Cheating? The Case of Producers' Under-Report Behavior in Hog Insurance in China

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Abstract: With the information asymmetry on the annual number of finish hogs, the base of hog insurance premium setting in China, farmers' under report or cheating is an important problem. In this paper, we analyze the producers' optimal decisions on whether to buy insurance and whether to under report, both analytically using risk decision theory and empirically by extending Heckman's two stage model dealing with sample selection bias into a three stage model using 2010 survey data from a cross-section of 444 Chinese hog farmers. Our results show that although there exist under reporting problems that producers report 14% below their actual quantity to the insurance company. However, the under report behavior is not related to producers' income, risk attitude, or even penalty imposed by the insurance companies. Rather, it is related to large production size. Also for all the producers who buy the insurance, results show that the longer the hog production experience they have, the closer their reported numbers get to the actual numbers. We attribute this to the farmers' low capability of estimating the actual finished hog numbers accurately. Policy implications are drawn from the results, which we believe can shed lights to new agricultural insurance programs in developing stages worldwide.

Key words: three-stage Heckman model, livestock insurance, cheating

JEL classification: G22, Q14

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1. Introduction

Except for a limited availability of insurance products covering specific perils, it is hardly found any agricultural multi peril insurance solely provided by private sectors. Moral hazard, adverse selection and systemic risks are the reasons to cause the market failure (Wright and Hewitt, 1990; Miranda, 1991; Glauber, 2004). One common condition for moral hazard and adverse selection is asymmetric information (Knight and Coble, 1997).

It has been well studied that the asymmetric information harms agricultural insurance under the two situations: adverse selection, when the insurers cannot observe individual insured producer's actual risk and set the premium at the average risk level resulting in only those with higher potential loss tend to buy the insurance; and moral hazard, when the insured producers alter their production behavior after buying the insurance resulting in higher potential loss or cheating, i.e. over reporting the loss (Pauly, 1974; Rothschild and Stiglitz, 1976; Holmstrom, 1979).

Despite many theoretical analyses, empirical studies have generated mixed results about adverse selection (Knight and Coble, 1997; Li et al., 2004; Cohen and Siegelman, 2010). Many studies, such as McCarthy and Mitchell (2003) and Cardon and Hendel (2001), could not confirm the existence of adverse selection; while others, such as Makki and Somwaru (2001), found the evidence for its existence.

There is rich empirical literature on moral hazard, especially on the producers' behavioral change after purchasing insurance (Horowitz and Lichtenberg, 1993; Coble et al., 1997; Smith and Goodwin, 1996; Babcock and Hennessy, 1996; Roberts et al., 2006; Zhong et al., 2007; Liang and Coble, 2009). All confirmed the farmers' behavior change after purchasing insurance.

Cheating as a direct result of asymmetric information is very important in insurance. The topic has attracted a lot of attention in insurance studies for most other industries since 1980s except for agriculture unfortunately (Atwood, et al., 2006). One reason is that it is very difficult to measure the degree of cheating, and there is even no widely accepted definition for the concept of cheating (Stijn and Dedence, 2004). Two studies on cheating have been found for agricultural insurance. Rejesus et al. (2003) found cheating behavior that when crop producers realize they can obtain indemnity during bad weather they decide not to grow the crop while taking advantage of the fallow articles in the contract. Atwood et al. (2006) found crop producers with multiple fields may cheat in terms of reporting the yield in each field in a way that can optimize their indemnities claimed. Neither of these studies addressed the issue of information asymmetry of risky asset values.

We attempt to study the asymmetric information and cheating behavior in livestock insurance, another field that few insurance publications exist (Koontz et al., 2006). We will also address the information asymmetry of risky asset values in the case of Chinese hog production insurance.

In this paper, we will empirically estimate the degree of finished hog quantity underestimation and investigate producers' optimal insurance coverage selection, using survey data from hog producers in Zhejiang province, China. Specific objectives of this research includes, 1) to assess whether hog producers will report the finished hog quantity falsely because of their cheating motivation or lack of relevant information; 2) to evaluate the degree of under coverage; and 3) to investigate producers' optimal behavior under the information asymmetry.

2. Background of Chinese Hog Insurance

Chinese agricultural insurance has never been broadly provided to farmers until 2004. With the central government's initiative and promotion, each provincial government started to support and pilot a variety of insurance programs to its farmers then. In 2010, Chinese agricultural insurance had premium revenue of 13.568 billion Yuan, among which about one half was subsidy from the central government (MOF, 2010). It covers crops, forestry and livestock, and has become the second largest agricultural insurance industry in the world only after the US. Many commercial insurance companies deliver the insurance with the support of governments.

Currently, the hog insurance is provided by private insurance company under central and provincial governments' subsidy. Zhejiang has been one of the few provinces that pilot new agricultural policies and initiatives, including agricultural insurance. It started to pilot hog insurance in 11 counties in 2006 and extended to all of its counties in 2008, one of the earliest in China. During this period, the premium revenue from hog insurance accounted for 20.7% of its total agricultural insurance revenue.

People's Insurance Company of China (PICC) is the primary provider in this province.

The insurance covers the loss of hog deaths caused by any biological or natural reasons such as diseases, fire, flood, building collapse, etc. Such insurance uses the quantity of finished hogs in a year and 60% of the market price as the base for coverage level and premium setting. All hogs on a farm have to be insured together or not insured. The producer should report the actual number of finished hogs and inventory, and the former should be no less than 2.4 times of the latter. Premium discount are provided from 5% to 20% if the insured quantity is larger than 1,000 heads. The government subsidy rate for the premium increased from 35% in 2007 to 65% in 2009.

Because the annual finished hog quantity is a flow measurement which is difficult for the insurance appraisers to observe, i.e. the risky asset is hard to measure, there exists serious information asymmetry. Without individual hog identification, such as ear tag, farmers tend to under report the annual finished quantity so that they can pay less premium resulting in the insurers will not be able to collect enough revenue. It has been observed that Chinese hog producers under estimate and under report their quantity of finished hogs, the problem of under coverage. This behavior is related to false report and cheating in moral hazard and also to adverse selection caused by asymmetric information. However, it is not exactly the same to either of these typical insurance problems. As a result, the loss ratio for hog insurance in Zhejiang Province reached 142% during the first two years.

3. Theoretical Model for Farmers' Decisions

In this particular setting, we assume the production decisions have been made exogenous to the insurance decisions, and N is the total number of hogs a producer raises. For each hog, the death occurs randomly and independently at a probability p. The probability that no hog will die is $p_0 = (1-p)^N$. Let D be the number of dead hogs, a random variable taking integers ranging [0, N], and it has a multinomial distribution with the probability $p_i = \Pr ob(D=i) = (1-p)^{N-i} p^i$.

The decisions involving insurance have several stages (Figure 1). At the beginning, the producer needs to make the decision whether to buy the insurance or not. If not buy, then he will face two random end results in oval circle, either the death will occur to the farm with a probability of 1 - p_0, or not with p_0. If he chooses to buy the insurance, he can also make a decision at this point that whether he reports the true number of hogs or under report so as to pay a lower insurance premium. Either way, he will face the same random death or no death situation for the hogs with the same probabilities. However, only when death occurs on the farm and the producer claims insurance indemnity, the insurance company will inspect the farm for the actual number of hogs. At this point, there is a probability λ, at which rate the underreport behavior will be caught by the insurance company, and the indemnity will be recalculated based on the company's estimated number of hogs on farm with a punishment.

A producer's decision on whether to buy the insurance follows a classic model of expected utility maximization.

$$EU[q(N-D)+Q-P] \qquad (1)$$

where q is the market value of each finished hog net of its production cost, Q is the indemnity received from the insurance company if the insurance is purchased, and P is the premium paid. The producer's decision is whether to purchase the insurance under given insurance contract terms.

Although N is exogenous to the insurance purchasing decision, there exist asymmetric information between the producer and the insurance company, for the company does not know the actual number. Because the premium is calculated based on N, producers may have an incentive to under report this number.

Now, denote the number of hogs by N_i, where i = A, R and E, respectively, represents the number that a producer actually has each year on average, he reports to the insurance company, and the company's own estimation. $N_R \leqslant N_A$ is for the possible under report.

The insurance coverage for each hog is y Yuan, and the insurance premium is calculated at the actuarially fair premium rate which equals to the death rate p per Yuan coverage or py per hog. The total premium a producer needs to pay is

$$P_i = pyN_i, \quad \text{where } i = A, R \qquad (2)$$

The reported number of dead hogs must satisfy $D \leqslant N_R$, and E(D) = pN_A. The total indemnity is denoted by Q_j, $j = A$, for a producer who reported honestly, or $j = R$ under report but was not caught. On the other hand, if the under report is caught by the insurance company, the indemnity, the case of $j = C$, will be discounted by the company's own estimated number of hogs with an additional discount factor f, $f < 1$, as a punishment.

$$Q_j = yD\begin{cases} 1 & \text{for } j = A, R \\ f\dfrac{N_R}{N_E} & \text{for } j = C \end{cases} \tag{3}$$

For a risk averse producer, the premium savings from under report must be bigger than the expected indemnity discount, when denoting the probability of being caught by ρ, ie,

$$P_A - P_R > E[Q_A - (\rho Q_C + (1-\rho)Q_R)] \tag{4}$$

Using (2) and (3), (4) can be rewritten as:

$$\rho\frac{N_A}{N_A - N_R}\left(1 - f\frac{N_R}{N_E}\right) > 1 \tag{5}$$

Under the actuarially fair premium, the left side of (5) is unit and contributing factors to a lower left side value will include 1) a small ρ, 2) a large N_A, 3) a big f, and 4) a small N_E. This means, a producer tends to under report if the probability of being caught is low, if the relative benefit from premium saving to the penalty size is bigger, and if the penalty rate is low because of either a high discount factor (close to 1) or the insurance company's own estimation of the total number of hogs is low.

For the six end situation in oval circles in Figure 1, the profit in each situation is listed.

i. Buy insurance, under report, no death occurs:
prof1= $qN_A - pyN_R$

ii. Buy insurance, under report, deaths occur, caught: [1]

prof2= $q(N_A - D) + yDf\dfrac{N_R}{N_E} - pyN_R$

iii. Buy insurance, under report, deaths occur, not caught:
prof3= $q(N_A - D) + yD - pyN_R$

iv. Buy insurance, true report, deaths occur:
prof4= $q(N_A - D) + yD - pyN_A$

v. Buy insurance, true report, no death occurs:
prof5= $qN_A - pyN_A$
This is a special case of 4, when $D = 0$.

vi. Does not buy insurance, deaths occur:
prof6= $q(N_A - D)$

vii. Does not buy insurance, no death occurs:
prof7 = qN_A
This is a special case of vi, when $D = 0$.

When the producer makes his insurance purchasing decision, he has fully considered the benefit of cheating, or under reporting. If cheating can brings him higher benefit than not cheating, this will makes him more likely to purchase the insurance comparing to the situation that cheating opportunity does not exist.

At the decision level of whether to cheat (under report), he will maximize his expected utility between the two situations, conditional on he has made the insurance participation decision at the previous stage:

$$V = MAX\{p_0 U(prof1) + \lambda\sum_{i=1}^{N_A} p_i U(prof2_i) + (1-\lambda)\sum_{i=1}^{N_A} p_i U(prof3_i), \sum_{i=0}^{N_A} p_i U(prof4_i)\} \tag{6}$$

The optimum solution to this model should be whether to cheat given the insurance purchasing decision. Plug it back to get the maximum value of the expected utility, denoted by V. We can claim from here that the optimum behavior depends on all parameters in equation (6), such as death rate, rate of being caught if lying, indemnity discount factor if caught, coverage value relative to market value, and parameters in the utility functional form representing the producer's risk attitude and other characteristics.

At the top decision level of whether to buy insurance or not, he will maximize his expected utility considering the consequences of his cheating decisions:

$$MAX\{V, \sum_{i=0}^{N_A} p_i U(prof6_i)\} \tag{7}$$

The Equations (6) and (7) can be combined, which says the decision among not buying insurance, buying insurance with a true report, and buying insurance with an underreport can be made simultaneously.

[1] When D shows up in the profit, it can be indexed by i, so is *prof2*. Same for cases iii, iv, and vi.

4. Data

We choose Deqing County in Zhejiang province as the base for our empirical study, because Deqing is a major hog production county in Zhejiang with an inventory of 483.3 thousand heads and also because it is one of the earliest counties with hog insurance piloted. Its hog insurance premium accounts over 50% of all agricultural insurance premiums, and its indemnification rate is around 70% each year except for 2007, 138.l6% when the Blue Ear disease broke out, which is at the medium level among all counties in the province.

Our data come from two sources: farmers' demographic and production data are from our own survey, and their corresponding insurance data are provided by PICC. We selected all hog producers with over100 finished hogs in 2009 by the census data of hog growers. The survey was administered by veterinaries in each township in a personal interview in 2010, asking their production and insurance situation for the year of 2009. Grower identifications are kept and follow-up interviews in case incomplete questionnaires are turned in or errors are found. 550 surveys were conducted and 537 were completed originally. After follow-up interviews, we obtained 444 valid surveys, 83.6% of the total surveys, and 23.6% of these respondents purchased the hog insurance.

Variables used in this study are explained in the following and their descriptive statistics are reported in Table 1. Demographic variables include the producer's *Age* in years, and *Education* measures the years of schooling. Production data include *Experience*, years of raising hogs; *Income Ratio*, the percentage of total income from hog production; *Income*, the amount of annual income; and the *Finished Hogs*, the actual number of finished hogs we calculated from the annual sales of each farm from the survey.

Financial and insurance variables include *Loan*, which is a binary variable taking value 1 representing the producer has loans, while 0, otherwise; and *Insurance*, another binary variable indicating whether the producer participates in the hog insurance. Among the 444 surveyed farmers, 105 of them bought the insurance, account for 23.6%. Among those who bought the insurance, *Paid Premium* is the variable measuring the amount of insurance premium they paid out of pocket.

From the actual finished hog numbers calculated by us and the producers' reported finished hog numbers provided by PICC, we develop the critical variable, *Gap*, by taking difference between the former and the latter and representing it as a ratio of the former. The sign of *Gap* is an indicator of under report. We develop another variable, *Under Report*, which is a binary indicator taking value 1 if *Gap* is positive, and 0 otherwise. *Penalty* is the ratio between the number of finished hogs reported by the producer and estimated by the insurance company after investigation when an indemnity is claimed, if it is less than one; otherwise it will just take value one. We only have 69 observations for these variables because only these farmers in our survey claimed the insurance indemnity in 2009. An additional variable of *Vaccine Cost* gives the amount of money the producer paid for hog vaccine in 2009. This bio-safety measurement indicates the producer's risk attitude, production quality, and willingness to take death preventing measurements.

Table 1 also presents the descriptive statistics of all the variables used in the econometric analysis. On average, the producers are 46 years old with some middle school education. They operate farms as large as 13,000 finished hogs annually with an average of 667, and most take hog production as their major source of income with an average 76% of income from this enterprise. About 37% of the producers take loans and a quarter of them participate in the hog insurance program. The average of under report accounts for 14% of their actual level. However, the identified cheating cases only bring a discount factor of 0.997 or a 0.3% penalty. This is because if no indemnity is claimed from an under reported farm there will be no assessment to find out such cheating.

Table 2 reports the descriptive statistics of the actual, reported and determined annual finished hogs for the 69 producers who claimed the indemnity. We can tell immediately that the self-reported number is smaller than the actual on average, and the PICC determined number is bigger than both.

5. Econometric Analysis

We first use two Probit models to investigate the factors that influence the two decisions, respectively, whether to buy the hog insurance with the whole sample of 444 observations, and whether to underreport if the first decision was yes for the 105 insurance buyers. We then use linear regression to investigate the size of the under report, using the subsample of 105 growers.

Because only those farmers who bought insurance have a chance to reveal their under report or honest report behavior, using the under report data will have a self-selection bias (Heckman, 1979). Heckman's two stage estimation method has been widely used to deal with such selection bias (Smith and Baquet, 1996; Zheng et al., 2010.

The two-stage model specifies as:

$$\text{Prob}(Insurence = 1) = 1 - \Phi[-(\theta_0 + \sum_{i=1}^{8} \theta_i X_i)],$$

$$\lambda = \frac{\phi[-(\hat{\theta}_0 + \sum_{i=1}^{8} \hat{\theta}_i X_i)]}{\Phi[(\hat{\theta}_0 + \sum_{i=1}^{8} \hat{\theta}_i X_i)]}, \text{then}$$

$$Gap = \beta_0 + \sum_{i=1}^{8} \beta_i X_i + \beta_9 X_9 + \alpha\lambda + \varepsilon$$

The inverse Mills ratio, λ, is first calculated from the estimates of the Probit model for whether to participate in the insurance program, and then it is included in the regression model for the under report equation. The eight explanatory variables included in every equation, X_1, … X_8, are *Age*, *Education*, *Experience*, *Income Ratio*, *Income*, *Finished Hogs*, *Vaccine Cost*, and *Loan.* An additional variable, *Paid Premium*, is included in the regression as the ninth explanatory variable. ϕ( ) and Φ( ) are standard normal probability density function and cumulative density function, respectively. ε is the random error term.

Not only those farmers who bought insurance have a chance to reveal their under report or honest report behavior, but also only those who bought insurance and claimed indemnity can be subject to a punishment by the insurance company. The farmers' reporting decision is influenced by the penalty as derived from equations (6) and (7). The penalty variable should also be included in the model, and the sample that includes the penalty observation is a sub-sample of those who bought insurance. We have three stages in this situation instead of two, because of the two levels of selections. Here we extend Heckman's two-stage estimation into a three-stage estimation by inserting the inverse Mills ratio calculated from the first stage Probit model into the second stage Probit estimation, and then inserting another inverse Mills ratio calculated from the second stage Probit into the final stage regression model.

The three-stage model specifies as:

$$\text{Prob}(Insurence = 1) = 1 - \Phi[-(\gamma_0 + \sum_{i=1}^{8} \gamma_i X_i)], \text{then}$$

$$\lambda = \frac{\phi[-(\hat{\gamma}_0 + \sum_{i=1}^{8} \hat{\gamma}_i X_i)]}{\Phi[(\hat{\gamma}_0 + \sum_{i=1}^{8} \hat{\gamma}_i X_i)]}.$$

(9)

（10）

$$\lambda^* = \frac{\varphi[-(\hat{\theta}_0 + \sum_{i=1}^{9} \hat{\theta}_i X_i + \hat{\delta}\lambda)]}{\Phi[(\hat{\theta}_0 + \sum_{i=1}^{9} \hat{\theta}_i X_i + \hat{\delta}\lambda)]}.$$

（11）

The tenth variable included in equation (11) is *Penalty*. (8)

6. Results

The insurance participation Probit model, under report Probit model, and the size of the under report linear regression model are reported in Table 3. The significant variables include *education*, *finished hogs* and *loan* for the participation model. Farmers with higher education and having large operation size tend to buy insurance, because the more educated people understand the risk and value of insurance better and the larger producers are more specialized and less diverse than smaller producers. Also, those who take loans tend to buy insurance. While the former results are in line with existing literature such as Wang and Rosenman (2007), and Smith and Baquet (1996), the latter result indicates that the hog production can transfer into higher financial risk for those who take loans and that the creditors may give favor to those producers under insurance which induce the insurance participation.

Age and *finished hogs* affect under report positively, and *experience* and *paid premium* affect that negatively. The older producers tend of under report, while those with more experience in hog production tend not to under report. This raises the explanation that under report may not be a subjective cheating behavior but may be result of lack of accuracy

$$\text{Prob}(Under\ \text{Re}\,port = 1) = 1 - \Phi[-(\theta_0 + \sum_{i=1}^{9} \theta_i X_i + \delta\lambda)], \text{then}$$

knowledge in the management. The larger the operation size contributes to the inaccuracy in reporting. Those producers with higher insurance premium cost are more risk averse and are willing to buy higher insurance coverage level, which is consistent to this explanation. These results do not support the hypothesis of cheating.

There are three significant coefficients in the size of under report equation, *finished hog*, *vaccine cost* and *paid premium*. Other than what have been explained for hog production and the insurance premium, those who invest more in vaccine also tend to report closer to the actual number. Again, this is consistent with the inaccuracy explanation that those who paid a higher vaccine cost are more risk averse and are more careful in operation management, and they tend to report more accurately.

Heckman's two-stage model indicates that the inverse Mills ratio is significant (Table 4). This means the selection bias exists and the standalone linear regression model estimation may be biased. We then turn to the results in Table 4 to interpret the under report behavior. Notice, the first stage Probit model for insurance participation is identical to that in table 3. The significant variables and the direction of their influence on the size of under report remain the same under the two-stage model, however, the magnitude all increase except for the number of finished hogs. This means, after considering those who did not buy insurance, the actual influence from production experience, vaccine cost, and paid insurance premium on the under report size is larger than that observed from the insured alone. We would have underestimated this influence, had we not used the two-stage estimation. The opposite holds for production scale.

Now, the three-stage model confirms that both inverse Mills ratios are significant (Table 5). This means if we attempt to evaluate the impact of the penalty on the under report size and have to use the sub sample of 69 producers those who bought insurance and claimed indemnities, we shall use the Heckman model to avoid selection bias and to gain efficiency. The first stage insurance participation Probit estimation is identical to the former ones, which is expected. The second stage under report Probit has slightly different results than the standalone Probit model in Table 3. Now *education* and *loan* both contribute positively to the under report possibility. However, when the penalty is considered in the model at the third stage, neither of the two are significant. The only remaining significant variables are *finished hogs*, positively, and *paid premium*, negatively. Notice, the insignificant of *penalty* indicates producers do not consider the penalty when they report the hog numbers in general, which does not support the cheating hypothesis.

7. Summary and Conclusion

In this paper, we have examined under report problem in livestock insurance for Chinese hog producers. We have analyzed the producers' optimal decisions on whether to buy insurance and whether to under report, both theoretically and empirically. One innovation of this research is to extend the application of Heckman's two stage model dealing with sample selection bias into a three stage model, because there are two levels of selections in the situation.

The results show that although there exist under reporting problems in that the producers report about 14% below their actual number of finished hogs to the insurance company. This confirmed the anecdotal observations of insurance under report, and is consistent to the fact that insurance companies have a loss ratio greater than unit. However, our analysis suggest that the under report behavior is not related to income, risk attitude represented by vaccine cost, or penalty imposed to the under reporters. It is related to large production size and low out of pocket premium cost. Also for all the producers who buy the insurance, results show that the longer the hog production experience they have, the closer their reported numbers get to the actual numbers. We attribute this to the farmers' low capability of estimating the actual finished hog numbers accurately.

Although our analysis confirms the discrepancies between the reported level and actual level of livestock property, the base of the insurance, which appears to be the moral hazard problems, however, it does not support the claim that farmers cheat intentionally. Rather, we suggest the inaccurate reporting is caused by farmers' lack of capability in figuring out the actual property value.

Several suggestions can be derived to deal with this problem. First, technical support can be provided to farmers by insurance companies or local governments to help hog producers come up with better estimations. Farmers should be benefitted from knowing the better estimation themselves for planning and budgeting purposes, so that they are expected to cooperate. Second, insurance companies may consider to modify the insurance design from finished hog based measurement into inventory based[2], which is much easier for farmer to measure and for the company to assess. Third, the government shall enforce the quarantine regulation at the marketing point, which can serve as the record keeping source. Last, if possible, individual animal identification, such as ear tags, is recommended, which will ultimately solve the problem of human error in estimation. This method will come with additional cost. However, to cope with the new traceability policy for food safety concern in China, ear tags are already on the way to many large hog producers.

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[2] Some farms are farrow-to-finish that may add and remove feeder hogs anytime over the year, and others are all-in-all-out that may bring in more than one groups of hogs each year. The inventory based measurement need to be measured more than once a year.

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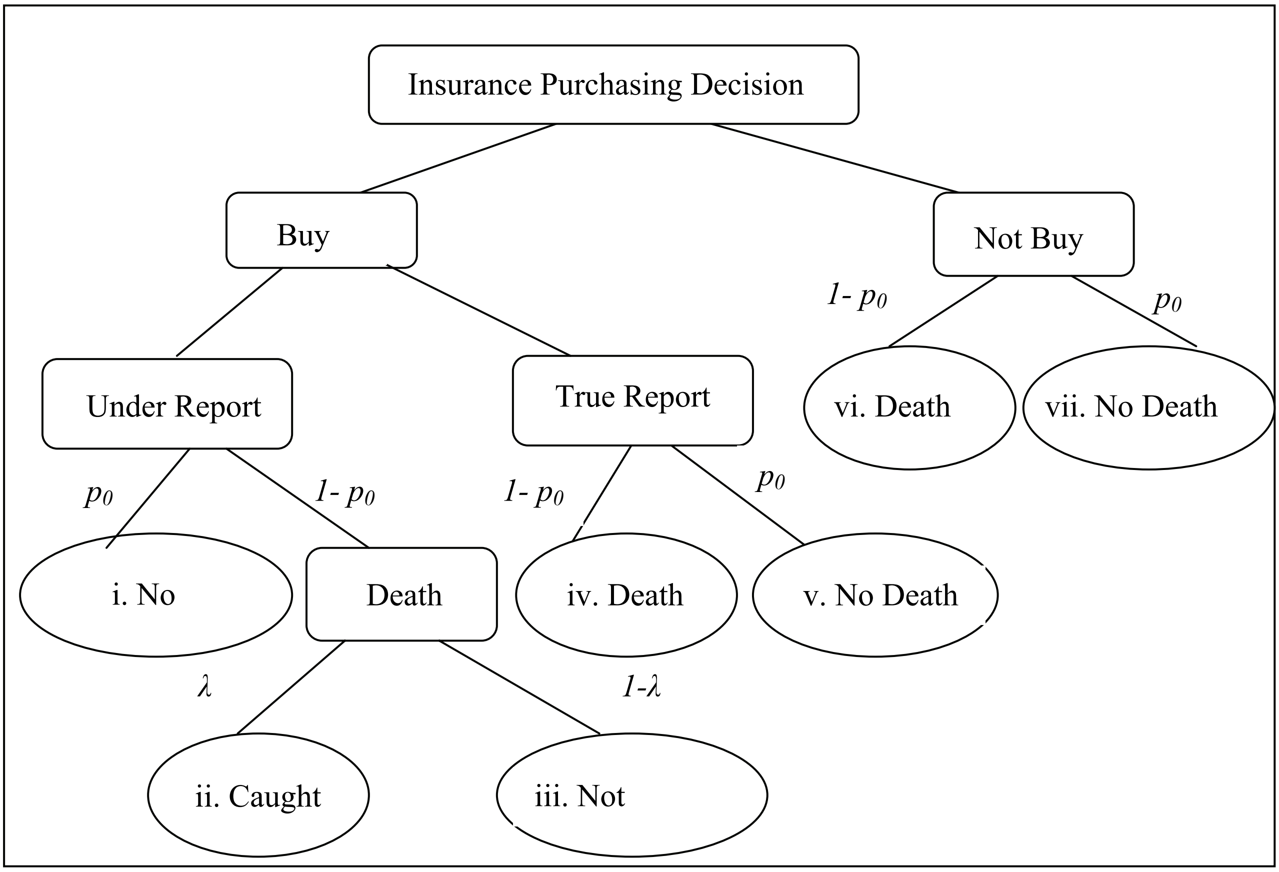

Figure 1 Decision Tree for the Producer's Problem

Table 1
Descriptive Statistics

Variable	Unit	Observation	Mean	Standard deviation	Minimum	Maximum
Age	Year	444	45.90	7.59	22	77
Education	Year	444	7.21	2.54	1	15
Experience	Year	444	8.57	4.73	1	35
Income Ratio	%	444	76.19	20.40	10	100
Income	K Yuan	444	13.76	23.18	0	217.5
Finished Hogs	Head	444	666.57	1078.37	0	13000
Loan		444	0.37	0.48	0	1
Insurance		444	0.24	0.43	0	1
Paid Premium	Yuan	105	6928.72	11190.17	972	94500
Gap	Ratio	105	0.14	0.44	-1	0.87
Under Report		105	0.62	0.49	0	1
Penalty	Ratio	69	0.997	0.024	0.8	1
Vaccine Cost	Yuan	444	6.061599	6.119979	0	30

Table 2
Comparison of Finished Hog Numbers for Producers with Indemnity Claim

Variable	Obs	Mean	Std. Dev.	Min	Max
Actual Finished Hogs	69	1151.377	1387.613	150	10000
Reported Finished Hogs	69	965.7101	894.8558	200	5000
Determined Finished Hogs	69	1275.03	1150.27	199	7200

Table 3
Standalone Insurance Participation and Under Report Estimations

	Insurance Probit		Under Report Probit		Size of Under Report	
	Coefficient	Z	Coefficient	Z	Coefficient	t
Age	0.014	1.32	0.087**	1.98	-0.0052	-1.01
Education	0.055*	1.79	0.029	0.32	-0.0081	-0.69
Experience	0.021	1.32	-1.35**	-2.32	-0.0072	-1.10
Income Ratio	-2.5E-05	-0.01	-0.0077	-0.47	0.00049	0.19
Income	0.0038	0.60	-0.025	0.61	-0.0016	-0.37
Finished Hogs	0.00076***	3.92	0.0092***	3.46	0.00030***	3.25
Vaccine Cost	-0.0047	-0.4	-0.00070	-0.02	-0.025***	-5.15
Loan	0.26*	1.68	-0.29	-0.57	-0.021	-0.33
Paid Premium			-0.0010***	-3.64	-4.2E-05***	-8.20
Constant	-2.61	-3.73	-3.77	-1.49	0.55	1.58
LR	95.55		92.60			
R^2					0.54	
# Obs.	444		105		105	

*, **, and *** denotes statistically significant at 10%, 5% and 1% level, respectively.

Table 4
Two-Stage Heckman Estimation

	Insurance Probit		Size of Under Report	
	Coefficient	Z	Coefficient	t
Age	0.014	1.32	-0.0060	-1.18
Education	0.055*	1.79	-0.017	-1.31
Experience	0.021	1.32	-0.012*	-1.74
Income Ratio	-2.5E-05	-0.01	-0.00040	-0.16
Income	0.0038	0.60	-0.0036	-0.85
Finished Hogs	0.00076***	3.92	0.00029***	3.22
Vaccine Cost	-0.0047	-0.4	-0.022***	-4.46
Loan	0.26*	1.68	-0.080	-1.12
Paid Premium			-4E-05***	-7.56
Constant	-2.61	-3.73	1.07**	2.39
λ			-0.22*	-1.83
Wald			91.20***	
# Obs.	444		105	

*, **, and *** denotes statistically significant at 10%, 5% and 1% level, respectively.

Table 5
Three-Stage Estimation

	Insurance Probit		Under Report Probit		Size of Under Report	
	Coefficient	Z	Coefficient	Z	Coefficient	t
Age	0.014	1.32	0.36**	2.49	-0.0033	-0.68
Education	0.055*	1.79	0.94**	2.11	-0.0027	-0.03
Experience	0.021	1.32	0.15	1.06	-0.0050	-0.76
Income Ratio	-2.5E-05	-0.01	-0.021	-1.04	-0.0030	-1.11
Income	0.0038	0.60	0.0017	0.02	-0.0033	-0.84
Finished Hogs	0.00076***	3.92	0.027***	2.70	0.00015*	1.82
Vaccine Cost	-0.0047	-0.4	-0.071	-1.26	-0.066	-0.99
Loan	0.26*	1.68	3.33*	1.89	-0.022	-0.37
Paid Premium			-0.0013***	-3.19	-1.8E-05***	-3.73
Penalty					75.84	1.01
Constant	-2.61	-3.73	-103.89**	-2.18	-74.92	-0.99
λ			104.14**	2.12	-0.22***	-2.96
Wald					23.74***	
# Obs.	444		105		69	

*, **, and *** denotes statistically significant at 10%, 5% and 1% level, respectively.