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A STUDY ON REVENUE INSURANCE BUYING FOR CUSTARD APPLE IN TAIWAN: PERSPECTIVES FROM PROSPECT THEORY AND AMBIGUITY PREFERENCE

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Abstract

This paper studies why the demand for Agricultural revenue insurance is so low in Taiwan even the government subsidize almost half of the premium. We look into how risk attitude, probability ambiguity and claim payment ambiguity can affect the lower demand of the insurance, and control factors like age, education, farming experience, scale, and loan borrowing. By the survey data of 199 farmers, we find that half of the sample farmers are kind of risk lovers, and, about half of them haver problem of probability ambiguity or claim payment ambiguity. By using the two-class logistic model of insurance buying or no buying, we find that the risk attitude as risk aversion has significant positive impacts on the insurance buying, or the risk lover has less demand for the insurance. However, the probability ambiguity and claim payment ambiguity, which are expected to have negative impacts on the insurance demand, is not statistically significant.
Keywords: *Prospect theory, ambiguity preference, agricultural revenue insurance.*
JEL Codes: *G12, G22, Q14.*

1. Introduction

Risk preference is a key factor for risk decision making and insurance demand. Based on the expected utility theory (EUT), people who are risk averse are willing to buy full insurance under fair premium or buy partial insurance under unfair premium. As risk averters are defined as people with decreasing marginal utility of wealth, most people are kind of risk averse. Thus, it is expected that most people would prefer buying some insurance. However, it is often found that farmers are not very interested in buying agricultural insurance even governments subsidize almost half of the premium. For instance, in Taiwan, custard apple revenue insurance policy is recently provided, and there is only about one percent of the total planted areas is covered by the insurance.

As risk preference relates to risk decision, ambiguity preference is associated with decision under uncertainty. Here, uncertainty is defined as an unknown-probability risk. By the seminal work of Ellsberg (1961), people tend to prefer known-probability risks to unknown-probability risks. That is, people are often ambiguity averse. With unknown-probability risks, if people are ambiguity averse, the willingness to buy insurance will be reinforced (Avary et al, 2013). Thus, if agricultural risks belong to an unknown-probability risk, we would not expect the weak demand for agricultural insurance.

This paper looks into the low agricultural insurance demand from the viewpoints of Prospect theory. Prospect theory, developed by Kahneman and Tversky (1979, 1992), is an alternative to EUT. As argued by Kahneman and Tversky (1979), facing risk of gains, people behave more like risk averters while facing risk of losses, they behave more like risk seekers. Thus, unlike EUT where risk aversion is normally assumed, there is a reference point of risk preference reversal in the Kahneman and Tversky framework. By Prospect theory, people's risk preference depends on the potential gains or losses relative to their specific situation (the reference point). Thus, people would rather stay with uncertain losses than paying the insurance premium, which can be regarded as a kind of certain losses to them. Therefore, to explain the willingness to buy insurance, we can look into whether the decision makers are mostly a risk averter or risk seeker. For risk seekers, they have no intention to buy any insurance even under fair premiums.

Risk preference can also be time varying and depend on previous outcomes. As argued by Thaler and Johnson (1990), people's risk preference varies with past outcomes. Past success reduces their risk aversion as they feel like "gambling with house money." In Thaler and Johnson (1990), their experiments support the house money effect, where people's risk aversion decreases in the presence of prior gains. Similarly, we argue that people's experience of no losses with no insurance become more risk seeking, and this keeps them from buying any insurance.

We further investigate the relationship between the willingness to buy insurance and ambiguity preference. As argued by Traumann and Wakker (2018), people are usually ambiguity averse when the probability distribution of gains is uncertain while they are usually ambiguity loving when they face losses with an uncertain probability distribution. This is similar to the risk preference reversal in Prospect theory. For ambiguity preference, there is also a reference point of ambiguity preference reversal. Thus, when people face losses with an unknow probability distribution, they often behave like ambiguity lovers. As opposite to ambiguity aversion, ambiguity loving may decrease the willingness to buy insurance.

For agricultural revenue insurance, the revenue risk comes from the price risk and production risk. Due to the unpredictable patterns of climate changes and natural disasters, we expect that the production risk could be an unknown risk for the farmers. Thus, for ambiguity lovers, the probability ambiguity of the production losses and then the revenue losses may decrease the demand for the revenue insurance.

Another ambiguity may also cause less demand for the revenue insurance. Though covering both price risk and production risk is the advantage of the revenue insurance, the insured may end up with no claim payments with very low price but high yield, and very high price but low yield. This may occur when one of the risks happens, but the revenue is not particularly low. In addition, in Taiwan, the claim payments are based on regional revenue, not individual farm's revenue. Thus, some farmers may end up with no claim payments even they suffer big revenue losses. We classify these as claim payment ambiguity. This ambiguity likely causes less demand for the revenue insurance as Peter and Ying (2019) prove that ambiguity aversion about contract nonperformance lowers optimal insurance demand.

Based on the survey of custard apple farmers, we hope to find out their risk attitude, and whether they have probability ambiguity and claim payment ambiguity, and their risk attitude after no recent losses and big recent losses. We also investigate how the risk attitudes, the ambiguity and other factors, like age, education, farming experience, scale, and loan borrowing, affect their willingness to buy revenue insurance. We hypothesize that the risk attitude and the probability and claim payment ambiguity could be the important factors in explaining the lower revenue insurance demand.

The rest of this paper is organized as follows: literature is reviewed in the second section. The survey data and methodology are presented in the third section. In Section Four, the results are reported and discussed. Section Five concludes.

2. Literature Review

The theory of insurance demand has long been studied by using expected utility theory. The utility function of the decision maker is always assumed to be an increasing and concave utility function. Thus, the decision maker is risk averse, dislike fair gambles, and has preference for certain losses over uncertain ones with the same expected value. As derived by Mossin (1968), with fair premium, the optimal insurance is full insurance while, under unfair premiums, partial insurance is optimal.

The EUT resolves the St. Petersburg Paradox and proves useful to explain some popular risk decisions which contradict the expected value rule. For instance, in risk decision making, except for the expected value, the standard deviation and the higher moments are often considered. However, there are some famous risk choices that cannot explained by the expected utility rule, for instance, Alias Paradox.

Similar to the utility function, Kahneman and Tversky (1979) develop the value function. Based on a reference point which divides the gain and loss situations, the value function of gains is concave while the value function of losses is convex. Thus, it is different from EUT where a concave utility function is generally assumed, and it always implies risk aversion. In Prospect theory, the risk preference is not constant, but can be reversed when crossing the reference point.

Like Prospect theory, where people facing the risk of gain behave like risk averters while, facing the risk of loss, they behave like risk seekers, Baillion and Bleichrodt (2015) find that people are ambiguity averse for likely gains, but ambiguity seeking for likely losses. In addition, Brenner and Izhakian (2018) also find that the aversion to ambiguity increases with the expected probability of favorable gains, and the love for ambiguity increases with the expected probability of unfavorable losses. Thus, like there is a reference point of risk preference reversal in Prospect theory, there is also a reference point of ambiguity preference reversal.

For firms' insurance, Mayers and Smith (1982) firstly use modern theory of finance to analyze corporate demand for insurance. In addition to risk aversion, they illustrate some important reasons for corporate insurance demand. For instance, insurers have a comparative advantage in taking risk (Mayers and Smith, 1982; Doherty and Smith, 1993; Eeckhoudt, Schlesinger and Gollier, 2005)). Insurance can reduce the volatility of revenues and therefore reduce firms' bankruptcy costs (Mayers and Smith, 1982; Smith and Stulz, 1985; Froot, Scharfstein, and Stein, 1993) or taxes (Mayers and Smith, 1982; MacMinn, 1987). Also, Bustos et al. (2021) provide empirical evidence that firms with greater financial constraint or in more volatile sector have higher insurance demand. Krummaker (2019) makes a explorative approach of investigating firms' demand for insurance by comparing the theory and practice.

Insurance may also affect the willingness of investing into risky projects as Cole et al. (2017) shows in the context of agricultural insurance. They find that insurance against rainfall can induce farmers to invest more in higher-return but rainfall sensitive crops, particularly among educated farm. Similarly, Falola et al. (2013) higher educated have more willingness to take agricultural insurance and produce more. Ashan et al. (1982) point out that, with fair premium, agricultural producers tend to produce more with insurance than those without insurance. Thus, they suggest that, to increase agricultural production, government should provide the insurance if the competitive insurance market does not exist.

3. The Survey Statistics

We conducted a survey of custard apple farmers about their revenue insurance buying, risk and uncertain attitudes, and attributes during the two-month (April and May) period in 2019. There are 199 samples collected. In the 199 observations, only 15% of farmers answered that

they did buy the revenue insurance last year. The majority of the farmers did not buy the insurance. Some basic statistics are summarized in Table 1.

Panel A of Table 1 lists the summarized results of the farmers' education Level and their revenue Insurance Buying. The farmers' education is categorized into four levels, "elementary", "junior high", "senior high" and "college", and the proportions of the insurance buying are 23%, 11%, 15% and 8% respectively. Thus, the results are unlike other insurances, which we often observe that the higher the education, the higher the insurance demand.

In the Panel B of Table 1, we report where their lands used are form and the proportions of the insurance buying. Their land resources are classified into three categories, "own", "own and leasing", and "leasing", and the proportions of the insurance buying are 19%, 14%, and 7% respectively. Other things being equal, the farmers with the "leasing" land face riskier profile. However, they bought less insurance.

In the Panel C of Table 1, we report the number of observations about whether they are borrowing fund for the production and the proportions of the insurance buying. Among the 199 observations, only 49 are borrowers. For the borrowers, 12% of them are the insurance buyers while for the non-borrowers, the insurance buyer accounts for 16%. Other things being equal, the borrowers also face riskier profile. However, they bought a little bit less insurance.

Panel D of Table 1 reports the farmers' risk attitude and the proportion of revenue insurance buying.The risk attitude is based on a question: "How do you deal with the risk of losses?". If they choose to accept the risk of losses, then they are classified as a risk seeker. Otherwise, they are risk averters. The number of the risk seekers are about the same as the risk averters. However, they are very different in the insurance demand. For the risk seekers, only 6% of them did buy the insurance while there are 24% of the risk averters buying the insurance.

Panel E of Table 1 reports the farmers' ambiguity or no-ambiguity and the proportion of revenue insurance buying. The ambiguity is based on a question: "Do you know with the probability of losses?". If they choose "No", then they are classified as ambiguity. Otherwise, they are no ambiguity. The number of the ambiguity are close to the no-ambiguity. Furthermore, the proportions of the two groups are similar. The ambiguity actually has a little less demand for the insurance. Thus, we cannot conclude that ambiguity would reinforce the demand for the insurance here.

Panel F of Table 1 reports the farmers' claim payment ambiguity or no-ambiguity and the proportion of revenue insurance buying. The ambiguity is based on a question: "Do you know the problem of uncertain claim payment of losses?". If they choose "Yes", then they are classified as ambiguity. Otherwise, they are no ambiguity. The number of the ambiguity are larger than the no-ambiguity. However, the proportions of the insurance buying for the two groups are similar. The ambiguity actually has a little higher demand for the insurance. Thus, we cannot conclude that claim payment ambiguity reduces the demand for the insurance here.

Finally, Panel G of Table 1 reports the mean results of farmers' age, land scale and planted years with insurance and no Insurance. There, only the land scale shows that the average is lower for the insured. The rest two means are similar.

In Table 2, we report if the farmers' willingness of insurance buying increase after no recent losses and after a big loss. Their willingness is classified into three categories, "Buy less", "No change", and "Buy more." After no recent losses, there is only 35% of them have intention to reduce insurance demand or increase risk taking. Thus, this is not consistent with Thaler and Johnson (1990). However, we find that 59% of the farmers have intention to increase insurance demand after a big loss. This is somehow consistent with Thaler and Johnson (1990).

Table 1. Basic Statistics of the Survey

Panel A. Farmers' Education Level and Revenue Insurance Buying

	Elementary	Junior High	Senior High	College
Observations	47	35	78	39
Proportion of insurance buying	0.23	0.11	0.15	0.08

Panel B. Land Leasing and Revenue Insurance Buying

	Own Land	Own and Leasing Land	Leasing Land
Observations	79	91	29
Proportion of Insurance Buying	0.19	0.14	0.07

Panel C. Fund Borrowing and Revenue Insurance Buying

	No Borrowing	Borrowing
Observations	150	49
Proportion of Insurance Buying	0.16	0.12

Panel D. Farmers' Risk Attitude* and the Proportion of Revenue Insurance Buying

	Observations	Insurance Proportion
Risk Seeker	100	0.06
Risk Averter	99	0.24

Panel E: Farmers' Probability Ambiguity and the Proportion of Revenue Insurance Buying**

	Observations	Insurance Proportion
No Ambiguity	105	0.16
Ambiguity	94	0.14

Panel F. Farmers' Claim Payment Ambiguity* and the Proportion of Revenue Insurance Buying**

	Observations	Insurance Proportion
No Ambiguity	84	0.14
Ambiguity	115	0.16

Panel G. Age, Land Scale and Planted Years with Insurance and No Insurance

	With Insurance	No Insurance
Mean of Farmers' Age (Years)	55	54
Mean of Land Scale (Acres)	1.87	2.44
Mean of Planted Years (Years)	11	10

Notes: * We have a question: "How do you deal with the risk of losses?". If they choose to accept the risk of losses, then they are classified as a risk seeker. Otherwise, they are risk averters. ** We have a question: "Do you know with the probability of losses?". If they choose "No", then they are classified as ambiguity. Otherwise, they are no ambiguity. *** We have a question: "Do you know the problem of uncertain claim payment of losses?". If they choose "Yes", then they are classified as ambiguity. Otherwise, they are no ambiguity.

Table 2. Summarized Results of Buying Revenue Insurance after No Recent Losses and after a Big Recent Loss?

	After no Recent Losses		After a Big Recent Loss	
	Observations	**Proportion**	**Observations**	**Proportion**
Buy Less	70	0.35	20	0.10
No Change	97	0.49	62	0.31
Buy More	32	0.16	117	0.59

4. The Logit Model and Results

The insurance buying or not buying decision is a typical binary choice. Thus, we use the two-class logistic regression model for the analysis. The explanatory variables include the farmer's age, the education level, the source of the land used, land scale, borrowing or not borrowing fund, the planted years, risk attitude, probability ambiguity and claim payment ambiguity.

The two-class logistic regression model is actually a type of generalized linear model (GLM) with the Logit link function and the dependent variable following a binomial distribution. Thus, if Y is the dependent variable, and $x_1, x_2, \ldots,$ and x_n are the independent variables, they have the following setup:

$$\log\left(\frac{E(Y)}{1-E(Y)}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n$$

where $\beta_0,\ \beta_1,\ \beta_2, \ldots,$ and β_n are coefficient to be estimated.

Table 3. The Logistic Regression Results

	Coefficient	**Std. Error**	**Z Statistics**	**P value**
Intercept	0.48	1.74	0.28	0.78
Age	-0.03	0.03	-1.21	0.23
Junior High	-1.42	0.76	-1.88	0.06*
Senior High	-1.32	0.78	-1.70	0.09*
College	-2.45	0.97	-2.53	0.01**
Own & Leasing	-0.13	0.52	-0.25	0.80
Leasing	-0.97	0.88	-1.11	0.27
Land Scale	-0.23	0.20	-1.10	0.27
Fund Borrowing	-0.45	0.55	-0.83	0.41
Planted Years	0.02	0.02	0.89	0.38
Risk Averter	1.95	0.52	3.74	0.00***
Prob Ambiguity	-0.59	0.49	-1.22	0.22
Claim Ambiguity	0.19	0.50	0.39	0.70

Note: *, ** and *** indicate the coefficient is significantly different from zero at 10% , 5% and 1% significant levels, respectively.

In our model, the dependent variable is whether the farmer bought insurance or not, and the independent variables are listed in the first column of Table 3. We use the maximum likelihood method for the coefficient estimation. The estimated regression results are reported in Table 3. They include the estimated coefficients, the standard errors of the estimated coefficients, the z statistics which can be used to test if the coefficient is zero, and the P value associated with the z statistics. Among all explanatory variables, the education level and the risk attitude have significant impacts on the probability of the insurance buying. Relative to

the elementary education level, higher education indicates lower probability of the insurance buying. For the risk attitude, the risk averter has higher demand for the insurance.

To evaluate the logistic model, we use the confusion matrix in the following table (Table 4). The number in each row represents the instances in an actual class (buying or no buying) while each column represents the instances in a predicted class. The accuracy rate, which is the sum of the true positive (23) and the rue negative (115) over the total observations, is 69%. The positive predictive value, which is the true positive (23) divided by the sum of the true positive (23) and false positive (7), is 77%.

Table 4. The Confusion Matrix of the Logit Model

	Predicted: Buying	**Predicted: No Buying**
Actual: Buying	23	54
Actual: No Buying	7	115

As we argue above, people are often ambiguity averse with uncertain gains while they are often ambiguity loving with uncertain losses. However, the empirical evidence does not support the argument. The probability ambiguity (about losses) has negative impact, but not significantly, on the demand for the insurance. The claim payment ambiguity (about gains) does not decrease the demand for the insurance either. Both estimated parameters are not significantly different from zero according to the *z* statistics.

5. Conclusion

This paper studies why the demand for Agricultural revenue insurance is so low in Taiwan even the government subsidize almost half of the premium. We use the insights of Prospect theory. In facing the risk of losses, the farmers could be a risk lover instead of a risk averter. Also, by Thaler and Johnson (1990), after no recent losses, they increase their risk taking. Thus, the risk preference depends on the gains or losses situations, and the degree of risk aversion is time varying. Furthermore, we look into how probability ambiguity and claim payment ambiguity can affect the lower demand of the insurance, and control factors like age, education, farming experience, scale, and loan borrowing.

In the survey statistics, we find that half of the sample farmers are kind of risk lovers. They tend to accept the risk of losses. After no recent losses, only 35% of them would increase risk taking by showing less willingness to buy the insurance. On the other hand, 59% of them would increase their willingness to buy the insurance. In addition, about half of them are probability ambiguity or claim payment ambiguity.

In the two-class logistic model of insurance buying or no buying, we find that the risk attitude as risk aversion has significant positive impacts on the insurance buying, or the risk lover has less demand for the insurance. However, we do not have evidence that the probability ambiguity and claim payment ambiguity produce less demand for the revenue insurance.

There are some limitations for this survey study of insurance demand. Like other studies using hypothetical surveys, it suffers the problem raised by Smith (1982). He emphasizes the important of salient rewards for the experimental subjects, and the rewards should be instructed in a way that the subjects are given incentives to make decisions according their own true preference. In addition, our survey sampling method might fail to produce a representative sample of the population.

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