loss			0.42	0.49	0.00	1.00
	1 = yes	39.33				
	0 = no	60.67				

Note. 1 mu = 0.067 hectares; ¥ 1 = $ 0.17. Farming year was reported by using age subtracted by 16 (for consistency assuming farming activity starts at 16 years old).

The choice experiment was conducted in the last section of the interview. As discussed, hypothetical questions were offered in a double-bounded bidding format. It is assumed the gross premium is ¥ 20/mu and potential indemnity is ¥ 400/mu. Then the first round offered an initial bid premium of ¥ 4/mu ($0.67/mu), which was according to the current subsidy rate of 80 per cent. In the second round growers who answered 'yes' were offered a higher premium of ¥ 10/mu ($1.67/mu), thus a lower subsidy of 50 per cent. Growers who answered 'no' were offered a lower premium of ¥ 2/mu ($0.33/mu), and a higher subsidy of 90 per cent.

To place above valuation questions within the context of agricultural activities and crop insurance purchase, participating growers were first asked about their annual rice harvest, the regular agricultural activities and family monthly expenses. Details survey information are provided in Appendix A. The dichotomous choice valuation questions were then asked as below:

➢ Bearing in mind that the potential indemnity is ¥ 400/mu, if it had cost you of ¥ 4/mu on crop insurance, would you willing to buy it next year? (Q1)

➢ Bearing in mind that the potential indemnity is ¥ 400/mu, if it had cost you of ¥ 10/mu on crop insurance, would you willing to buy it next year? (Q2)

➢ Bearing in mind that the potential indemnity is ¥ 400/mu, if it had cost you of ¥ 2/mu on crop insurance, would you willing to buy it next year? (Q3)

The above questions were asked double-bounded bidding procedure in Chinese. They are translated line by line to be depicted in the paper for the purpose of illustration.

Table 3 presents the observed distribution of growers' responses to the two consecutive bid offers. The majority (53 per cent) are willing to pay a high insurance premium above ¥10 (about $ 1.7). On the other side, about 23 per cent of growers have low private values about crop insurance below ¥2 ($ 0.34). Only 3 per cent of growers value crop insurance in the category of [¥2, ¥4). There is about 11 per cent of growers' willingness to pay closed to the current premium price, which is in the interval of [¥4, ¥10). Most growers indicated that they are willing to pay a high price for crop insurance as long as they could receive indemnity successfully in the case of crop loss. On average, the WTP is higher than the current insurance premium. The political implication is that Chinese government may consider to shift the policy focus from solely increasing the subsidy rate towards strengthening the financial supervision and monitor in insurance indemnity process.

Table 3. Distribution of respondents in each bidding category

Category	Response	Observations	Frequency (%)
(–∞, ?)	'no/no'	68.00	22.67
[¥2, ¥4)	'no/yes'	9.00	3.00
[¥4, ¥10)	'yes/no'	32.00	10.67
[¥10, +∞)	'yes/yes'	192.00	63.66

Note. ¥ 1 = $ 0.17.

Table 4 provides and compares data of responses in each second round bid. For the second round discount bid, the percentage of male is 37.66 for those who chose "no/no", it is 45.45 per cent for those who chose "no/yes". The difference between the gender proportions for these two groups was tested with the 95 per cent confidence interval provided. At level 0.05, the difference is not statistically significant. Thus the proportion of male in the "no/no" groups is not significantly different from that in the "no/yes" group. However, results are more illustrative when we look at the second round premium bid. The difference in gender proportion is significant (p-value = 0.000; confidence interval [0.38,0.70]), implying that men are more likely to respond "yes/no" than "yes/yes".

Table 4. Distribution of responses to second round discount/premium bid

Variables	Discount bid			Premium bid		
	NO	YES	95%Δ C.I.	NO	YES	95%Δ C.I.
Percentage of Male (%)	37.66	45.45	[-0.44,0.29]	75.61	21.18	[0.38,0.70]***
Mean of income	834.26	672.95	[224.52,547.13]	744.04	1005.88	[-533.84,10.17]*
Mean of landholding	1.85	2.32	[-1.39,0.43]	2.88	4.45	[-5.27,2.13]
Mean of Experience	37.57	37.27	[-8.30,8.89]	36.37	39.01	[-5.82,0.54]
Mean of household size	4.07	3.82	[-0.31,0.83]	4.19	3.88	[-0.12,0.74]

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

Group means are also significantly different in the second round premium bid at level 0.1, implying that mean of income for the group who answered "yes/no" is significantly lower than those who chose "yes/yes". Similarly, means of landholding, experience and household size were also compared between discount bid groups "no/no" and "no/yes", and compared between premium bid groups "yes/no" and "yes/yes". Results didn't indicate any significant differences.

4. Results

The effects of demographic variables on growers' demand for crop insurance are empirically explored. Table 5 assembles results of maximum log-likelihood estimates for both Equations (5) and (6) (with covariates). For variable *income*, estimations of both models suggest a positive relationship significant at 0.01 (Model I: 4.7, p-value = 0.00; Model II: 0.84, p-value = 0.00). These results are consistent with the expectations. The direct effect from income is positive, implying growers are more likely to buy the crop insurance given a higher income. Possible explanation could be that larger disposable income increases the incentive for all consumptions including crop insurance. In addition, positive gender effect is also obtained in both models (Model I: 8.43, p-value = 0.21; Model II: 1.13, p-value = 0.00), indicating men are more likely to purchase insurance than women. While Model I shows a significantly positive effect of education (coefficient: 6.59, p-value = 0.00) which is consistent with expectation, model II indicates a contrarily negative effect (coefficient: -0.9, p-value = 0.07). As discussed, the direct effect of education is more likely to be positive. A better educated grower is more likely to understand the role of crop insurance in agricultural production. Next we present results for each variable of the *bid*, *household size*, *farming experience*, *landholding* and *loss*.

Table 5. Coefficient estimates of Log-Likelihood model

Variables	Model I (without covariates) (Equation 5)		Model II (with covariates) (Equation 6)	
	coefficient	robust s.e.	coefficient	robust s. e.
Intercept	-1.83***	0.108	0.98***	0.023
Bid	-3.89**	1.175	-4.13**	1.117
Household size	-1.19***	0.195	-0.71	0.349
Landholding	0.10***	0.013	-0.98***	0.035
Education	6.59***	0.587	-0.90	0.304
Experience	-1.48***	0.235	-1.05**	0.282
Income	4.70***	0.248	0.84***	0.099
Loss	3.68***	0.650	1.85	0.792
Gender	8.43	5.225	1.13***	0.041
Income_Landholding			-1.64***	0.140
Income_Education			1.39***	0.118
Income_Farming			0.36***	0.046
Log likelihood	227.99		227.99	
Likelihood Ratio Test	1436.27		1436.27	

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

The *Bid* denotes the insurance premium offered to growers. It takes values of ¥2, ¥4 and ¥10. The signs of the coefficients for *Bid* are negative in both models and are statistically significant at 0.05(Model I: -3.89, p-value = 0.04; Model II: -4.13, p-value = 0.03). The signs are expected because growers are more likely to buy the crop insurance if it is offered at a lower premium price. The results imply that insurance price matters substantially for insurance adoption, which is consistent with findings in Kong et al. (2011). However, it may as well be noted that the price elasticity might be low given a sufficiently low premium. Consequently, when the premium is at a very low level, further reduction may not increase the insurance demand substantially.

The variable *Household size* is measured by the number of persons per household. Results from both models indicate that the household size is negatively associated with the demand (Model I: -1.19, p-value = 0.00; Model II: -0.71, p-value = 0.16). Thus a larger household size is likely to reduce the likelihood of crop insurance purchase. For larger family, the disposable income per capita is smaller, leading to a lower demand for crop insurance. In addition, the coefficient in Model I is significant at 0.01, implying that *Household size* is an important variable in explaining the crop insurance adoption decisions.

Interestingly that farming experience has a significant negative effect obtained by both models (Model I: -1.48, p-value = 0.00; Model II: -1.05, p-value = 0.03). One possible explanation is that a sophisticated and experienced grower is likely to be overconfident and rely on his common-sense experience instead of scientific methods in coping with production risks. Conversely, he may as well spend costly amounts of resources on other existing risk management alternatives, relative to crop insurance.

The effect of variable *Landholding* is ambiguous and controversial (Model I: 0.1, p-value = 0.00; Model II: -0.98, p-value = 0.00). The signs do not agree with each other but both are statistically significant at 0.01 level. Consequently, Model I indicates that an increase in landholdings increases the demand but Model II obtains a contrary effect.

The explanation in the current paper leans towards Model I's results, emphasizing the positive effects of landholdings on crop insurance purchase. Rural China is dominated by marginal agricultural producers. This feature is a crucial determinant in explaining the insufficient insurance demand. Because growers may not suffer substantial income reduction in case of crop loss, they may be ignorant of the importance of crop insurance. On the other side, government subsidy may not be effective due to the small landholding. This fact is reflected in Table 3 where most growers expressed that they are willing to pay a high price, as increasing the insurance premium may not cost them too much due to the small amount of lands.

Small landholding reduces the production efficiency and prevents the achievement of economies of scale. Chinese government, in response to this disadvantage, encourages the land corporative where growers are able to pool their croplands. In many other developing countries, farmers are also allowed to transfer their land ownership, which leads to high land concentration. Growers who operate with large land acres may be more likely to have a high crop insurance demand. Thus an increase in landholding increases the willingness to purchase.

As expected, both models show a positive coefficient of variable *Loss* (Model I: 3.68, p-value = 0.00; Model II: 1.85, p-value = 0.12). The coefficient is significant at 0.01 in Model I. Thus it indicates that previous experience of crop loss increases the willingness to pay. This is because growers who have experienced crop loss before are likely to be more aware of the importance of crop insurance, thus are more willing to purchase. This is consistent with results indicated in Table 5 where most growers viewed receiving indemnity as the most important factor influencing insurance purchase.

The estimated interactive effects are as follows. The coefficient for ($Inc_i \times Land_i$) is negative and significant at 0.01 (coefficient: -1.64, p-value = 0.00). Thus growers tend to have lower demand with a high income level as landholding increases. In addition, the coefficient for ($Inc_i \times Edu_i$) is positive and significant at 0.01 (coefficient: 1.39, p-value = 0.00), implying growers tend to have higher willingness to pay with a high income level as they receive more education. The coefficient for the term ($Inc_i \times Exp_i$) is positive and significant at 0.01 (coefficient: 0.36, p-value = 0.00), indicating that the growers tend to have higher demand with a high income level as farming experience increases.

5. Conclusion

This study conducted extensive in-person interviews and home visiting with over 300 rural households in west China. It revealed that majority of rice growers were willing to pay a high crop insurance premium, implying that Chinese government may consider to shift the policy focus from solely increasing the subsidy rate towards strengthening the financial supervision and monitor in insurance indemnity process. The in-depth interview revealed the potential barriers due to the undesirable production features in rural China, such as small landholding, low income level and large household size. It was found that *household size*, *farming experience* adversely affect the insurance adoption decisions. Moreover, the effects from *landholding*, *education* and *income* are all positive and statistically significant.

The findings of this study can be provided to insurance companies and policy makers who are attempting to understand the factors related to crop insurance adoption in China, in the hope to encourage the use of crop insurance. Understanding farm-level insurance demand can be instrumental in assisting the design of effective subsidy mechanism. Moreover, estimating growers' preferences can be useful in identifying the insurance market potentials. The study also revealed the importance of designing comprehensive indemnity schemes that can be accessible by small rural households.

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Notes

Note 1. Agricultural lands per capita is 0.37 mu in 2013 (2014 Sichuan Statistical Yearbook).