Dairy Cattle Insurance Will Change Dairy Farmers' Anti-risk Inputs?

------ Based on the date of Dairy Farmers in Inner Mongolia in China

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A major problem facing dairy farmers is production risk, and dairy cattle insurance is one alternative for reducing this risk. The primary objective of this paper is to test the effects of dairy cattle insurance on farmers' anti-risk inputs. Based on the survey data of dairy farmers in 2015, this paper selects the main area of dairy farming in China-the Inner Mongolia Autonomous Region as the study area, using treatment-effects model for empirical test and analysis.

The findings indicates that the existing dairy cattle insurance policies in China do not have a significant effect on farmers' anti-risk inputs. Due to the low insurance payments and the narrow insurance coverage for the death of dairy cattle, the farmers who participate in dairy cattle insurance, will not weaken their health management measures for dairy cattle, and they do not have negative anti-risk behaviors in the process of dairy production.

Keywords: Dairy farming, Dairy cattle insurance, Anti-risk inputs, Moral hazard

Introduction

As a non-price protection tool which could decentralized risk and losses of dairy farming, dairy cattle insurance has been paid more attention by every government. China government implemented Dairy Cattle insurance policy with premiums subsidies since 2007. At present, the dairy cattle insurance policy has become an important tool of the government to support the development of dairy farming, and obtain a large number of financial supports from different levels of government in China. By the end of 2014, the region with government premium subsidies support of dairy cattle insurance has already widened to a nationwide, and the premium subsidy proportion is also improved continually. For instance, the proportion of local financial subsidies is at least 30%, on this basis, the premium subsidy proportion of central government subsidy have risen to 50% in western regions in China.

As a city of western China, Inner Mongolia is China's largest dairy farming and dairy production area. In 2013, the number of dairy cattle in Inner Mongolia was 2.29 million, which was the largest in the whole country, accounting for 15.91% of the total dairy cattle. And the milk production in Inner Mongolia for 2013 was 7.67 million tons, accounting for 21.73% of the country's milk production, ranked first in the country. Therefore, the sustainable development of dairy industry in Inner Mongolia is not only an important measure to promote the economic development of Inner Mongolia, but also has an important impact on the sustainable development of China's dairy industry.

Taking into account the importance of Inner Mongolia dairy industry in the country, Inner Mongolia was selected as one of the first batch of provinces to implement dairy cattle insurance in 2007.The insurance subject is 1-7 years old dairy cattle that died from significant diseases, natural disasters and accidents. The guarantee levels of dairy cattle insurance are 6000 CNY per cow, 8000 CNY per cow or 10000 CNY per cow and the premium rate is 5% in 2015. Most notably, 85% of the insurance expenses come from subsidy from the central, autonomous regions, municipalities and county government, and the remaining 15% is assumed by the dairy farmers.

The purpose of the government supporting dairy cattle insurance is to establish risk prevention and dispersal mechanism of diseases and natural disasters, encourage dairy farmers to use insurance means to carry out risk management, and recover the loss caused by natural disasters and disease risk and ensure a steady supply of high quality raw milk. However, under the impact of dairy cattle insurance, whether farmers' traditional risk prevention inputs will change? Is there any negative anti-risk behaviors for dairy farmers with dairy cattle insurance? Or weaken their health management measures for dairy cattle if they know they are insured? Based on the survey data of 500 dairy farmers in Inner Mongolia, this paper examines the relationship between farmers' anti-risk inputs and dairy cattle insurance participation. Firstly, this paper make a literature review of the experts and scholars researches. Then, in the theoretical analysis part, this paper analyzes how farmers' anti-risk inputs will be affected by the dairy cattle insurance. Lastly, based on household survey data form insurers for the year 2015 in Inner Mongolia , this paper apply treatment effects model with two-stage estimation and maximum likelihood estimation(MLE) to test the effect of dairy cattle insurance on farmers' anti-risk inputs. The information from this study should be useful for insurance companies and government policy makers who are attempting to increase the adoption rate of dairy cattle insurance.

Literature

As a part of agricultural insurance, there are few directly related studies about the changes of anti-risk investment of insured dairy farmers, but there are many similar studies about the agricultural insurance. However, there is a serious debate on whether the agricultural insurance leads farmers to reduce the anti-risk inputs or increase the anti-risk inputs.

Some scholars argue that farmers will reduce the anti-risk inputs if they know they are insured. Quiggin, Karagiannis and Stanton (1993) using Cobb Douglas production function for empirical analysis, found that insured farmers would reduce the usage of fertilizers and pesticides. Smith and Goodwin (1996) choose wheat producers in Kansas in the United States as the research object, using simultaneous equation model and Bootsrapped model to test the relationship between farmers' anti-risk inputs and insurance participation, the results showed that insured farmers, in order to maximize their expected claims, will use less fertilizers compared to the uninsured farmers. Based on the survey data of poultry farmers in Zhejiang Province in China, Lin, G. and S. Wang (2013) applied self-selection simultaneous equation to analyze the relationship between the disease prevention investment decision and insurance decision. They found that farmers' poultry insurance decision has a negative effect on farmers' disease prevention investment decision, and the farmers who participated in insurance tend to use less of the disease prevention inputs.

However, some scholars argue that the implementation of agricultural insurance will encourage insured farmers to increase the anti-risk inputs. John K. Horowitz et al (1993) analyzed the effect of agricultural insurance on farmers' usage of agrochemical fertilizer in the Midwest of the United States. They found that farmers who participated in agricultural insurance would increase the use of the nitrogen by 19% and the pesticide by 21% per acre of corn, compared to those who did not take part in the insurance. Zhong, F. et al (2007) took cotton insurance in the Manasi Watershed in Xinjiang as a study case, applied simultaneous equation model to test the effect of agricultural insurance on farmers' agrochemical uses. They found that farmers who buy agricultural insurance tend to use more fertilizers and agricultural films.

In addition, some scholars believe that the impact of agricultural insurance on farmers' anti-risk inputs is not conclusive. Ahsan, Ali and Kurian (1982), Chamber (1989) argued that under the assumption of rational economic man, driven by the expected profit maximization, insured farmers would change their behaviors in agricultural anti-risk inputs, increasing risk increased elements, reducing risk reduced elements. Horowitz and Lichtenberg (1993) took crop insurance as a study case, and pointed out that the relationship between farmers' insurance decision and their anti-risk inputs was mainly depended on the agricultural environment of the research area, the properties of agricultural insurance clauses (such as insurance premium, insurance compensation, insurance coverage, etc.) and the types of insurance subject.

The above researches mainly discuss the impact of crop insurance on farmers' anti-risk investment. Although the related research about crop insurance can deepen our understanding of the relationship between the agricultural insurance policies and the farmer's production behavior, expand our research ideas and enrich our research methods, but the dairy cattle insurance has its unique characteristics. Many differences are existed between dairy farming and crop planting, such as the mode of production, production conditions, production cycle and the risk characteristics, etc. However, what is the relationship between farmers' anti-risk inputs and dairy cattle insurance participation. For this problem, the existing researches are rare. Our study attempts to fill this gap.

Theoretical Analysis

As a kind of biological production, dairy farming is vulnerable to natural disasters and diseases. In practice, reasonable dairy farmers will take various measures to control the loss of risk, and make optimal choice according to the costs and effect of different measures. As a risk management tool, the dairy cattle insurance, through the insurance risk transfer and economic loss-sharing mechanisms, helps avoid major risks for dairy farmers. Moreover, due to the insurance payment function, when farmers are deciding the optimal risk prevention methods, they would change their risk prevention methods according to the marginal derogation of insurance and other anti-risk inputs.

Currently, dairy cattle insurance is a kind of insurance against death, especially the death of adult cows caused by the serious diseases, natural disasters and accidents. Here we proposed a formula: *L* = *PD*, where *L* represents the loss of the death of adult cows, *P* represents the average price of a cow and *D* represents the number of dead cows. *P* is an exogenous variable, not controlled by farmers. While the number of dead cows can be given as $\mathrm{D}=\mathrm{f}(x,\varepsilon,r,\varphi)$, it is determined by the following factors: x visible anti-risk inputs, such as disinfectant, cleaning agents, veterinary drugs and vaccines. ε is the invisible inputs such as the care taking of cows; r is random risks such as natural disasters (earthquake, flood, fierce freeze-up, etc.) and accident (such as fire, explosion, building collapse, etc.). φ is the invisible parameter such as the competence of farmers.

Therefore, the loss function can be denoted as following

$$L = P\mathrm{f}(x,\varepsilon,r,\varphi) \tag{1}$$

Where the first- and second-order partial derivatives of $\mathrm{f}(x,\varepsilon,r,\varphi)$ to x are all negative, i.e., $f'(x)<0$, $f''(x)<0$, namely the loss would decrease when increase the anti-risk inputs, but with the decreasing marginal profit for this inputs. The first-order partial derivative of $\mathrm{f}(x,\varepsilon,r,\varphi)$ to r is positive, meaning that the casualties would increase when disasters increase.

Assume that the price vector of visible anti-risk inputs is ω, then the observable investment for farmers would be $C=\omega x$.

Suppose in the absence of dairy cattle insurance, the farmers' main aim is to choose the optimal x, achieving the lowest investment *C* and death loss *L*. On this ground, the investment consideration would be recognized as an optimization problem, and should obey:

$$\min\left[L(x)+\omega x\right] \tag{2}$$

To achieve the above minimum value at $x \geq 0$, the premise would be:

$$-\frac{\partial L}{\partial x}=\omega \tag{3}$$

As the cow dead loss function is monotone decreasing function of the prevention investment, namely $\frac{\partial L}{\partial x}<0$. Here in does not affect the premise of economics, can transform (3) for the following form

$$\left|\frac{\partial L}{\partial x}\right|=\omega \tag{4}$$

Where $\frac{\partial L}{\partial x}=P\frac{\partial \mathrm{f}(x,\varepsilon,r,\varphi)}{\partial x}$ (5)

Formula (4) denotes that the decision-making of farmers to minimize death loss need to meet the following condition: the marginal loss benefit of each anti-risk input is equal to the each price. So, when the marginal benefit or cost of anti-risk inputs changes, farmers' optimal inputs will also change, and economic rational farmers will readjust the anti-risk inputs in order to get the best derogation benefits.

Next, we consider the optimal decision-making of anti-risk inputs in the existence of dairy cattle insurance. After the implementation of insurance, farmers' loss function will be changed. The new loss function L^* would be

$$L^*=\begin{cases} PD+\rho & D<D^* \\ PD-P_1(D-D^*)+\rho & D\geq D^* \end{cases} \tag{6}$$

Where D^{*} is the threshold of the death number of cows for insurance compensation. Namely, when the number of casualties larger than this, the insurance take effect, otherwise, don't take effect. P_{i} is the payment for per dead cow, ρ is the total premium paid by farmers.

At this time, the marginal loss benefit of prevention inputs becomes

$$\frac{\partial L^{*}}{\partial x}=\begin{cases} P\dfrac{\partial \mathrm{f}(x,\varepsilon,r,\varphi)}{\partial x} & D<D^{*} \\ (P-P_i)\dfrac{\partial \mathrm{f}(x,\varepsilon,r,\varphi)}{\partial x} & D\geq D^{*} \end{cases} \tag{7}$$

Comparing (5) and (7), in the presence of dairy cattle insurance, the marginal loss benefit would decrease, due to the payment of insurance

$$\left|\frac{\partial L^{*}}{\partial x}\right| \leq \left|\frac{\partial L}{\partial x}\right| \tag{8}$$

Introduce (8) to (4), we can find that the marginal loss benefit of anti-risk inputs is smaller than their price:

$$\left|\frac{\partial L^{*}}{\partial x}\right| \leq \omega \tag{9}$$

If the other parameters stay unchanged, reasonable farmers, under the condition of limited resources, will reduce their anti-risk inputs to achieve the optimal marginal loss benefit. However, it is necessary to point out that, in this model, by comparing the marginal loss benefit of with/without insurance, showed by the function (7)/(5), farmers will reduce their anti-risk inputs only in the case of a larger probability of $D \geq D^{*}$.In real production, if the probability of dairy cattle death within the scope of insurance liability is small, and it is difficult to trigger the insurance compensation, farmers may not reduce investment risk prevention. In order to ensure the dairy farming income, the farmers think it's not worth it. So what is the relationship between farmers' anti-risk inputs and dairy cattle insurance participation, we will carry out a further empirical test.

Data

The data of this study are form a survey conducted in Inner Mongolia in 2015. Inner Mongolia is China's largest dairy farming and dairy production area. In 2013, the number of dairy cattle in Inner Mongolia was 2.29 million, which was the largest in the whole country, accounting for 15.91% of the total dairy cattle. And the milk production in Inner Mongolia for 2013 was 7.67 million tons, accounting for 21.73% of the country's milk production, ranked first in the country.

We conducted a random questionnaire survey of dairy farmers with different scales, including small-scale farmers and large-scale farmers. The questionnaire covered the information of dairy farmers' production and insurance situation for the year of 2013 and 2014, covered demographic information (age and schooling), background of dairy farming (the number of farm workers, the experience of dairy farming, the annual mortality rate of dairy cattle), financial and insurance variables (loans, feed cost, dairy cattle insurance, other insurance), farmers' cognition degree of dairy cattle insurance, and farmers' anti-risk inputs. In our study, the anti-risk inputs include the usage of disinfectants, cleaning agents, vaccines, drugs and the environmental pollution treatment. In order to facilitate the statistics during this survey, we unified the anti-risk inputs of farmers in the form of CNY. In this questionnaire survey, we obtained 500 valid surveys, 94.70% of the total surveys, and 43% of these respondents purchased the dairy cattle insurance. The detailed variable definitions and summary statistic are listed in Table 1.

Table 1 Variable definitions and summary statistics

Variable	Definition	Mean	SD	Min	Max
Total sample N=500					
Anti-risk inputs	the anti-risk inputs in CNY per cow per year, here is in the logarithmic form	5.09	1.32	0.87	9.81
Insurance	=1 if the farmer participate in dairy cattle insurance, 0 otherwise	0.43	0.50	0	1
Age	age of the dairy farmer	45.06	10.13	21	66
Schooling	number of years of farmers' education	7.90	3.51	0	17
Experience	the experience in years of farmers	14.91	8.43	1	45
Loan	=1 if the farmer has a loan from a financial institution, 0 otherwise	0.19	0.39	0	1
Annual mortality rate of cows	the proportion of dead cows accounted for the total cows for one year	2.92	5.81	0	50
Grouping feeding	=1 if farmers breed cows by group, 0 otherwise	0.51	0.50	0	1
Feed cost	feed input in CNY per cow per day	31.62	15.43	4.5	100
Other insurance	the number of other insurance purchased by the farmer	2.06	1.18	0	6
Cognition degree of dairy cattle insurance	=1 if the farmer is not clear or only one of the insurance clauses(including insurance compensation, insurance coverage, exemption clause, damage survey and claim clause),=2 if the farmer only know two of them,=3 if the farmer know three of them,=4 if the farmer know four of them,=5 if the farmer know all of them	2.53	1.58	1	5

Source: Dairy farmer survey, Inner Mongolia, China, 2015.

Table 2 presents farmers' anti-risk inputs for the year of 2013 and 2014 with or without insurance. In 2013, the anti-risk inputs for dairy farmers who participated in dairy cattle insurance was 477.74 CNY per cow. Compared with it, the anti-risk inputs for dairy farmers who did not participate in dairy cattle insurance was 403.95 CNY per cow. In 2013, the insured farmers' anti-risk inputs was slightly more than the uninsured farmers. However, it showed the opposite relationship in 2014. In 2014, the anti-risk inputs for dairy farmers who participated in dairy cattle insurance was 318.02 CNY per cow, while the uninsured farmers' anti-risk inputs was 356.20 CNY per cow, the uninsured farmers' anti-risk inputs was slightly more than the insured farmers. In order to accurately estimate the impact of dairy insurance policy on the anti-risk inputs of farmers, the following we will carry out an empirical test on this issue.

Table 2 Anti-risk inputs for farmers with or without insurance

Anti-risk inputs (CNY per cow)	With insurance	Without insurance
2013	477.74	403.95
2014	318.02	356.20

Source: Dairy farmer survey, Inner Mongolia, China, 2015.

Empirical model and estimation

In this part, we apply Treatment-effects model for empirical test and analysis. Farmers' anti-risk investment behavior and insurance purchase behavior may influence each other, facing the problems of endogeneity. To eliminate the resultant error, we chose the simultaneous equation (see Maddala, 1983) to solve this problem. The basic form of this model is like this:

$$\mathrm{y}_i = \alpha X_i + \beta z_i + \varepsilon_i \tag{10}$$

$$\mathrm{z}_i^* = \gamma \omega_i + u_i \tag{11}$$

In formula (10), z_i denotes the endogenous variable "whether or not purchase insurance", this parameter is determined by z_i^*. y_i means farmer's anti-risk inputs. X_i is the vector set consisted of the parameters which influence the anti-risk inputs, ε_i stands for random variables.

Treatment Effect Model（TEM）can be described by the following steps

Stage 1, construct the insurance equation of z_i, applying Probit model to estimate the parameters influencing the farmers' insurance purchase decision, i.e., (12)

$$P(z_i = 1 \mid x_1, x_2, \cdots, x_i) = \Phi(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_i x_i) \qquad (12)$$

Where Φ(x) is the standard normal cumulative distribution function, z_i means whether farmer purchase insurance (no=0, yes=1), x_i (i=1,2, …n) means the factors influencing farmers' decision to purchase insurance. β_i is the regression coefficient, β_0 is a constant.

In formula (12), based on Probit regression, we calculated the Mills reverse ratio (λ) of each parameter, obtained the estimated values of selection bias error as:

$$\lambda_i = \begin{cases} \phi(\hat{\beta} x_i) / \Phi(\hat{\beta} x_i), & z_i = 1 \\ -\phi(\hat{\beta} x_i) / \left\{1 - \Phi(\hat{\beta} x_i)\right\}, & z_i = 0 \end{cases} \qquad (13)$$

Where $\phi(x)$ is the standard normal distribution density function, Φ(x) is the standard normal cumulative distribution function, $\hat{\beta}$ is the estimate of β.

Stage 2, name λ as the correction variable of selection bias error, and introduce it into (10) as a parameter, and construct a regression equation, employing OLS to calculate the unbiased estimates of coefficient as

$$y_i = \alpha X_i + \beta z_i + \rho \sigma \lambda_i + \varepsilon_i \qquad (14)$$

Where X_i is a set parameter vectors influencing farmer's anti-risk investment, z_i is the estimated value of whether the farmer would purchase insurance, λ_i is to test whether a selection bias error exist, ε_i represents random variables.

Table 3 The estimation results of TEM regression

Variable	Model 1				Model 2			
	Input equation		Insurance equation		Input equation		Insurance equation	
	Coefficient	SD	Coefficient	SD	Coefficient	SD	Coefficient	SD
Insurance	0.4691	0.3167	-	-	0.4563	0.2925	-	-
Age	0.0062	0.0062	-0.0034	0.0077	0.0062	0.0062	-0.0026	0.0077
Schooling	-0.0600***	0.0171	0.0193	0.0211	-0.0598***	0.0171	0.0197	0.0210
Experience	-0.0156**	0.0070	0.0014	0.0090	-0.0156**	0.0070	0.0017	0.0090
Loan	0.0981	0.1728	0.4405**	0.1942	0.1002	0.1708	0.4373**	0.1940
Mortality rate	0.0226**	0.0091	0.0077	0.0119	0.0227**	0.0091	0.0089	0.0117
Grouping feeding	-0.4083***	0.1113	-	-	-0.4119***	0.1115	-	-
Feed cost	0.0258***	0.0044	-	-	0.0259***	0.0044	-	-
Other insurance	-	-	0.1368**	0.0594	-	-	0.1279**	0.0584
Cognition degree	-	-	0.3237***	0.0466	-	-	0.3255***	0.0462
Year dummy variable	-0.2362	0.1720	1.4209***	0.1390	-0.2306	0.1637	1.4173***	0.1384
Area dummy variable	0.5955***	0.1469	0.0192	0.1613	0.5946***	0.1467	0.0288	0.1603
Constant	4.5412***	0.3461	-2.1791***	0.4405	4.5429***	0.3454	-2.2160***	0.4421
λ	-0.3399*	0.1979	-	-	-			
Wald Chi-square	268.18***				158.74***			
Obs.	500				500			

Notes: ** and *** represent significance at 0.05 and 0.01 levels, respectively.

Table 3 shows the estimation results of TEM regression. Model 1 displays the results of TEM with two-stage estimation. Form the input equation, dairy cattle insurance is not found to be significantly related to farmers' anti-risk inputs. The result indicates that the existing dairy cattle insurance policies in China will not change farmers’ anti-risk inputs. Farmers who participate in dairy cattle insurance, that is to say, will not weaken their health management measures for dairy cattle. Model 2 displays the results of TEM with maximum likelihood estimation. Consistent with the finding in models 1, the dairy cattle insurance policies in China do not have a significant effect on farmers’ anti-risk inputs, indicated that insured farmers do not have negative anti-risk behaviors in the process of dairy production. In addition, dairy farmers’ education years, farmers’ experience of dairy production, mortality rate of cow, whether grouping feeding and feed cost are found to be significantly related to farmers' anti-risk inputs.

Meanwhile, form the results of insurance equation, we can find the major parameters influencing the farmers' insurance purchase decision. Because these results are not the main content of this article, here is no more statement.

Discussion

Although the theoretical analysis results show that farmers who participate in dairy cattle insurance, taking into account the economic loss-sharing mechanisms of insurance, may reduce the anti-risk inputs, that is, dairy cattle insurance provides incentive for dairy farmers to be less careful in the process of dairy production. But form the empirical analysis based on the examples of dairy farmers in Inner Mongolia in China, we do not find a significant correlation between the dairy cattle insurance and farmers' anti-risk inputs. The main causes of the above results are related to the characteristics of the current dairy insurance policy and the actual situation of dairy farming in Inner Mongolia. The details are as follows:

(1) It is unwise for dairy farmers to reduce anti-risk inputs and increase the risk of dairy farming in the current dairy cattle insurance policy of “low-guarantee, low-indemnity” and” the death insurance coverage”. This view has also been confirmed in the author's field interviews with many dairy farmers.

First, the motivation of insured farmers to get insurance claims at the expense of the death of dairy cattle is very small. In order to ensure the sustained and stable income of dairy farming, farmers will not take actions to reduce the degree of the care of dairy cattle. Currently, with the development of dairy specialization, dairy farming is a kind of industry that can bring sustainable income to most farmers in Inner Mongolia , and the dairy cattle is the important tool for farmers to create wealth. Therefore, in order to maximize their dairy farming income, as the rational people, dairy farmers will take good care of their dairy cattle, and try to reduce the risk of dairy farming, improve the quality and quantity of milk. For most dairy farmers, it is not worth to reduce the anti-risk inputs and lead to the death of dairy cattle, even if they know they have been insured.

Second, the indemnity of dairy cattle insurance is very low, this is not enough to "induce" dairy farmers to reduce the anti-risk inputs, leading to the death of dairy cattle. This survey data shows that the average market price of the adult dairy cattle in 2013 in Inner Mongolia was 14506.50 CNY per cow, and the price was 14132.61 CNY per cow in 2014, it was far higher than the insurance compensation (4000 CNY per cow, 5000 CNY per cow and 6000 CNY per cow). Obviously, the insurance payment is very low, it is not enough to compensate for the direct losses of the death of dairy cattle. Therefore, the dairy farmers will not to obtain a lower insurance payments, and deliberately reduce the anti-risk inputs, leading to the death of dairy cattle.

(2) The dairy cattle insurance policy implemented in China has the characteristics of "advance prevention " and "insurance compensation after the disaster". The effective function of "advance prevention" of dairy cattle insurance can remind and regulate the insured farmers' anti-risk behavior. For example, in order to reduce the probability of loss of insured dairy cattle, insurance companies have to provide the

necessary risk prevention reminder to the insured farmers, and help them to carry out effective risk prevention work. Therefore, in reality, dairy insurance does not necessarily have a negative relationship with farmers' anti-risk inputs.

References

Ahsan, S. M. , A. G. AH, and N. J. Kurian. “Toward a Theory of Agricultural Insurance.” American Journal of Agricultural Economics 64 (1982): 520-52.

Chambers, R. G. “Insurability and Moral Hazard in Agricultural Insurance Markets.” American Journal of Agricultural Economics 71(1989): 604-16.

Goodwin，B., Vandeveer, M., Deal, J. “An empirical analysis of acreage effects of participation in the Federal crop insurance program.” American Journal of Agricultural Economics 86 (2004):1058 -77.

Horowitz, J.K., and E. Lichtenberg. “Insurance, Moral Hazard, and Chemical Use in Agriculture.” American Journal of Agricultural Economics 75(1993):425–34.

Lin, G. and S. Wang. “Study on the effect of poultry insurance on farmers’ risk prevention of animal epidemics.” Journal of Agrotechnical Economics 12(2013):94-102.

Maddala，G. S. Limited-Dependent and Qualitative Variables in Econometrics. Cambridge: Cambridge University Press,1983.

Meuwissen, M. P. M., M. A. P. M. van Asseldonk, J. R. Skees, and R. B. M. Huirne. “Designing Epidemic Livestock Insurance.” In The Economics of Livestock Disease Insurance: Concepts, Issues and International Case Studies, edited by S. R. Koontz, D. L. Hoag, D. D. Thilmany, J. W. Green, and J. L. Grannis. Wallingford, UK: CABI Publishing, 2006.

Quiggin, J. C., G. Karagiannis, and J. Stanton. “Crop Insurance and Crop Production: An Empirical Study of Moral Hazard and Adverse Selection.” Australian Journal of Agricultural Economics 37 (1993): 95-113.

Smith, V.H., and B.K. Goodwin. “Crop Insurance, Mor[1]al Hazard, and Agricultural Chemical Use.” American Journal of Agricultural Economics 78(1996):428–38.

Zhong, F., M. Ning, L. Xing. “Does Crop Insurance Influence Agrochemical Uses under Current Chinese Situations? A Case Study in the Manasi Watershed, Xinjiang.” Agric.Econ 36 (2[2]007):103-12.

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