JARQ 50 (3), 253 - 265 (2016) http://www.jircas.affrc.go.jp

# Experimental Measure of Rural Household Risk Preference: The Case of the SLCP Area in Northern Shaanxi, China

**Qianqian MAO[1&], Wenlue WANG[1&], Shunji ONIKI[2], Masaru KAGATSUME[3] and Jin YU[1]***

[1] College of Economics and Management, Northwest A&F University, (Yangling, Shaanxi 712100, China)

[2] Japan International Research Center for Agricultural Sciences (Tsukuba, Ibaraki 305-8686, Japan)

[3] Graduate School of Agriculture, Kyoto University (Kyoto, Kyoto 606-8502, Japan)

## Abstract

This study elicits the risk preferences of rural households through a field experiment conducted in Shaanxi Province using the Holt-Laury mechanism that considers the effects of implementing the Sloping Land Conversion Program (SLCP) on the risk preferences of farmers. The program has significantly changed the structure of farmers' productive property, which may further influence their risk attitudes. This study reveals that household geographic and demographic characteristics have a significant effect on the risk preferences of participants in the experiment. More importantly, the SLCP has had a significant effect on farmers' risk preferences. Hence, when assessing the outcome of such public policies as the SLCP that may affect the future incomes of farmers, we should consider the socioeconomic characteristics of the households concerned and the public policies implemented in the targeted area in detail.

**Discipline:** Agricultural Economics

**Additional key words:** Holt-Laury mechanism; expected utility theory

## Introduction

Behavioral studies have focused on the fundamental issue of economic success and the extent to which it is linked to risk preference. The expectation of risks in production activities may affect the investment decisions of people in real life. Many scholars have pointed out that household demographic features and social/natural conditions are closely related in terms of risk preference. However, all of these factors could change conspicuously due to the implementation of public programs in certain areas, which may further influence local people's expectations of risk. Thus, our study explores how the implementation of public programs may affect people's risk preferences.

Studies on poverty and risk have been central to the discussions of economic development. Kanbur (1999) emphasized the role of risks in research on poverty, and pointed out that the risk attitude of the poor is probably an emotional tendency toward suffering loss. Meanwhile, economists have conducted substantial field experiments to estimate the risk attitudes of farmers in developing countries. The core theories behind these experiments are based on the expected utility theory of Von Neumann et al. (1944) and prospect theory of Kahneman (1979). Many inconsistent experimental results have subsequently been obtained. Rosenzweig et al. (1992) found that wealthy rural households undertook more risky productive activities that resulted in increased household income. Nielsen (2001) discovered a positive correlation between individual risk attitudes and levels of wealth, while Yesuf (2004) found a negative correlation. Moreover, Binswanger (1980) and Mosley (2005) found no significant relationship between risk aversion and the level of wealth.

Risk preferences may depend on the individual factors or background risks of participants in the experiment. These inconsistent findings led to further studies that considered other demographic factors, and experiments that covered larger geographical ranges. The experimental mechanisms applied included a menu of pair-wise lottery choices in order to estimate risk preference, termed the Holt–Laury mechanism that originates from the Multiple Price List (MPL) method (Holt and Laury 2002). Initially used to elicit risk attitudes by Miller et al. (1969), the MPL

*Corresponding author: e-mail yujin@nwsuaf.edu.cn.

[&] These authors contributed equally to this work and should be considered co-first authors.

Received 7 November 2014; accepted 17 December 2015.

entails the experiment participants being given an ordered array of binary lottery choices to make all at once. A detailed description of the Holt-Laury mechanism is presented later in this paper.

Tanaka et al. (2014) conducted a similar field experiment that covered all of Uganda. They divided the country into several areas according to the local landform, rainfall capacity, and crop. They concluded that risk preferences differed significantly across the agricultural climatic zones of Uganda. Large differences were also found in the risk and time preferences of individuals. These results proved that participants in the experiment were affected by regional factors and background risks posed by the local environment.

Compared with studies based on traditional expected utility theory, some of the latest research tests prospect theory. Tanaka et al. (2010) conducted experiments in nine villages in Vietnam. They expanded measurements of risk and time preferences beyond the one-parameter expected utility and exponential discounting model, replacing it with prospect theory and the three-parameter hyperbolic discounting model created by Benhabib et al. (2004). They concluded that time and risk preferences are significantly relevant, and that village-level average income and household income are correlated with patience (i.e., lower interest rate), but not with risk preferences.

In addition to the determinants of risk preference, it has become more important to introduce personal risk attitudes into the process of predicting the economic behavior of individuals. Liu (2013) conducted an experiment in China similar to that conducted by Tanaka et al. (2010) in Vietnam. It introduced personal risk attitudes into the technology adoption function of farmers. The study concluded that the level of risk aversion among farmers was negatively correlated with the time elapsed since the date they adopted insect-resistant cotton, and that farmers who overemphasized small probability events were relatively earlier adopters of the insect-resistant cotton. Liu (2013) pioneered the research on the influence of farmers' risk attitudes on their production decisions in China.

In China, Wang et al. (2011) elicited risk preferences in experiments involving college students. The authors suggest the use of more social factors in future investment behavior studies. Zhou et al. (2012) also used college students as experiment participants and found that most people were risk averse, although the degrees of risk aversion varied; in particular, such factors as household income, gender, and place of birth (whether urban or rural) affected people's risk attitudes. However, only a few similar studies have been conducted on the risk preferences of farmers in China, given the requirement that experiment participants must be highly educated, that is, individuals engaged in these experiments should understand the experimental mechanisms well.

This study used the policy area of the Sloping Land Conversion Program (SLCP) as its targeted area. Initiated in 2001, the SLCP is one of the largest public programs in China and covers 25 underdeveloped provinces. Since the start of the program, rural household production activities and local economic conditions have experienced a conspicuous change. Numerous studies have confirmed that the SLCP not only had ecological benefits but has also served an anti-poverty tool (Xu et al. 2010, Li et al. 2011). However, existing studies tend to focus on the macro-engineering effects of the program or its microscopic impact on the livelihoods of local households. Relatively few studies have investigated the impact of such policies on the basic risk preferences of farmers.

We adopted the Holt-Laury mechanism to estimate the risk preference level of farmers in the targeted area. We also examined demographic and natural factors along with social conditions that could be correlated with the risk preferences of farmers. In fact, this is the first study to introduce the effect of a national public program, and it reveals certain other potential effects of public environmental resource conservation policies, such as the SLCP. The remainder of this paper is structured as follows: "Theory and experimental mechanism" discusses the theory, experimental mechanism, and experiment site that we chose; "Experimental Results and Empirical Study" provides a statistical analysis of our experiments and the regression results. Finally, "Conclusion" describes our concluding remarks.

## Theory and experimental mechanism

### 1. Expected Utility Theory

Before defining the uncertainty utility function, we introduce the concept of a lottery. Known probability can be used to describe alternatives with uncertain results, and using a lottery is a concrete method of showing risky alternatives.

In recent years, a growing number of studies on time and risk preferences have been conducted based on Von Neumann's expected utility theory and Kahneman's prospect theory, which are at the forefront of the field of development economics. There are many arguments that justify the use of these theories in development economics; however, the results lack consistency. Expected utility theory has played a dominant role in this field, and our study adopts it. We also introduce the concept of loss aversion that originated from prospect theory. Loss aversion may suggest that a person's utility toward loss is greater than the gain of the same absolute value. The concepts of risk and loss aversion are introduced into our study as follows:

Expected utility theory argues that a rational individual maximizes his or her expected utility of final wealth obtained from the risky activities he or she undertakes, or

$$\sum_{i=1}^{n} p_i u(W_i) \quad (1),$$

where,

$u(W_i)$ is the level of utility derived from final wealth $W_i$, which occurs with probability $p_i$ for each of the n possible states. When the utility function is concave, the individual is said to be risk averse, preferring a guaranteed income of $W_i$ to a fair gamble with expected value $W_i$. Using the Arrow-Pratt measure of risk aversion:

$$r(W) = -u''(W) / u'(W) \quad (2),$$

the risk averse individual is represented by $r(W)>0$, the risk preferring individual by $r(W)<0$, and the risk neutral individual by $r(W)=0$. In experiments, the relative risk aversion equation,

$$r(W) = -M * u''(W) / \mu'(W) \quad (3),$$

is often estimated, where **M** (i.e., change in wealth) is used in the experiment instead of final wealth. Because the level of risk aversion should not vary with the change in wealth M, we assume a constant relative risk aversion (CRRA) utility function,

$$u(M) = \frac{M^{1-\sigma}}{1-\sigma} \quad (4),$$

where, σ denotes the curvature of the utility function or the risk aversion level, and $r(M) = \sigma$ and level risk aversion σ elicited from the experiment have nothing to do with the change in wealth **M**.

To estimate the risk aversion parameter σ, field experiments have always adopted the pair-wise probability $p_i$, and provide the payment $M_i$(i.e., the Holt-Laury mechanism). Risk aversion σ is calculated by equating the expected utilities,

$$\sum_{i=1}^{n} p_i \frac{M^{1-\sigma}}{1-\sigma} \quad (5)$$

of two lotteries.

Besides risk aversion, loss aversion is also one of the important aspects of farmers' risk attitudes. The term "loss aversion" originated from prospect theory, which is a revised form of expected utility theory. In prospect theory, a person's decrease in utility form from a loss is greater than the increase in utility from a gain of the same absolute value, that is, $u(M) < -u(-M)$. Loss aversion is also estimated in our experiment by adding negative wealth values. When faced with possible loss, the participants in the experiment always choose the safe options. Using the utility function, we can also estimate the loss aversion level. For the gain $M>0$,

$$u(M) = \frac{M^{1-\sigma}}{1-\sigma} \quad (6),$$

and for the loss $M<0$,

$$u(M) = -\lambda\left(-\frac{M^{1-\sigma}}{1-\sigma}\right) \quad (7),$$

where, λ is the level of loss aversion.

## 2. Experiment Site and Methods

(1) Experiment Site

We selected Mizhi County (located in the northern part of Shaanxi Province) as the experiment site for two main reasons. First, the northern part of Shaanxi was the key test site in China for implementing the Sloping Land Conversion Program (SLCP), which was subsequently introduced to other areas nationwide. Mizhi is one of the first counties in China to implement the SLCP, and thus using Mizhi as our experiment site is likely to provide representative results. Second, our research team has conducted a successive tracking survey since 2006. We selected 420 rural households from eight villages in Mizhi County for annual tracking, providing us first-hand data on farmer demographic factors to assist with further analysis on the effects of their risk attitudes. Among the 420 households, we ruled out households unable to provide answers to our questionnaire due to natural death, family migration, or not being able to comprehend the experiment. Eventually, we randomly chose 102 households as participants in our experiment. We conducted the experiment during the first two months of 2013.

The participants in our experiment were distributed among eight villages in Mizhi County: Chenjiagou, Fujiagou, Gongjiagou, Qianyuanze, Doujiagelao, Fengjiazhongzhuang, Gaoxigou, and Heiyanqing. These villages are scattered across the county (Fig. 1).

Among these villages, Gaoxigou had the highest average village income (60,438.72 yuan) due to tourism. Fujiagou had the lowest average village income (8,399.68 yuan), and is also the village second farthest from the county capital. Fengjiazhongzhuang is the village farthest from the county capital, and its average village income was only higher than that of Fujiagou. Of these eight villages, only Qianyuanze and Heiyanqing did not participate in the SLCP.

(2) Experimental Method

We adopted the Holt-Laury mechanism that provides a simple test for risk aversion using the MPL method.[1] Each experiment participant is presented with a choice between two lotteries termed A and B (see Table1-A). Panel A of Table 1-A is the fundamental payoff matrix presented to the

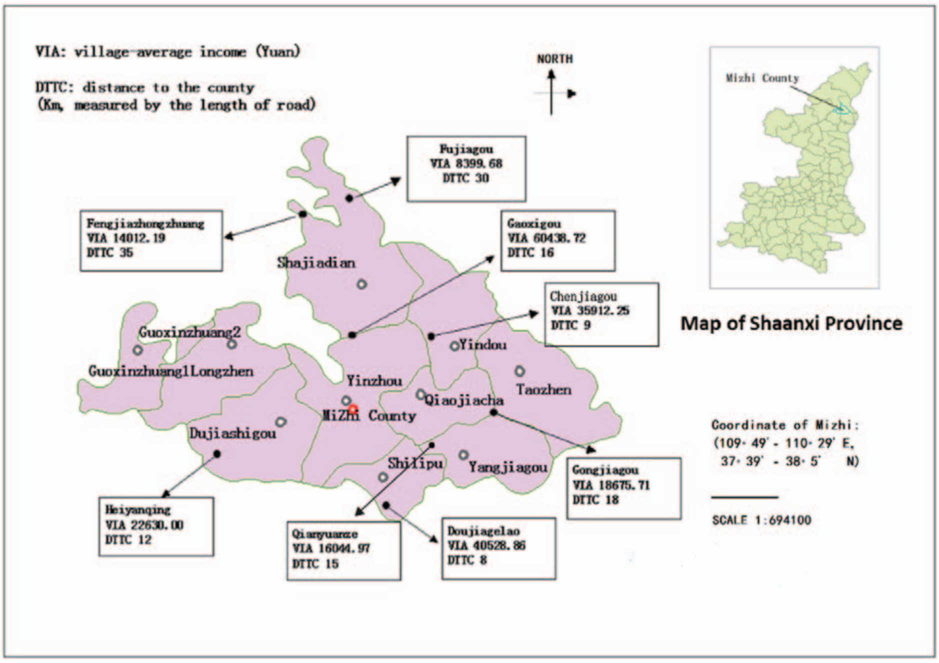


**Fig. 1. Map of Study Sites**

Note: This map is drawn based the county's administrative division in 2013.

participant. Take the first row of Table 1-A; lottery A offers a fixed payoff of 12 yuan. Similarly, lottery B in the first row of Table 1-A offers a 50% chance of receiving 8 yuan and a 50% chance of receiving 6 yuan. E (A) and E (B) are the expected values of lotteries A and B, respectively. E (A)-E (B) is the difference in the expected values of lotteries A and B. The column of E (A)-E (B) is not shown to the participants. As participants proceed down the matrix, E (B) and the value of "E (A)-E (B)" become greater. Moreover, participants were told before the start of the experiment that only one row of the 10 lotteries in each table would be played out, and that they would be paid in cash based on their answers in the game. The questionnaire has four tables. The values of monetary income in Tables 1-A, 2-A, and 3-A are all positive, and are used to elicit the risk aversion parameters. Conversely, the positive and negative values in Table 4-A are used to elicit the loss-aversion parameter. Since the participants are poorly educated, we simplified the probability by using a bingo game where four Ping-Pong balls are placed in a bingo cage. One of the balls is black and three are white. In this way, we were able to easily explain the probabilities to the farmers. The probabilities changed while the payoff increased from Tables 1-A to 3-A (i.e., 50% in Table 1-A, 25% in Table 2-A, 10% in Table 3-A). The participants made choices more cautiously when the probabilities dropped. They are expected to first choose A, and then turn to B according to their inner risk aversion and loss aversion levels. The purpose of the game for the researcher is to identify the point at which the participant's preference changes from A to B, which in turn indicates the range of the participant's degree of risk aversion. All of these instructions were explained to the farmers before starting the game.

Prior to eliciting every farmer's risk aversion level, we calculated the risk aversion parameters from Tables 1-A, 2-A, and 3-A. The results can be seen in the fourth column of these three tables, but are not shown to the experiment participants. The calculating process is as follows: if a participant chooses A in row 2 of Table 1-A, then chooses B in row 3 of Table 1-A, his or her risk preference can be represented as:

$$\frac{12^{1-\sigma}}{1-\sigma} \geq 0.5 * \frac{10^{1-\sigma}}{1-\sigma} + 0.5 * \frac{6^{1-\sigma}}{1-\sigma} \tag{8}$$

and

$$\frac{12^{1-\sigma}}{1-\sigma} \leq 0.5 * \frac{11^{1-\sigma}}{1-\sigma} + 0.5 * \frac{6^{1-\sigma}}{1-\sigma} \tag{9}$$

By solving the two equations simultaneously, we obtain the interval for the risk aversion parameter as 0.9697

[1] There are also several other methods to elicit risk attitudes, but Harrison (2008) has proven that the results are roughly the same despite of these different methods. The MPL method provides a relatively transparent procedure to elicit risk attitudes. Participants rarely get confused about the incentives to respond truthfully. The whole procedure of MPL is easy to explain to participants and implement. (Andersen et al. 2014)

**Table 1-A**

| NO. | Option A | Option B | E(A)-E(B) (yuan) | Risk aversion of turning points |
|---|---|---|---|---|
| 1 | 100% chance of winning 12 yuan | 50% chance of winning 8 yuan and 50% chance of winning 6 yuan | 5 | —— |
| 2 | 100% chance of winning 12 yuan | 50% chance of winning 10 yuan and 50% chance of winning 6 yuan | 4 | 0.9704 |
| 3 | 100% chance of winning 12 yuan | 50% chance of winning 11 yuan and 50% chance of winning 6 yuan | 3 | 0.9703 |
| 4 | 100% chance of winning 12 yuan | 50% chance of winning 16 yuan and 50% chance of winning 6 yuan | 1 | 0.0275 |
| 5 | 100% chance of winning 12 yuan | 50% chance of winning 19 yuan and 50% chance of winning 6 yuan | -1 | -0.3196 |
| 6 | 100% chance of winning 12 yuan | 50% chance of winning 22 yuan and 50% chance of winning 6 yuan | -2 | 0.5023 |
| 7 | 100% chance of winning 12 yuan | 50% chance of winning 22 yuan and 50% chance of winning 6 yuan | -2 | 0.7279 |
| 8 | 100% chance of winning 12 yuan | 50% chance of winning 29 yuan and 50% chance of winning 6 yuan | -5 | 0.7601 |
| 9 | 100% chance of winning 12 yuan | 50% chance of winning 34 yuan and 50% chance of winning 6 yuan | -8 | 0.7886 |
| 10 | 100% chance of winning 12 yuan | 50% chance of winning 38 yuan and 50% chance of winning 6 yuan | -10 | 0.7804 |

Note: "E(A)" represents the expected value of option A. "E(B)" represents the expected value of option B. "Risk aversion of turning points" represents the risk aversion level of the participant if he or she switched to option B in that row.

**Table 2-A**

| NO. | Option A | Option B | E(A)-E(B) (yuan) | Risk aversion of turning points |
|---|---|---|---|---|
| 1 | 100% chance of winning 12 yuan | 25% chance of winning 8 yuan and 75% chance of winning 6 yuan | 6 | —— |
| 2 | 100% chance of winning 12 yuan | 25% chance of winning 11 yuan and 75% chance of winning 6 yuan | 5 | 0.9733 |
| 3 | 100% chance of winning 12 yuan | 25% chance of winning 14 yuan and 75% chance of winning 6 yuan | 4 | 0.9775 |
| 4 | 100% chance of winning 12 yuan | 25% chance of winning 24 yuan and 75% chance of winning 6 yuan | 2 | 0.1983 |
| 5 | 100% chance of winning 12 yuan | 25% chance of winning 30 yuan and 75% chance of winning 6 yuan | 0 | -0.2925 |
| 6 | 100% chance of winning 12 yuan | 25% chance of winning 37 yuan and 75% chance of winning 6 yuan | -2 | 0.1706 |
| 7 | 100% chance of winning 12 yuan | 25% chance of winning 43 yuan and 75% chance of winning 6 yuan | -3 | 0.4272 |
| 8 | 100% chance of winning 12 yuan | 25% chance of winning 50 yuan and 75% chance of winning 6 yuan | -5 | 0.5648 |
| 9 | 100% chance of winning 12 yuan | 25% chance of winning 59 yuan and 75% chance of winning 6 yuan | -7 | 0.6344 |
| 10 | 100% chance of winning 12 yuan | 25% chance of winning 69 yuan and 75% chance of winning 6 yuan | -10 | 0.6557 |

Note: "E (A)" represents the expectation value of Option A. "E (B)" represents the expected value of option B. "Risk aversion of turning points" represents the risk aversion level of the participant if he or she switched to option B at that row.

**Table 3-A**

| NO. | Option A | Option B | E(A)-E(B) (yuan) | Risk aversion of turning points |
|---|---|---|---|---|
| 1 | 100% chance of winning 12 yuan | 10% chance of winning 8 yuan and 90% chance of winning 6 yuan | 6 | —— |
| 2 | 100% chance of winning 12 yuan | 10% chance of winning 16 yuan and 90% chance of winning 6 yuan | 5 | 1.0535 |
| 3 | 100% chance of winning 12 yuan | 10% chance of winning 24 yuan and 90% chance of winning 6 yuan | 4 | -0.7695 |
| 4 | 100% chance of winning 12 yuan | 10% chance of winning 48 yuan and 90% chance of winning 6 yuan | 2 | -1.4307 |
| 5 | 100% chance of winning 12 yuan | 10% chance of winning 64 yuan and 90% chance of winning 6 yuan | 0 | -0.1866 |
| 6 | 100% chance of winning 12 yuan | 10% chance of winning 80 yuan and 90% chance of winning 6 yuan | -1 | 0.0619 |
| 7 | 100% chance of winning 12 yuan | 10% chance of winning 96 yuan and 90% chance of winning 6 yuan | -3 | 0.2098 |
| 8 | 100% chance of winning 12 yuan | 10% chance of winning 112 yuan and 90% chance of winning 6 yuan | -5 | 0.3096 |
| 9 | 100% chance of winning 12 yuan | 10% chance of winning 136 yuan and 90% chance of winning 6 yuan | -7 | 0.3939 |
| 10 | 100% chance of winning 12 yuan | 10% chance of winning 160 yuan and 90% chance of winning 6 yuan | -9 | 0.4618 |

Note: “E(A)” represents the expected value of option A. “E(B) ”represents the expected value of option B. “Risk aversion of turning points” represents the risk aversion level of the participant if he or she switched to option B in that row.

**Table 4-A**

| NO. | Option A | Option B | E(A)-E(B) (yuan) |
|---|---|---|---|
| 1 | 50% chance of winning 30 yuan and 50% chance of losing 8 yuan | 50% chance of winning 60 yuan and 50% chance of losing 30 yuan | 12 |
| 2 | 50% chance of winning 26 yuan and 50% chance of losing 8 yuan | 50% chance of winning 60 yuan and 50% chance of losing 30 yuan | 10 |
| 3 | 50% chance of winning 22 yuan and 50% chance of losing 8 yuan | 50% chance of winning 60 yuan and 50% chance of losing 30 yuan | 8 |
| 4 | 50% chance of winning 18 yuan and 50% chance of losing 8 yuan | 50% chance of winning 60 yuan and 50% chance of losing 30 yuan | 6 |
| 5 | 50% chance of winning 14 yuan and chance of 50% losing 8 yuan | 50% chance of winning 60 yuan and 50% chance of losing 30 yuan | 4 |
| 6 | 50% chance of winning 10 yuan and 50% chance of losing 8 yuan | 50% chance of winning 60 yuan and 50% chance of losing 30 yuan | 2 |
| 7 | 50% chance of winning 6 yuan and 50% chance of losing 8 yuan | 50% chance of winning 60 yuan and 50% chance of losing 30 yuan | 0 |
| 8 | 50% chance of winning 2 yuan and 50% chance of losing 8 yuan | 50% chance of winning 60 yuan and 50% chance of losing 30 yuan | -2 |
| 9 | 50% chance of losing 2 yuan and 50% chance of losing 8 yuan | 50% chance of winning 60 yuan and 50% chance of losing 30 yuan | -4 |
| 10 | 50% chance of losing 202 yuan and 50% chance of losing 8 yuan | 50% chance of winning 60 yuan and 50% chance of losing 30 yuan | -8 |

Note: “E (A)” represents the expected value of option A. “E (B)” represents expected value of option B.

≤≤ 0.97097. Thus, the mean value is 0.9703.

Finally, we took the average value of the risk aversion parameters obtained from Tables 1-A, 2-A, and 3-A as the risk aversion level of the respondents. Not all questionnaires conformed to the rule of first choosing A then choosing B from each table. We removed these questionnaires in our final analysis, so as to ensure our ability to elicit the risk aversion parameters precisely.

## Experimental Results and Empirical Study

### 1. Experimental Results

We classified the experimental results into different categories by computing the proportion of safe choices in each lottery term for the participants in the eight villages.

Figures 2-17 above indicate that the experimental results all deviated, to varying degrees, from the baselines (i.e., 1-A, 2-A, 3-A standard lines) calculated using expected utility theory. Moreover, the farmers of the eight villages had indicated their preference for safer choices.

By averaging the values of risk aversion of our experiment participants, we can see that the overall average level of risk aversion in the eight villages is 0.19. The level of average risk aversion of Gaoxigou is 0.02, which implies that farmers from Gaoxigou are almost neutral to risks. Furthermore, the risk aversion levels of Doujiagelao and Fujiagou are relatively higher than those in other villages. As estimated in other similar studies, the risk aversion level is 0.68-0.97 in the United States of America (Holt and Laury 2002), 0.68-0.71 in India (Binswanger 1980), 0.81-2.00 in Zambia (Wik et al. 2004 as cited in Tanaka et al. 2014), 0.6 in Vietnam (Tanaka et al. 2010), and 0.48 in other provinces of China (Liu 2013). The level of loss aversion is 3.93 in Uganda (Tanaka et al. 2014) and 2.50-3.00 in other provinces of China (Liu, 2013). The overall average level of loss aversion in our research is 2.52, which is also lower than other estimates of loss aversion levels. These results indicate that the farmers involved in our research showed lower levels of risk aversion than those in other studies, providing us with the hypothesis that the Sloping Land Conversion Program (SLCP) affected the basic risk attitudes of farmers from our targeted area.

Tanaka et al. (2010) found a direct relationship between average village income and farmers' risk aversion levels: farmers from poorer villages were more loss averse than those from wealthy villages. In our experiment, we found that although Gaoxigou possessed the highest average income and the lowest risk aversion level, there was no correlation between village average income and risk aversion or the loss aversion level. Thus, we further explored the effect of personal risk attitudes.

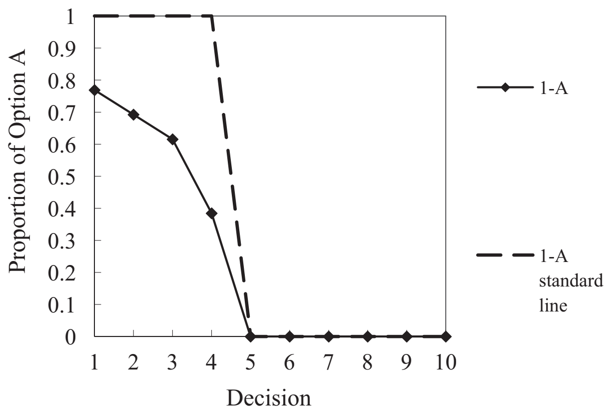


**Fig. 2. Proportion of safe choices in each decision of Table 1-A in Doujiagelao**

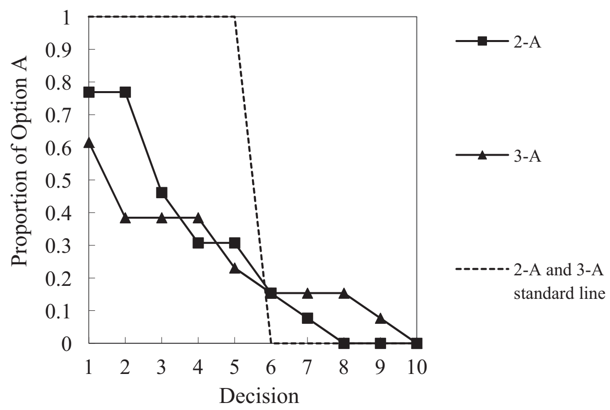


**Fig. 3. Proportion of safe choices in each decision of Tables 2-A and 3-A in Doujiagelao**

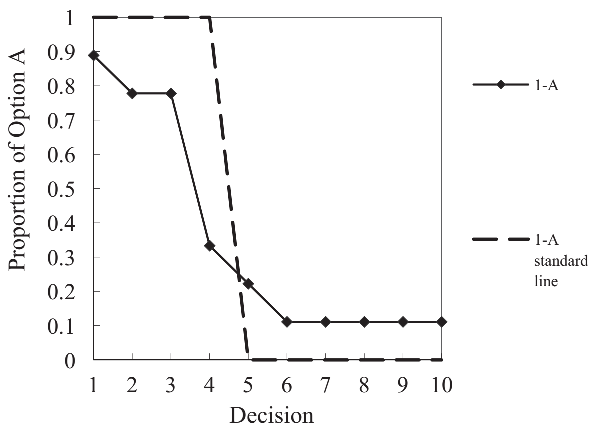


**Fig. 4. Proportion of safe choices in each decision of Table 1-A in Fengjiazhongzhuang**

### 2. Regression Analysis

(1) Method

Based on the dataset used to track developments in the eight villages, we introduced household demographic characteristics into our regression equation. We did not include adopt household income in the regression due to the

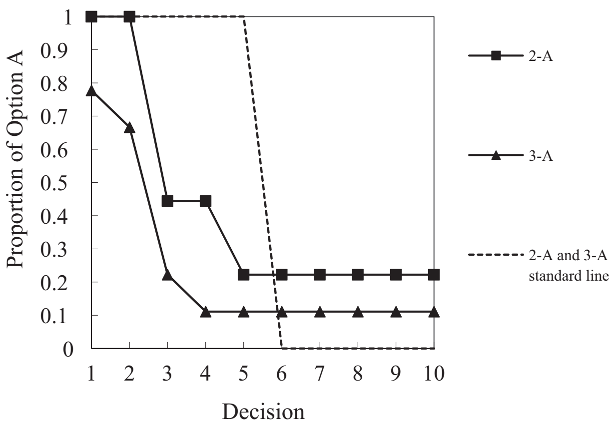


**Fig. 5. Proportion of safe choices in each decision of Tables 2-A and 3-A in Fengjiazhongzhuang**

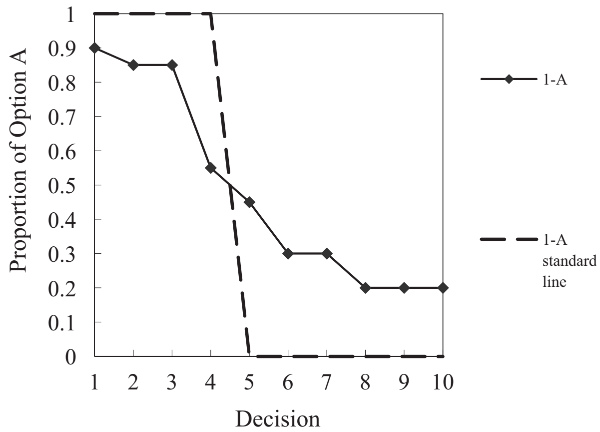


**Fig. 8. Proportion of safe choices in each decision of Table 1-A in Heiyanqing**

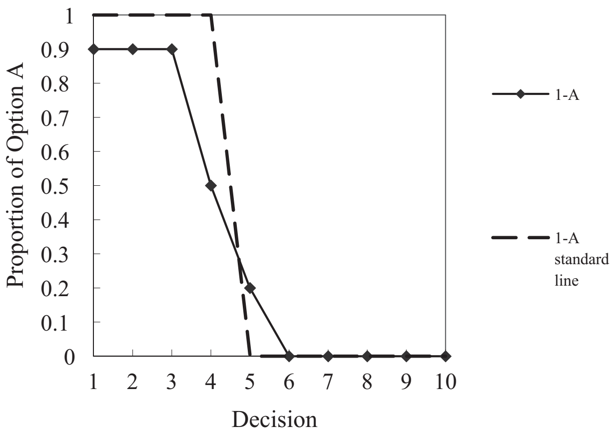


**Fig. 6. Proportion of safe choices in each decision of Table 1-A in Gaoxigou**

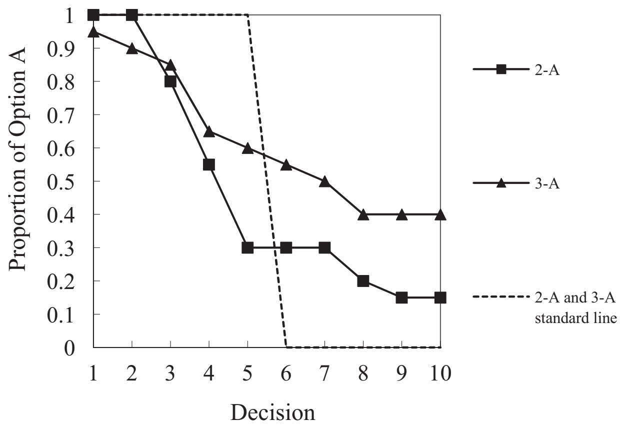


**Fig. 9. Proportion of safe choices in each decision of Tables 2-A and 3-A in Heiyanqing**

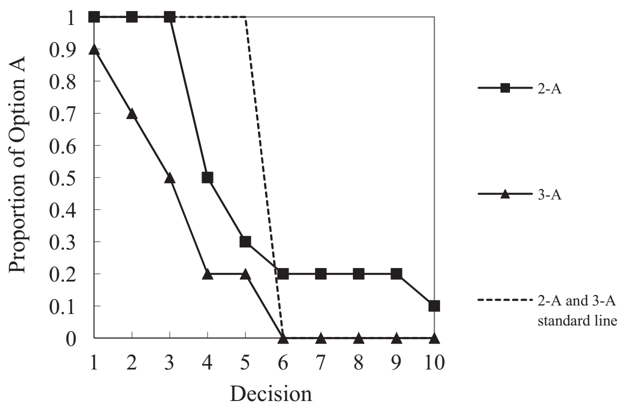


**Fig. 7. Proportion of safe choices in each decision of Tables 2-A and 3-A in Gaoxigou**

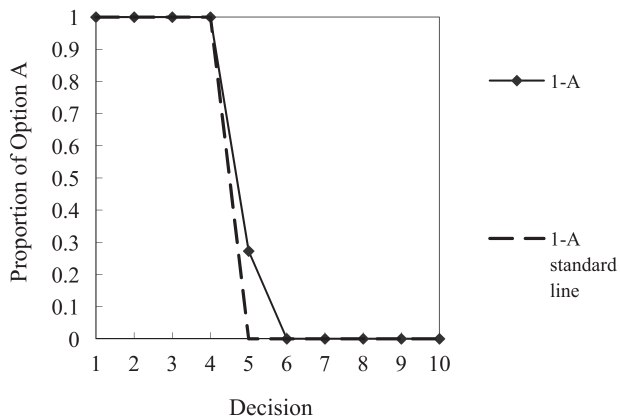


**Fig. 10. Proportion of safe choices in each decision of Table 1-A in Qianyuanze**

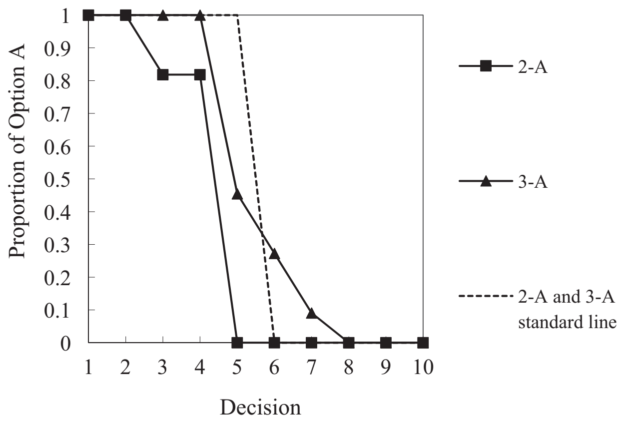


**Fig. 11. Proportion of safe choices in each decision of Tables 2-A and 3-A in Qianyuanze**

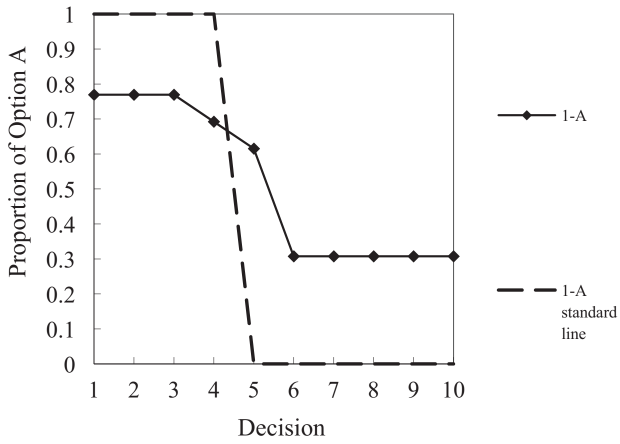


**Fig. 14. Proportion of safe choices in each decision of Table 1-A in Fujiagou**

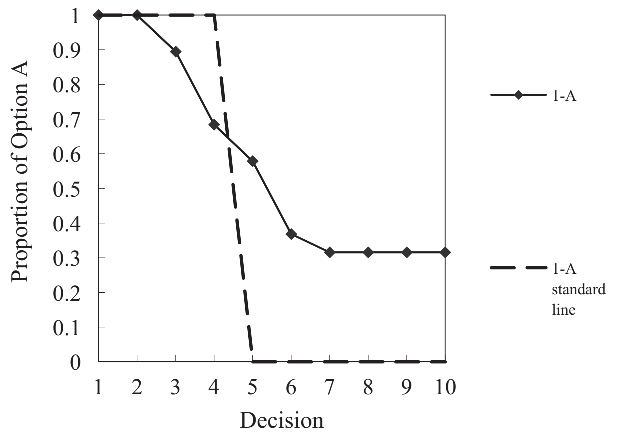


**Fig. 12. Proportion of safe choices in each decision of Table 1-A in Gongjiagou**

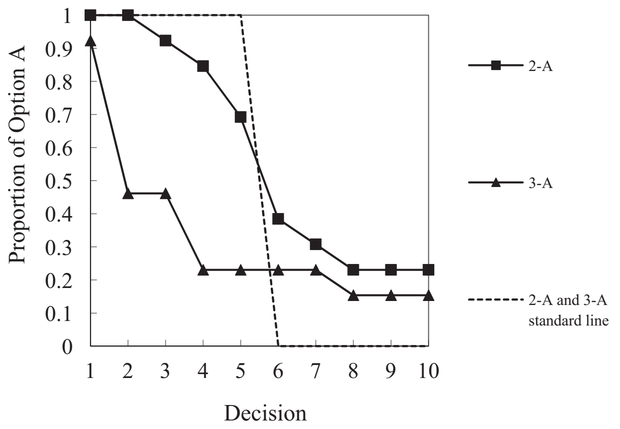


**Fig. 15. Proportion of safe choices in each decision of Tables 2-A and 3-A in Fujiagou**

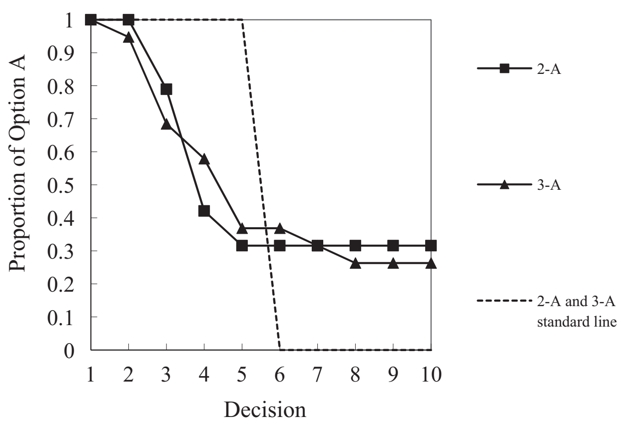


**Fig. 13. Proportion of safe choices in each decision of Tables 2-A and 3-A in Gongjiagou**

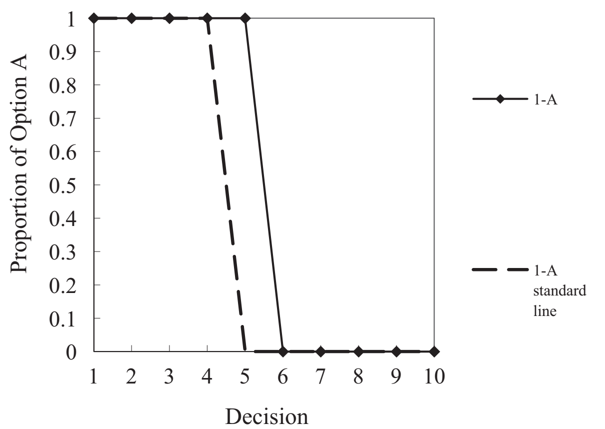


**Fig. 16. Proportion of safe choices in each decision of Table 1-A in Chenjiagou**

problem of endogeneity. Instead, we used the proportion of wage earners in a family as an instrumental variable. The correlation index between household income and the proportion of wage earners was 0.7. Table 1 lists the definitions of these variables.

In addition to household demographic factors, we added two more independent variables: the proportion of converted land area to the total farmland area of the rural household (PCL), and the proportion of sloping land area to the total farmland area of the rural household (PSL), in order to represent the effect of the SLCP. We regressed the curvature of the utility function (σ) by using OLS regression. In order to test the robustness of the OLS regression results, we used the method of maximum likelihood estimation (MLE). The equation is as follows:

$$\boldsymbol{Y_i} = \boldsymbol{a} + \boldsymbol{bX_i} + \varepsilon_i \qquad (10).$$

Here, $\boldsymbol{Y_i}$ denotes the observed degree of risk or loss aversion from the experiment, $\boldsymbol{X_i}$ is the vector of individual participants, and household characteristics of participant **i**. $\varepsilon_i$ is assumed to be normally distributed with zero mean.

Before conducting the final regression, we performed a simple regression without using the PSL and PCL variables. Table 2 presents all estimation results.

(2) Factors that influence risk aversion

Table 2 shows that in the regression without using the PCL and PSL variables, not all independent variables are significant; however, the variables age square and education are relatively more significant than the others. Similar results were found for Vietnamese villages studied in Tanaka's study (2010).

After introducing the PCL and PSL variables, the R-square value largely improved to 0.2543 from 0.05, which means that PCL and PSL truly affect farmer's risk attitudes. We found that the education level of the head of the household has a significant effect on the level of risk aversion at the 5% significance level, suggesting that more educated heads of households are more risk averse. The effect of distance to the county capital is 0.0128, which is significant at the 10% level of significance, implying that the risk aversion level of farmers increases with distance to the county capital. This is probably because the availability of market information varies with distance to the county

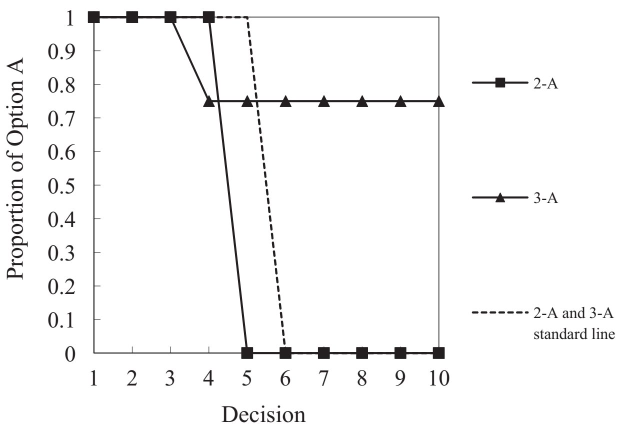


**Fig. 17. Proportion of safe choices in each decision of Tables 2-A and 3-A in Chenjiagou**

Note: The horizontal axis represents the options (lotteries) from 1 to 10 in each table; the vertical axis represents the proportion of safe choices (choosing A) in each option (lottery). The 1-A line represents the proportion of safe choices in Table 1-A; the 2-A line represents the proportion of safe choices in Table 2-A; the 3-A line represents the proportion of safe choices in Table 3-A. The 1-A, 2-A, and 3-A standard lines are the standard conversion (turning A to B) lines calculated by expected utility theory for Tables 1-A, 2-A, and 3-A, respectively. Further details about the lines are given in the attached tables.

**Table 1. Definitions of Variables**

| Variables | Definition |
|---|---|
| Distance | Distance from the house to the center of Mizhi County in kilometers |
| Education | No. of years of education completed by the head of the household |
| Wage earners | Proportion of household wage earners to total household members |
| Age | Age of the head of the household |
| Age square | Squared age of the head of the household |
| No-work members | Proportion of household members who cannot work |
| Land | Household land area per capita |
| PCL | Proportion of converted land area to total household farmland area |
| PSL | Proportion of sloping land area to household's total farmland area |
| Allowance | Allowance income from participation in the SLCP. |

Note: We introduce the "Age square" variable in an attempt to verify the non-linear effect of human capital on risk aversion.

**Table 2. Estimates of Risk Aversion and Loss Aversion**

| | Risk aversion (OLS) | Risk aversion (OLS) | MLE of Risk aversion | OLS estimates with allowance level | OLS based on Table 3-A (OLS) | Loss aversion (OLS) |
|---|---|---|---|---|---|---|
| Independent variables | | | | | | |
| Constant | 0.1492<br>(0.7185) | 0.3353<br>(0.4353) | -1.03E-06<br>(1.0000) | 0.3296<br>(0.4384) | 0.1388<br>(0.8624) | 0.6560<br>(0.3749) |
| Education | 0.1492<br>(0.1898) | 0.1025<br>(0.0364**) | 0.8410<br>(0.0396**) | 0.1032<br>(0.0333**) | 0.1890<br>(0.0385**) | -0.1100<br>(0.1550) |
| Distance | 0.0034<br>(0.6019) | 0.0128<br>(0.0873*) | 0.2659<br>(0.1333) | 0.0128<br>(0.0843*) | 0.0159<br>(0.2564) | -0.0240<br>(0.0595*) |
| Wage earners | 0.0283<br>(0.9037) | -0.0559<br>(0.8057) | -0.0419<br>(0.7409) | | -0.0744<br>(0.8592) | 0.3084<br>(0.3883) |
| Age | 0.0002<br>(0.9712) | 0.0028<br>(0.6215) | 0.0786<br>(0.6264) | 0.0029<br>(0.6174) | 0.0045<br>(0.6710) | 0.0080<br>(0.4467) |
| Age square | -0.0055<br>(0.2395) | -0.0095<br>(0.0433**) | -0.8323<br>(0.0444**) | -0.0097<br>(0.0360**) | -0.0166<br>(0.0622**) | 0.0072<br>(0.1635) |
| No-work members | 0.1300<br>(0.4803) | -0.0325<br>(0.8610) | -0.0240<br>(0.8558) | -0.0402<br>(0.8244) | 0.2119<br>(0.5473) | 0.3031<br>(0.3227) |
| Land | 0.0023<br>(0.8364) | 0.0065<br>(0.5530) | 0.0757<br>(0.5455) | 0.0065<br>(0.5476) | -0.0129<br>(0.5305) | 0.0235<br>(0.0579*) |
| PCL | | -0.7890<br>(0.0049***) | -0.5316<br>(0.0050***) | | -1.3920<br>(0.0064***) | 0.4990<br>(0.0083***) |
| PSL | | -0.9256<br>(0.0006***) | -0.7517<br>(0.0019***) | -0.9180<br>(0.0005***) | -1.5442<br>(0.0020***) | 0.4671<br>(0.0044***) |
| Allowance | | | | -0.7942<br>(0.0041***) | | |
| $R^2$ | 0.0528 | 0.2543 | | 0.2159 | 0.2175 | 0.2687 |
| F-statistic | 0.4615 | 1.9702 | | 2.2487 | 1.6983 | 1.6329 |

Note: *** represents significance at the 1% level; **represents significance at the 5% level; *represents significance at the 10% level. All of the data have been standardized.

In this study, participants played a series of four games that contain 40 pair-wise choices. Each participant was asked to make their own choices for each row in the following tables:

capital. Sufficient knowledge owing to proximity to the county market reduces the uncertainty of production activities. The effect of the age of the head of the household is not significant at 0.0028, and that of the age of the head of the household squared is -0.0095 at the 10% significance level, indicating that level of risk aversion increases with the age of the head of the household, but at a decreasing rate. These results are similar to findings from Vietnam and Uganda. When the head of the household ages, livelihood activities become more stable, leading to a low level of risk aversion.

Our study is the first to introduce public policy factors into the discussion of risk aversion. We used PSL and PCL to estimate the effect of a public program on farmers' risk attitudes. Here, PCL is 0 for those not participating in the Sloping Land Conversion Program (SLCP).

The regression results show that the effect of PCL is -0.7890, which is significant at the 1% significance level. This indicates that implementation of the SLCP has had a strong negative influence on the farmers' risk aversion levels. The increased conversion of farmland leads to a lower level of risk aversion among the farmers. There are two possible explanations for this finding. First, the SLCP delivered a sufficient and stable government allowance to the farmers. And secondly, local farmers turned to more non-farm production activities after participating in this public program. Non-farm income is much higher and more stable in these provinces than farming income because the local climate is unsuitable for agriculture. However, we found that the proportion of family wage earners is not a significant variable, which suggests that the sufficient and stable government allowance is the main reason affecting the farmers' risk aversion level.

The effect of PSL is also negative and significant at the 1% significance level. The implementation of the SLCP reduced PSL, and thus, farmers shifted their resources for use on flat farmland. This increased the level of risk aversion to crop failure due to the terrible climates in the northern area of Shaanxi.

In the regression of loss aversion, the effect of the household land variable is positive and significant at the 10% significance level; this indicates that farming income is very uncertain for farmers in this region. The effect of PCL is 0.4990, and that of PSL is 0.4671. Both effects are significant at the 1% level. Thus, when people earn more stable income and possess more flat farmland, they tended to be more averse to the loss of wealth.

Primarily, we see that the effect of the SLCP on farmers' risk aversion level was mixed because farmers were affected in different ways after participating in the SLCP.

(3) Robustness test

We used different regression methods to reestimate the effect of independent variables on the level of risk aversion, in order to guarantee the robustness of our conclusions. The results are also presented in Table 2 as the maximum-likelihood estimates (MLE) of risk aversion, ordinary least-squares (OLS) estimates with the allowance obtained by farmers participating in the SLCP, and OLS estimates based on Table 3-A.

The regression results on the third line of Table 2 report the MLE results. The OLS estimates with the allowance replacing the PCL variable are showed on the fourth line of Table 2. In the regression based on Table 3-A showed on the fifth line of Table 2, the risk aversion level elicited from the table was used to replace the original dependent variable. We chose the risk aversion level elicited from Table 3-A, because monetary values in this table are roughly equivalent to the daily wages of a normal laborer in rural area of Mizhi County. Thus, the respondents choose more cautiously for Table 3-A. Binswanger (1980) and Holt (2002) both support this point.

Through the robustness test we found that the parameters of each variable and their significance levels remain stable. Although the distance variable is insignificant even at the 10% significance level, it is the most significant of the insignificant variables. Thus, we can conclude that the results of our regression results are robust.

## Conclusion

This study measured the level of risk aversion and loss aversion of rural households in the Loess Plateau area of Shaanxi Province in China. The average levels of risk aversion and loss aversion in our study were 0.19 and 2.52, respectively, which are lower than respective levels estimated in other areas worldwide. Education, distance to the county capital, and the age of the head of the household significantly affected the risk aversion level of the rural household.

After introducing the effects of reforestation of the cultivated land on rural households participating in the Sloping Land Conversion Program (SLCP), we drew the following conclusions: We used PCL and PSL to represent the effects of the SLCP. A high proportion of converted area corresponds to a low risk aversion level and a high loss aversion level. Further analysis implies that a high level of allowance income is the main reason leading to that result. As for PSL, under harsh climates, increasing the proportion of flatland leads to increased concentration of agricultural investment by farmers, thereby lowering their risk aversion.

Our study had two limitations, however. First, we used data from a tracking survey for Mizhi County only, which raises questions about the applicability of our conclusions to other places. We need to conduct more research on other areas to confirm our conclusions. Second, when processing the experimental data, we used a simple averaging method. An alternative method is the interval regression method, which thus far is only found in Tanaka's research (2014) in rural Uganda. By using this method, they intended to make full use of internal data but lacked definitive proof. Thus, multiple econometric methods are needed for more effective digging for data in this field. We should also further develop the experimental data processing method to improve the precision of estimates.

## Acknowledgements

This paper reported the results obtained in joint projects on "Research on the Peasant Households Responding and the Economic Effects of Ecological Migration Policy from an Anti-poverty Perspective" (71377208) and "Experimental Measurement on Farmers' Risk Preferences and Interconnection between Public Policies and Farmers"(71573208) sponsored by the National Natural Science Foundation of China, "Econometric Analysis on Development, Utilization and Conserveation of Regional Common Resources and Building of Environment Friendly Rural Industry System" sponsored by the Japan Society for the Promotion of Science, and two other projects

(A213021203, A213021501). In addition, the authors are thankful for the valuable comments of the anonymous reviewers.

## References

Andersen S. et al. (2004) Elicitation Using Multiple Price List Formats [J]. *Experimental Economics*, **9(4)**: 383-405(23).

Benhabib, J. et al. (2004) Hyperbolic discounting: An experimental analysis. *New York University Department of Economics Working Paper*.

Binswanger, H. P. (1980) Attitudes toward risk: Experimental measurement in rural India. *American Journal of Agricultural Economics*, **62(3)**, 395-407.

Harrison, G. W. & Rutström, E. E. (2008) Risk aversion in the laboratory. Research in Experimental Economics, **12(8)**, 41-196.

Holt, C. A. & Laury, S. K. (2002) Risk aversion and incentive effects. *American Economic Review,* **92(5)**, 1644-1655.

Kahneman, D. & Tversky A. (1979) Prospect theory: An analysis of decision under risk. *Econometrica*: **47(2)**, 263-291.

Kanbur, R. & Squire, L. (1999) The evolution of thinking about poverty: exploring the interactions. In *Symposium on "Future of Development Economics in Perspective"* held in Dubrovnik, sponsored by the University of Zagreb and the World Bank (Vol. **13**, p.14).

Li, J. et al. (2011) Rural household income and inequality under the Sloping Land Conversion Program in western China. *Proceedings of the National Academy of Sciences*, **108(19)**, 7721-7726.

Liu, E. M. (2013) Time to change what to sow: Risk preferences and technology adoption decisions of cotton farmers in China. *Review of Economics and Statistics*, **95(4)**, 1386-1403.

Miller, Louis et al. (1969) "Choice Among Equal Expected Value Alternatives: Sequential Effects of Winning Probability Level on Risk Preferences," *Journal of Experimental Psychology*, **79(3)**, 419-423.

Mosley, P. & Verschoor, A. (2005) Risk attitudes and the 'vicious circle of poverty'. *The European Journal of Development Research*, **17(1)**, 59-88.

Nielsen, U. (2001) *Poverty and attitudes towards time and risk: Experimental evidence from Madagascar*. Royal Veterinary and Agricultural Univ.

Rosenzweig, M. R. & Binswanger, H. P. (1992) *Wealth, weather risk, and the composition and profitability of agricultural investments*. World Bank Publications.

Tanaka, T., Camerer, C. F. & Nguyen, Q. (2010) Risk and time preferences: linking experimental and household survey data from Vietnam. *American Economic Review*, **100(1)**, 557-571.

Tanaka, Y. & Munro, A. (2014) Regional Variation in Risk and Time Preferences: Evidence from a Large-scale Field Experiment in Rural Uganda. *Journal of African Economies*, **23(1)**, 151-187.

Von Neumann, J. & Morgenstern, O. (2007) *Theory of Games and Economic Behavior (60th Anniversary Commemorative Edition)*. Princeton University Press.

Wik, M. et al. (2004) On the measurement of risk aversion from experimental data. *Applied Economics*, **36(21)**, 2443-2451.

Wang, S. & Cai, M. (2011) Measurement and Influencing Factors of citizens in China: Based on the data of the Citizens' Investment Behavior in China. *Jinrong Yanjiu* (*Journal of Financial Research)*, **8**, 192-206 [In Chinese with English abstract].

Xu, J. et al. (2010) China's sloping land conversion program: does expansion equal success? *Land Economics*, **86(2)**, 219-244.

Yesuf, M. (2004) *Risk, time and land management under market imperfections: Applications to Ethiopia*. No.139

Zhou, Y. et al. (2012) Experiment Research on the individuals' risk aversion. *Guanli Shijie* (Management World*)*, **6**, 86-95 [In Chinese with English abstract].