Crop Insurance Program Purchase Decision and Role of Risk Aversion: Evidence from Maize Production Areas in China

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Abstract: Risk aversion is a key determinate in risk management in the agricultural insurance market. Based on the unique datasets of risk preference experiment and maize producer survey in maize production areas in China, this paper explores the determinants of farmers' CIP participation and scrutinizes the role of risk aversion in farmers' CIP decision. Results show that risk aversion plays an important role in CIP decision, not only in the form of its' direct effect, but also in the form of interaction term together with loss expected. We also find the purchase experience, CIP environment (village purchase ratio) and contract items (insured amount) are significant determinates in the CIP purchase decision. No significant evidence is found that serious adverse selection exists in the sampling areas.

Key words: Crop Insurance Programs, Purchase Decision, Willingness to Pay, Maize Producer, China

1. Introduction

Agricultural production is an inherently risky business. Weather, pests, diseases and other calamities may affect crops yield. The long production cycle makes farmers particularly vulnerable to natural disasters, which cause uncertainty in production profits and livelihoods, so that yield variability is listed at the top two risks feared by producers of major field crops (USDA, 1999). This risky environment causes low take-up rates of new agricultural technologies and practices, despite their high expected rates of return (Lipton, 1989). Consequently, risk-averse households may be unwilling to bear income fluctuations associated with these investments and may decide not to adopt them, or instead to shift towards lower-risk, lower return strategies (Cole, Giné, and Vickery, 2011). Due to high uninsured risk exposure, such strategies mean less accumulation in assets needed to escape poverty through autarchic savings and investment (Barnett, Barrett, and Skees, 2007). Overall, people in low-income countries are four times more likely to die due to natural disaster and the cost per disaster as a share of GDP is considerably higher in developing than in OECD countries (Gaiha and Thapa, 2006).Though risk cannot be totally eliminated, some risks can be reduced (Miller, et al., 2004). There is a broad range of tools and strategies that can be employed in agriculture to manage risks, such as enterprise diversification, vertical integration, marketing contracts, hedging in future, maintaining financial reserves and leveraging liquidity, off-farm employment and other types of off-farm income, etc. (USDA, 1999). A classification of these tools is proposed by the OECD (2009) which distinguishes risk reduction, risk mitigation and risk coping strategies (**Table 1**).

Besides these strategies, crop insurance has been advocated as a direct way of assisting small-scale farmers confronting production risks (Hazell, Bassoco, and Arcia, 1986). Usually, it is hypothesized that crop insurance would lead to less risk-averse behavior and to a more efficient use of farm resources. Interestingly, Atwood, Watts and Baquet (1996) have shown that, over time, farmers with agricultural insurance have incentives to increase their indebtedness precisely because the insurance program does protect them against insolvency and loss of their farm assets. Meanwhile, India rainfall insurance demonstrates that when a population has substantial levels of risk coverage, they will adjust their investment decisions towards more profitable, albeit riskier, crops (Cole, Giné, and Vickery, 2011).

Interventions by government can also alter the incentives for farmers to act privately to manage risks. Frequently, the reason for subsidizing crop insurance is closely lined with potential market failures due to the combination of farmer risk aversion, farm-specific risk, and information problems (moral hazard and adverse selection) (Knight and Coble, 1997). Furthermore, through a theoretical model, Innes (2003) proved that ex ante government farm insurance can deter ex post "disaster relief" and improve production incentives by countering the moral hazard that otherwise prevails. Similarly, to withstand adverse weather conditions and stabilize agricultural sector, a subsidized Crop Insurance Programs (CIP) has been initiated in China since 2007. Though great achievement has been made for the CIP since then, the coverage ratio is still low. It is reported that despite an 80% subsidy, the average coverage rate of sown area of five staple crops (rice, wheat, maize, soybean, and cotton) is 40% in 2012, which means that household coverage rate is much lower since households with large land size tend to show higher enthusiasm for the CIP. Are there economic efficiency arguments that explain the concomitance of high subsidy and low coverage in the CIP? And are there any incentives for uninsured farmers to be involved in the CIP for next few years? Analysis on the farmers' purchase decision behavior leaps to be the first priority for such questions. In theory, different risks, alone with a farmer's attitude toward risk, have a major impact on the choice of risk management strategies and tools (USDA, 1999). What's about the CIP?

Our objective in this study is to contribute to the aforementioned literature on the linkage between economic activity and human preference by estimating the cross-sectional determinants of farmers' CIP participation and identifying the impediments preventing the remaining from participating. After describing the CIP in China, this article establishes a theoretical framework linked with local CIP contract items, and presents empirical evidence on the CIP decision based on a household survey and risk aversion experiment implemented in 2010. The rest of the paper is organized as follows. Section 2 reviews the literatures related. Section 3 provides an overview of the market for subsidized agricultural insurance in China. Section 4 describes the theoretical model that drives the selection of the data used, presented in section 5. Our econometric approach is developed and empirical analysis results are offered in section 6. Section 7 concludes.

2. Literature Review

Considering our goal is to explore the CIP decision mechanism, literature reviews will be deployed in two areas: demand for agricultural insurance participation and Willingness to Pay for agricultural insurance.

2.1 Agricultural insurance participation

Knight and Coble (1997) has summarized systematically the literatures on Multiple Peril Crop Insurance (MPCI) participation from 1980 to 1997. They categorize the econometric research literatures into aggregate and farm levels. At the aggregate level, Gardner and Kramer (1986) reported that the expected rate of return to insurance had a positive and statistically significant effect on participation, which is consistent with other studies conducted by Barnett, Skees, and Hourigan (1990) and Niewoudt et al (1985) who use return to insurance as variable, and Cannon and Barnett (1995) who substitute cost of insurance as proxy. Besides expected return or rate of return to insurance, Cannons and Barnett (1995) and Goodwin (1993) found a positive and significant effect of farm size on MPCI participation, and Barnett, Skees, and Hourigan (1990) and Niewoudt et al (1985) reported an inverse relationship between off-farm income and participation.

At the farm level, studies incorporating expected return to insurance (Calvin, 1992; Coble et al., 1996) or change in expected per-acre return (Just and Calvin, 1990) indicate a positive and significant relationship with MPCI participation. Goodwin and Kastens (1993) found there are negative and significant effects of premium rate on participation and coverage level, and positive effects of yield risk, measured in terms of yield variation, on participation. Calvin (1992) also reported that crop specialization had a positive effect on crop insurance participation, while diversifying the farm operation via livestock had a negative effect.

Since then, additional studies about agricultural insurance participation have been conducted. Using longitudinal data from 1995 to 1999, Makki and Somwaru (2001) indicate that the availability of new revenue insurance products, the level of risk, premium rate, subsidy level, and the design of the contract affect crop insurance program participation and contract choice. After new revenue and group insurance products have expanded farmers' choices on types and levels of coverage in the U.S., Sherrick et al. (2004) explored farmers' choices among crop insurance alternatives (hail, yield, and revenue insurance) with a two-stage estimation procedure and their determinants, and indicated that buyers are characterized by significantly larger acreages, older ages, higher debt-to-asset ratios, perceived risk, and expected yields, and greater leasing of farmland and importance attributed to risk management. The effects of drought forecasts and increased insurance subsidies have been also analyzed (Changnon, 2002; Claassen, Lubowski and Roberts, 2005, Babcock and Hart, 2005).

Other studies try to test the role of risk aversion on agricultural insurance participation. Using randomized field experiments conducted in villages in rural Gujarat, Cole, Tobacman, and Topalova (2007) explored take-up of a rainfall index insurance product and found that education, wealth, risk aversion and the ability to understand probabilities are positively correlated with insurance take-up, and that the framing of the insurance product has a significant impact on the household’s decision to purchase insurance. Similarly, Giné, Townsend, and Vickery (2008) examined insurance participation using a randomized field experimental design that explicitly controls for the type of information and marketing received by households, and found that take-up of an innovative rainfall index insurance policy offered to smallholder farmers decreases with basis risk between insurance payouts and income fluctuations, increases with household wealth, and decreases with binding credit constraints. However, they observed that risk-averse households are marginally less likely to purchase rainfall insurance and other two utility function proxies ambiguity aversion and discount rate are neither statistically significant. They explain it by the measurement error from indirect inference.

Boyd et. al. (2011) examined the factors affecting crop insurance purchases by farmers in Inner Mongolia, China and found those variables are statistically significant: knowledge of crop insurance, previous purchases of crop insurance, trust of the crop insurance company, amount of risk taken on by the farmer, importance of low crop insurance premium, government as the main information source for crop insurance, role of head of village, and number of family members working in the city. However, the effect of farmers’ risk preference has been captured. When testing for adverse selection of crop insurance in northern China, Hou, Hoag, and Mu (2011) did use the subjective perception of risk and loss as the proxy of risk aversion.

2.2 Willingness to Pay for agricultural insurance

Some studies have investigated the willingness of farmers to pay for crop insurance products using information on farm behavior. Some focused on the willingness of farmers located in high risk, semi-arid regions of Australia to pay for rainfall insurance (Patrick, 1988). He analyses producers' demand for a MPCI program with indemnities based on actual yields, and a rainfall insurance program with indemnities based on area rainfall. He finds that 57 percent of the farmers were not willing to consider rainfall insurance, comparing with 25 percent for MPCI. He also shows that very few were willing to pay more than 110 percent of the actuarially fair premium, and almost no one would buy insurance if the load exceeded 20% of the actuarially fair premium.

Some studies have examined willingness to pay for rainfall index based crop insurance in two developing countries, Morocco (McCarthy, 2003) and Tanzania (Sarris et al, 2006). McCarthy (2003) reported that Moroccan farmers with relatively high incomes were more likely to consider purchasing rainfall insurance than farmers with low incomes. He also found that insurance will be preferred in the areas with higher temporal rainfall variability where farmers may be subject to less basis risk. Sarris et al (2006) reported that many of the poorest farmers in Tanzania could not afford any insurance premiums because their cash flow situation was so dire and their incomes and wealth were so low. The three studies above indicate that many farmers are not willing to pay the actuarially fair premium rate (that is, the pure risk premium rate) for either individual yield or rainfall index insurance.

Vandeveer and Loehman (1994) applied both dichotomous choice and ranking of activities in a study of farmer response to modifications in crop insurance. The ranked responses were used in a ranked Logit model to derive WTP. They find changes, namely more detailed classification of yield risk accompanied by new rate-making procedures, and higher yield guarantees combined with coinsurance, could significantly increase demand for individual crop insurance in an area where it has been historically low.

To identify the farmers' willingness to join (WTJ) and the amount of willingness to pay (WTP) for a hypothetical insurance policy, Ramasubramanian (2012) employs a contingent valuation model to study the demand for rainfall index based insurance program among 400 farmers in Tamil Nadu. Results reveal that while WTJ is influenced by household wealth, risk attitudes, product literacy and basis risk, the amount a household is WTP is driven by other risk coping avenues (such as savings, borrowings and diversification) and only the 'residual' risk is passed on to insurance.

Hill, Hoddinott and Kumar (2011) examine which farmers would be early entrants into weather-index insurance markets in Ethiopia. Using 1400 Ethiopian households tracked for 15 years, They find that educated, rich and proactive individuals are more likely to purchase insurance, that risk aversion is associated with low insurance take-up, that basis risk reduces demand for insurance particularly when premium is high, and that provision of insurance through groups is preferred by female headed households and individuals with lower levels of education.

Few studies attempt to estimate WTP for agricultural insurance by the indirect approach. Hazell, Bassoco and Arcia (1986) applied a programming model to infer the demand for crop yield insurance by the representative farmer in Mexico. Fraser (1992) uses an indirect method to estimate WTP for crop insurance. He does this by estimating and comparing certainty equivalents, in the presence and absence of insurance, of expected utility, based on the mean-variance framework and constant relative risk aversion. Bardsley, Abey and Davenport (1984) use a simulation model to estimate the amount of insurance at a given minimum price that will be purchased, per unit of insured quantity.

Our study focuses on MPCI in the maize sector in China. We develop a theoretical model which highlights some specific factors which are tested on a sample of Chinese farmers. The sampling was implemented in four major maize producing provinces, where their sum output accounted for 44.54 % of China in 2010. Maize production plays a significant role in their agricultural business.

3. Subsidized crop insurance market in China

In 2003 grain output slipped into China's lowest point since 1990. Agricultural development has been the central government's first priority since then and a bunch of subsidy policies have been initiated to stimulate grain production (Lu and Yu, 2011). To stabilize the agricultural sector and ensure long-term food security, some small subsidized agricultural insurance program (AIP) were piloted in few provinces in 2004 in China. 9 provinces (Heilongjiang, Jilin, Shanghai, Xinjiang, Inner Mongolia, Hunan, Anhui, Sichuan, and Zhejiang), have been approved to pilot agricultural insurance program in October 2004 (Xing and Lu, 2011). After three-year small scale experiment, the central government announced formally to initiate national Multi Peril Crop Insurance (MPCI) Agricultural Insurance Program (AIP) with premium subsidy in 2007, which includes 6 provinces (Inner Mongolia, Jilin, Jiangsu, Hunan, Xinjiang, and Sichuan) and some insurance types like major crops, breeding sows and cattle. The subsidized AIP pilot province number has expanded from 16 in 2008, to 19 provinces in 2009, 23 in 2010, and all 31 provinces in mainland in 2011. Variety coverage of the AIP has included all staple crops and main livestock varieties. Normally, the subsidy structure is composed by 35% from the central government, 25% from provincial government, 20% from city and county government, and the rest of 20% from farmers[1]. The AIP premium subsidy from the central government climbed from 2 billion CNY in 2007, to 6.06 billion CNY in 2008 to 7.9 billion CNY in 2009, 9.71 billion CNY in 2011.

Agricultural insurance market in China has expanded with a very high speed in the past 5 years. According to the latest national CIP statistics, the area coverage of crop and forest has reached 1.72 billion mu (0.11 billion ha) in 2011. Meanwhile the area coverage rate of main crops such as rice, wheat, maize, soybean, and cotton, has accounted for 40% of all their planting areas, with 169 million households[2] being involved, 652.3 billion CNY of amount insured, 8.9 billion CNY of insurance indemnity paid to farmer, and 22.83 million beneficiary households. Fig. 1 shows that the AIP premium rose from 0.85 billion CNY in 2006, to 11.07 billion CNY in 2008, and 16.73 billion CNY in 2011. From the perspective of premium amount, China has ranked the second largest market after the USA in the world (Zeng and Mu, 2010).

However, coverage rate of the CIP still stays in a low level (Fig. 2). It seems more complicated to sort out the CIP situation in provincial level. Since each county may involve in

[1] Considering the difference in economy's development level, the subsidy structure may be different from others, especially for those developed areas. Beijing is a good example. There is no subsidy from the central government, and half subsidy comes from the Beijing Municipal government. Besides, the subsidy structure also depends on insurance varieties.

[2] It is permitted for one farmer to purchase more than one piece of CIP contracts for different crops. Here this number is the CIP contact amount no matter how many households are involved in. Therefore, the real participation household numbers should less than this figure. The same for later statistics.

different programs, such as national subsidy program, provincial program, or even local cooperative insurance program, it's very difficult to identify the initiated time when local famers involved in these programs. There are many companies operating the CIP within in one province. Take sampling provinces Heilongjiang and Jilin for example, though the two provinces did involve in agricultural insurance pilot in 2004, some sampling counties weren't listed even after 2007.

As for crop insurance programs (CIP), the subsidies from the central and local governments account for 80% share of premium for staple crops. Under such policy setting, are there any incentives for uninsured farmers to be involved in the CIP for next few years? Theoretically, decision making under uncertainty depends on the beliefs of the individual about how likely decision results are. If people are extremely averse to financial risk, they may be reluctant to create businesses that may have inherently risky cash flows (Tanaka, Camerer, and Nguyen, 2010). Similarly, if insured farmers are extremely averse to production risks, are they willing to purchase the CIP without any reluctance? A good scrutiny on farmers' risk aversion helps us probe farmers' insurance purchase behavior in future and understand better the extent to which economic activity is linked to basic features of human preferences.

4. Theoretical framework

Before establishing the theoretical framework, let's image the decision-making progress.

4.1 CIP Purchase Decision Process

A rational farmer could make the CIP decision as follows when confronted to a particular crop insurance market in China (**Fig. 3**).

- Step one: disaster frequency estimation

A primary image of the frequency and severity of natural hazards will be formed in the famer's memory when linking with his previous experience and prediction of the future. And new occurrence possibility estimation will be made for the coming underwriting period.

- Step two: loss estimation

Relate disaster history to loss history (personal and neighbors) to form an estimation of the probability density function of crop losses.

- Step three: income impact evaluation

Relate losses due to disasters to income variations to determine if crop losses actually impact incomes or if other income smoothing techniques are sufficient (diversification, credit, etc.).

- Step four: CIP purchase analysis

Benefit and cost of CIP purchase will be analyzed by combining with insurance market context, such as specific crop insurance contract items, and confronted ensured environment.

4.2 Theoretical model

In the Chinese MPCI program, a farmer cannot decide his coverage level, which means that once a farmer decides to buy the CIP for one crop, all plots planting the crop should be insured as one package. As a result, the CIP purchase decision can be simplified by the question whether a farmer will insure land as a package or not. We simplify again this framework by working in a world with only two states of nature: a good harvest (q_h) and a bad harvest (q_l).

Expected utility theory offers a useful way to formalize a farmer's Crop Insurance Scheme (CIP) decision making under uncertainty. In equilibrium, with identical households, each household buys complete insurance at actuarial odds given risk aversion (Rothschild and Stiglitz, 1976).

We assume that farmers face negative shocks with a probability p. Hence expected utility if the farmer is not insured is:

$$E[U; z|insu=0] = pU(A.q_l(x) - A.w.x) + (1\text{-}p).U(A.q_h(x) - A.w.x) \qquad (1)$$

where U() is the farmer utility function, A is the amount of land used for production, q_l and q_h are the value of yield in case of a shock (q_l) or in normal years(q_h), x is input use and w is market price of inputs. z represents households characteristics that determine his preferences.

If the farmer decides to insure his plot then his expected utility becomes:

$$E[U;z|insu=1] = pU(A.q_l(x) - A.w.x - c.A + m.A) + (1\text{-}p).U(A.q_h(x) - A.w.x - c.A) \qquad (2)$$

where c is the insurance premium by unit of land the farmer has to pay, and m is the payoff by land unit in case he experiences an negative shock.

Assuming that land (A) is a fixed input, the farmer can determine the optimal input use whether his purchases insurance or not:

$$\begin{aligned} x^*_{|insu=0} &= x^*(p, A, w, z) \\ x^*_{|insu=1} &= x^*(p, A, w, z, c, m) \end{aligned} \qquad (3)$$

Given these optimal input choices, the farmer can compare his expected utility with or without insurance and make his decision to purchase or not. The farmer purchases insurance coverage if

$$E[U;z|insu=1, x^*_{|insu=1}] \ > \ E[U; z|insu=0, x^*_{|insu=0}] \qquad (4)$$

Another way to think the purchasing behavior is to derive the willingness to pay of the farmer for the insurance product. The willingness to pay is the maximum amount of money the farmer can pay to purchase the insurance product. It can also be defined as the price c* such that farmer's expected utility is the same if he purchases insurance or not:

$$\begin{aligned} &E[U; z|insu=0] = pU(A.q_l(x) - A.w.x) + (1\text{-}p).U(A.q_h(x) - A.w.x) \\ &= E[U;z|insu=1] = pU(A.q_l(x) - A.w.x - c^*.A + m.A) + (1\text{-}p).U(A.q_h(x) - A.w.x - c^*.A) \end{aligned} \qquad (5)$$

Given optimal input demand functions $x^*_{|insu=0}$ and $x^*_{|insu=1}$ defined above, we obtain an expression for this willingness to pay the insurance:

$$c* = \ c*(\,p, A, w, z, m) \qquad (6)$$

Hence, farmer's willingness to pay for the insurance product depends on the probability of a negative yield shock p, land size A, input prices w, household preferences z and the payoff offered by the insurance company in case of an adverse event m.

Given this willingness to pay *c**, the farmer decides to purchase the insurance product only if his willingness to pay *c** is higher than the actual price c asked by the insurance company. So, the probability that a farmer purchases the insurance product is the probability that his willingness to pay is higher than the price of the insurance product:

$$Prob(\text{insu}=1) = Prob(c^* > c) \quad (7)$$

Assuming that $c^* = c^*(p, \text{A}, \text{w}, \text{z}, \text{m})$ can be approximated by an exponential form, $c^*=\exp(\beta X+\varepsilon)$ (where X is the vector of determinants of the willingness to pay (p, A, w, z, m)), and that ε is an independently and identically distributed error following a normal distribution $N(0,\sigma)$, we obtain:

$$Prob(\text{insu}=1) = Prob(\ln(c) - \beta X < \varepsilon) = 1 - \Phi(\ln(c) - \beta X) = \Phi(\beta X - \ln(c)) \quad (8)$$

where Φ( ) is the cumulative density function of the normal distribution.

The estimation of such "non-zero threshold *Probit* model" (the threshold here is the insurance premium *ln(c)* which is province specific) is estimated within a standard *Probit* model in which the parameter attached to the premium is constrained to equal -1. This latent variable presentation of the *Probit* model has however one important shortcoming since it can only estimate β up to scale. Indeed, it sets the variance of the error term to be one ($\varepsilon \sim N(0,1)$), so that we can only estimate β/σ where σ is the true standard deviation of ε.

5. Data description and variable specification

5.1 Sampling information

The empirical analysis we carry out in this article is based on a dataset corresponding to a sample of farmers located in four major maize producing provinces, which were surveyed in May and July in 2010. The four provinces, Heilongjiang, Jilin, Henan and Shandong, were selected only because the sum of maize output accounts for 44.54 percent of national total in 2010. Obviously, maize production plays more significant role for sampling farmers than those in other provinces. It is meaningful to analyze the role of risk aversion in the sampling farmers' crop insurance purchase decision since they are more sensitive to natural risks than others.

Geographically, the first two provinces are located in the north-east of China, which are the main grain producing areas. The low average temperature in high latitude restricts cropping in this region, which means that farmers can only plant grain one season in a year. The alternative grains include rice and soybean. Compared with other two sampling provinces, Heilongjiang and Jilin are featured with higher ratio of arable land over population and larger planting scale, especially in Heilongjiang. The last two provinces belong to the North China Plain and Henan province is in the center of China and Shandong is in the east of China. Both two provinces are double cropping, and winter wheat- summer maize farming system is chosen by most of local farmers. However, farmers can choose between competitive crops of maize and soybean in the same season.

The data were collected using a multiple stage sampling method, by which the sampling household was randomly selected in county, township, village and household levels. Within a province, five counties were determined using Probability Proportional to Size (PPS) method based on maize production in county level. Within county and township levels, 2 townships and villages were selected using Symmetric Systematic Sampling (SSS) based on maize yield and planting area. Within villages, 8 households were Random Symmetric Sampling (RSS). The sampling size includes 640 households with 4 provinces, 20 counties, 40 townships, and 80 villages. The questions cover household features (such as population, arable land, labor, and head's education, gender, age, and agricultural experience, etc.), land and plot features, maize production, maize consumption, selling and storing, seed selection, and production disaster and risk preference, etc. Besides, a risk preference experiment was implemented for each sampling household respondent, which is linked with real payment incentives. After cleaning a dataset with 637 sampling households and 1230 plots[3] were obtained finally.

It should be emphasized some primary results about the sampling. First of all, if one county is selected into the list of CIP, normally it will continue to stay in the list in the following years. It means if we can obtain the initial year of one county to be involved in the CIP, we can project what the county will be in the future. Secondly, within one province the subsidy structure normally is the same. Considering the bridge role of province governments in the CIP implementation, they have the crucial power on the decision of local varieties to be insured and

[3] Considering there are many plots for a household to plant maize, only two of them at most was selected randomly based the order reported by the respondent. Some information on geography, soil fertility and productivity were reported for each plot.

the CIP bidding by insurance companies within provinces. Therefore, the CIP contract drafting is organized by provincial government, who is normally in charge of 60% of premium (35% from the central government) payment. Thirdly, we could deduce indirectly the initial time by judging formal provincial document. Once provincial government decides the variety insured and specific items in contract, one formal official document will be issued in public, which helps us to capture the CIP's initial time. Considering input cost and high consumer price index (CPI), the amount insured and premium could be adjusted a little larger than before in few cases, though most of them keep unchanged during the past few years.

5.2 Maize production difference between uninsured and insured

In summary, Knight and Coble (1997) presented three propositions "supported by a preponderance of evidence" from the econometric studies on crop insurance participation which they reviewed: (1) as farm size increases, participation increases; (2) diversification reduces participation; (3) yield variability and income risk increase participation.

The CIP purchase decision is highly related with a farmer's normal crop production behavior. The input information during crop production is very important because it not only implicates risk preference to prevent potential production risk, but also explicates production cost which determines potential disaster loss. The influence of risk preferences on input choices in agricultural production has long been recognized and a large literature exists on the empirical estimation of production risk and risk preferences among agricultural producers (Moschini and Hennessy, 2001; Picazo, 2011). For farmers with high risk aversion, they will make carefully decision on the input types, varieties, and quantities to mitigate loss caused from production self and natural disasters. As an important tool to compensate the loss after disaster they will of course make good use of all potential risk-reduction tools, including CIP purchase. Meanwhile, the sum expenditure of inputs decides directly the potential loss caused by natural disaster. If risk preference plays an important role in the method of estimating loss expected in the CIP, then input cost decides directly the loss base of CIP.

Results show that the insured group spends more in material inputs, while less in labor input than uninsured in maize production in 2007-2009 (**Table 2** and **Table 3**). The gaps of material inputs between two groups indicate that if farmers use more materials in maize production, they tend to buy the CIP to mitigate the risk of future loss. Compared with the uninsured, the insured uses less labor in maize production, which reveals that the insured stage on a higher modern production level. Yield comparison proves further that modern maize production style, namely high material input and high yield, helps farmers boost the use of new risk disperse tools.

It should be noticed that some of inputs are seldom used in maize production. Comparison results using mean and median methods show that, most of households don't use film, irrigation, and manure in maize production (**Table 4**). Further scrutiny shows that in all sampling households only 0.84% plots had used film, 5.04% with manure expenditure, 8.21% using manure in maize production, and 38.86% with irrigation expenditure. Normally, irrigation facility is closely related with selected region since irrigation public investment is affordable only by government.

5.3 Data description

According to the theoretical model developed above, the estimation of a Probit model on the decision to purchase the agricultural insurance product allows us to predict farmers' willingness-to-pay for the insurance product ($\hat{c}* = exp(\hat{\beta}X)$) and study the effect of X = (*p*, A, w, z, m) on the decision to insure.

Our theoretical model emphasizes the use of 5 different classes of variables: First, insurance purchase decision is shown to depend on the probability p of a negative event. We capture this unobserved probability by including variables depicting previous year's events and insurance purchase. These data consist in dummy variables about the occurrence of a disaster in the past two years so that they reflect the history of loss for the farmer.

A second set of variables consists in the premium and the amount insured by the insurance contract. The expected payoff claim is highly related with farmers' expected benefit. Evidences show there is a positive and statistically significant relationship between the expected rate of return to insurance and crop insurance participation (Calvin, 1992; Coble et al. 1997). Therefore, the important items such as premium and amount insured will be added in the empirical model to capture the expected benefit consideration. **Table 5** shows the insured amount and premium in sampling provinces. In China's background, 80% of premium will be covered by government's subsidy. Such ratio designing framework for subsidy result in lacking flexibility in amount insured, since a higher amount insured means more subsidy from government. In fact, some farmers express a strong demand for a higher amount insured, even covering a higher ratio in premium.

Following the predictions of the theoretical model, we constrain the coefficient attached to the premium to be -1 in every equation and we expect that the amount insured increases the probability of insurance purchase. We also normalize these data by dividing them by the average price of maize at the township level since the output price serves as a numeraire in our theoretical model. Given the serial correlation in insurance purchase behavior (a farmer who bought insurance at time t is very likely to purchase insurance at time t+1), we also introduce a dummy variable for those farmers who bought insurance the year before the survey.

A third set of explanatory variables is made of input prices (wages, seeds, and fertilizers). These data are taken as township averages (divided by maize price township average to normalize prices) in order to avoid quality or market power differentials effects.

The fourth and fifth sets of variables include data related to land (size of cultivated land dedicated to maize production) and household preferences with respect to risk. To test risk preference of farmers, a ball game experiment was implemented following Holt and Laury (2002). To interact with respondent effectively, the design of the experiment was slightly modified so that it could be easily understood by farmers with normally low education.

The experiment consisted in 5 games with hypothetical gambles. Each of the game proposes a low risk option (A) and high risk option (B) (**Table 6**). The respondent will be asked to select between options A and B so that risk preferences can be elicited from these successive choices. At the end of the 5 games, the respondent is asked to draw a random number which determines the last round of the game: the farmer picks a random number from 1 to 5 and obtains the payoff (in CNY) that corresponds to his choice during the first stage of the experiment for this particular game. Thus, there's strong incentive for respondents to make carefully each decision on five games because his/her selection determines how much money he/she would be paid in the last round.

Compared with normal daily wage, the payoff are still charming for the respondent to play the game seriously. Using lottery-choice data from a field experiment, Hans P. Binswanger (1980) concluded that most farmers exhibit a significant level of risk aversion that tends to increase as payoffs are increased. In our experience, the expected payoff of 20 CNY accounts for 25% of daily wage. It seems attractive considering that it takes only 20 minutes to finish the experiment.

The experimental game results have been used as a proxy of risk preference: following Cai (2012), we use the ratio of option B choices in the total five games as a proxy for farmer's tolerance for risk.

Though not formally included in the theoretical model, a sixth set of determinants of insurance purchased will also be considered in order to account for informal risk management tools like production diversification, and access to loans. These informal risk management strategies could reduce significantly farmers' willingness-to-pay if they are effective. Evidence shows that there is an inverse relationship between off-farm income and crop insurance participation (Barnett, Skees, and Hourigan, 1990).

Table 7 shows a classical sampling household features. Normally, the household head is around 50 years old and obtained more than 7 year education. In all family members, 1.12 of family members was involved in non-agricultural jobs in 2009. In 2009 the household cultivated the land with a size of 27.69 mu, among them 19.43 mu plating maize . Members in this household tend to use more pesticide than required. The household confronts a CIP with an average amount insured of 233.68 CNY, which can cover 77.55% of total cost, and 83.90% of materialized non-labor cost.

In all samples, 98.43% of household head is male, 19.47% planting vegetable and fruits more than 1 mu, 41.13% and 38.15% confronting disaster in 2007 and 2008 in maize production, 33.44% having purchased CIP in 2009, 26.88% township member purchasing CIP in 2008, and 32.81% borrowing money in 2009.

6. Estimation results

Estimation results of our Probit model are presented in **Table 8**. We start in column 1 with an econometric model very close to our theoretical model that we will relax gradually. This model comprises dummy variables for past disasters, input prices, risk tolerance levels, the amount covered by the insurance, land size and household spending. Estimation results point to different important mechanisms. First, recent disaster events tend to increase farmers willingness to pay for the insurance product and farmers are more sensitive to the most recent event. The insured amount offered in the insurance contract and cultivated land size also positively influence farmers desire to purchase insurance. The effect of input prices is more mixed in this specification since high fertilizer prices tend to decrease the probability to insure, while increasing seed prices and wages have a positive and no significant effect respectively. Despite its importance in theory, risk aversion does not appear to play a significant role in purchase insurance according to this first econometric model.

We include three dummy variables distinguishing farmers who experienced a shock in 2008 but were not insured at that time, farmers who were insured in 2008 but did not experience a disaster and farmers who experienced a negative event in 2008 and were insured against it. The reference group is thus farmers who did not experienced a disaster in 2008 and were not insured.

Given the important serial correlation in insurance purchase decisions (farmers who bought insurance once are more likely to buy it again in the future). Column 2 introduces an additional dummy variable capturing participation in the insurance program the year before. Estimation results show that experience in insurance purchase is an important determinant of the willingness to pay. Indeed only 10% of farmers who purchased insurance in 2008 did not renew their contract in 2009. But among these 10%, 66% did experience a disaster in 2008, which might be interpreted as a sign that they quitted the insurance program because the coverage level did not match their expectations. Indeed these farmers are concentrated in Jilin province which exhibits a high premium combined with a relatively low insured amount. It is the less attractive insurance product in the sample. The introduction of past experience in insurance also allows the degree of risk tolerance to appear significantly in the regression, confirming theoretical predictions showing that more risk adverse farmers should be ready to pay a higher price for a similar insurance product when compared to very risk tolerant households.

Column 3 refines the relation between past disaster experience and insurance purchase. It distinguishes between farmers who did not experience a disaster in 2008 while they were not insured (they are the reference population here), those who experienced a disaster while they were not insured, households who bought insurance in 2008 but did not experience any disaster and farmers who insured themselves in 2008 and experienced a disaster the same year. It appears that farmers who bought the insurance product in 2008 are very likely to renew their contract in 2009 no matter if they actually experienced a disaster in 2008 or not. It also shows that farmers who suffered from losses due to a disaster in 2008 without being insured value more the insurance product than those not-insured who did not experience any disaster. The effects of the insured amount, land size and risk aversion are not questioned by this refinement in the effect of past year insurance and disaster experience.

Households often not only rely on their own experience when they make decisions like insurance purchase. They can also benefit from their neighbors experience. This network effect is introduced in column 4 which adds last year take-up rate in the insurance program at the township level. Again, the variable is very significant. Most of farmers renewed their contract in 2009 and the positive impact of the take-up rate in 2008 on willingness-to-pay could be understood as sign that they made good advertisement of the insurance product to the not-yet-insured farmers. The effect of the insured amount and risk aversion is not robust to the inclusion of last year take-up rate. A possible mechanism behind this effect would be that the insured amount matters as a signal for the introduction of the insurance product. Once some farmers experienced the insurance product, their neighbors gradually engage in formal insurance through networking effects as depicted in Cai (2012).

Though interesting, the results presented in **Table 8** are somehow in contradiction with our theoretical model (weak effect of risk aversion, insured amount and input price). An often cited mechanism that was not accounted for in the theoretical model is the informal risk management strategies. Indeed, farmer can choose to diversify their production/activities in order to protect themselves against risk associated to a particular crop. In that case, the insurance product might appear as a costly alternative and the willingness-to-pay for formal insurance can be significantly reduced. This possibility is explored in the first column of **Table 9** in which we introduce some informal risk management tools like credit, production diversification (livestock raising, crop diversification, non-farm labor). Only crop diversification appears to significantly influence farmers' willingness-to-pay in our setting. But the introduction of these controls also permits to the insured amount and risk aversion to appear significantly, as predicted by our theoretical model.

Another limit of the econometric approach developed above is that it can only give a very simplified picture of the relationship between risk aversion and the other variables. Indeed, it is easy to understand that a farmer with high risk aversion and high land acreage is willing to buy the CIP, and one with low risk aversion and small land acreage would refuse to buy the CIP (**Table 10**). However, what's above the other two cases, namely with high risk aversion but small land acreage, or with low risk aversion but large land acreage? To explore the latter two cases, an interaction term of land acreage and risk preference is added in column 2 of **Table 9**. The introduction of this interaction term does not question other estimation results but shows that the effects of land size and risk aversion are closely linked: for a given level of risk aversion, the marginal effect of risk aversion on the willingness-to-pay will be smaller if land size is large; Eventually, for the largest land owners, the degree of risk aversion has no impact on insurance purchase, while it is a very important (positive) factor for smallholders. Similarly the positive marginal effect of land on farmer's willingness-to-pay is stronger for risk tolerant household than for risk adverse farmers. If a farmer is very risk averse, then land size has a low or no effect on insurance decision.

In order to refine our analysis of the effect of risk aversion and its interactions with other determinants, columns 3 and 4 introduce interaction effects of risk aversion with the insured amount and input prices. While the introduction of the cross item between risk aversion and the insured amount has no important consequence for our estimation results, the introduction of interactions effects with input prices reveals many interesting mechanisms. Indeed, even if the average marginal effects of our variables remain similar to previous estimates (**Table 11**), a more detailed picture of the mechanisms at work emerges. The insured amount now significantly and positively influences insurance purchasing behavior only if the farmer exhibits a high enough degree of risk tolerance. Another interpretation is that if the insured amount offered is high enough, then every farmer, risk averse or not, will engage in formal insurance. On the opposite, when fertilizer prices increase, the effect of risk aversion on insurance purchase is reinforced. This result can be interpreted as a sign that fertilizer purchase is an informal risk management tool and when it becomes too costly, farmers engage in formal insurance purchase.

In order to check for the predictive quality of our model, we compare actual purchasing decisions with insurance take-up predicted by our econometric results (**Table 12**). We obtain less than 12% of false classification, which proves the accuracy of the model despite its numerous shortcomings like our inability to control for unobserved fixed effects at the household, village, township or even province level. Indeed, since the premium and insured amounts are province-specific, it is impossible to include any of these fixed effects to control for other possible unobserved variables.

7. Conclusion

We have explored the determinants of CIP decision of maize farmer in four major maize producing provinces in China, where maize dominates in grain production. Based on two datasets, risk preference experiment dataset and household survey dataset, we have especially scrutinized the role of risk aversion in farmers' CIP decision. Under the EU maximization framework, we deployed the expected utility of uninsured and insured situations. Theoretical model discloses the CIP decision is related to three factors, namely risk aversion information, production information, and insurance information. Connected with CIP reality in China, we deploy the empirical framework with risk aversion, production features, risk management tools, plot features, household features, affordability, and CIP environment.

Using experimental game data, we calculate the risk aversion for the same respondent as the one who responses the household survey questionnaire. Considering the opposite effects of risk preference and expected loss on CIP decision, an interaction term of them has been added to explore the behavior of those farmers with high risk aversion but low loss expected, and low risk aversion but high loss expected. Production features are presented by land size, disaster history, where land size is an epitome of real inputs and loss expected. Crop diversification, borrowing money and non-agricultural work are presented as traditional different risk reduction strategies. Farmers' CIP purchase history, village purchase ratio, and insured amount are listed to capture the CIP environment and contract's key items.

With regard to the risk preferences of the farmers, we find that risk aversion plays an important role in CIP decision, not only in the form of its' direct effect, but also in the form of interaction term together with loss expected. Quantitatively, the direct marginal effect of risk aversion by real experiment is 0.52% : if risk aversion increases marginally, farmer's willingness-to-pay increases by 0.52%. This effect passes through different channels that have been incorporated in the econometric model using interaction terms. Hence, the insured amount and input prices appear to affect the effect of risk aversion, so that if the insured amount is high enough, then risk aversion will not have any effect on insurance purchase anymore.

Some interesting conclusion can also be drawn from our research. The fact that farmers' purchase history and village purchase ratio are significant helps insurance companies to make effective village targeting strategy in the future CIP extension. The insured amount's significant role in CIP decision is also useful for us to consider carefully on how to revise contract items or even reform the existed subsidized CIP in China. Because constrained by subsidy budget under the background of ratio subsidy policy, the insured amount can't follow well the increasing production cost and potential large demand from large-scale production farmers. We also find that normal adverse selection problem is not significant in our samples.

Generally, subsidy policies provide effective incentives for farmers to attend CIP in the past years. However, before promoting some related polices, such as polices help increase land operation scale, policies help to increase loss coverage, and policies help target potential customs effectively, the CIP extension would still face similar obstacles in the future. However, if stakeholders could manage to break constrains, the crop insurance might go far away with higher efficiency.

Table 1 – Risk management tools in agriculture

Tool	Farm / household / community	Market	Government
Risk Reduction	▪ Technological choice	▪ Training on risk management	▪ Macro policies ▪ Disaster prevention (flood control) ▪ Prevention of diseases
Risk Mitigation	▪ Diversification in production ▪ Crop sharing	▪ Futures /options ▪ Insurance ▪ Vertical Integration ▪ Production/market contract ▪ Spread sales ▪ Diversified finance ▪ Off-farm work	▪ Tax system income smoothing ▪ Counter-cyclical Programme ▪ Border and other measures in case of contagious disease outbreak ▪ Market-price support (intervention buying, buffer stocks)
Risk Coping	▪ Borrowing from neighbours / family ▪ Intra-community charity	▪ Selling financial assets ▪ Saving / borrowing ▪ Off-farm income	▪ Disaster relief ▪ Social assistance ▪ All agricultural support programs

Source: adapted from OECD (2009).

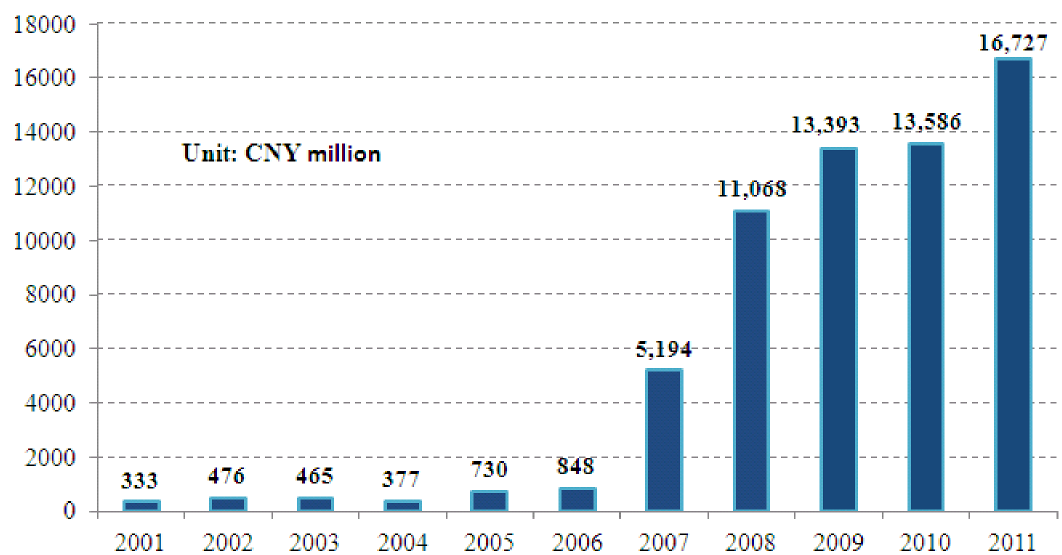

Fig. 1 Agricultural insurance premium in China (2001-2011)

Source: Exacted by authors from China Insurance Yearbook Press: *Yearbook of China's Insurance.*

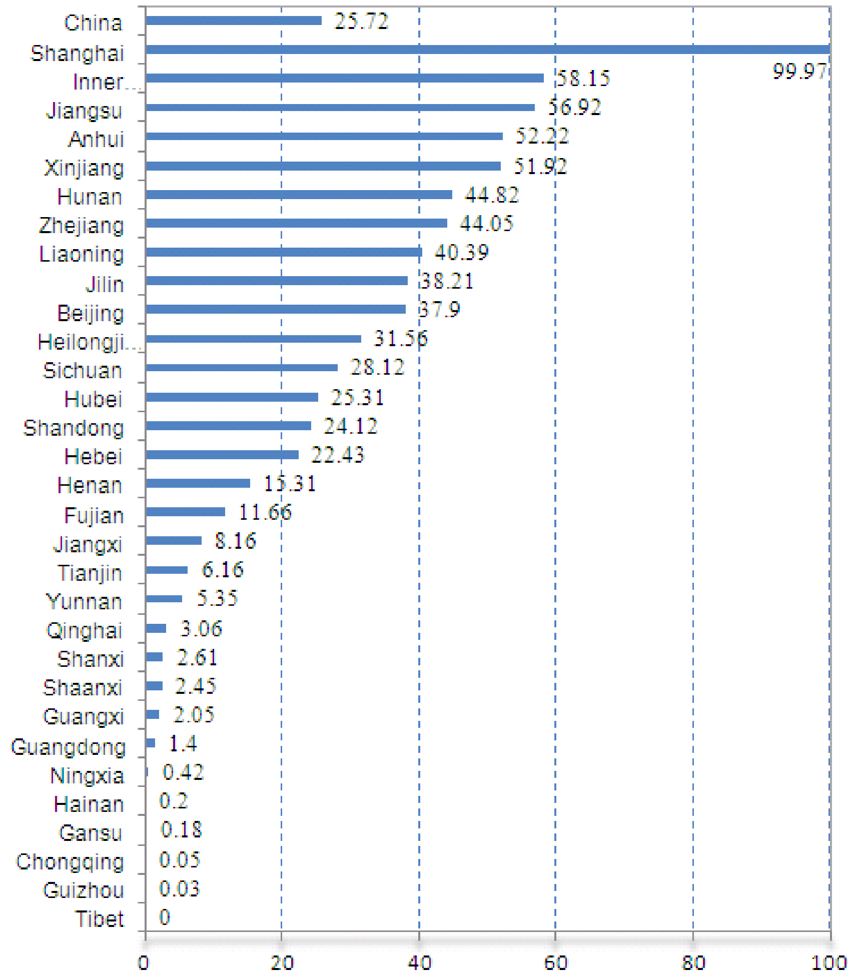

Fig. 2 Acreage Coverage rate of CIP in 2009 in China (Unit: %)

Source: Feng and Su, 2012.

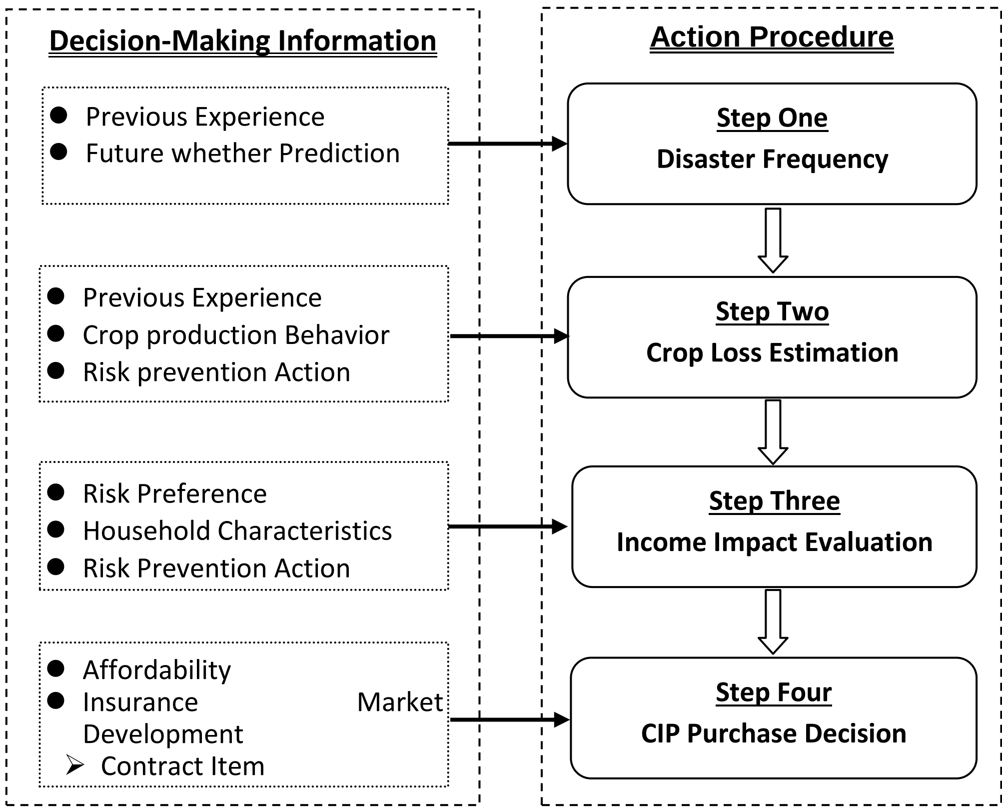

Fig. 4 Farmer's CIP Decision Process

Table 2 - Difference in output and input between Insured and Uninsured maize farmers (household level)

Year	Groups	Area	Yield Jin/mu	Film money	Seed money	Machine money	Irrigation money	Fertilizer Money	Pesticide money	Manure money	Manure quantity	Self labor	Hire labor	Hire labor cost
2007	Uninsured	8.35	1203.11	0.49	37.95	57.14	10.08	131.45	20.93	5.17	142.79	45.19	3.96	24.64
	Insured	8.31	***1677.02***	***1.91***	***58.89***	***63.49***	***10.43***	***189.17***	19.21	1.43	228.86	***25.25***	***2.41***	***14.95***
	Total	8.34	1292.38	0.76	41.89	58.34	10.14	142.32	20.60	4.47	159.01	41.44	3.67	22.82
2008	Uninsured	8.21	1177.02	0.54	36.62	56.03	9.78	125.60	20.69	5.40	150.95	46.06	4.13	25.57
	Insured	8.71	***1606.76***	***1.34***	***56.27***	***64.62***	***11.15***	***187.91***	20.36	1.92	180.95	***28.84***	***2.40***	***15.31***
	Total	8.34	1292.38	0.76	41.89	58.34	10.14	142.32	20.60	4.47	159.01	41.44	3.67	22.82
2009	Uninsured	8.45	1185.35	0.34	37.50	56.24	9.30	123.20	19.97	5.56	161.16	45.48	4.15	25.88
	Insured	8.13	***1505.44***	***1.58***	***50.64***	***62.53***	***11.82***	***180.40***	21.86	2.29	154.72	***33.39***	***2.71***	***16.71***
	Total	8.34	1292.38	0.76	41.89	58.34	10.14	142.32	20.60	4.47	159.01	41.44	3.67	22.82

Table 3 - Difference in output and input between Insured and Uninsured maize farmers (plot level)

		area	fertility	Disaster	Odecr	Yield	Film	Seed	Mach	Irri	Fert	Pest	Manu	Manu_q	Labor_s	Labor_h	Labor_hc
2007	Uninsured	4.55	2.12	0.48	23.32	1206.87	0.41	38.26	56.63	10.21	131.68	21.00	4.81	136.79	47.26	3.82	23.79
	Insured	4.38	2.23	***0.53***	***24.94***	***1671.39***	***1.48***	***60.54***	***63.68***	***10.62***	***188.68***	19.27	1.55	268.65	***25.25***	***2.62***	***15.43***
	Total	4.52	2.14	0.49	23.65	1294.11	0.61	42.45	57.95	10.29	142.38	20.68	4.20	161.55	43.12	3.59	22.22
2008	Uninsured	4.53	2.14	0.47	23.05	1181.93	0.46	36.95	55.51	9.73	125.57	20.74	5.18	148.61	47.98	3.97	24.37
	Insured	4.48	2.14	***0.54***	***25.04***	***1592.57***	***1.02***	***57.07***	***64.45***	***11.77***	***187.10***	20.51	1.59	195.98	***30.20***	***2.58***	***16.49***
	Total	4.52	2.14	0.49	23.65	1294.11	0.61	42.45	57.95	10.29	142.38	20.68	4.20	161.55	43.12	3.59	22.22
2009	Uninsured	4.67	2.12	0.47	23.10	1187.18	0.37	37.77	55.90	9.42	123.21	20.02	5.29	157.75	47.84	3.97	24.56
	Insured	4.22	2.17	***0.53***	***24.59***	***1504.86***	***1.09***	***51.67***	***62.00***	***11.99***	***180.17***	21.97	2.06	169.04	***33.83***	***2.84***	***17.62***
	Total	4.52	2.14	0.49	23.65	1294.11	0.61	42.45	57.95	10.29	142.38	20.68	4.20	161.55	43.12	3.59	22.22

Table 4 -Method Comparison of maize production for maize farmers: mean and median (plot level, year 2009)

		area	fertility	Disaster	Odecr	Yield	Film	Seed	Mach	Irri	Fert	Pest	Manu	Manu_q	Labor_s	Labor_h	Labor_hc
Mean	Uninsured	4.65	2.12	0.47	23.05	1188.11	0.37	37.84	55.90	9.42	123.20	20.02	5.29	157.75	47.86	3.98	24.59
	Insured	4.22	2.17	***0.53***	***24.59***	***1504.86***	***1.09***	***51.67***	***62.00***	***11.99***	***180.17***	21.97	2.06	169.04	***33.83***	***2.84***	***17.62***
	Total	4.51	2.14	0.49	23.61	1294.73	0.61	42.49	57.95	10.29	142.38	20.68	4.20	161.55	43.14	3.60	22.24
Median	Uninsured	2.80	2.00	0	20.00	1100.00	0	33.33	50.00	0	118.00	15.87	0	0	40.45	1.00	6.25
	Insured	3.00	2.00	1.00	20.00	1403.13	0	39.67	60.69	0	172.55	18.79	0	0	28.07	0.04	0
	Total	3.00	2.00	0	20.00	1200.00	0	35.00	53.66	0	134.00	17.00	0	0	35.26	0.56	3.41

Table 5 - Insured amount and premium in sampling provinces

Province	Insured amount	Premium
Unit	CNY	CNY/mu
Heilongjiang	145	10
Jilin	200	20
Shandong	400	8
Henan	190	11.5

Source: Collected by authors.

Table 6- Programs and game ball with expected payoff (Unit: CNY)

Game Order	Program A		Program B	
	White	Yellow	White	Yellow
1	20	20	15	25
2	20	20	10	30
3	20	20	10	40
4	20	20	5	45
5	20	20	0	50

Note: In each game, respondent will be given a box with 8 balls, 4 white and 4 yellow definitely. The farmer must choose the option he prefers, then pick up a ball from the box and obtain the corresponding payoff.

Table 7 - Variable Description

Category	Variable and explanation	Unit	Mean	Std. Dev.	Min	Max
Dependent Variable	Dummy: purchase CIP in 2009	Yes=1,no=0	0.33	0.47	0	1
Risk aversion	Risk aversion parameter, from 0 (= high) to 1 (= low)	-	0.31	0.31	0	1
Production feature	Cultivated maize land size	mu=0.0667 ha	19.43	23.70	0.9	230
	Share of cultivated land dedicated to Maize	-	0.79	0.45	0.01	1
	Wage of agricultural labor in township average	CNY/day	54.52	13.40	30	91.85
	Fertilizer price in township average	CNY/jin	1.22	0.15	0.99	1.96
	Seed price in township average	CNY/jin	9.28	4.76	3.64	28.33
	Dummy: experienced a disaster2008	Yes=1,no=0	0.38	0.49	0	1
CIP environment	take-up rate of CIP in township in2008	ratio	0.27	0.33	0	0.94
	Dummy: Insured CIP in 2008	Yes=1,no=0	0.27	0.44	0	1
	Insured amount for CIP	1 USD = 6.23087 CNY	233.68	98.21	145	400
	Premium for CIP	CNY/mu	12.37	4.57	8	20
HH feature	Household head: working year in crops	year	28.35	11.62	0	57
	Household head: gender	Yes=1,no=0	0.98	0.12	0	1
	Household head: age	year	49.94	9.72	27	76
	Household head: schooling year	Year	7.12	2.68	0	25
Risk management	Dummy: Produce vegetables or fruits more than 1 Mu	Yes=1,no=0	0.19	0.40	0	1
	Dummy: Contracted a loan in 2009	Yes=1,no=0	0.33	0.47	0	1
	Number of non agricultural labor in household	person	1.12	1.14	0	6
	Maximum numbers of large animals raised last year	Animal number	5.86	21.04	0	300
	Maximum numbers of poultry raised last year	Poultry number	36.62	366.50	0	8400
Affordability	Dummy: monthly household spending last year:	-				
	1="<500 yuan", 2="500- 1000 yuan", 3="1000-2000 yuan", 4= "2000-3000 yuan", 5=">3000 yuan"		1.87	0.74	1	4

Note: household sample number is 637, and plot sample number is 1195.

Table 8 - Insurance Purchase Decision Results (*Probit* Model)

	(1)	(2)	(3)	(4)
Disaster in 2008 (0=no, 1=yes)	0.7816***	0.2525		
	(0.1311)	*(0.1618)*		
Disaster in 2007 (0=no, 1=yes)	0.3193**	0.2701*		
	(0.1362)	*(0.1610)*		
Insured in 2008 (0=no, 1=yes)		2.7478***		
		(0.1935)		
Not insured but experienced a disaster in 2008			0.4396**	0.3825**
			(0.1792)	*(0.1795)*
Insured but did not experience a disaster in 2008			3.0283***	1.9854***
			(0.2841)	*(0.2804)*
Insured & experienced a disaster in 2008			3.0203***	1.9764***
			(0.2238)	*(0.2554)*
take-up rate in the township in 2008				2.0750***
				(0.3125)
Insured amount	1.4942***	0.8582***	0.7977***	0.4042
	(0.2243)	*(0.2481)*	*(0.2481)*	*(0.2663)*
Wage (township average)	0.4365	0.1789	0.2230	0.1416
	(0.2879)	*(0.3361)*	*(0.3372)*	*(0.3265)*
Chemical fertilizer price (township average)	-1.5003***	-0.0915	-0.0358	0.7057
	(0.3709)	*(0.4285)*	*(0.4289)*	*(0.4566)*
Seed price (township average)	0.5479***	-0.1248	-0.1584	-0.4069*
	(0.1660)	*(0.2188)*	*(0.2203)*	*(0.2186)*
Cultivated Maize Land size	0.3842***	0.2863***	0.2887***	0.2006**
	(0.0704)	*(0.0800)*	*(0.0800)*	*(0.0896)*
Risk Aversion	-0.2787	-0.4801**	-0.4651**	-0.3660
from 0 (= high risk aversion) to 1 (= low risk aversion)	*(0.1889)*	*(0.2240)*	*(0.2234)*	*(0.2297)*
Household spendings	-0.0320	-0.1654*	-0.1646*	-0.1175
(< 500 yuan, 500-1000 yuan, 1000-2000 yuan, or 2000-3000 yuan)	*(0.0829)*	*(0.0987)*	*(0.0987)*	*(0.1016)*
Constant	-9.8758***	-4.2255**	-3.9904**	-1.4459
	(1.7325)	*(1.9579)*	*(1.9606)*	*(2.1180)*
Observations	637	637	637	637

Robust standard errors in parentheses ; *** p<0.01, ** p<0.05, * p<0.1

Table 9 – Insurance Purchase Decision Results (*Probit* Model)

	(1)	(2)	(3)	(4)
Not insured but experienced a disaster in 2008	0.3547*	0.3703**	0.3667**	0.3756**
	(0.1837)	*(0.1858)*	*(0.1852)*	*(0.1906)*
Insured but did not experience a disaster in 2008	1.9003***	1.8893***	1.8857***	1.9361***
	(0.2740)	*(0.2719)*	*(0.2723)*	*(0.2798)*
Insured & experienced a disaster in 2008	1.9397***	1.9388***	1.9387***	1.9995***
	(0.2605)	*(0.2597)*	*(0.2593)*	*(0.2573)*
take-up rate in township in 2008	2.0501***	2.0813***	2.0798***	2.0994***
	(0.3182)	*(0.3207)*	*(0.3206)*	*(0.3248)*
Insured amount	0.5071*	0.5243*	0.5437*	0.2377
	(0.2759)	*(0.2776)*	*(0.2838)*	*(0.3461)*
Wage (township average)	0.0375	0.0162	0.0125	-0.5960
	(0.3245)	*(0.3257)*	*(0.3260)*	*(0.4143)*
Chemical fertilizer price (township average)	0.6907	0.6971	0.7040	1.8592***
	(0.4477)	*(0.4477)*	*(0.4489)*	*(0.5502)*
Seed price (township average)	-0.3800*	-0.3796*	-0.3780*	-0.6171**
	(0.2246)	*(0.2247)*	*(0.2247)*	*(0.2819)*
Cultivated Maize Land size	0.1452	0.0612	0.0608	0.0556
	(0.0905)	*(0.1077)*	*(0.1080)*	*(0.1195)*
Risk Aversion	-0.3941*	-1.1242**	-0.7901	-21.3806***
from 0 (= high) to 1 (= low)	*(0.2287)*	*(0.5312)*	*(1.2218)*	*(6.7601)*
Household spending	-0.0898	-0.0886	-0.0877	-0.0725
	(0.1036)	*(0.1045)*	*(0.1045)*	*(0.1074)*
Contracted a loan in 2009 (0=no, 1=yes)	0.2120	0.2127	0.2137	0.1884
	(0.1580)	*(0.1577)*	*(0.1577)*	*(0.1589)*
Produce vegetables (1 = yes)	-0.2617	-0.2580	-0.2596	-0.2666
	(0.2044)	*(0.2058)*	*(0.2056)*	*(0.2161)*
Grow livestock number	0.0000	-0.0002	-0.0003	-0.0008
	(0.0024)	*(0.0023)*	*(0.0023)*	*(0.0024)*
Grow poultry number	-0.0001	-0.0001	-0.0001	-0.0001
	(0.0001)	*(0.0001)*	*(0.0001)*	*(0.0001)*
Share of cultivated land dedicated to Maize	0.6759**	0.6705**	0.6707**	0.5908*
	(0.3269)	*(0.3252)*	*(0.3250)*	*(0.3338)*
Number of non agricultural labor in household	-0.0579	-0.0666	-0.0666	-0.0694
	(0.0780)	*(0.0783)*	*(0.0783)*	*(0.0801)*
Risk aversion * Cultivated Maize Land size		0.3158*	0.3137*	0.3941
		(0.1849)	*(0.1847)*	*(0.3203)*
Risk aversion * insured amount			-0.0565	1.5007*
			(0.2000)	*(0.8986)*
Risk aversion * wage				2.6571**
				(1.1191)
Risk aversion * seed price				1.0929
				(0.7186)
Risk aversion * fertilizer price				-5.2297***
				(1.4163)
Constant	-2.0349	-1.8494	-1.9533	2.4673
	(2.0592)	*(2.0761)*	*(2.0998)*	*(2.4919)*
Observations	637	637	637	637

Robust standard errors in parentheses ; *** p<0.01, ** p<0.05, * p<0.1

Table 10 - Different Cases for Farmers to Make Decisions

Category	Large land acreage	Small land acreage
Risk aversion	Insured	?
Risk lover	?	Uninsured

Table 11 - Average Marginal Effect of Interacted Variables on WTP

Variable	Coefficient	Standard Error
Risk Aversion	-0.52*	(0.288)
Land size	0.18*	(0.093)
Insured amount	0.7**	(0.275)
Wage	0.24	(0.355)
Fertilizer price	0.23	(0.465)
Seed price	-0.29	(0.232)

Table 12- Actual Versus Predicted Insurance Purchase Decision

		Actual		
		No	Yes	Total
Predicted	No	396	48	444
	Yes	28	165	193
	Total	424	213	637

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References

1. Babcock, B.A., and C. E. Hart., 2005. Influence of the Premium Subsidy on Farmers' Crop Insurance Coverage Decisions. Working Paper 05-WP 393, Center for Agricultural and Rural Development, Iowa State University, America.
2. Bardsley, P. Abey, A. & Davenport, S., 1984. The economics of insuring crops against drought. Australian Journal of Agricultural Economics. 28(1),1–14.
3. Barnett, B. J., Barrett, C. B. and Skees, J. R., 2008. Poverty Traps and Index-Based Risk Transfer Products. World Development. 36(10), 1766–1785.
4. Barnett, B.J., Skees, J.R. and Hourigan, J.D., 1990. Examining Participation in Federal Crop Insurance. Staff Paper 275, Department of Agricultural Economics, University of Kentucky, Lexington, August.
5. Binswanger, H., 1980. Attitudes toward risk: Experimental measurement in rural India. American Journal of Agricultural Economics. 62, 395–407.
6. Boyd, M., Pai,J., Zhang, Q.,Wang,H.H., and Wang,K., 2011. Factors affecting crop insurance purchases in China: the Inner Mongolia region", China Agricultural Economic Review. 3(4), 441–450.
7. Cai, J., 2012. Social Networks and the Decision to Insure: Evidence from Randomized Experiments in China. http://ecnr.berkeley.edu/vfs/PPs/Cai-Jin/web/JMP_JingCai_012812.pdf (accessed on Dec 8, 2012 at 2.00 pm)
8. Calvin, L., 1992. Participation in the U.S. Federal Crop Insurance Program. Washington DC: U.S. Department of Agriculture, ERS Technical Bulletin No. 1800.
9. Cannon, D.L., and Barnett, B.J., 1995. Modeling Changes in the Federal Multiple Peril Crop Insurance Program Between 1982 and 1987. Selected paper presented at the American Agricultural Economics Association annual meetings, Indianapolis.
10. Changnon, S.A., 2002. Impacts of the Midwestern Drought Forecasts of 2000. Journal of Applied Meteorology. 41,1042–1052.
11. Claassen, R., Lubowski, R.N. and Roberts, M. J., 2005. Extent, Location, and Characteristics of Land Cropped Due to Insurance Subsidies. Selected paper presented at the American Agricultural Economics Association annual meetings, Providence.
12. Coble, K.H., T.O. Knight, R.D. Poe, and Williams, J.R., 1997. An Expected Indemnity Approach to the Measurement of Moral Hazard in Crop Insurance. American Journal of Agricultural Economics. 79, 216–226.
13. Coble, K.H., T.O. Knight, R.D. Pope, and Williams. J.R., 1996. Modeling Farm-Level Crop Insurance Demand with Panel Data, American Journal of Agricultural Economics. 78, 439–447.
14. Cole, S., Giné, X., Vickery, J., 2011. How Does Risk Management Influence Production Decisions: Evidence from a Field Experiment. Northeast Universities Development

Consortium Conference. November 12–13. http://www.econ.yale.edu/conference/neudc11/schedule.htm

15. Cole, Shawn, Jeremy Tobacman, and Petia Topalova. 2008. "Weather Insurance: Managing Risk through an Innovative Retail Derivative." Working Paper, Harvard Business School, Cambridge, Mass.; Oxford University, Oxford, U.K.; and the International Monetary Fund, Washington, D.C.

16. Feng W.L.and Su, X. P., 2012. Analysis on High Subsidy and Low Coverage Rate issue in agricultural insurance in China. South Finance. 3, 70–73.

17. Fraser, R.W., 1992. An analysis of willingness-to-pay for crop insurance. The Australian Journal of Agricultural Economics. 36(1), 83–95.

18. Gaiha, R. and Thapa, G., 2006. Natural Disasters, Vulnerability and Mortality: A Cross-country Analysis. International Fund for Agricultural Development working paper.

19. Gine´, X., Townsend, R. and Vickery, J., 2008. Patterns of Rainfall Insurance Participation in Rural India. The World Bank Economic Review. 22(3), 539–566.

20. Goodwin, B.K., and Kastens, T.L, 1993. Adverse Selection, Disaster Relief, and the Demand for Multiple Peril Crop Insurance." Contract report for the Federal Crop Insurance Corporation, May

21. Goodwin, B.K., 1993. An Empirical Analysis of the Demand for Crop Insurance. American Journal of Agricultural Economics. 75, 425–434.

22. Hazell, P. Bassoco, L.M. & Arcia, G., 1986. A model for evaluating farmers' demand for insurance: applications in Mexico and Panama. In P. Hazell, C. Pomareda & A. Valdes (eds.) Crop insurance for agricultural development. Baltimore. The Johns Hopkins University Press for the International Food Policy Research Institute.

23. Hill, R.V., Hoddinott, J. and Kumar, N., 2011. Adoption of weather - index insurance: Learning from willingness to pay among a panel of households in rural Ethiopia". International Food Policy Research Institutehttp://www.csae.ox.ac.uk/conferences/2011-EDiA/papers/345-Kumar.pdf (accessed on Dec 8, 2012 at 2.00 pm)

24. Holt, C. A. and Laury, S. K., 2002. Risk Aversion and Incentive Effects. American Economic Review. 92(5). 1644–1655.

25. Hou, L.G., Hoag,D.L.K.and Mu,Y.Y., 2011. Testing for adverse selection of crop insurance in northern China. China Agricultural Economic Review. 3(4), 462–475.

26. Just, R.E. and Calvin. L., 1990. An Empirical Analysis of U.S. Participation in Crop Insurance. Unpublished report to the Federal Crop Insurance Corporation.

27. Knight,T .O.and Coble, K .H.. 1997. Survey of U.S. Multiple Crop Insurance Literature Since 1980. Review of Agricultural Economic. 19,128–156.

28. Lipton, M., 1989. Agricultural Research and Modern Plant varieties in Sub-Saharan Africa: Generalizations, Realities and Conclusions. Journal of International Development. 1(1), 168–179.

29. Lu,K.Y. and Yu, B.X., 2011. The Impact of High Food Prices on Poverty in China. Development in Practice. 21(4-5), 679–690.

30. Makki, S.S., and Somwaru, A., 2001. Farmers' Participation in Crop Insurance Markets: Creating the Right Incentives. American Journal of Agricultural Economics. 83,662–667.

31. McCarter, N., 2003. Demand for Rainfall-Index Based Insurance: A Case Study from Morocco. IFPRI Environmental and Production Technology Division Working paper Number 106, Washington D.C.

32. Miller, A., Dobbins, C., Pritchett, J.,Boehlje, M. and Ehmke, C. 2004. Risk Management for Farmers. Staff Paper 04–11. September. Department of Agricultural Economics. Purdue University. http://future.aae.wisc.edu/publications/risk_management_for_farmers.pdf.

33. Moschini, G., Hennessy, D.. 2001. Uncertainty, risk aversion and risk management for agricultural producers. In Gardner, B., Rausser, G. (Eds.), Handbook of Agricultural Economics. Elsevier Science Publishing, Amsterdam, The Netherlands. 1A, 88–153.

34. Niewoudt, W.L., Johnson, S.R., Womack, A.W., and Bullock, J.B., 1985. The Demand for Crop Insurance." Agricultural Economics Report No. 1985–16, Department of Agricultural Economics, University of Missouri-Columbia, December

35. OECD. 2009. Risk Management in Agriculture: A Holistic Conceptual Framework. Part of the Trade and Agriculture Directorate project on Risk Management in Agriculture.

36. Picazo-Tadeo, A. and Wall, A. 2011. Production risk, risk aversion and the determination of risk attitudes among Spanish rice producers. Agricultural Economics. 42, 451–464.

37. Ramasubramanian,J.A.. 2012. Willingness to pay for index based crop insurance in India. DPhil candidate (Economics), University of Sussex, United Kingdom.

38. Robert Innes. 2003. Crop insurance in a political economy-an alternative perspective on agricultural policy. American Journal of Agricultural Economics. 85(2), 318–335.

39. Rothschild, M. and Stiglitz, J., 1976. Equilibrium in competitive insurance markets: an essay on the economics of imperfect information. Quarterly Journal of Economics. 90(4), 629–649.

40. Sherrick, B., Barry, P.T., Ellinger, P.N., Schnitkey, G. D.. 2004. Factors Influencing Farmers' Crop Insurance Decisions. American Journal of Agricultural Economics. 86(1), 103–114.

41. Tanaka, N.T., Camerer,C.F. and Nguyen, Q., 2010. Risk and Time Preferences: Linking Experimental and Household Survey Data from Vietnam. American Economic Review. 100(1), 557–571.

42. USDA. By: Harwood, J., Heifner, R., Coble, K., Perry, J. and Somwaru, A., 1999. Managing risk in farming: concepts, research, and analysis. Market and Trade Economics Division and Resource Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report. No. 774. March.

43. Xing, L., Lu, K.Y. 2010. Research on Agricultural Production Risk and Insurance Rating in China. Beijing: China Agricultural Press. October.

44. Zeng, Y. and Mu, Y., 2010. Development evaluation of China's policy-oriented agricultural insurance: based on the realization degree of policy objectives. Agriculture and Agricultural Science Procedia. 1, 262–270.