HETEROGENEOUS CHOICE IN THE DEMAND FOR CROP INSURANCE IN CHINA: RESULTS FROM IN-THE-FIELD CHOICE EXPERIMENT

A Thesis

Presented to the Faculty of the Graduate School

of Cornell University

In Partial Fulfillment of the Requirements for the Degree of

Master of Science

by

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May 2019

ABSTRACT

Agricultural insurance is rapidly becoming one of the most important policy initiatives in Chinese agriculture. While numerous studies have examined crop insurance in China, several important aspects of the problem remain elusive. One of these is the determination of the demand for agricultural insurance and the willingness to pay (WTP) for coverage relative to risk, amongst other important attributes. The current pricing structure in China is relatively homogenous, with farmers paying a similar rate regardless of local conditions. Under these conditions, determining a 'true' demand response to different premium structures is difficult because there is insufficient exogenous variation in premiums from which to judge. To overcome this problem, I conducted in-the-field discrete choice experiments involving 417 farmers across 5 Chinese provinces in 2018.

Overall, farmers prefer a crop insurance with lower premium, higher indemnity, issued by a state-owned insurance company and is acceptable as a loan collateral when given a higher frequency of disaster. In addition, it was found that education, years of farming, connection with government, economic situation and knowledge on crop insurance affect farmers' ranking and willingness to pay for the above attributes. Since the research focuses on both overall demand and regional differences, the findings help to better design the insurance products in order to meet the actual demand of the farmers in that particular area and provide benefits to both farmers and insurance companies.

BIOGRAPHICAL SKETCH

Mingwei originally comes from Beijing, China, who is a native Beijinger. During the summer after she graduated from high school, many of her friends went for college in other cities or countries though she was reluctant to say goodbye. However, a seed of exploring outside world had been sowed in her mind. She was major at Agricultural Economics and Management at China Agricultural University (CAU). The diligent efforts in the four-year study were paid off when she received the offer from Charles H. Dyson School of Applied Economics and Management at Cornell University. Therefore, after graduating from CAU, Mingwei continued her journey on agricultural economics at Cornell. She is inspired by the concepts in consumer demand economics, and therefore focuses on the decision making in agricultural industry. The two-year experience brings her not only the cutoff ideas, but also treasurable life experience and friendships.

This study is wholeheartedly dedicated to my beloved mother, Jing Yan, who has been my source of inspiration and gives me strength when I thought of giving up, and who continually provides moral, emotional and financial support.

ACKNOWLEDGMENTS

I would like to acknowledge everyone who played a role in my academic accomplishments.

First of all, I sincerely record the special thanks to my Chair Dr. Calum G. Turvey, who provided guidance and encouragement not only throughout the research process, but also during the two years of master study. I extend my thanks to my Minor Dr. Jennifer Ifft, for her insightful comments and suggestions.

Secondly, I am grateful to professors Kong Rong (Northeast Agriculture and Forestry University), Hong Fu (Shandong University of Finance and Economics), Yanling Peng (Sichuan Agricultural University), Yuehua Zhang (Zhejiang University), Li Zhou (Nanjing Agricultural University) who helped organize the field experiments and the students from these universities who helped in conducting the field research. This project was funded by 111 Project (B17050) and the Fundamental Research Funds of the Central University of Finance and Economics. I am particularly thankful to the project management efforts of Principal Investigator Professor Ming Zhou (Central University of Finance and Economics) and Professor Ken Seng-Tan (University of Waterloo) for supporting this research plan and Chinese research team. I would also like to acknowledge the financial support from the W.I. Meyers endowment account, Cornell University, for covering the field research expenses of Cornell students in China.

Thirdly, I appreciate the critical advice and unwavering support given by Qi Liu and Nan Meng, my fellow graduate students in Dyson School of Applied Economics and Management.

Last but not least, I would like to thank my mother Jing Yan, who consistently supports me with love and understanding. Without her, I could never have reached this current level of success.

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CHAPTER 1

INTRODUCTION

Agricultural insurance as one of the agricultural policies allowed by the World Trade Organization (WTO), provides a safety net for the revenue in the agricultural sector. It is continuously of interest to the Chinese government because of many of its traits: alleviating poverty, stabilizing rural economy and ensuring food materials for the nation. Since China acceded to the WTO in 2001, it has made a great contribution to global poverty reduction. According to the newest released "China and the World Trade Organization" white paper by China's State Council Information Office (SCIO, 2018), over the past 40 years of reform and opening-up, more than 700 million Chinese people have been lifted out of poverty under the current UN standards. This number accounts for more than 70% of the world over the same period, which makes the largest contribution to poverty reduction in the world.

China's agricultural sector is continually facing limitations. China makes up more than one-fifth of the world's population and the population is growing quickly, while it only holds 10% of the arable land (OECD, 2005). Though the concerns are relieved by modern technology innovation, weather and other risks to agricultural production still exist, for instance, drought, floods, fire, diseases and other natural disasters which can be exacerbated by global warming. Moreover, market risk like the price fluctuation affects the stabilization of rural economy and people's everyday life. Therefore, the importance of risk management in agriculture is noticeable. In the United States, government assists agricultural sector to manage agricultural risk, concentrating on ad hoc disaster relief (disaster payments and emergency loans) and

loss assistance (agricultural insurance) (USDA, 2018). However, the system of risk management in China is not as comprehensive as that of the United States. Besides agricultural insurance, direct financial support is the major method adopted by the Chinese government. When a disaster occurs, the Ministry of Finance of the People's Republic of China directly funds the farmers for their loss. Though the government works efficiently, sending out the subsidies right after the disaster happens, the post-disaster subsidies are more temporary compared with agricultural insurance which is more planned (Song, 2011). The explicit requirements of agricultural insurance are shown as they have been set as an important component in the No. 1 Central Document, which is issued by the Central Committee of the Communist Party of China and the State Council. Since 2007, agricultural insurance has been continuously written in the No. 1 Central Document. In the first policy document of 2018 (Kim, 2018), it focused on the issue of rural vitalization strategy. It pointed out that to improve the agricultural supporting and protecting system, the government will regulate the compensation mechanism for the interests of major grain-producing areas. Pilot projects of full cost insurance and income insurance for rice, wheat and maize will be employed. And accelerating the establishment of a multi-level agricultural insurance system will be the main focus.

Given the fact above and the current political environment, it can be seen that more varieties of agricultural insurance will be created in the near future. It is desirable that the participation rates of agricultural insurance products are sufficiently high, in that the products stabilize farmers' incomes in the long run and ensure a stable

supply in food industry. Woodard & Yi (2018) developed a formula of the optimal deductible demand which is the first-order condition (FOC) of utility.

$$c = -\frac{(a+b)\,r(c) - b}{(a+b)r'(c)} = \frac{1}{r'(c)}\left[\frac{b}{a+b} - r(c)\right]$$

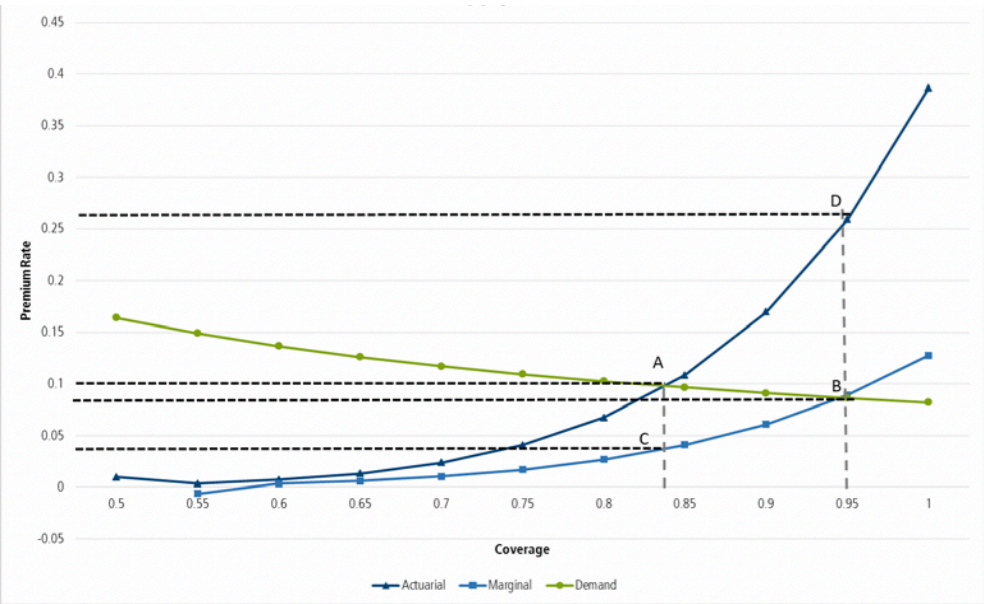
where $c \in [0,1]$ is the coverage level which is 1 minus the deductible percent, $r(c)$ is premium rate conditional on the coverage level, $r'(c)$ is the FOC of $r(c)$, a and b are the limited expected values of marginal utility under insurance over the range of the probability distribution for outcomes above and below the insured liability.

They pointed out that the deductible demand is determined by the producer's utility function through a and b, the distribution of underlying of the interest being insured (e.g., revenue) which is embedded in a, the level of premium rate and its slope. The other finding was that the optimal demand would decrease if increasing the FOC of the premium rate.

Michaels, A, et al. (2017) studied the susidy design of insurance premium, indicating that if the marginal cost becomes the effective supply, the area between the marginal cost and actuarial cost would be the zone of subsidy (Figure 1), which encourages higher uptake and higher levels of coverage.

The conceptual frameworks denote that farmers' demand for agricultural insurance depends on premium and premium subsidies. Therefore, to develop a sustainable rural economy, the most important question is how to design an agricultural insurance that actually meets the demands for the current agricultural sector while taking these factors into account.

Figure 1. Insurance supply and demand



1.1 Economic problem

Since the agricultural insurance industry is not a competitive market in China, it is difficult to study the demand for agricultural insurance. The economic problem is what are the factors affecting crop insurance purchases by farmers in contemporary China? It is desirable to understand how Chinese farmers weight various attributes of crop insurance demand to determine whether they follow the traditional demand model and indicate farmers' preferences and willingness to pay (WTP) for insurance. Consequently, this research develops a multi-attribute discrete choice model and assesses the willingness to pay for these attributes and to compare and contrast WTP across five Chinese provinces (Shandong, Sichuan, Shaanxi, Jiangsu and Henan).

1.2 Research problem

In previous years, the handicap of the Chinese agricultural insurance industry was the lack of data analysis, so that there was an economic loss for both farmers and

insurance companies. Besides that, since farmers in a particular village receive the same premium rate, there was not much variability in current data. In the absence of widespread variation in insurance rates it is difficult to determine the true insurance demand curve and relative elasticity of demand relative to premiums, coverage and risk. Experimental methods can introduce certain forms of exogenous variation into field-surveys to address this problem. Therefore, a choice experiment will be adopted to provide variation in farmers' preference in that this method allows for preference variation. Moreover, WTP measures from in-the-field choice experiments can be translated into practical implications and policy guidelines for both the government and insurance companies.

1.3 Objectives

The overall objective of this thesis is to investigate farmers' willingness to pay for certain attributes of crop insurance in China. Using the choice experiment method and testing results under conditional and mixed logit models as the vehicles to achieving this objective, the specific goals of the study are to

a. Analyze the attributes that affect farmers' preference towards crop insurance purchase and compare the results between different regions.

b. Calculate the willingness to pay for all attributes and compare the results between different regions.

c. Provide insights into factors affecting the demand for insurance, and from this discuss policy options for crop insurance.

The outline of the thesis is as follows. In Chapter 2, the background of agricultural insurance in China is discussed, including its development and current

mechanism. Besides, preliminary studies in both western and Chinese literature on agricultural insurance are discussed at the end of the chapter. Chapter 3 focuses on the methodology and its related literature. Moreover, the econometrics of both conditional and mixed logit model are presented, along with the properties and the comparison between the two models. In Chapter 4, designs of the two rounds of choice experiment are provided, including the explanation of D-optimal design, variable selection and description, and expected results. The design of survey, as the other part of both rounds, and the descriptive results from the survey are presented as well. In addition, the how the two rounds of experiments were carried out is described in this chapter. In Chapter 5, the empirical results from both conditional and mixed logit regressions logit with respect to both experiments are presented. For the choice experiment results in each round, the overall result is presented first, followed by the results from individual province. At the end of each round, WTP with respect to each attribute in separate province and the overall situation are illustrated along with the interpretation. Chapter 6 as the last chapter, includes the future work and the conclusion.

CHAPTER 2

BACKGROUND

This chapter discusses the definition of agricultural insurance and its development in China. It also explains the current mechanism of crop insurance in China, for instance how agricultural insurance works, the governmental subsidy, the premium rate and indemnity. At the end of the chapter, preliminary studies in both western and Chinese literature on agricultural insurance are discussed.

2.1 What is agricultural insurance

Agricultural insurance is the "insurance applied to crops, livestock, aquaculture, and forestry" according to the definition from the World Bank (2010). A survey from Food and Agriculture Organization of the United Nations (FAO, 1991) in 1991 suggested that agricultural insurance has been used for a variety of purposes and in various forms in more than 70 countries. Traditionally, farmers deal with disasters through selling part of their assets for instance livestock, using on-farm stocks and family savings, and/or moving working places to send money back home. However, Hazell et al. (1986) pointed out that the effectiveness of these methods highly depends on the covariance between agricultural and nonfarm income within and across regions. With the existence of agricultural insurance, this risk-preventing method provides stability of farmers' income which can be broadly extended to the rural economy. FAO [1] lists the types of businesses including crop insurance, livestock insurance, aquacultural insurance and forestry. It also points out that building and equipment insurance are often excluded. Among various agricultural insurance products, crop insurance is the main focus in this research and FAO defines it as an agricultural

insurance which provides protection against loss or damage to growing crops for instance, hail, windstorm, fire and flood. The measurement of loss could be based on yield, production costs, agreed value or rehabilitation costs. Crop-revenue insurance is also a popular variety. And the crop insurance also can be geared towards the loss of productive asset such as tree crops. In this paper, crop insurance is explained as a financial product that farmers pay the premium to an insurance company, then if there was a disaster that generating damage ratio, for example, affecting 70% of the crop production compared with the average yield in normal years, farmers need to inform the insurance company and the insurance company will compensate farmers based on its calculation. How exactly current insurance works will be elaborated in the following context.

2.2 History of agricultural insurance development in China

As a country facing a large variety of destructive natural disasters in the world, China has experienced a few billion losses (yuan) in the agricultural sector (Wang, 2011). To ensure the stability of rural economy and national food security, establishing an agricultural insurance system is the promising solution. In general, the development of agricultural insurance can be classified into three stages: the stop-begin circle stage of 1949-1982, the market decreasing stage of 1982-2003, and the government intervention-exploration and development stage since 2004 (Bao, 2010).

Wang et al. (2011) in their paper of the History of Agricultural Insurance in China provided solid information for the three stages. In terms of the first stage, agricultural insurance as one of the insurance products that have a long history, was first operated by the People's Insurance Company of China (PICC) when the nation

was founded in 1949. Beginning in 1950, agricultural insurance in livestock and cotton was ran in selected counties and districts. Then in 1951 the livestock insurance program extended to the nation and the whole cotton production area were covered by cotton insurance. Moreover, several selected regions tried out rice and cole insurance. However, under the policy of downsizing institutions, the unurgent agricultural insurance programs were suspended. PICC reemphasized the agricultural insurance in 1954 but it did not last long. All the early programs were abandoned after four years as the People's Commune system was established. Though the first several trials did not stand long, farmers were getting to be familiar with agricultural insurance.

A new round of agricultural insurance pilot project in China dates from 1982, which was the beginning of the second stage. It was developed from Opinion and Suggestion on the Recovery Situation of Domestic Insurance Business and Future Development released by the People's Bank of China and operated by PICC. This report was approved by the State Council and since then a gradual introduction of rural property and livestock insurance occurred. In the beginning of the second stage, in order to increase the adoption rate, government provided huge subsidies to agricultural insurance companies, for instance waving business tax. As the result, the collected premium climbed fast and the influence diffused largely, which is called the Golden development stage. By 1993, positive feedback on both the variety of agricultural insurance and the coverage of regions were received. Most villages in 29 out of 34 provinces in China were covered by agricultural insurance. However, year 1993 was a turning point of the second stage. After 1993, due to the commercialization of PICC and the insignificant growth in the agricultural sector, the

annual collected premiums significantly decreased in 1994 and experienced fluctuation in the following years (Figure 2).

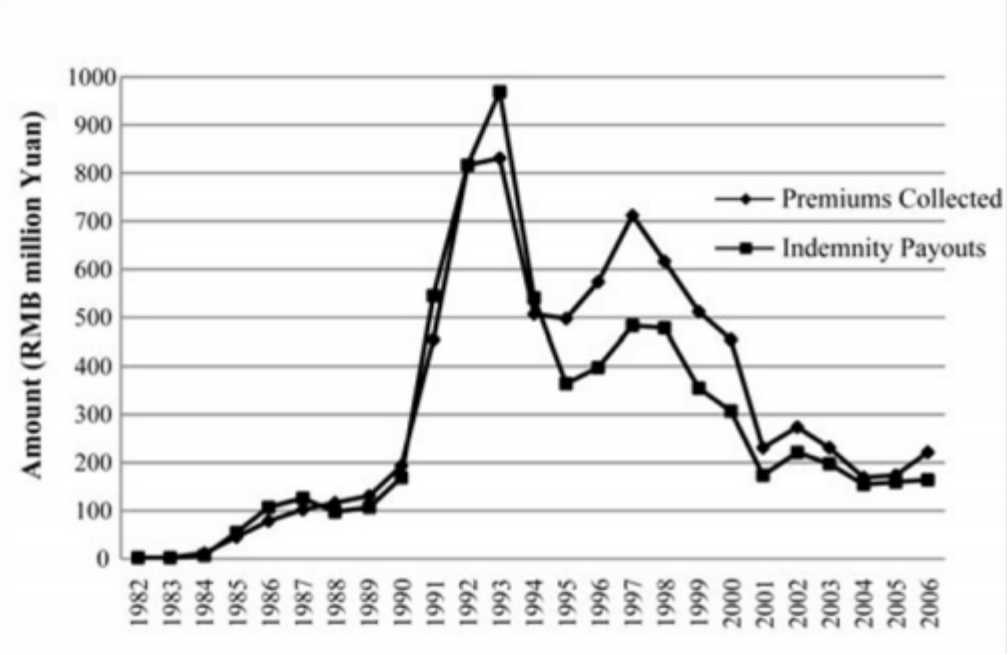


Figure 2.Profile of agriculture insurance for the PICC from 1982 to 2006

Source: Editorial Committee of Yearbooks of China's Insurance 2002–2010; Editorial Committee of Yearbooks of China's Economy 1991–2001; Guo et al. 2007

In 1986, the Production and Construction Corps of Xinjiang founded the Agriculture Insurance Company of Xinjiang Corps (now is named as the China United Property Insurance Company), which solely provided agricultural insurance in Xinjiang Uyghur Autonomous Region. Since the company adopted the combination of low premium rate and moderate reimbursement, it gradually occupied a significant share of the market (Figure 3). In 2002, China United Property Insurance Company (China United) expanded the range of its products to all property types and was given the authorization to operate the business in the nation. Though the annual collected premiums steadily rose for China United, overall the insurance companies in China

were facing the burden of indemnity payouts due to natural disasters during 1982-2003 period. The loss ratio (total payments / total collected premiums) in 2003 reached 92.1% which is significantly higher than the normal loss ratio at 70% (Fei & Zhang, 2004). Besides, the lack of strong drivers in agricultural economy, which further suppressed the business growth of the agricultural companies.

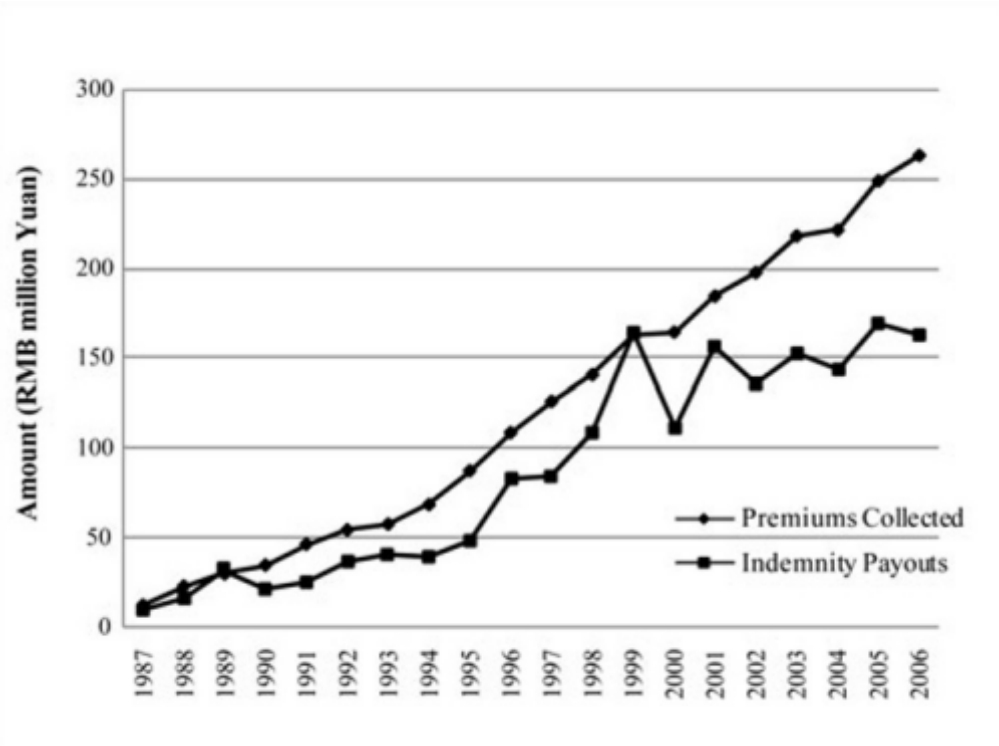


Figure 3. Profile of agriculture insurance for the China United from 1987 to 2006

Source: Editorial Committee of Yearbooks of China's Insurance 2002–2010; Editorial Committee of Yearbooks of China's Economy 1991–2001; Guo et al. 2007.

The Chinese central government realized that the current agricultural insurance products did not meet the needs of the farmers and the development of the rural economy. After rethinking the previous operation mode and combining the western experience and Chinese situation, the agricultural insurance business transited from

commercialized to policy-oriented (Li & Zhao, 2015). The governmental intervention on agricultural insurance market introduced the third stage. In 2004, China Insurance Regulatory Commission (CIRC) launched policy-oriented agricultural insurance trials in 9 selected provinces. Later, the government started to emphasize the importance of agricultural insurance and included it in the No. 1 Central Document. In 2007, the Ministry of Finance funded 1 billion yuan to subsidize agricultural insurance premium to another 6 provinces. Sichuan and Inner Mongolia were two provinces selected to evaluate the performance of premium subsidization in 2011. Two more provinces were chosen to be evaluated in the following year. In 2013, a total of 10 provinces were included to report the performance of premium subsidization which indicated the system of premium subsidization was officially formed (Li & Zhao, 2015).

For continually valuing agricultural insurance, the statistics released by the CIRC (2018) indicated that in 2017, agricultural insurance provided the risk management to 213 million farmers. The annual collected premiums achieved 47.906 billion RMB, yielding 14.69% year-on-year growth and annual indemnity payout was 33.449 billion RMB, obtaining 11.79% year-on-year growth. Compared with 5.18 billion RMB in 2007, the annual collected premiums had increased 9 times during the 10 years. Crops valued at 279 billion RMB were secured by agricultural insurance in 2017 compared with that of at 112.6 billion RMB in 2007. The insured area increased more than 9 times, starting from 230 million Mu in 2007 to 2.1 billion Mu in 2017, which took up 84.1% of the national planted acreage.

2.3 Current mechanism of crop insurance in China

Agricultural insurance has been available in all provinces since 2017 compared with the pilot projects in few selected provinces at the beginning of the nation establishment. Similar to the international definition, planting insurance and animal husbandry insurance are the two major agricultural insurance in China, including 211 different products in agriculture, forestry, animal husbandry and fishery sector. China Banking Regulatory Commission (CBRC) in 2010 released an official document named *Opinions on Strengthening the Cooperation between Agriculture-related Credit and Agriculture-related Insurance*. Besides the emphasis of developing new variety of agricultural insurance products, the document encouraged the cooperation between banks and agricultural insurance companies providing preferential loan rate and faster loan application to farmers. The first agricultural insurance-based loan was granted in Yangling, a district in Shaanxi province (2016). The annual interest rate was 6%, which was 2~3% lower than other institutions who also provides agricultural loan. 0.5 million RMB was granted from PICC to a hog farmer. Not only banks and insurance companies, private companies like JD Finance (2018) also collaborates with insurance company, developing a loan product named “Jingnongdai” which accepts the animal husbandry from China United from farmers as the collateral in order to get the animal husbandry-related loan.

The percentage of contract coverage for the three major grain crops: maize, rice and wheat already achieved 70% (Gov, 2017). According to the Research Report on China's Agricultural Insurance Guarantee Level published by Chinese Academy of Agricultural Sciences (2017), China has become the world's second largest country in

terms of the collected premium in agricultural insurance business, after the United States, and the largest country in Asia. The report also predicted that the guarantee level of agricultural insurance will achieve 24% by 2020, and access 40% by 2030, approaching the level of developed countries.

If the agricultural insurance is subsidized by the government, its premium is determined based on different variety and different province. In 2016, the Ministry of Finance released the document named *Central finance administration of agricultural insurance premium subsidy* (2016) pointed out the insurance varieties that central government would subsidize and the relevant standard (Table 1). As shown in the table, since local government may compensate differently according to the standard, the governmental subsidy with respect to wheat, corn and rice is calculated based on the actual crop insurance product provided by Anhua insurance company (Table 2).

Table 1. Government insurance premium subsidization standard

Category	Products	Insurance Subsidy
Planting	Corn, rice, wheat, cotton, potato, oil plant, sugar plant	On the basis of provincial financial subsidies of at least 25%, the central government subsidizes 40% for the central and western regions and 35% for the eastern regions, 65% for Xinjiang Production and Construction Corps, the reclamation areas directly under the central government, China Grain Reserve Management Corporation, China Agricultural Development Group Co., Ltd. (hereinafter referred to as the central unit).
Breeding	Breeding sow, cow, growing-finishing pig	On the basis of at least 30% subsidies from provincial and sub-provincial finance (hereinafter referred to as local finance), the central government subsidizes 50% in the central and western regions, 40% in the eastern regions and 80% in the central units.
Forestry	Public good forests that have basically completed the reform of forest tenure system, the clarity of property rights, the normal production and management, and commercial forests.	On the basis of local financial subsidy of at least 40%, the central financial subsidizes 50%, and the central financial subsidizes 90% for Daxing'anling Forestry Group Company. On the basis of provincial financial subsidy of at least 25%, the central financial subsidizes 30%, and the central financial subsidizes 55% for Daxing'anling Forestry Group Company.
Others	Highland barley, yak, Tibetan sheep (hereinafter referred to as Tibetan varieties), natural rubber and other variety required by the central government	On the basis of provincial financial subsidy of at least 25%, the central financial subsidizes 40%, and for central units, the central financial subsidizes 65%.

Table 2. Wheat, corn and rice insurance premium and governmental subsidy

(unit in RMB/Mu)

Product	Initial premium	Premium after subsidy	Subsidy range
Wheat	15~27.5	3~5.5	63%~89%
Corn	15~36	3~7.2	60%~91%
Rice	17.5~32	3.5~6.4	63%~89%

The responsibilities are almost the same across different crop insurance contracts, including the natural disaster rainstorms, floods, waterlogging, wind, hail, freezing, droughts, earthquakes, debris flow, landslide, pests and diseases. When the damage within the responsibilities occurs, farmers need to contact the custom service directly or ask the local staff to contact the custom service. The insurance company will send agricultural experts and staffs to investigate and claim the damage. The statement of indemnity will be posted to the public in the village. After the expiration of public notice, the insurance company will transfer the payout to farmers' bank account.

In the United States, for crop insurance products, the expected indemnity *E[I]* is calculated based on the guarantee level. The guarantee yield is estimated for each insured farm based on ten years of yield records and the guarantee level is chosen by each farmer. Then the expected indemnity for a typical yield insurance contract is

$$E[I] = MAX[0, Y^g - Y]\, P^g$$

where Y^g is the guarantee yield per acre, Y is the actual farm yield per acre, P^g is the guarantee price (Makki & Somwaru, 2001).

Unlike the United States, the agricultural insurance system is still developing in China. Therefore, the payment calculation can be slightly different from crop to crop and province to province. Using corn yield insurance in Shandong province from Anhua Agricultural Insurance Company (Anhua, 2019) as an example, most of the insurance companies estimate the payout as

$$E[I] = \text{the maximum payout standard} * \text{ damage ratio} * \text{damaged area}$$

where the maximum payout standard varies across different growth period, damage ratio is defined differently in different crop and province which will be elaborated later, and damaged acre is usually measured in Mu.

Other insurance contracts measure the expected indemnity as, taking rice yield insurance in Anhui province from Guoyuan Agricultural Insurance Company (GUOYUAN, 2015) for an example,

$$E[I] = \text{the maximum payout standard} * (\text{damage ratio} - 10\%) * \text{damaged area}$$

where farmers will not receive any payment if the damage ratio is below (including) 10%,

or taking crop insurance in Jilin province from Anhua (2015) for instance,

$$E[I] = \text{the maximum payout standard} * \text{damage ratio} * \text{payment index} * \text{damaged area}$$

where payment index is an index based on the loss percentage of production cost.

Besides the difference in expected indemnity calculation, some crop contracts indicate that farmers will not receive any payment if the damage ratio is below (including) 30%, for example the crop insurance in Jilin province from Anhua (2015) In terms of the damage ratio, measurement can be different across contracts. Most of the crop insurance contracts define damage ratio as the reduction of production within the responsibility divided by the normal production which is determined by the local government, for instance the crop insurance in Jilin province from Anhua (2015). While the rice insurance in Anhui province from Guoyuan uses the number of damaged plants per unit area divided by the average number of plants per unit area as the damage ratio.

Though different calculations are applied based on different crop and province, one common statement that can be found in all contracts is that as long as the damage ratio goes beyond 80%, it will be defined as total crop failure and farmer will receive the payment based on the total insured area.

2.4 Literature review on the demand of agricultural insurance

Encouraged by recent performance, there is no doubt that the Chinese central government will attach increasing importance to the development of agricultural insurance industry. It can be foreseen that more varieties of agricultural insurance products will appear in the market. Therefore, it is necessary to study the demand of agricultural insurance, explaining the factors that affect its purchases, which helps the products become more useful to meet the actual needs of Chinese agricultural economy and better embrace the new era of Chinese agricultural insurance development.

The demand for agricultural insurance has been studied for a long history. Plenty of preliminary studies have examined factors related to farmers' purchase of crop insurance. Early in late 20th century, Hazell et al (1986) developed an experiment that allowed farmers to choose between insuring or not insuring maize and beans, and to choose among three different insurance policies or any linear combinations of them. The experiments were conducted under the national food plan in Mexico, a program aimed to achieve national self-sufficiency in food and raise the income of farmers in rainfed areas. In this study, the insurance was free. The researchers segmented the respondents into two groups based on their risk perception: risk neutral and risk averse. The result showed that nearly all maize crops were insured when policies were

available. Furthermore, for farmers who were risk-neutral, maize insurance was even voluntarily purchased. The small disappointment appeared in bean production as the result indicated that in both insured and not insured cases, bean production was reduced to the minimal level which was required to meet family consumption.

Unlike Hazell et al. who used experiment to test the demand of maize and bean insurance, Coble et al. (1996) applied panel data of Kansas wheat farmers to examine the demand of Multiple Peril Crop Insurance (MPCI). The data contained records of 354 farms who produced wheat every year between 1977 and 1990. The empirical results revealed that the mean and variance of both market returns and the returns to insurance are significant. To be more specific, the expected return to insurance and the variance of market return were positively correlated with the insurance purchase decision. The variance of return to insurance, expected market return and net wealth had a strong negative impact on the probability of purchasing insurance. The coefficient of wheat acres was significant and positive as well. The variance of indemnity had negative effect on MPCI participation which indicated that producers who expected to frequently receive smaller indemnities were more likely to insure than producers who rarely got large. And the price elasticity of demand was -0.65 which meant farmers were inelastic to the premium changes.

Enjolras et al. (2012) extended the study of demand for crop insurance to the countries comparison, in this case France and Italy. Their sample included 9306 farms belonging to the Farm Accountancy Data Network, with 2998 from France and 6308 from Italy. They found little differences between French and Italian farmers. The results showed that agricultural indicators such as farm size referring to the cultivated

area, and diversification referring to the number of grown crops, were factors influencing the insurance purchase decision in both countries. However, financial characteristics of the farm such as leverage and returns on equity were not significant in the two countries, since the researchers assumed that a farm with higher debts is more willing to insure to maintain the agricultural activity. Other variables like weather conditions had no influence on insurance decision as well.

In general, based on the previous research conducted by Gardner and Kramer, Goodwin and Smith, Knight and Coble, and Coble and Knight, factors such as the costs and returns of insurance, yield and other business risks, financial risks, farm size, enterprise and other forms of diversification, coverage levels, and relationships to adverse selection and moral hazard were factors that potentially affected the crop insurance purchase decision. However, farmers' choices on types and levels of coverage have been expanded, as new varieties of agricultural insurance appeared in the market. Realized by the fact of the increasing complexity of agricultural insurance alternatives, researchers are attaching more attention to understand the factors that influence farmers' purchase decisions among available crop insurance products.

In terms of studying the decision among different types of agricultural insurance, Sherrick et al. (2004) found more evidence in crop insurance purchase decision when given different choices. They used two-stage process to investigate whether a purchase decision was made or not. Data was collected from 3,000 farmers in Illinois, Indiana, and Iowa states. The results indicated that farmers who were older and less wealthy, had larger acreages and higher leveraged farms, and perceived yield risk more importantly were more likely to engage in an insurance. Furthermore, these

farmers were more likely to choose revenue protection instead of more specific yield and hail protection.

Another research area refers to the same type of agricultural insurance product with different combinations. Vandeveer, M. L (2001) studied the factors that influenced farmers' purchase decision given various hypothetical insurance contracts through survey under the context of litchi in Vietnam. The insurance products were different in yield guarantee (85%; 90%), indemnity price (15,000 dong/kg, 25,000 dong/kg, 35,000 dong/kg) and premium level (Low; High). The contracts were offered for the district and commune insurance. The results showed that farmers were more interested in the district than the commune insurance and they preferred the 90% guarantee level over the 85% guarantee level. Moreover, lower indemnity prices were more attractive to farmers. However, farmers were not very responsive to the reductions in premiums. In other words, farmers' response to premium changes were inelastic. From the regression results, farmers preferred insurance with higher yield guarantee, lower indemnity price. And farmers with higher average total income were more likely to purchase insurance.

Few preliminary researches on the demand for agricultural insurance exist in Chinese literature, especially experimental research（Zhang, Shi, & Gu, 2007). Ning, Xing and Zhong (2005) used survey to investigate the factors of farmers' purchase decision on cotton insurance. The sample selection was divided into three stages. In the first stage, Shihezi Xiang, Shihezi Zongchang, Xinhu Zongchang, 141 Tuanchang and Manas county were selected based on the cotton yield and the principle of equidistant. In the second stage, each district selected four villages according to the

same principle as in the first stage. In the third stage, researchers randomly sent out survey to farmers and collected data. A total of 450 surveys were received and 340 of them were valid. Probit model was adopted in the paper. The results showed that the coefficient of variability on cotton production is positively related to the purchase decision, which means the higher variability of cotton production, the higher probability that farmers would purchase cotton insurance. Moreover, the larger the total land, the longer the farmer attends farming activity, the higher the cotton revenue percentage of total revenue, farmers would be more willing to purchase cotton insurance. It's also noticeable that receiving disaster subsidy positively affects the purchase decision which can be explained that although farmers can maintain living using post-disaster subsidy, the production loss cannot be compensated which makes farmers difficult to recover the activity.

Zhang, Shi and Gu (2007) used experimental method and analyzed the demand for wheat insurance from three aspects: substitution effect between insurance and other goods, the ranking of agricultural insurance among different varieties and the comparison between the cost of different methods of agricultural risk diversification. The research was carried out in 11 villages in Henan province. Students randomly investigated around 60 farmers in each village. The questionnaire included three parts: demographic information, risk situation and perception of governmental subsidy. They found that though natural risk is the major risk in agricultural production, the market of agricultural insurance commercialization is unclear due to the low income of farmers and the less preference of agricultural insurance compared with other insurance products. Moreover, education, working out of the farm and total income

significantly affect farmers' purchase decision on agricultural insurance. Furthermore, working out of farm, disaster loss from last year and knowledge on agricultural insurance have impact on the perception of the necessity of agricultural insurance.

To conclude this chapter, it can be seen that as the safety net to both farmers and the nation, agricultural insurance receives huge attention from Chinese government. Though it did not development smoothly in China, the government is still encouraging the relative research. Most of the current studies focus on whether farmers purchase an agricultural insurance on a given agricultural insurance product, or farmers' choice between different types of agricultural insurance products. Seldom does the literature center on the purchase decision on the same type of agricultural insurance product with different combinations. The goal of this study is to analyze farmers' choice among different combinations of the same crop insurance product. The CE is adopted to study farmers' preference towards the hypothetical insurance product. In the next chapter, how preliminary researches studied on the agricultural insurance, the econometrics behind the choice experiment will be discussed

CHAPTER 3

METHODOLOGY

The demand for agricultural insurance in both western and Chinese literature is discussed in the previous chapter, this chapter focuses on the methodology (Choice experiment) and its related literature. Moreover, the econometrics of both conditional and mixed logit model which act as the analytics tools in this study are presented, along with the properties and the comparison between the two models.

3.1 Literature review on the choice experiment

Choice experiment (CE) is a type of analysis that typically has applied goals related to transport studies, environmental valuation, and food choices (Adamowicz, et al.,1998; Jayne, et al., 1996; Unterschultz et al., 1998), predicting customers choice by determining the relative important attributes. In CE, respondents are presented by different hypothetical alternatives in choice sets. Each alternative is described by levels of a set of predefined attributes. The tradeoff between different factors can be therefore analyzed through the choice that consumers made. Furthermore, if there is a price-related attribute in the experiment design, the willingness to pay (WTP) for other attributes can be estimated. The technique originates from Lancaster's theory of value and random utility theory (1966). It assumes that consumer's utility is derived from the consumption of the attributes associated with the good or service instead of the good or service itself. Then McFadden's choice model (1973, 2001) states that consumers have the ability to rank good and service which are combined with different attributes and consumers are willing to make compensatory decision. When consumers making tradeoff between alternatives, the unattractive levels of an attribute

in an alternative can be compensated by attractive levels of another attribute, then consumers compare the overall utility obtained from the two alternatives.

3.1.1 Application of the choice experiment to agricultural insurance

In agricultural literature, most of the preliminary studies focused heavily on logit and probit model under the utility theory. Recently, increasing research appear in the literature using CE to study the demand of agricultural insurance. Zooming into agricultural insurance sector, Wang and Lu (2018) conducted a choice experiment to explore Chinese corn producers' demand for alternative types of insurance. The experiment was carried out in ten villages in four cities in Liaoning province. They adopted in person interview and received valid data from 198 rural households. There were five attributed in the choice experiment: insurance products, indemnity, self-paid premium, time to receive indemnity payment and government/ private. A combination of alternative levels of the attributes form one option. In each round, five options, one for each product, plus an opt-out were provided for farmers. Each farmer experienced eight rounds, called one situation. Using random sample design in SAS with D-efficiency design, 48 situations were selected in the experiment. Since each farmer did eight choices, the 48 situations were blocked into six groups. Besides the choice experiment, researchers also investigated four parts: demographics, economics, production and risk attitude. The results denoted that farmers preferred yield insurance, index insurance, price insurance over revenue insurance since yield insurance is the primary insurance available and the one that farmers most familiar with. Moreover, farmers were willing to purchase a corn insurance with greater subsidy, higher indemnity, shorter time to receive payout and is provided by a state-

owned insurance company. Furthermore, from the results of willingness to pay with respect to each attribute, the government ownership was a more important factor than the fast payment. And for every Yuan increased in the indemnity, the WTP was increased by 3 to 18 cents.

Vigano et al (2014) conducted a CE in Ethiopia regarding the smallholder farmers' preferences and willingness to pay for weather derivatives. There were 120 rural households who lived in the Wolayta zone in Southern Ethiopia as the respondents. Farmers were randomly selected from a larger sample of 360 farmers who already participated in a three-year data collection project and they came from three different villages that represented different agro-ecological zones in terms of altitude, rainfall patterns, and household livelihood strategies. The researchers designed a discrete choice experiment instead of using survey-based techniques. Focus group interviews were first carried out in the villages in order to understand household's perception on drought risk. In later fieldwork, they performed the CE that contained eight different choice situations and an extra choice which was a strictly dominant alternative to allow for potential inconsistency. Within each choice situation, the respondent could choose one of the two different insurance products or the status quo alternative. Five categories of the product attributes were chosen in this study: covered season, intensity of drought, supplier, premium, and compensation. They ran two models: conditional logit and mixed logit model. Comparing the results, all the coefficients were almost significant and the overall goodness of fit was higher under mixed logit model. Moreover, the standard deviation of the two random coefficients were significant. These observations suggested that mixed logit was more appropriate.

The results from mixed logit showed that premium, compensation and perceived drought frequency significantly affected the insurance take-up. Unlike the other two attributes, an unexpected negative coefficient sign was received by compensation. The researchers interpreted that farmers were reluctant to insure against larger losses as the result of perceived unfairness in the premium/compensation ratio, since large losses rarely happened. They also found that WTP had a non-linear relationship with economic situation. In other words, very poor farmers had nothing at stake in the case of drought, while very rich ones can diversify the risk and need less insurance.

Liesivaara and Myyrä (2014) conducted a CE in Finland to indicate the demand for crop insurance products in 2012. They sent the survey to 5,000 farmers. In the questionnaire, respondents were presented six crop insurance product cards. Each choice card included two different crop insurance products with varying attributes. Farmers were asked to select the most desirable crop insurance product for them. They could also choose an opt-out which indicates that the respondent won't purchase crop insurance at all. There were 42 choice cards in total, being grouped into seven blocks. Other attributes chosen for the insurance products were the insurance cover (deductible), type of insurance, and expected indemnity (scale). The researchers conducted a pilot survey with 105 farmers first. They then used the prior information to better design the later experiment for it gave the expected signs of the parameters which was known as the Bayesian design. According to the pilot survey, price and deductible negatively affected on the demand for crop insurance. Expected indemnity had positive relationship with the demand for crop insurance. The prior results were in line with the preliminary studies. After the pretest, the visual version of choice cards

was presented in order to ensure that the choice cards were visually independent of each other. Then the experiment was run in the field. The results showed that all coefficients had expected signs and farmer's demand for crop insurance was inelastic in the premium range overall. The premium and deductible negatively correlated with farmers' purchase decision, while the expected indemnity positively affected on farmers' utility. The coefficient for the farm insurance type was significantly negative, denoting that farmers preferred index insurance where compensation is based on regional indices over farm-specific insurance where an inspection is needed if the farm experiences a crop loss. The outcomes also revealed that the demand was higher among younger farmers and farms with more arable land. They also found that farmers' willingness to pay for crop insurance products was very sensitive to the premium interval presented in the CE design.

3.2 Econometrics of conditional and mixed logit model

Several approaches are available to model farmers' demand of crop insurance. In the CE, the random utility is determined by a deterministic (V_{ij}) and a stochastic (ε_{ij}) component.

$$U_{ij} = V_{ij} + \varepsilon_{ij}$$

where U_{ij} is the ith consumer's utility of choosing alternative j, V_{ij} is the systematic portion of the utility function determined by the crop insurance attributes and their values for alternative j, and ε_{ij} is a unobserved stochastic element.

The probability that a consumer chooses alternative j is given by

$$Prob\{V_{ij} + \varepsilon_{ij} \geq V_{il} + \varepsilon_{il}\} \text{ for all } l \in C_i$$

where C_i is the choice set for respondent i. In the first experiment, $C_i = \{A, B\}$ since there were two alternatives in each card, $C_i = \{A, B, C\}$ in the second experiment in that the alternatives were extended to three.

When the random error ε_{ij} is independent and identically distributed (IID) across the j alternatives and N individuals with Gumbel or Fisher-Tippett extreme value type I (EV1),

$$x \sim EV1(\mu, \lambda)$$

where μ is the location (mode), λ is the scale.

Given the assumptions, the model is called *Conditional Logit Model*, and the logit probability in this case is (McFadden, 1973)

$$P_{ij} = \frac{e^{\lambda^{-1} V_{ij}}}{\sum_{l \in C_i} e^{\lambda^{-1} V_{il}}}$$

Ceteris paribus, $\lim_{V_{ij} \to \infty} P_{ij} = 1$ and $\lim_{V_{ij} \to -\infty} P_{ij} = 0$

Suppose the utility that a farmer obtains from choosing alternative j is a linear combination of the insurance product attributes x_{kij}. Then the functional form of the utility function is expressed as

$$V_{ij} = \beta_1 x_{1ij} + \beta_2 x_{2ij} + \cdots + \beta_n x_{nij}$$

where x_{kij} represents the kth attribute for alternative j for consumer i, and β_n stands for the coefficients to be estimated. In this study, $\mathrm{n} = 5$ since there are five attributes.

With ε_{ij} being IID, the conditional logit imposes the independence from irrelevant alternatives (IIA) assumption which means the ratio of two probabilities

does not depend on the third event (McFadden, Tye, & Train, 1977). It can be proved through the probability ratio of choosing between j and l.

$$\frac{P_{ij}}{P_{il}} = \exp(V_{ij} - V_{il})$$

From the above equation, it can be seen that the probability ratio only depends on the attributes of j and l, and not on the attributes of other alternatives. As the conditional logit model assumes IID, and owns the IIA property, it assumes that all respondents share the same coefficients in terms of all attributes. However, such assumptions will be unrealistic if unobserved heterogeneity exists in the form of taste variations in a factor. Similar with the conditional model, the mixed logit model is then introduced to overcome the restriction by allowing for the estimates to vary across individuals.

In general, the coefficient vector for individual i is

$$\beta_i = \bar{\beta} + \Pi w_i$$

where $\bar{\beta}$ represents preferences for the average respondents (population mean), parameters in Π are preference variations with respect to the average marginal utility, and w_i is the independent standard normal deviates.

Therefore, the probability under the *Mixed Logit Model* is presented as (Train, 2003)

$$P_{ij} = \int \left(\frac{e^{\beta' x_{ij}}}{\sum_{l \in C_i} e^{\beta' x_{il}}}\right) f(\beta) d\beta$$

where $f(\beta)$ is the density function.

Taking the ratio of two alternatives, the property of IIA is no longer valid in the mixed logit model.

It is inconvenient to directly interpret the estimates from both logit models. However, willingness to pay (WTP) can be derived to display a more obvious result (Train, 2003).

$$WTP = -\frac{\beta_n}{\beta_p}$$

where β_p is the price coefficient.

In the case of mixed logit model, the price coefficient is fixed, in order to ensure the WTP is normally distributed. And the other advantage is that the price coefficient of all respondents will be negative, while this may not be true when the coefficient is assumed to be normally distributed.

This chapter reviews the literature on CE and its application in agricultural insurance sector. The econometrics of conditional and mixed logit model are included, along with the properties and the comparison between the two models. The design of two experiments in this paper and the descriptive results from the fields will be presented in the next chapter.

CHAPTER 4

EXPERIMENTAL DESIGN AND DATA DESCRIPTION

The details of designing the two rounds of choice experiment are provided in this chapter, including the explanation of D-optimal design, variable selection and description, and expected results. Besides CE, the design of survey part, the other part of both rounds, and the descriptive results from the survey are presented. In addition, the how the two rounds of experiments were carried out is described in this chapter.

4.1 Design of the experiment

4.1.1 Design of the first experiment

The first experiment includes two sections: CE (Card 1) and survey (Appendix 1). The CE was created under the D-optimal design, which was generated through JMP software under the Choice Design tab. D-optimal designs minimize the generalized variance of the estimated regression coefficients. Suppose matrix X represents the matrix of independent variables in the regression. D-optimal designs minimize the overall variance of the estimated regression coefficients through maximizing the determinant of X'X (NCSS). In the first experiment, there were five attributes (more descriptions in the following text): Frequency with five levels, Coverage with four levels, Premium with 8 levels, Insurer with two levels and Collateral with two levels. Since the completely replicated factorial design of the first experiment would require 5*4*8*2*2 = 640 different combinations, an exhaustive search of all possible designs (full factorial design) for a given sample size is not feasible. The D-optimal design is therefore chosen as a reasonable choice to decide

which 120 of the 640 possible should be included in the CE, given the limited budget can afford only 120 combinations.

The D-optimal algorithm begins with a randomly selected set of combinations. Combinations in and out of the current design are exchanged until no exchange can be found that will increase the determinant of X'X. Oftentimes, this method does not guarantee the global maximum. To overcome this problem, the algorithm is repeated several times in hopes that at least one iteration leads to the global maximum. The D-optimal algorithm can be used to deal with both quantitative and qualitative attributes. The levels of quantitative factors are scaled with the minimum value at -1 and the maximum value at 1. The levels of qualitative factors are further represented by (number of levels - 1) that amount of variables. For example, if a qualitative variable contains three levels, there will be two variables generated to represent this factor. Moreover, since the first experiment does not organize any pilot survey prior to the fieldwork, all coefficients of the attributes are specified to have a prior mean of zero and a finite variance.

The CE reveals farmers' preference of different sets of crop insurance, which provides the evidence to study the demand. Ten blocks were developed, which means that there were ten different versions of CE. Each block contained six cards and each card had two alternatives (hypothetical insurance products). The opt-out was excluded in the design since the major focus of this study is to understand how farmers value the trade-off between the attributes that potentially affect their purchase decision. There were five attributes in the card (Frequency, Crop coverage(RMB/Mu), Crop premium(RMB/Mu), Type of insure, Can be used as collateral) with a set of levels.

Levels are determined by the current offerings in the market. An alternative was the combination of five attributes with a specific level. There was also a question regarding the certainty of the choice, which ranges from 1 to 5 as the certainty degree rising. (Table 3 & 4). 10 respondents were expected for each block and the first experiment would be conducted in three provinces. Therefore, there would be 100 respondents in each province and a total of 10*6*2*10*3 = 3600 data was expected to collect.

Table 3. Sample cards in the first experiment

	Crop insurance 1	**Crop insurance 2**
Frequency	1 in 6 years	1 in 4 years
Indemnity (RMB/Mu)	500	300
Crop Premium (RMB/Mu)	17.64	1.8
Type of insurer	Private	Private
Can be used as collateral	Yes	Yes
Your choice		
How certain of your choice	1 2 3 4 5	

	Crop insurance 1	**Crop insurance 2**
Frequency	1 in 4 years	1 in 2 years
Indemnity (RMB/Mu)	500	600
Crop Premium (RMB/Mu)	28.44	1.8
Type of insurer	Private	Government
Can be used as collateral	Yes	Yes
Your choice		
How certain of your choice	1 2 3 4 5	

Table 4. Variable abbreviation and description

Attribute and Abbreviation	**Description**	**Level**
Frequency of disaster (Frequency)	(Damage frequency) How often a disaster happens that will trigger the indemnity	1 in 2yrs, 1 in 4yrs, 1 in 6yrs, 1 in 8yrs, 1 in 10yrs
Crop premium (RMB/Mu) (Premium)	How much a farmer pays for the insurance company per Mu	1.8, 8.64, 10.44, 14.04, 17.64, 24.84, 28.44, 35.64
Indemnity (RMB/Mu)	How much a farmer gets from the insurance company per Mu	300, 400, 500, 600
Type of Insurer (Insurer)	0 = private insurance company, 1 = state-owned insurance company	private, government
Can be used as collateral (Collateral)	0 = No, 1 = Yes	No, Yes

Frequency as a measure of risk is given to farmers. Michaels, A, et al. (2017) showed that crop insurance reduces the risk in farm income. Thereofore, Frequency is expected to have negative correlation with the decision, assuming if the disaster occurring less frequently, farmers would be less willing to purchase a crop insurance. Premium and indemnity are included in that Woodard and Yi (2018) showed that they related to farmers' utility. Moreover, in order to estimate the willingness to pay for the rest of the attributes, the factor of premium is necessary in the choice experiment. The levels were determined based on the most conservative calculation. Since the data in Table 2 was collected from Anhua agricultural insruance company, who provides the service only in several provinces, the premium range in Table 2 cannot represent the

whole agricultrual insurance market. Therefore, different subsidy percentges (5%, 24%, 29%, 39%, 49%, 69%, 79%, 99%) were applied to the highest premium rate (36 RMB/Mu) to capture the most conservativve premium range. Premium is supposed to have negative coefficient according to the traditional demand model. The level of indemnity took Wang and Lu (2018) and the public crop insurance contracts (Anhua, 2019; Guoyuan, 2015) as the reference. Indemnity is expected to have a positive effect on the decision, since farmers would be more willing to receive higher payout given the same damage. Since the Chinese government continually encourages and funds the agricultural insurance market, it is important to understand farmers' preference to different types of insurer. Insurer is expected to positively influence the decision, assuming that farmers tend to trust a state-owned insurance company more than a private one. According to the document released by CBRC (2010), the government is encouraging the cooperation between banks and insurance insurance companies, in order to better provide agriculture-related loan to farmers. Studying the current response toward the policy therefore has political implication which helps policy makers adjust the policy based on farmers' feedback. Collateral is expected to generate positive impact since the cost of getting a loan would be lower if the crop insurance can be used as collateral, which facilitates farmers to engage agricultural productivity in the future.

The CE is the main focus of this study and the survey section provides additional personal information to better depict farmers' demand for crop insurance which includes four parts: Farm Characteristics and Farmer Risk Attitude (Part A), Sources of Risk and Risk Perceptions (Part B), Precautionary Savings (Part C) and

Crop Insurance Use and Perceptions (Part D). Part A investigates the demographic and basic farm-related information which provides the simple background of the respondents. Part B addresses risky activities in order to cluster farmers in three segments based on their risk perception. Part C puts forward saving activities to classify farmers into three groups according their precautionary attitude. Both Part B and C help to analyze whether farmers' risk and precautionary perception affect their willingness to pay for the attributes. Part D raises farm-related questions which helps to explain the result from the CE and check whether the results from the CE are consistent with the observation in this part.

4.1.2 Design of the second experiment

The second experiment was designed to provide a robust check of the previous result which also includes two sections: CE (Card 2) and survey (Appendix 2). In the second experiment, means and variance of previous estimates were used in the choice design. This method is named as the Bayesian D-optimal design which adjusts the D-optimal design under Bayesian criteria. Since the prior measure is included, the extension allows to describe the conditional distribution of the experimental data for a given model parameter (Alexanderian, 2016). Without prior estimators, there is no way of knowing which attribute levels are better. In other words, a higher frequency of disaster may or may not be more desirable than a less frequency of disaster, a private insurance company may or may not be better than a state-owned insurance company, and so forth. As a result, some choice sets might not convey useful information in the first experiment. When including the estimate of prior means and variances of the attributes, the results will be leveraged, obtaining more precise estimates of the

parameters. According to Zhang's dissertation paper (2006), Bayesian D-optimal designs are found to be more efficient and robust than non-Bayesian D-optimal designs.

In addition, instead of ten blocks and six cards, there were three different blocks in total, with nine cards in each block. Instead of two alternatives in the previous design, the new design used three alternatives in each card (Table 5). Furthermore, pictures were included in the card, with the expectation that farmers would better understand the content in the CE. Level of certainty was included in case the abnormal phenomenon was observed which needed explanation. It needs to be emphasized that the wordings in the second experiment were identical to that of in the first experiment (Card 1). Besides the same wordings, by providing a different CE schema through altering the block design under the Bayesian D-optimal design, the second experiment provided a robust check, meaning the sign of the variables should remained the same.

Table 5. Sample cards in the second experiment

	Crop Insurance1	Crop Insurance2	Crop Insurance3
Frequency	1 in 6 years	1 in 4 years	1 in 2 years
Crop coverage (RMB/Mu)	500	300	500
Crop premium (RMB/Mu)	17.64	1.8	24.84
Type of insurer	private	private	government
Can be used as collateral	yes	yes	no
Your choice			
How certain of your choice	1 2 3 4 5		

	Crop Insurance1	Crop Insurance2	Crop Insurance3
Frequency	1 in 2 years	1 in 4 years	1 in 10 years
Indemnity (RMB/Mu)	600	300	400
Crop premium (RMB/Mu)	14.04	28.44	8.64
Type of insurer	private	government	government
Can be used as collateral	yes	yes	no
Your choice			
How certain of your choice	1 2 3 4 5		

In terms of the survey part, due to the purpose of robust check, only basic information that related to demographic and purchase characteristics were contained. Risk perception and precautionary savings were excluded in the second experiment. Regarding the issue of expected number of respondents for each block, given the fact that there would be three blocks, nine choice situations and three alternatives, and the second experiment would be carried out in two provinces, 20 respondents were expected in each block to ensure the similar total number of data that would be collected, which was 3*9*3*20*2 = 3240 compared with 3600 in the first experiment.

4.2 Fieldwork and sample description

4.2.1 First experiment in three provinces

The first experiment of farmers was undertaken in China in May 2018 to study farmers' demand of crop insurance. It involved farmers among three provinces: Shandong, the eastern region of China on the lower reaches of the Yellow River, bordering on the Bohai and Huanghai seas in the east; Shaanxi, the north-central region of China where the entire eastern border is constituted by the Yellow River; and Sichuan, the southwest region of China where the eastern part is the gate way to Tibet. The experiment lasted for a month and was conducted in the sequence of Shandong, Sichuan, and Shaanxi for the purpose that the researchers could bring the previous experience to the following fields, helping the following experiments to go smoothly. The local students assisted with the field work and were trained before going to the field. Ten different versions of the CE with six cards (choice situation) in each version were randomly assigned to the farmers and they were asked to choose only one alternative from each card. Recall from Chapter 2 that the crop insurance in

this paper was explained to farmers as a financial product that given the damage frequency (e.g. 1 in 2 years) , they pay the premium (e.g. 17.64 RMB/Mu) to an insurance company (e.g. a state-owned company), then if there was a disaster that generating damage ratio, for example, affecting 70% of the crop production compared with the average yield in normal years, farmers need to inform the insurance company and the insurance company will compensate farmers based on its calculation (e.g. 500 RMB/Mu).

4.2.1.1 Part A: Farm Characteristics and Farmer Risk Attitude

The total expected respondents should be 100 in each location. As the result turns out, a total of 297 respondents provided valid information in the first experiment. Among all 297 respondents. Several of the demographic indicators are similar among the three provinces for instance gender, age, total number of households, primary decision, education, years of farming, agribusiness environment, and nonagricultural income (Appendix 3). Overall, 62.7% of them are male, 37.3% are female. The average age of the respondents is 57.545 years old, with the minimum 23 and maximum 82. The average number of people in a household is 4.347 and roughly two people are working in the farm and one person works outside the farm. On average, 78.4% of the respondents are the primary decision maker in agricultural affairs. In terms of education, 7.1% of the respondents never go to school, 32.3% of the respondents attend at least elementary school, 45.5% of the respondents attend at least middle school, 11.8% of the respondents attend at least high school, 3.0% of the respondents attend some university or college, and one respondent, accounting for 0.3% of the respondents, completes college or university. The average years of

farming among all the respondents are 36 years, with a minimum of no experience, up to 69 years. Farmers who believe the current agricultural business in the area compared to last year is getting better in general takes up 43.4% of the total respondents. 37.7% of the respondents believe the agricultural business remains the same compared with the previous year. 18.9% of the respondents indicates that the current agricultural business is getting worse compared to the previous.

However, there are other demographic factors that vary noticeably among three provinces. In terms of the government relationship, roughly 15.6% and 22.2% of the respondents have household member(s) working for village leader, committee, government-related institution in Shandong and Sichuan, respectively. Farmers in Shaanxi seemed have relatively weak belt with government, only 7% of the respondents had some relationship with government. Regional differences also appear in total Mu of contracting and transfer land. On average, farmers in Shandong have the largest Mu of contracting land, around 7 Mu per family, compared with 4 Mu in Shaanxi and Sichuan. However, Sichuan's farmers own the largest amount of Mu in transferred land, 78.802 Mu, which is more than one and a half times of farmers in Shandong and 1065 times of Shaanxi. It is interesting to find out that the variation inside Shaanxi province is not significant at all while it is violent in both Shandong and Sichuan provinces. In Shaanxi province, the total amount of transferred land lies between [-8, 15], while the range expands to [-10, 2360] and [-8, 2000] in Shandong and Sichuan, respectively. Regarding agricultural income, Sichuan is the highest, followed by Shandong, while Shaanxi's farmers only earn half of the agricultural income compared with the other two provinces. Though there is no significant

difference in non-agricultural income, including other expenses, farmers in Shaanxi have the lowest profits and Sichuan's farmers are the wealthiest.

There is no significant relationship between the area of owned land and transferred land. But the statistics show that larger amount of lands that are rented in is significantly impacted by a higher perception of farmer him/herself regarding farming ability. Moreover, the more lands are transferred, the higher the agricultural income and the net profits, and the less household members working outside the farm.

4.2.1.2 Part B: Sources of Risk and Risk Perceptions

Farmers are segmented into three groups in terms of risk perception and the overall cluster quality was fair (Table 6 & Appendix 4). In order to divide the respondents most effectively, the results from the Two Step Cluster Analysis show that question "Can you bear with higher risk?" is the most important indicator among the ten questions, followed by "Are you willing to try new technology but under certain risk?" and "Are you willing to try new mode of agribusiness management?". According to the output, 32.1% of the total respondents are inclined to lower risk, 20.9% of the population perceive risk in medium degree and 47% of the total respondents prefer higher risk. Zooming into three provinces, all have similar proportion in low risk preference group. However, Sichuan takes up a relatively higher percentage of farmers in medium risk group and fewer Sichuan's farmers are in high risk group. In the case of Shandong and Shaanxi, most of the farmers accept higher risk. To conclude, both Shaanxi and Shandong's farmers are willing to accept higher risk, especially Shaanxi, while farmers in Sichuan are more likely to be classified into the medium risk segment.

Table 6. Cluster analysis of risk perceptions

	Shandong		**Shaanxi**		**Sichuan**	
Bin	***Frequency***	***Percentage***	***Frequency***	***Percentage***	***Frequency***	***Percentage***
weak	29	31%	32	34%	34	36%
moderate	19	31%	15	24%	28	45%
strong	48	35%	53	38%	38	27%

4.2.1.3 Part C: Precautionary Savings

Under the Two Step Cluster Analysis, the farmers are divided into three segments based on eight questions in the survey. (Table 7 & Appendix 5) The results indicate that the cluster quality is fair and question "Do you save in case losing job?" is the most important indicators, followed by "Do you save in case health emergency happening?" and "Do you save in case unexpected agricultural loss?". Among all respondents, 41.2% and 43.5% of them are classified into medium and high precautionary groups, respectively. 15.3% of the total respondents have relatively low precautionary perception. Taking a closer look at three provinces, in the case of Shaanxi, though almost half of the farmers are in the middle precautionary group and 27% of the respondents are under the low precautionary segment, these 27% Shaanxi's farmers contribute 60% in the overall low precautionary group. In other words, Shaanxi's farmers are relatively less precautionary compared with the other two provinces, which is consistent with the conclusion in Part B. Farmers in Shandong dominate the medium precautionary group. Sichuan's farmers are most precautionary among the three provinces.

Table 7. Cluster analysis of precautionary savings

	Shandong		**Shaanxi**		**Sichuan**	
Bin	***Frequency***	***Percentage***	***Frequency***	***Percentage***	***Frequency***	***Percentage***
weak	9	20%	27	60%	9	20%
moderate	54	45%	45	37%	22	18%
strong	31	24%	28	22%	69	54%

4.2.1.4 Part D: Crop Insurance Use and Perceptions

When asking "how much do you know about crop insurance?", farmers on average lie between the groups of "heard of it, but don't know much" and "relatively understand it". Analyzing the results by province, the statistics reveal that only one respondent in Shaanxi never heard of crop insurance, compared with three farmers in Shandong and 19 farmers in Sichuan. It can be seen that Sichuan's farmers in general lack of knowledge on crop insurance relatively. Since Sichuan has relatively more farmers who lack knowledge on crop insurance, they are not as familiar as the other two provinces in general. In terms of the crop insurance coverage, 92.9% of the 297 respondents indicate that crop insurance is available in their region. Only one record in Shaanxi and two observations in Shandong and Sichuan show that it is currently not available. It can be seen that farmers in Shaanxi are most familiar with crop insurance. It can be attributed to the government efforts and previous pilot projects that were carried out in Shaanxi, since it has relatively low income per family compared with other agricultural provinces.

4.2.2 Second experiment in two provinces

The second experiment was conducted in two provinces, Jiangsu and Henan, in October 2018 and lasted for half of a month. Three different versions of the CE were randomly distributed to the farmers and they were asked to choose only one of the three alternatives in each card. A total of 120 farmers were involved in the second experiment, with 60 respondents in each province. With a substantial amount of details provided by the respondents in the first experiment, it was decided to use a reduced survey in the second round of experiment. Those results are provided in this section. The descriptive table shows that age, the total number of households, primary decision, education and years of farming are not the indicators that significantly differentiated two provinces. Farmers on average are 51.208 years old, with a minimum of 22 and a maximum of 83. The average number of households are 4.158. Among the total respondents, 60% of them make the primary decision in agricultural affairs. In terms of education level, 10.8% of the respondents never go to school, 23.3% of the respondents attend at least elementary school, 43.3% of the respondents attend at least middle school, 18.3% of the respondents attend at least high school, 4.2% of the respondents attend some university or college, none of the respondents completes college or university. The average years of farming are 27.833 years, with a minimum of no experience and a maximum of 55 years. (See Appendix 7)

Noticeable differences are observed in the rest of the questions. Around 73.3% of the farmers in Henan are female, compared with 36.7% in Jiangsu. Although the average contracting lands are similar between the two provinces, the largest in Henan is more than one and a half times of that in Jiangsu. Larger gap appears in transferred

lands. In Henan, the range goes from -8.1 Mu to 35.5 Mu, while it extends to [-12, 2000] in Jiangsu. Moreover, the average of transferred land in Jiangsu is 90 times of Henan. The impact is revealed in agricultural income and expense. The average agricultural income in Jiangsu is 26 times of Henan, and the net profit per year in Jiangsu is almost 6 times of Henan. The wealthiest farmers with respect to agricultural income in Jiangsu is 60 times of that in Henan. It can be seen from the descriptive data that farmers in Jiangsu are overall richer than Henan.

This chapter discusses the design of both CE and survey in first and second round of experiment. Recall that no prior information is inputted to design the CE in the first experiment. The results from the second round are expected to perform as a robust check given the prior estimation is added into the design of the second CE. Moreover, the descriptive results from the survey in both rounds are presented. In the next chapter, it can be seen how those information help to interpret the results and whether the performance of models meet the expectations in the theory.

CHAPTER 5

RESULTS AND DISCUSSION

Knowing the design of experiment and the expected results in both rounds (the first experiment was carried out from May-June 2018, the second experiment was carried out from Oct-Nov 2018) in the previous chapter, the empirical results from both conditional and mixed logit regressions logit with respect to both experiments are presented to be checked and analyzed. Because of the difference in experimental and block design, each experiment is investigated separately and compared, starting with the first experiment. Recall that in the second experiment, the D-optimal design is conditional for dominant alternatives under Bayesian criteria. For the CE results in each round, the overall result is presented first, followed by the results from individual province. At the end of each round, WTP with respect to each attribute in separate province and the overall situation are illustrated along with the interpretation.

5.1 Discrete choice results of the first experiment

5.1.1 Overall results of the three provinces

Running both conditional and mixed logit regression, all variables are significant given the result under the Choice Model, which suggests that the chosen contract attributes are all relevant for farmers in this context (Table 8). In other words, all of the factors significantly affect the crop insurance purchases. Having a closer look, the two results show the effects in order of significance with a small difference. In the conditional logit regression, Frequency has the most significant effect, followed by Premium, Insurer and Indemnity. Though Collateral has the smallest effect, it is also significant, which indicates that farmers do not entirely ignore this attribute when

making a purchase decision. In terms of the mixed logit regression, Premium has the strongest effect on the purchase decision, followed by Insurer, Indemnity and Frequency. Though the top rankings are not exactly the same, Collateral still captures the smallest influence on whether farmers would purchase the hypothetical crop insurance. The F statistics indicates that both conditional and mixed logit model are valid. However, according to Akaike information criterion (AIC), mixed logit model performs better while according to Bayesian information criterion (BIC) which places a higher penalty on using degrees of freedom (DF) than AIC, conditional logit is preferred. The results are therefore not conclusive. Since the number of variables is not large, the heavier penalty on DF is not necessary. Hence, the following discussion is based on the mixed logit regression results.

The negative estimate of Frequency indicates that as the frequency of disaster gets higher, farmers are more willing to purchase crop insurance which meets the expectation. Given the function of a safeguard to agricultural business and being as a significant factor, the result shows that farmers identify the role of insurance. When disaster occurs more frequently, harvest will be influenced so that the agricultural revenue will more likely to be fluctuated. To minimize the production loss, they therefore purchase crop insurance to make sure when agricultural income is hit by the disaster, at least a portion of their cost will get back, relieving the situation. If disaster occurs more rarely, farmers will be less likely to have the incentive to value the importance of purchasing crop insurance.

Table 8. Conditional logit (CL) and Mixed logit (ML) model comparison under overall data in the first experiment

VARIABLES	(1) CL	(2) ML. Mean	(3) ML. SD
Frequency	-0.347***	-0.378***	0.195***
	(0.027)	(0.047)	(0.038)
Indemnity	0.003***	0.003***	0.000
	(0.000)	(0.000)	(0.001)
Premium	-0.063***	-0.065***	
	(0.005)	(0.005)	
Insurer	0.968***	1.009***	0.169
	(0.090)	(0.098)	(0.230)
Collateral	0.430***	0.445***	-0.290
	(0.094)	(0.108)	(0.184)
Observations	3,554	3,554	3,554
LR chi2	527.260	23.130	
Prob > chi2	0.000	0.0001	
AIC	1946.188	1931.055	
BIC	1977.067	1986.637	

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

A positive estimate of Indemnity meets the expectation as well. The result shows that farmers tend to make purchase of crop insurance with higher payout from the insurance company. Although the process of loss assessment relies on insurance company, and several farmers complained about the procedure of the settlement of claims in the fields, farmers are more likely to purchase crop insurance which states a higher indemnity in the contract.

The negative sign of Premium meets the expectation. As premium gets higher, farmers are less likely to purchase a crop insurance. Since it is the most important factor among all variables, it reveals that even if the government subsidy has already supported the most part of the crop insurance's premium, farmers still strongly prefer lower crop premium than the higher one which follows the traditional downward sloping demand states.

In terms of the type of insurer, a dummy variable is created, with 1 representing the state-owned company, 0 standing for the private company. The positive estimate indicates that farmers tend to purchase crop insurance from state-owned insurance company rather than private firm which meets the expectation, which is consistent with the result that Wang and Lu (2018) observed in Liaoning province. It is interesting to notice that farmers value this attribute as the second most important factor when they make a purchase decision on the crop insurance. Since Chinese government is continually encouraging the development of agricultural insurance market over recent years, more private companies enter the market and some even provide more kinds of products than state-owned insurance companies. However, from the result it can be seen that farmers trust the government-based insurance company more than the private ones.

Collateral is also transformed in a dummy variable with 1 representing Yes and 0 standing for No. The positive estimate shows that farmers are more willing to purchase crop insurance that can be used as collateral when they apply for a loan in a bank. CBRC (2015) released an official document in 2015, encouraging the collaboration between insurance company and bank. Several pilot projects have been

implemented in the recent years. However, whether the crop insurance can be used as collateral when applying for a loan is the least important one among all the significant factors. In other words, it generates the smallest impact on farmers' purchase decision compared with other parameters. Therefore, it can be seen that even though several actions have been taken to spread the idea of using agricultural insurance as collateral, most of the farmers are not familiar with this concept.

In general, farmers are more likely to choose crop insurance with lower premium, higher reimbursement, issued by a state-owned insurance company and can be used as collateral to get loan when given a higher frequency of disaster.

5.1.2 Separate results of the three provinces

Since the overall model aggregates the data of three provinces, the result assumes no difference in marginal effect. Therefore, it is valuable to look at the three provinces separately which allows the existence of geographic difference (Table 9).

The statistical results show that the mixed logit model in all three provinces are not significantly different from the null model. This observation is revealed through the large p-value for the LR test. The null model assumes all coefficients of standard deviation terms are zero which is equivalent to the conditional logit model. Since there is no prior information used in the experimental design, it can be possible that mixed logit model does not significantly differ from conditional logit model. Similar coefficients from the two models reinforce the result. It is also interesting that all three provinces have lower AIC and BIC in conditional logit compared with mixed logit, meaning the conditional logit model is statistically better than the mixed logit model.

Since all the estimates are almost the same and the assumption of mixed logit is more realistic, the following interpretation will use the results from mixed logit.

The mixed logit results from Shandong and Sichuan show that all attributes are significant except for Collateral. Also, the results from survey part indicate that this variable has the lowest average evaluation among all the attributes in all three provinces. In May 2018, Shandong Agricultural Development Credit Guarantee Company (SDNYDB) signed a contract with AnHua Agricultural Insurance Company (Shandong branch), determining the financial collaboration between the two parties on agricultural insurance products. Farmers who purchased the agricultural insurance from AnHua can enjoy the preferential policy on loan application in SDNYDB. Moreover, PICC developed a soybean insurance product in August 2018, which not only relieves the related production and market risk, but also can be used as collateral when applying the loan. Though more crop insurance products are available to obtain better loan policy, the concept is relatively new in Shandong and appeared after the fieldwork. Therefore, farmers in Shandong were unfamiliar with this concept during the survey and it can be the reason why Collateral is not significant in the model.

Table 9. Conditional logit (CL) and Mixed logit (ML) model comparison under three provinces in the first experiment

VARIABLES	(1) Shandong. CL	(2) Shandong. ML. Mean	(3) Shandong. ML. SD	(4) Shaanxi. CL	(5) Shaanxi. ML. Mean	(6) Shaanxi. ML. SD	(7) Sichuan. CL	(8) Sichuan. ML. Mean	(9) Sichuan. ML. SD
Frequency	-0.527***	-0.556***	0.166**	-0.161***	-0.161***	0.038	-0.405***	-0.423***	0.168**
	(0.054)	(0.079)	(0.075)	(0.045)	(0.047)	(0.110)	(0.049)	(0.073)	(0.068)
Indemnity	0.003***	0.003***	0.000	0.004***	0.004***	-0.000	0.003***	0.003***	0.001
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Premium	-0.071***	-0.072***		-0.081***	-0.081***		-0.040***	-0.041***	
	(0.010)	(0.010)		(0.009)	(0.009)		(0.009)	(0.009)	
Insurer	1.157***	1.187***	0.202	0.737***	0.739***	-0.014	1.165***	1.203***	0.082
	(0.172)	(0.187)	(0.595)	(0.149)	(0.150)	(0.241)	(0.163)	(0.171)	(0.291)
Collateral	0.389**	0.368*	-0.340	0.597***	0.598***	-0.082	0.330**	0.344*	0.233
	(0.176)	(0.209)	(0.310)	(0.161)	(0.164)	(0.570)	(0.163)	(0.183)	(0.250)
Observations	1,168	1,168	1,168	1,186	1,186	1,186	1,200	1,200	1,200
LR chi2	230.800	3.650		165.320	0.060		187.380	3.95	
Prob > chi2	0.000	0.456		0.000	0.9996		0.000	0..413	
AIC	588.794	593.146		666.748	674.691		654.397	658.451	
BIC	614.110	638.714		692.140	720.396		679.847	704.261	

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Unfortunately, in Sichuan, no collaboration between insurance company and bank has been revealed online so far. The concept is therefore not familiar to the farmers when conducting the experiment and the variable is not significant. It was observed that whether the concept is familiar or not is critical when farmers making their choices. When farmers asked "How does the crop insurance function as a collateral?", most of them still did not fully understand the concept after hearing the explanation from the students and hence the results were influenced by the understanding. However, crop insurance can be used as collateral is not a fresh idea under the case in Shaanxi. Early in 2016, the Shaanxi government had published the document, encouraging the pilot projects of agricultural insurance that can be used as collateral (Shaanxi Gov, 2016). To respond the governmental document, the first agricultural insurance-based loan was granted from PICC to a hog farmer in Shaanxi (2016). Influenced by the macro policy, farmers in Shaanxi have more chances to get exposure to this new type of insurance product and are therefore value this concept as significant.

Farmers in Shandong and Shaanxi believe Premium has the largest impact on their purchase decision on a crop insurance, while Sichuan's farmers value the type of the insurance company most. It can be seen from Table 10 that though farmers in Sichuan spend the largest money in agricultural production among three provinces, their income from both agriculture and non-agriculture sector are the highest as well. Furthermore, after considering other income and expense, farmers' left income in Sichuan is significantly higher than the others. Therefore, it may due to personal wealth that farmers in Sichuan value the premium as the second least important

attribute when making a purchase decision on crop insurance, while Shandong and Shaanxi's farmers believe the premium has the largest effect on decision making.

Table 10. Farmers' income and cost in three provinces

Province	Agricultural income	Nonagricultural income	Production cost	Left income
Shandong	102508.613	42552.857	74487.649	35989.992
Shaanxi	5752.369	41607.212	2349.2	20722.883
Sichuan	193990.253	58831.478	133529.511	87869.096

According to the survey, 15.6% of the respondents have relative(s) working in government related institution in Shandong, 7% in Shaanxi and 22% in Sichuan. It shows that respondents in Sichuan have more connection with government. Since people's perception can be influenced if they have relatives working for the government, farmers in Sichuan are likely to trust the government more than others. Therefore, when a crop insurance is offered, they tend to attach more concerns on whether it is provided by a state-owned insurance company or a private insurance company.

5.1.3 Willingness to pay from the first experiment

The below table (Table 11) indicates the WTP for the overall and three provinces respectively under conditional logit (CL) and mixed logit models (ML). It can be seen that the difference between the two models is trivial. Besides, farmers in Sichuan are willing to pay the highest amount for every increased two-years frequency of disaster, nearly two times of the average, while farmers in Shaanxi do not pay a lot of attention on that, roughly one third of the average. For every increased 100 yuan on

indemnity, farmers in Shaanxi have the most similar WTP to the average level, while farmers in Shandong and Sichuan are willing to pay less and more than the average respectively. In terms of the type of insurer, Shandong and Sichuan's farmers are willing to pay more than the average for the state-owned insurance company, while farmers in Shaanxi would pay the least for the changing from private insurance company to state-owned insurance company. It is interesting that though farmers in Sichuan do not significantly value the importance of whether the crop insurance can be used as collateral, they have the highest WTP for this characteristic, which is even higher than Shaanxi's farmers who treat this property as a significant factor when they make a purchase decision on crop insurance.

It is also noticeable that the WTP respecting all attributes in Sichuan are the highest among the three provinces, despite the fact from the survey part that none of the average evaluations of all attributes is the highest among three provinces and Sichuan's farmers value themselves as the one who are not very familiar with the agricultural insurance products. The result of cluster analysis (Table 6 & 7 in Chapter 4) supports the outcome, suggesting that farmers in Sichuan are classified in the least risky and most precautionary segment. Therefore, they are naturally willing to pay more to avoid the agricultural risk. The other potential reason could be the economic situation for Sichuan's farmers is better than the others. Furthermore, they may not have reference value to the question due to the lack of knowledge in crop insurance which is revealed through the question from Part D in the survey.

Table 11. WTP in the first experiment

	3 Provinces		Shandong		Shaanxi		Sichuan	
	CL	**ML**	**CL**	**ML**	**CL**	**ML**	**CL**	**ML**
Frequency	-5.522	-5.847	-7.439	-7.699	-1.985	-1.981	-10.119	-10.394
Indemnity	0.049	0.049	0.035	0.036	0.043	0.043	0.084	0.085
Insurer	15.385	15.611	16.322	16.422	9.066	9.071	29.126	29.542
Collateral	6.837	6.890	5.492	5.090	7.343	7.337	8.262	8.449

5.2 Discrete choice results of the second experiment

5.2.1 Overall results of the two provinces

One remarkable improvement in the second experiment is that both AIC and BIC are smaller under mixed logit model than that of under conditional logit model (Table 12), which means mixed logit performs better. Recall that in Chapter 4, Bayesian D-optimal designs which include the prior information are found to be more efficient and robust than non-Bayesian D-optimal designs. Since the second experiment design adopts Bayesian D-optimal design, the better performance of mixed logit model corresponds to a more effective design. The significant small p-value for the LR test also supports the observation. Moreover, based on the preference results under conditional and mixed logit models, all variables are significant and the signs all meet the expectation which reveals that the second experiment is the robust check. Compared with the first experiment, two results show similar effects in order of significance. In both models, farmers value Premium most, and consider the least effects of indemnity and collateral property.

Table 12. Conditional logit (CL) and Mixed logit (ML) model comparison under overall data in the second experiment

VARIABLES	(1) Cl	(2) ML. Mean	(3) ML. SD
Frequency	-0.288***	-0.435***	0.616***
	(0.032)	(0.074)	(0.065)
Indemnity	0.002***	0.003***	0.003***
	(0.000)	(0.001)	(0.001)
Premium	-0.050***	-0.068***	
	(0.005)	(0.007)	
Insurer	0.766***	1.198***	1.630***
	(0.086)	(0.197)	(0.161)
Collateral	0.336***	0.479***	-0.782***
	(0.070)	(0.114)	(0.131)
Observations	3,240	3,240	3,240
LR chi2	153.430	282.260	
Pro > chi2	0.000	0.000	
AIC	2229.577	1955.318	
BIC	2259.993	2010.068	

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

5.2.2 Separate results of the two provinces

In the second experiment, the LR test shows that the mixed logit model is significantly different from the conditional model. Besides, the performance of mixed logit model gets significantly improved (Table 13). For both provinces, the value of

AIC and BIC are smaller under mixed logit model, indicating that mixed logit model provides a better fit than conditional logit model. All variables in both provinces are significant under the Wald test and all signs meet the expectation.

Table 13. Conditional logit (CL) and Mixed logit (ML) model comparison under three provinces in the second experiment

VARIABLES	(1) Jiangsu. CL	(2) Jiangsu. ML. Mean	(3) Jiangsu. ML. SD	(4) Henan. CL	(5) Henan. ML. Mean	(6) Henan. ML. SD
Frequency	-0.349***	-0.517***	0.759***	-0.232***	-0.309***	0.468***
	(0.046)	(0.106)	(0.107)	(0.046)	(0.086)	(0.092)
Indemnity	0.002***	0.003***	0.003***	0.002***	0.003***	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Premium	-0.049***	-0.073***		-0.052***	-0.068***	
	(0.007)	(0.010)		(0.007)	(0.010)	
Insurer	0.625***	0.958***	1.689***	0.922***	1.615***	1.902***
	(0.121)	(0.249)	(0.236)	(0.126)	(0.313)	(0.299)
Collateral	0.241**	0.491***	0.570***	0.441***	0.704***	1.124***
	(0.098)	(0.150)	(0.190)	(0.101)	(0.189)	(0.215)
Observations	1,620	1,620	1,620	1,620	1,620	1,620
LR chi2	85.100	164.86		84.910	124.810	
Prob > chi2	0.000	0.000		0.000	0.000	
AIC	1111.403	954.543		1111.589	994.777	
BIC	1138.354	1003.054		1138.54	1043.288	

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

However, the effect of attributes does not have the similar order in two provinces. In Jiangsu, farmers value Premium the most, followed by Frequency, Insurer, Indemnity and Collateral. Farmers in Henan place the most importance on Premium, while value Insurer, Indemnity and Collateral in the following. Frequency has the least effect on the purchase decision on crop insurance.

This result is also observed in the survey when farmers were directly asked the ranking of the importance among these attributes (Table 14). It can be seen that farmers in Henan do not value much about the frequency of disaster, which obtains significantly less valuation than that of in Jiangsu. Furthermore, whether the crop insurance can be used as collateral has the lowest average valuation in the survey for both provinces, indicating that it is the least or almost the least important factor in farmers' minds.

In Jiangsu, the agricultural income is nearly 26 times of Henan, and its left income of the year is almost 6 times of Henan. Moreover, the production cost is roughly 50% of the agricultural revenue in Henan, while 13% in Jiangsu. The data reveals that farmers in Jiangsu are much wealthier than Henan and agriculture in Jiangsu is more profitable than Henan (Table 15). Jiangsu's farmers could be considered as the shrewd type of character. In other words, they would calculate how to maximize the profit with respect to the cost. Therefore, the premium of crop insurance as part of the agricultural expenses, is one of the concerns to farmers in Jiangsu. The interpretation is different in Henan. Since the production cost already takes up a large proportion of the agricultural revenue, and farmers' agricultural income on average is relatively low, the premium of the crop insurance therefore

significantly relates to the profit they would earn. Moreover, farmers in Jiangsu has higher education and longer years of farming than Henan which helps Jiangsu's farmers better understand how to efficiently allocate the cost. Hence, it can be seen that though both farmers in Jiangsu and Henan value the crop insurance premium as the most important attribute when they make a purchase decision, the behind reasons are not similar.

Table 14. Average evaluation in the second survey

	Frequency	**Premium**	**Coverage**	**Insurer**	**Collateral**
Jiangsu	3.683	3.183	3.533	3.2	1.4
Henan	2.883	2.967	2.983	3.067	2.85

Table 15. Farmers' income and cost in two provinces

	Agricultural income	**Nonagricultural income**	**Production cost**	**Left income**
Jiangsu	375957.322	50325	50325	79161.767
Henan	14525.442	30173.729	7048	13528.905

To understand why the collateral property is the least important attribute, the development of insurance-based loan needs to be investigated. In 2016, the Department of Finance of Jiangsu Province, Postal Savings Bank of China (Jiangsu branch) and PICC jointly launched a loan product "Nongbaodai", which accepts policy-supported agricultural insurance as collateral. Nongbaodai relies on the government's financial risk compensation pool as the method of improving credit and provides financial support with a low cost and low threshold. The oriented objects are farmers' cooperative, family ranch, agricultural specialist and agricultural enterprise.

By September 2018, 1200 farmers got financial support from Nongbaodai. The average transferred land in Jiangsu is around 165 Mu, including two farmers who rent in 1000 and 2000 Mu respectively. It is surprising that most of the respondents meet the standard of applying the insurance-based loan, but they do not respond to the preferential policy. It can be explained that most of the farmers are more willing to borrow money in the traditional way and hesitate to try this new borrowing procedure. Therefore, Collateral has the least influence on farmers' purchase decision on crop insurance. According to Manager Xu of PICC Jiangsu branch, the current coverage is far below what was originally envisaged. Therefore, more public awareness campaigns are desirable to help farmers better understand the role of agricultural insurance in the procedure of loan application.

Under the case of Henan, some agricultural insurance products which can be used as collateral when applying agriculture-related loan, started to appear in the market. However, the survey suggests that the average transferred land is around 2 Mu, which is far below the large agricultural activity scale. Therefore, for the respondents in Henan, it is unnecessary to apply loan in order to enlarge the productivity scale. In other words, they would not place the collateral property as an important factor compared with other attributes like premium or the type of insurer.

5.2.3 Willingness to pay from the second experiment

It is observed that in the first experiment, the WTP in conditional and mixed logit model are almost the same, while in the second experiment there is a larger gap between the two sets of WTP in different models. (Table 16) This is due to the more effective experiment design after using the prior estimators.

Table 16. WTP in the second experiment

	2 Provinces		Jiangsu		Henan	
	CL	**ML**	**CL**	**ML**	**CL**	**ML**
Frequency	-5.762	-6.393	-7.092	-7.112	-4.476	-4.528
Indemnity	0.044	0.041	0.048	0.040	0.041	0.042
Insurer	15.309	17.616	12.729	13.173	17.821	23.697
Collateral	6.708	7.046	4.898	6.749	8.515	10.321

In terms of Frequency, farmers in Jiangsu are willing to pay more than the average when the disaster happens more frequently, while Henan's farmers will pay less than the average. This is revealed in the survey, where the ranking of Frequency is higher in Jiangsu than in Henan (Table 14). In general, the weather condition is better in Jiangsu than Henan. Therefore, farmers in Jiangsu put more attention on the climate risk in case it influences the yield. For every increased 100 yuan on indemnity, farmers in both provinces have similar WTP. Regarding to the type of insurer, Jiangsu's farmers are willing to pay less for the government than Henan's farmers. It can be explained that overall, the economic environment in Jiangsu is better than Henan. More private companies participate in agricultural market in Jiangsu. Therefore, the perception of trust in government in Jiangsu is not as strong as Henan. Farmers in Henan are willing to pay more on a crop insurance that can be used as collateral in loan application than Jiangsu. It is an interesting result since this characteristic would be more useful for Jiangsu's farmers since they have larger productivity scale than Henan's farmers on average. One possible explanation could

be farmers in Jiangsu have not entirely accepted this new idea. Therefore, they are less willing to pay more for the thing they are uncertain about.

CHAPTER 6

FUTURE WORKS AND CONCLUSION

6.1 Futures works

One observation when doing the experiment was that some farmers did not fully understand the setting of CE at the beginning in that they believed some levels stated in the choice were not realistic, so they couldn't make a choice. Though this concern would be revealed by the level of certainty, obtaining a significant amount of uncertain choices will hurt the effectiveness of the experiment. Besides, an informative experiment is always desired in any research. One way to improve that could be dropping the first two or three questions in the CE, which refers to the "learning phase" to the respondent. Another alternative would be designing the CE with different levels in Premium and Indemnity through researching the available crop insurance products and the average indemnity in that region, making the CE looks more reasonable to farmers in that particular area.

6.2 Conclusion

The overall purpose of this study is to explain farmers' demand for crop insurance in China. Two choice experiments in five provinces were carried out during May and June in 2018. The first experiment includes three provinces, covering different geographic regions. The signs of all estimates are significant based on the aggregate data and meet the expectation that farmers would prefer to choose a crop insurance with higher indemnity, lower premium, issued by a state-owned insurance company and can be acceptable as collateral when given a higher frequency of disaster. Zooming into three provinces, the separate mixed logit analysis is not

significantly different from conditional logit model. The signs all meet the expectation, however, Collateral is not a significant variable in Shandong and Sichuan under 99% significance level. It can be interpreted that the collateral property is a new concept to farmers in these two provinces, since a few projects are taken recently after the field experiment. Therefore, the unfamiliarity leads to the insignificant result. Farmers in Shandong and Shaanxi value Premium as the most important attribute, while this is not true for Sichuan's farmers. Because of the noticeable higher wealth, farmers in Sichuan do not treat the cost of insurance as important as the other two provinces. On the other hand, Sichuan's farmers place the most importance on the type of insurer. From the survey it can be seen that farmers in Sichuan have the strongest connection to the government which results in stronger trust in government. Therefore, the type of insurer significantly affects farmers' purchase decision in Sichuan. Regarding to the WTP, farmers in Sichuan are willing to pay the highest amount for all other variables among the three provinces, even though they do not value Collateral as a significant attribute. The behind reason is not only the economic situation, but also could be the lack of knowledge on crop insurance products.

The second experiment was conducted in two provinces with quite different economic background. Since prior information from the first experiment is used in the second experimental design, it excludes the dominant choices that appear in the first experiment. The performance of mixed logit improves significantly and is statistically better than the conditional logit. The signs all meet the expectation and are significant in both aggregate and separate cases. Though Premium significantly influences farmers' decision on purchasing a crop insurance in both provinces, the underlying

reasons are not the same. Since the farmers in Jiangsu are significantly wealthier and have higher education and longer years of farming than Henan on average, they better understand how to allocate the cost and seek the optimal solution which minimizes the total cost while ensuring the largest profit. Therefore, as part of the cost, they believe premium of an insurance is critical. In the other case, farmers in Henan already borne with a relatively high proportion of production cost so that any additional cost will reduce the net profit they would earn. Therefore, premium becomes their biggest concern. Farmers in both provinces treat Collateral as the least or almost the least important factor when making a purchasing decision. It is interesting that in Jiangsu, there is an available crop insurance product that can be used as collateral to apply for loans, and many of the farmers meet the standard of the oriented objects. The reason why they do not attach a lot of attention on the collateral property can be the traditional thinking on borrowing therefore they are hesitant to try the new kind. The story is different in the case of Henan. It is unnecessary to apply loan to expand the agricultural production since the average transferred loan is around 2 Mu. Even if the crop insurance can be used as collateral, it does not provide extra benefit to farmers. Hence, farmers in Henan do not place Collateral as important factor when they make decision. The WTP in two provinces is consistent with the effects ranking in mixed logit analysis. It is noticeable that farmers in Jiangsu are willing to pay significantly less for a state-owned insurance company than Henan. It can be explained that private companies are more active in Jiangsu which leads to lower connection with the government. Hence, whether the insurer is a state-owned or private company is not as important in Jiangsu as that of in Henan.

To conclude, the findings are consistent with the expectation. In general, farmers prefer crop insurance with lower premium, higher reimbursement, issued by a state-owned insurance company and can be used as collateral to get loan when given a higher frequency of disaster. It has several practical implications including helping insurance companies and policy makers better develop the products or policies that increase the adoption rate of crop insurance in China. Noticing that farmers in different regions place the importance of factors differently, it is worth studying the demographic information first for both the government and the insurance companies, then developing the new variety of crop insurance products. Since the agricultural and economic development can be much different in different regions across China, by doing so, the insurance products will meet the actual demand of the farmers in that particular area, providing benefits to both farmers and insurance companies. Moreover, the preferential policy will not sleep in the governmental document, instead, it will truly promote the sustainable rural economic development and ensure the food safety for the nation.

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APPENDIX

Appendix 1. Survey in the first experiment

Number	Category	Question	Unit	Response
A1	Farm Characteristics	Gender	0=Female, 1=Male	
A2		Age		
A3		Including yourself how many people live in this house	Number of people	
A4		How many members of your household are primarily involved in agricultural work	Number of people	
A5		How many members of your household earn off-farm wages	Number of people	
A6		Are you the primary decision maker in agricultural affairs	0=No, 1=Yes	
A7		Do any household members work for village leader, village committee, state government, county government, state enterprise, and RCC or banks)	0=No, 1=Yes	
A8		What is your education level	0=Never Went to School, 1=At least elementary school, 2=At least middle school, 3=At least high school, 4=Some University or college, 5=Completed College or University	

A9		How many years have you been farming		
A10		What is the total size of your household farm (Mou, allocated Land Use rights, excluding land rented in)		
A11		How much land do you rent in for agricultural use (total mou rented)	Mu	
A12		In general, how would you describe the current agricultural business in your area compared to last year	1=Getting worse, 2=About the same, 3=Getting better	
A13		Please list the top five crops you have grown in the past 12 months from the most valuable to the least valuable	1	
			2	
			3	
			4	
			5	
A14		Farm income	Yuan	
A15		Off-farm income	Yuan	
A16		Total income	Yuan	
A17		Productive expenditure	Yuan	
A18		Household Consumption expenditures (food, clothes, health, education, etc)	Yuan	
A19		Other expenditures (e.g. car, house, vacation travel)	Yuan	
A20		Gross Incomes minus Expenditures	Yuan	
B1	Sources of Risk and Risk Perceptions	Accepting greater production risks to increase the chance of higher profits is important to me	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	

B2		I am more likely to take risks with new agricultural technologies (mechanical or management practices or input use) before I see good results on other farms	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
B3		I am willing to take risks with new management practices before I see good results in other farms	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
B4		Diversifying my crop (including livestock) mix in order to reduce risk is important to me	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
B5		Having different Fields or farms at different locations (geographic diversification) is important to me	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
B6		I would consider growing more risky crops if I had (or have) greater access to irrigation	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	

B7		I would, or do, sell my agricultural products over a period of time rather than at harvest in order to reduce market price risk (diversified marketing)	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
B8		I have (or would if I could) made some non-farm investments in new business, or financial assets like stocks and bonds in order to diversify household income.	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
B9		I am willing to ACCEPT more risk in all aspects of life relative to my peers (other farmers that you know)	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
B10		In general, I believe that I TAKE more risks in all aspects of life than my peers.	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
C1	Precautionary Savings	What proportion of Household income (define income here as revenues minus productive expenses minus consumption and other non-productive expenditures) are you able to save in a year	1=none, 2=less than 5%, 3=3%-5%, 4=more than 10%	

C2		I save in case my house needs repair	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
C3		I save in case my automobile (e.g. car, motorcycle, tractor) breaks down.	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
C4		I save in case I cannot repay a loan from earnings.	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
C5		I save for unexpected medical emergency	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
C6		I save in case I lose my job	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	

C7		I save for unanticipated crop loss.	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
C8		In your opinion, do you think saving is important?	1=Strongly unimportant, 2=Moderately unimportant, 3=important, 4=Moderately important, 5=Strongly important	
D1	Predicted and Historical Yield	If you grow rice, corn or wheat, identify the lowest yield you believe possible, the yield that you believe is most likely to be received, and the highest possible yield you believe possible (Jin/Mu) where (1jin = 500g) in ***the next crop year (2018/19)***	Corn	
			Wheat	
			Rice	
D2		What is the percentage chance that your yields in the next crop year will fall outside the range of the Lowest and Highest values reported above		

D3		What is the percentage chance that your yields in the next crop year will be at least as high as the most likely yield you reported above		
D4		If you grow rice, corn or wheat, what is the lowest and highest yield (Jin/Mu) that you recall from your years in farming? If you do not recall exacts, please answer to nearest within 10 Jin/Mu. What is the average or most likely yield you have harvested	Corn	
			Wheat	
			Rice	
E1	Crop Insurance Use and Perceptions	How much do you know about crop insurance	1=I never heard of crop insurance, 2=I know nothing about crop insurance, 3=I know a little about crop insurance, 4=I know crop insurance well	

E2		Is crop insurance currently available to you (if Yes skip to E4)	1=Yes, 2=No, 3=Not sure	
E3		If crop insurance was offered in your region next year do you think that you would purchase crop insurance (If Yes skip to E10; If No skip to E11)	0=No, 1=Yes	
E4		Have you purchased crop insurance (If No skip to E11)	0=No, 1=Yes	
E5		In what year did you first purchase crop insurance		
E6		Whether the listed crops covered; How much do you pay per Mu; Have you ever received the indemnity	Corn	
			Wheat	
			Rice	

E7		For most crops, crop insurance is subsidized by up to 80% of its fair value. For example, if you pay 3RMB/Mu the true cost would be 15 RMB/Mu. Would you still purchase crop insurance if you had to pay 15 RMB/Mu, an increase of 5 times the current rate	1=Definitely not purchase, 2=Will unlikely purchase, 3= Will likely purchase, 4=Will definitely purchase	
E8		(If definitely not or unlikely in E7) You responded that you are unlikely to purchase crop insurance if the price rose from 3RMB to 15RMB/Mu. Would you change your mind if you received a 50% subsidy so that the price was 7.5 RMB/Mu	1=Definitely not purchase, 2=Will unlikely purchase, 3= Will likely purchase, 4=Will definitely purchase	
E9		If the cost of insurance remains the same as your last purchase, will you continue to purchase insurance for the next crop	1=Definitely not purchase, 2=Will unlikely purchase, 3= Will likely purchase, 4=Will definitely purchase	
E10		Why do you purchase crop insurance? a. The insurance premium is affordable b. Crop yield in previous year was low c. The probability of future climatic risk occurrence is high d. Change in the local climate has caused damage to our crops	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	

		e. Government subsidizes the insurance premium f. My relatives or friends purchase crop insurance g. The richest person (or leader) in my village purchases crop insurance h. There are many propagandas in my village that encourages farmer to purchase crop insurance		
E11		Why have not you or would not purchase crop insurance. a. I will not purchase crop insurance because I do not have enough money to pay for it b. I will not buy crop insurance because I do not believe that it is necessary c. I will not buy crop insurance because I don't trust the insurer to compensate me if the insurance is triggered d. I will not buy crop insurance because I do not understand how crop insurance works e. I will not buy crop insurance because it is offered by a private insurance company and I would prefer to buy crop insurance from a government agency f. I will not buy crop insurance because the	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	

		payout if the insurance is triggered is too low		
E12		If the frequency of disaster gets higher, would you be more willing to purchase a crop insurance	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
E13		If the premium per Mu gets lower, would you be more willing to purchase a crop insurance	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
E14		If the indemnity per Mu gets higher, would you be more willing to purchase a crop insurance	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
E15		If a crop insurance is provided by a state-owned firm instead of a private one, would you be more willing to purchase it	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
E16		If a crop insurance is acceptable as loan collateral, would you be more willing to purchase a crop insurance	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	

E17		I believe that purchasing crop insurance will reduce my production risks which will better enable my ability to repay money I borrowed from banks, friends and/or relatives	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
E18		If I purchase crop insurance, it will increase my chances of obtaining a loan from a RCC or other formal bank	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
E19		I believe that by purchasing crop insurance I can increase the amount of money I can borrow from RCC or other formal banks	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
E20		I believe that crop insurance would become more important to me if I were to increase my farming operation by renting land (production rights) from a Land Transfer Center or from private individuals	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
E21		Have you ever purchased other types of insurance (for example, life insurance, fire insurance, automobile insurance)	0=No, 1=Yes	

F1	Answered by interviewer only	Do you think the respondent was engaged in this survey and answered truthfully all questions	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
F2		Do you think the quality of answers provided in this survey is adequate to include in any written reports	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	

Appendix 2. Survey in the second experiment

Number	Question	Unit	Response
A1	Gender	0=Female, 1=Male	
A2	Age		
A3	Including yourself how many people live in this house	Number of people	
A4	Are you the primary decision maker in agricultural affairs	0=No, 1=Yes	
A5	What is your education level	0=Never Went to School, 1=At least elementary school, 2=At least middle school, 3=At least high school, 4=Some University or college, 5=Completed College or University	
A6	How many years have you been farming		
A7	What is the total size of your household farm (Mou, allocated Land Use rights, excluding land rented in)		
A8	How much land do you rent in for agricultural use (total mou rented)	Mu	
A9	Farm income	Yuan	

A10	Off-farm income	Yuan	
A11	Total income	Yuan	
A12	Productive expenditure	Yuan	
A13	Household Consumption expenditures (food, clothes, health, education, etc)	Yuan	
A14	Gross Incomes minus Expenditures	Yuan	
A15	How much do you know about crop insurance	1=I never heard of crop insurance, 2=I know nothing about crop insurance, 3=I know a little about crop insurance, 4=I know crop insurance well	
A16	Is crop insurance currently available to you	0=No, 1=Yes	
A17	If crop insurance was offered in your region next year do you think that you would purchase crop insurance	0=No, 1=Yes	
A18	Have you purchased crop insurance	0=No, 1=Yes	
A19	When you make purchase decision on crop insurance, rank the attributes matters to you from least important(1) to most(5)	Frequency of disaster	
		Crop premium	
		Indemnity	
		Type of insure (0=private, 1=government)	
		Collateral (0=not acceptable as loan collateral, 1=acceptable)	

A20	Highest amount of money you would pay for a crop insurance	Yuan/Mu/year	
B1	Do you think the respondent was engaged in this survey and answered truthfully all questions	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	
B2	Do you think the quality of answers provided in this survey is adequate to include in any written reports	1=Strongly Disagree, 2=Moderately Disagree, 3=Agree, 4=Moderately Agree, 5=Strongly Agree	

Appendix 3. Descriptive data in the first experiment (1)

	Mean				Standard Deviation			
	Shandong	**Shaanxi**	**Sichuan**	**Total**	**Shandong**	**Shaanxi**	**Sichuan**	**Total**
Gender	0.609	0.690	0.580	0.627	0.491	0.465	0.496	0.485
Age	56.536	59.070	57.000	57.545	11.399	10.389	12.056	11.317
Total # households	3.814	4.670	4.540	4.347	1.616	1.985	1.755	1.826
# in farm	1.866	2.130	2.210	2.071	0.772	1.405	1.113	1.135
# outside farm	0.771	1.490	1.420	1.233	0.761	1.202	1.156	1.106
Primary decision	0.814	0.770	0.768	0.784	0.391	0.423	0.424	0.412
Work in govern	0.156	0.070	0.220	0.149	0.365	0.256	0.440	0.366
Education	2.804	2.700	2.670	2.724	0.786	0.835	1.045	0.895
Year of farming	32.691	39.980	36.301	36.361	13.372	12.992	17.205	14.901
Farm ability	3.031	2.810	3.100	2.980	1.287	0.971	1.040	1.109
Land contracting	7.011	4.493	4.473	5.303	5.750	2.797	3.798	4.418
Land transfer	46.878	0.074	78.802	41.851	247.155	2.796	296.290	224.049
Agribzness environ	1.680	1.640	1.940	1.754	0.715	0.811	0.694	0.751
Agricultural income	101440.800	5694.845	188170.500	98394.790	573565.600	11748.080	667221.900	510918.200
Nonagri income	31354.740	41191.140	54124.960	42407.830	35953.740	54948.470	114942.200	77236.900
Total income	135841.900	41823.180	242365.100	140066.400	571935.600	36058.890	752093.900	549935.200
Production cost	73703.570	2349.200	125517.700	67079.770	483211.000	4380.729	501674.600	402504.800
Living cost	20181.040	16597.000	24131.800	20304.930	19034.180	15009.360	32433.990	23557.110
Other cost	6103.864	3136.000	11302.000	6878.264	9335.606	3590.603	31418.030	19576.620
Left income	34876.900	20308.420	87869.100	47678.860	92904.690	28573.780	243636.500	153791.800

Appendix 3. Descriptive data in the first experiment (2)

	Min				Max			
	Shandong	**Shaanxi**	**Sichuan**	**Total**	**Shandong**	**Shaanxi**	**Sichuan**	**Total**
Gender	0	0	0	0	1	1	1	1
Age	23	25	27	23	76	81	82	82
Total # households	1	1	1	1	10	10	9	10
# in farm	0	0	0	0	4	10	6	10
# outside farm	0	0	0	0	3	6	4	6
Primary decision	0	0	0	0	1	1	1	1
Work in govern	0	0	0	0	1	1	2	2
Education	1	1	1	1	5	5	6	6
Year of farming	0	3	3	0	58	65	69	69
Farm ability	1	1	1	1	5	5	5	5
Land contracting	0	0	0	0	40	12	22	40
Land transfer	-10	-8	-8	-10	2360	15	2000	2360
Agribzness environ	1	1	1	1	3	3	3	3
Agricultural income	0	0	0	0	5600000	91200	4100000	5600000
Nonagri income	0	0	0	0	180000	470000	1053600	1053600
Total income	3427.2	1600	1442	1442	5600000	214890	5153600	5600000
Production cost	0	100	0	0	4700000	41560	3240000	4700000
Living cost	3000	1000	200	200	120000	70000	200000	200000
Other cost	0	0	0	0	70000	30000	300000	300000
Left income	-30000	-30500	-47000	-47000	850000	153790	1663600	1663600

Appendix 4. Quality of cluster analysis on the perception of risk in the first experiment

Model Summary

Algorithm	TwoStep
Inputs	10
Clusters	3

Cluster Quality

Appendix 5. Quality of cluster analysis on the perception of precautionary savings in the first experiment

Model Summary

Algorithm	TwoStep
Inputs	8
Clusters	3

Cluster Quality

Appendix 6. Perception of crop insurance in the first experiment

Shandong	***Frequency***	***Premium***	***Indemnity***	***Insurer***	***Collateral***
1	**1%**	**1%**	**0%**	**2%**	**24%**
2	**1%**	**4%**	**2%**	**3%**	**43%**
3	**11%**	**19%**	**18%**	**9%**	**13%**
4	**17%**	**17%**	**11%**	**13%**	**16%**
5	**70%**	**59%**	**69%**	**73%**	**5%**
Average	4.531	4.292	4.469	4.510	2.354

Shaanxi	***Frequency***	***Premium***	***Indemnity***	***Insurer***	***Collateral***
1	**0%**	**1%**	**1%**	**1%**	**16%**
2	**7%**	**12%**	**3%**	**8%**	**43%**
3	**5%**	**7%**	**10%**	**9%**	**6%**
4	**42%**	**34%**	**40%**	**40%**	**26%**
5	**46%**	**46%**	**46%**	**42%**	**9%**
Average	4.270	4.126	4.270	4.140	2.690

Sichuan	***Frequency***	***Premium***	***Indemnity***	***Insurer***	***Collateral***
1	**4%**	**4%**	**2%**	**2%**	**23%**
2	**8%**	**8%**	**10%**	**2%**	**33%**
3	**8%**	**10%**	**9%**	**7%**	**5%**
4	**36%**	**46%**	**40%**	**30%**	**31%**
5	**44%**	**32%**	**39%**	**59%**	**8%**
Average	4.080	3	4.040	4.420	2.680

Appendix 7. Descriptive data in the second experiment (1)

	Mean			Standard Deviation		
	Henan	**Jiangsu**	**Total**	**Henan**	**Jiangsu**	**Total**
Gender	0.267	0.633	0.45	0.446	0.486	0.500
Age	48.417	54	51.208	9.652	10.527	10.440
Total # households	4.717	3.6	4.158	1.878	1.429	1.754
Primary decision	0.533	0.667	0.6	0.503	0.475	0.492
Education	2.75	2.883	2.817	0.836	1.136	0.996
Year of farming	27.633	28.033	27.833	10.096	14.400	12.385
Land contracting	7.503	9.393	8.448	6.295	4.800	5.654
Land transfer	1.807	163.980	82.212	6.161	348.506	257.582
Agricultural income	14525.44	389011.4	201768.4	13405.44	818678.9	606419.9
Nonagri income	30173.73	50325	40334.03	23982.72	53130.02	42384.93
Total income	53314.25	439336.4	249596.7	62215.54	810993.7	609190.3
Production cost	7048	318462.5	162755.3	7537.802	648466.2	482663.4
Living cost	22059	41712.1	31885.55	16093.43	26735.84	24086.98
Left income	13528.91	79161.77	46901.55	22486.58	216525.7	158032.3

Appendix 7. Descriptive data in the second experiment (2)

	Min			Max		
	Henan	**Jiangsu**	**Total**	**Henan**	**Jiangsu**	**Total**
Gender	0	0	0	1	1	1
Age	22	27	22	72	83	83
Total # households	2	1	1	10	7	10
Primary decision	0	0	0	1	1	1
Education	1	1	1	5	5	5
Year of farming	0	0	0	45	55	55
Land contracting	0	0	0	45	27	45
Land transfer	-8.1	-12	-12	35.5	2000	2000
Agricultural income	0	3000	0	80975	4836000	4836000
Nonagri income	0	0	0	100000	206400	206400
Total income	2000	7500	2000	480000	4886000	4886000
Production cost	0	0	0	36300	3148000	3148000
Living cost	250	4200	250	78000	110000	110000
Left income	-27100	-5000	-27100	98670	1668000	1668000

Appendix 7. Descriptive data in the second experiment (3)

	Mean			Standard Deviation		
	Henan	**Jiangsu**	**Total**	**Henan**	**Jiangsu**	**Total**
Heard insurance	2.085	2.750	2.420	0.596	0.836	0.797
availability	0.967	0.967	0.967	0.181	0.181	0.180
continuity	0.683	0.850	0.767	0.469	0.360	0.425
Ever purchased	0.683	0.733	0.708	0.469	0.446	0.456
Frequency	2.883	3.683	3.283	1.508	1.334	1.473
Indemnity	2.967	3.183	3.075	0.991	1.033	1.014
Premium	2.983	3.533	3.258	1.157	1.033	1.126
Insurer	3.067	3.200	3.133	1.528	1.400	1.461
Collateral	2.850	1.400	2.125	1.867	0.924	1.638
Max WTP	18.140	22.590	20.422	10.533	16.836	14.238

Appendix 8. Willingness to pay under conditional logit model in two experiments

	First experiment				Second experiment		
	3 Provinces CL	**Shandong CL**	**Shaanxi CL**	**Sichuan CL**	**2 Provinces CL**	**Jiangsu CL**	**Henan CL**
Frequency	-5.522	-7.439	-1.985	-10.119	-5.762	-7.092	-4.476
Indemnity	0.049	0.035	0.043	0.084	0.044	0.048	0.041
Insurer	15.385	16.322	9.066	29.126	15.309	12.729	17.821
Collateral	6.837	5.492	7.343	8.262	6.708	4.898	8.515

Appendix 9. Willingness to pay under mixed logit model in two experiments

	First experiment				Second experiment		
	3 Provinces ML	**Shandong ML**	**Shaanxi ML**	**Sichuan ML**	**2 Provinces ML**	**Jiangsu ML**	**Henan ML**
Frequency	-5.847	-7.699	-1.981	-10.394	-6.393	-7.112	-4.528
Indemnity	0.049	0.036	0.043	0.085	0.041	0.04	0.042
Insurer	15.611	16.422	9.071	29.542	17.616	13.173	23.697
Collateral	6.89	5.09	7.337	8.449	7.046	6.749	10.321