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AN EMPIRICAL STUDY ON AQUACULTURE INSURANCE PURCHASE IN TAIWAN FROM A BEHAVIORAL ECONOMICS PERSPECTIVE

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Abstract

In Taiwan, fish farmers buying aquaculture insurance are subsidized by over 50% of the premiums, but the demand is still low. Also, there is clear pattern that if they got little claim payments this year, their incentive to insure would decrease next year, and vice versa. This paper investigates the factors that affect aquaculture insurance purchase insurance in Taiwan from a behavioural economics perspective. By the survey sample data of 343 fish farmers from a research project of Council of Agriculture, we provide the evidence of the farmers' narrow framing bias, and, by using a logistic regression, the results shows that those who are less willingness to buy, because the claims did not occur, less likely buy the insurance. It also supports the hypothesis that fish farmers with higher narrow framing bias and short-sightedness would buy less aquaculture insurance. Thus, it leads to the low demand for the aquaculture insurance.

Keywords: *Aquaculture insurance, Parametric insurance, Narrow framing bias*
Jel Codes: *G41*

1. Introduction

As an island country, fishing industry plays an important role in Taiwan economy. In the industry, aquaculture gradually becomes even more important because, in nature environment, less fish can be caught from off-shore and in-shore fishing in the future. There are good environments and technical supports for aquaculture growth in Taiwan. However, aquaculture could suffer severe production losses due to climate risk such as heavy rainfall or low temperature. It is well known that climate risk has been increasing by climate change and global warming. Thus, climate risk management has become a critical issue for aquaculture farmers.

Aquaculture insurance is a tool for climate risk management. In 2017, the first parametric aquaculture insurance was provided for the fish farmers to protect heavy rainfall risk. The claim payments would be triggered if the accumulated rainfalls exceed a threshold. For the aquaculture area eligible for the insurance, there was only 1.39% of the area covered by the insurance. The insurance demand is quite low even though the insurance premium loading is only 20% and the government subsidizes half the premium.

The low demand can be partly attributed to that fish farmers have been used to the climate risk and government's assistance for natural disaster for a long period of time. In this paper, it is considered that behavioural bias in insurance decision could be another reason for the low insurance demand.

Consumers or producers buying less insurance, or under-investing in protecting themselves against risk has been investigated under the topic of behavioural insurance. (Richter et al., 2014; Richter et al., 2019) For instance, they tend to cancel insurance after a long period with claims. Thus, low frequency but high severity risk is less insured than the high frequency but modest risk.

Another behavioural bias to explain underinsurance is narrow framing or the tendency to make decisions in isolation (Tversky and Kahneman, 1981; Kahneman and Lovallo, 1993; Read et al., 1999). Gottlieb and Mitchell (2019) propose a model of narrow framing in insurance decision making. They show that individuals who frame their insurance narrowly are less likely to purchase coverage. Their empirical results support that why people underinsure long-term care risk. With narrow framing, people buying insurance consider only premium and claim payments, and the claim payments are the only payback for the insurance buying. If they did not get the payments over the premiums this time, they might not like to insure next time. Thus, they are kind of speculators and short-sighted. If the chance of payback is low, they will not buy the insurance. Further, it is difficult to convince people with narrow framing that it is good to have an insurance policy which is no return at all.

Insurance is a means of reducing financial variability. The large loss principle suggests that, for low frequency but high severity risk, buying an insurance policy with a smaller known premium removes the possibility of a larger loss. Thus, rational insurance decision should consider premium payment, claim payments and insured losses aggregately. In aggregate, by the indemnity principle, the claim payments and insured losses will tend to be cancelled out if the risk happens. If no risk happens, they will be happy with no losses. Their total financial positions are stabilized by continuously buying the insurance no matter risk happens or not.

For this study, we use a survey question "If you buy the insurance policy and get nothing back from claim payments, then what will be the willingness to insure next time?" for measuring the degree of the narrow framing bias and short-sightedness. We propose the hypothesis that fish farmers with higher narrow framing bias and short-sightedness would buy less aquaculture insurance.

The rest of this paper is organized as follows. In the next two sections, we present literature review and some aggregate aquaculture insurance statistics and possible implications. Then, data and methodology are presented in the fourth section. In the fifth section, the empirical results are discussed. The final section concludes.

2. Literature Review

The theory of rational insurance demand is based on the expected utility theory (EUT). It assumes that decision-makers have increasing and concave utility functions, which means that they are risk averse and prefer certain gains (or losses) over uncertain ones with the same expected value. Individuals with increasing and convex utility functions, or risk lovers, prefer uncertain outcomes over certain ones, even if the expected value is the same. According to the expected utility theory (Mossin, 1968), the optimal amount of insurance for risk averse people depends on the fairness of the insurance premium. If the premium is fair, then full insurance is optimal. However, if the premium is unfair, then partial insurance may be optimal. Risk lovers, on the other hand, have no insurance demand because they prefer uncertain outcomes over certain ones.

EUT typically assumes that decision makers are always risk averse. However, Kahneman and Tversky (1979) find that people's risk behavior is different when it comes to gains and losses. People are mostly risk-averse when they face gains, meaning they prefer a certain amount of money to a lottery with the same expected value. However, people are often risk-seeking when it comes to losses, meaning they prefer a lottery with the same expected loss to a certain loss. Thus, in face of uncertain losses, they are risk lovers, and have no intention to buy insurance.

One key feature of natural disaster risk is that it is low probability and difficult to estimate. People who overestimate small probabilities may reverse their risk preferences. This means that they may overestimate a small probability of a large gain, making the opportunity more attractive and leading them to become risk-loving, even though it concerns gains. Conversely, people may also overestimate a small probability of a large loss, making the corresponding risk seem more threatening. This can lead them to become risk-averse and more likely to accept insurance policies, which is consistent with the large loss principle for insurance buying.

The uncertain losses from natural disaster are a kind of risk with a small probability and a large loss. However, the insurance demand is often low even when insurance premiums are subsidized. Friedl et al. (2014) investigates the rather low demand for disaster insurance for hurricanes and floods. One rational reason in the sense of EUT for the low demand might be that people anticipate ex post disaster relief by public or private organizations (Raschky and Weck-Hannemann, 2007). Thus, there no need to insure individually.

Another reason for the weak demand is that the willingness to pay for disaster insurance is too low, as people underestimate low probability events. Whether people overestimate or underestimate the probability, the evidence is mixed (Camerer and Kunreuther, 1989; McClelland et al., 1993; Ganderton et al., 2000; Laury et al., 2009). Laury et al.'s (2009) experiment found no evidence to support the claim that people underweight the probability of low probability events, which is a possible explanation for underinsurance.

Friedl et al. (2014) propose a new perspective on disaster insurance by focusing on the fact that individual risks are often correlated. Since many people in the same community are often affected by the same disaster, social comparison may be an important factor affecting people's willingness to purchase insurance. Friedl et al. model this social comparison using preferences that represent inequity aversion (Fehr and Schmidt, 1999).In a laboratory experiment, Friedl et al. compare the willingness to pay of participants in treatments with both correlated and uncorrelated risks. They find that participants have a lower overall willingness to pay when the risks are correlated. This result is consistent with other studies, such as Rohde and Rohde (2011) and Linde and Sonnemans (2012). This suggests that people are less likely to buy insurance if they know that their peers are not buying it. This is known as herding behavior.

3. Aggregate Aquaculture Insurance Statistics

Table 1 reports some yearly aggregate aquaculture insurance statistics from 2017 to 2022. They include number of policies, insured areas, insurable areas, insurance rate (insured areas divided by insurable areas), total premiums, number of policies claimed, claimed areas, total claim payments, and loss ratio (total claim payments divided by total premiums).

The statistics give some hints on insurance buying behaviour. Fish farmers speculate on the insurance with adapted expectation. If they got high claim payments this year, their incentive to insure would increase next year, and vice versa. For 2017, devastating rainfall did trigger the claim payments of 26 policies in the 62 in total. The total payments are 3.57 times of the premiums. Next year, the insurance rate increases from 1.39% to 2.49%. In 2018, less percentage of the policies claimed happened and this came with lower loss ratio. Then, the insurance rate dropped in the beginning of 2019. The further big drops in the policies claimed and the loss ratio in the end of 2019. We see the lowest insurance rate 0.87% in 2020. However, in the end of 2020, a high percent of the policies (94 over the 137) got the claim payments, and it is followed by the highest insurance rate 3.49% in 2021. The, with the lowest percent of policies claimed, the insurance rate cut down to 1.60% in 2022.

Table 1. Aquaculture Insurance Statistics in Taiwan

Year	Number of Policies	Insured Areas	Insurable Areas	Insurance Rate	Total Premiums	Number of Policies Claimed	Claimed Areas	Total Claim Payments	Loss Ratio
2017	62	61.11	4,404	1.39%	6,979,769	26	22.54	24,931,376	357.19%
2018	273	463.50	18,600	2.49%	41,022,153	62	59.94	32,264,166	78.65%
2019	264	460.69	23,974	1.92%	41,116,449	27	49.00	2,317,577	5.64%
2020	137	204.59	23,484	0.87%	20,822,740	94	142.34	22,973,675	110.33%
2021	476	690.64	19,776	3.49%	66,153,392	32	66.93	3,948,997	5.97%
2022	175	211.06	13,200	1.60%	25,909,550	99	131.00	11,380,730	43.92%

4. Data and Methodology

To study how behavioural bias affect insurance buying decision, we use a survey data of fish farmers from a research project of Fishery Agency in Council of Agriculture. The survey was conducted in June 2022. Two key questions are whether they bought any aquaculture insurance in the last five years, and if there are no claim payments, what is the willingness to buy insurance next time? The first one is a yes or no question. The second one is answered by 0 to 100, where 0 and 100 indicate the lowest and highest willingness, respectively. There are over 500 sample farmers being surveyed, but 343 samples with complete answers are used for analysis. Among them, 66 farmers did buy the insurance. For these buyers, their second answers score 41, on average, while those, who did not buy any, score 23. Thus, those not buying express, on average, less willingness to buy in the future when they did not get the claim.

The survey also includes some important features of the farmers, such as gender, age, farming experience, farming scale, farming style, location, other income sources, contract farming or not, natural disaster financial aids, degree of risk bearing, and willingness to pay for risk. Among them, age, farming experience, farming scale, degree of risk bearing, and willingness to pay for risk are numerical variables. The age and farming experience are measured in years. The unit of the farming scale is an acre. The degree of risk bearing and the willingness to pay for risk are measured as the same way as the willingness to buy in the previous paragraph.

The rest are categorial variables. Two categories for the gender (male and female), and natural disaster financial aids (yes and no). Three categories for the farming style (simple, mix, and simple plus mix), other income sources (yes, no and no answer), contract farming or not (yes, no and no answer). Finally, there are six locations.

To study how the insurance buying or not buying, we use a two-class logistic regression model for the analysis. This logistic regression model is one type of generalized linear model (GLM) with the response variable following a binomial distribution and the Logit link function. It is different from the linear model (LM) in which the link function is an identity, i.e.,

$$E(y|x) = x'\beta$$

where y is the response variable following a normal distribution, x is the column vector of the explanatory variables, and β is the column vector of the coefficients to be estimated. $x'\beta$ is the linear predictor of the expected response variable.

For a logistic regression model, the expected response E(y│x) and the linear predictor is linked by the following:

$$\log\left(\frac{E(y|x)}{1-E(y|x)}\right) = x'\beta$$

It is a logit link function. As y is a binary variable (1 or 0), the relation states that the log function of the odds ratio is equal to the linear predictor.

In this empirical study, the explanatory variables include farmer's gender, age, farming experience, farming scale, farming style, contract farming or not, other income source, location, degree of risk bearing, willingness to pay and willingness to buy.

5. Empirical Results

Table 2 presents statistical information regarding categorical variables. It provides details for each variable and category, including the number of insured and uninsured samples (as shown in the 'Insurance Buying' column) and the proportion of insured individuals (found in the 'Insurance Rate' column). Additionally, the 'Row Total' column displays the total number of samples for each category within each variable, and the 'Proportion' column represents the sample proportion for each category.

Table 2. Statistics of the Categorical Variables

Variable	Categories	Insurance Buying		Row Total	Proportion	Insurance Rate
		No	Yes			
Gender	Female	43	9	52	15%	17%
	Male	234	57	291	85%	20%
Location	Changhua	27	1	28	8%	4%
	Yunlin	29	3	32	9%	9%
	Chiayi	51	21	72	21%	29%
	Tainan	90	20	110	32%	18%
	Koashiung	52	17	69	20%	25%
	Pingtun	28	4	32	9%	13%
ContractFarming	No	224	44	268	78%	16%
	Yes	44	19	63	18%	30%
	NA	9	3	12	3%	25%
Farming Style	Simple	81	20	101	29%	20%
	Mix	169	33	202	59%	16%
	Simple+Mix	27	13	40	12%	33%
Other Income	No	101	23	124	36%	19%
	Yes	52	3	55	16%	5%
	NA	124	40	164	48%	24%
Natural Disaster Financial Aids	No	136	24	160	47%	15%
	Yes	141	42	183	53%	23%
Column Total		277	66	343		

Note: NA stands for no answer. Farming style S+M stands for the simple plus mix type.

On average, the overall insurance rate is 19%. Notably, gender does not significantly impact insurance rates, with rates of 17% for females and 20% for males. However, insurance rates vary considerably across different locations, ranging from a high of 29% in Chiayi to a low of only 4% in Changhua.

Individuals with contract farming arrangements exhibit a notably higher insurance rate of 30%, while those without such arrangements have a relatively lower rate. Furthermore, the farming style labelled 'Simple+Mix' boasts the highest insurance rate at 33%, whereas individuals with 'Other Income' sources exhibit a remarkably low rate.

"In Table 3, we provide a comprehensive summary of numerical variables, including Age, Years of Experience, Farming Scale, Degree of Risk Bearing, Willingness to Buy, and Willingness to Pay. For each of these variables, we present key statistics such as the minimum, maximum, mean, and standard deviation, offering a complete overview of their distribution across all samples.

To gain further insights, we've divided the entire dataset into two distinct sets based on whether individuals have purchased insurance or not. Table 4 then highlights the mean values of each numerical variable for these two sets. This comparative analysis enables us to discern potential differences between those who have opted for insurance and those who have not, shedding light on how these variables may influence insurance buying decisions. For example, the means show some differences for Farming Scale and Willingness to Buy.

Table 3. Statistics of the Numerical Variables

Variables	Min	Max	Mean	Standard Deviation
Age (Unit: Year)	20	92	50.70	14.27
Years of Experience (Unit: Year)	0	80	17.53	14.31
Farming Scale (Unit: Acre)	0.03	55.00	4.04	5.81
Degree of Risk Bearing	0	100	25.69	17.05
Willingness to Buy	0	100	26.36	27.55
Willingness to Pay	0	100	26.53	26.60

Table 4. The Mean of the Numerical Variables with Insurance Buying and without Insurance Buying

Variables	Insurance Buying	
	No	Yes
Age (Unit: Year)	50.30	52.38
Years of Experience (Unit: Year)	17.04	19.61
Farming Scale (Unit: Acre)	3.59	5.92
Degree of Risk Bearing	26.52	23.33
Willingness to Buy	22.78	41.36
Willingness to Pay	24.55	34.85

We use the maximum likelihood method for the model estimation. There is no closed-form expression for the maximum likelihood estimators. They are determined using numerical methods. The standard algorithm is called iterative weighted least squares. Using R package glm2, it is an implementation of the familiar Fisher scoring algorithm. The estimated results are reported in Table 5. 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.

In the regression analysis, the most important issue to be discussed is how the willingness to buy (if no claims happen) affect the odds of buying the insurance. The results show that the estimated coefficient is positive and different from zero at 1% significant level. Thus, this variable has significantly positive effect on the odds. This implies that those who are less willingness to buy, because the claims did not occur, less likely buy the insurance. As discussed above, it also supports the hypothesis that fish farmers with higher narrow framing bias and short-sightedness would buy less aquaculture insurance.

Table 5. The Logistic Regression Results

	Coefficient	Std. Error	Z Statistics	P value
Intercept	-6.73	2.09	-3.21	0.00
Willingness to Buy	0.03	0.01	4.22	0.00***
Gender Male	0.21	0.47	0.45	0.65
Location_Yunlin	2.76	1.86	1.49	0.14
Location_Chiayi	3.84	1.75	2.20	0.03**
Location_Tainan	3.67	1.76	2.09	0.04**
Location_Kaohsiung	3.62	1.76	2.05	0.04**
Location_Pingtun	3.13	1.87	1.67	0.09*
Age	0.01	0.02	0.53	0.60
Farming Experience	0.01	0.02	0.38	0.70
Farming Scale	0.06	0.03	2.21	0.03**
Contract Farming_Yes	0.80	0.41	1.94	0.05*
Contract Farming_NA	0.62	0.77	0.81	0.42
Farming Style_Mix	-0.18	0.40	-0.45	0.65
Farming Style_S+M	0.55	0.53	1.04	0.30
Other Income_Yes	-1.70	0.69	-2.45	0.01**
Other Income_NA	0.06	0.34	0.17	0.86
Risk Bearing	-0.01	0.01	-1.33	0.18
Financial Aids_Yes	0.13	0.35	0.36	0.72
Willingness to Pay	0.01	0.01	1.18	0.24

Note: *, ** and *** indicate the coefficient is significantly different from zero at 10%, 5% and 1% significant levels, respectively. NA stands for no answer. Farming style S+M stands for the simple plus mix type. Financial aids are the above mentioned for natural disaster. The reference group for the location is Changhua.

The results of some other variables are worth discussing. The farming scale is significantly positive. Thus, larger scale farms more likely buy the insurance than those of the smaller. The contract farming is also significantly positive (at 10% level). As they have more sense of risk management for both price and yield risk. The farmers with other income sources less likely to buy the insurance as the coefficient is significantly negative. It could be that they have diverse sources of income. Thus, their risk is less high than those without other income sources so that less insurance is bought.

6. Conclusion

This paper investigates the factors that affect the purchase of aquaculture insurance in Taiwan. The insurance is a type of parametric insurance, triggered by accumulated rainfalls or persistent low temperatures. Thus, the claim payments are not directly related to the aquaculture losses. This feature could lead the fish farmers speculating on the insurance instead of using it for risk management. From a behavioural economics perspective, this could be regarded as narrow framing bias as they separate out the insurance account from the aquaculture revenue account. By a survey question "If you buy the insurance policy and get nothing back from claim payments, then what will be the willingness to insure next time?" for measuring the degree of the narrow framing bias and short-sightedness. The empirical evidence supports the fish farmers behave narrow framing bias, and this leads to the low demand for the aquaculture insurance. This is consistent with behavioural insurance literature that narrow framing bias can explain underinsurance.

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