Research on Dynamic Relationship between Agricultural Insurance and Agricultural Disaster Degree

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Abstract Agricultural insurance is an important system of rural financial support for agricultural development. Based on the analysis of agricultural insurance improving farmers' anti-risk ability and reducing the damage, the dynamic relationship is discussed with the adoption of error correction model and the data of Guangdong province between 1997 and 2010. The result shows that the promotion of agricultural insurance depth is beneficial to reducing agricultural damage degree and there exists long-term equilibrium relationship. More precisely, agricultural insurance depth is the Granger reason of agricultural damage degree while the reverse relationship has not been supported yet. Based on the empirical analysis, this paper discusses the characteristics and foundation of agricultural production as well as market characteristics of agricultural insurance to further explore the necessity of financial support.

Key words Agricultural insurance, Disaster degree, Financial support

Agriculture has taken up a strategic position in the economic development of China and is the basic industry of national economy. Vulnerability is the primary feature of agriculture and agricultural development is confronted with many uncertainties, especially the frequent agricultural disasters in recent years, which force farmers to bear various risks during agricultural production and management. Low comparative advantage of agricultural production and management, limited accumulation ability, weak anti-disaster ability of peasants and large - area disasters may cause poverty-returning of farmers. However, agricultural insurance is a kind of system arrangement to transfer and disperse agricultural risks, share economic loss, stabilize agricultural production and reduce the fluctuation of farmers' incomes. Agricultural insurance, as a key rural financial system and the innovation of benefiting-farmers policy, has captured growing attention of the government and domestic academic circle. No. 1 document of the cental government clearly put forward the establishment of agricultural insurance system as well as the testing sites in four consecutive years between 2004 and 2007. Since 2007, Guangdong Province has actively implemented the testing work of agricultural insurance, serving the work of "agriculture, countryside and farmers" as well as the construction of new socialist countryside. Insurance industry in Guangdong province provided over 299 billion yuan of risk protection and paid nearly 500 million yuan of indemnity from 2007 to 2011. However, high premium rate of agricultural insurance, farmers' limited purchasing ability and relatively severe adverse selection as well as moral risks in agricultural insurance market jointly hamper the development of agricultural insurance[1]. Without governmental support, especially the public fiscal measures to support agricultural insurance, it is difficult to motivate the enthusiasm of insurance companies in participating in the insurance supply and improve farmers' effective demands, thus a comprehensive agricultural insurance market with strategic meaning is hard to be achieved[2]. Agricultural insurance market malfunction makes the public fiscal subsidy a necessary control means in order to promote the formation of agricultural insurance market, reduce damage, increase anti-risk ability of farmers as well as promote the development of agriculture and the countrysides. The current researches analyze the necessity of governmental financial support from the perspectives of the production features and strategic position of agriculture as well as product characteristics of agricultural insurance. These researches also study the relationship between agricultural insurance and agricultural output as well as farmers' incomes through empirical researches to further explore the significance of financial support in agricultural and rural development. However, researches on the relationship between agricultural insurance market development and agricultural damage degree are still in demand. Taking Guangdong as an example, this article tries to further explore the necessity of financial support in agriculture through discussing the favorable impact of agricultural insurance on reducing damage degree and from the perspective of increasing farmers' ability of resisting risks in agricultural production and management.

1 Literature review

1.1 Function and evolution of insurance Adam Smith pointed out in *The Wealth of Nations* that insurance premium should be enough to compensate usual loss and pay for management fees and provide the same profit gained with the same funds in any usual trade. Insurance trade brings great security to personal possessions[3]. Insurance can be understood as to disperse risks, reduce risk loss and protect property safety. The functions of insurance have been extended and increased with the economic development. Early insurance is theoretically regarded as for economic

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compensation and payment. However, with the development of insurance industry and financial market, insurance has begun to distribute part of the social saving to satisfy future payment and exert the function of financing. With the rise of neo – liberalism, government impact in social management has been stressed and insurance has been entrusted social management function[4]. Therefore, modern insurance involves three main functions of economic compensation, fund financing and social management, among which economic compensation is the basic function while funding financing and social management are the derived functions to meet social demand.

1.2 Agricultural insurance, damage degree and agricultural output Agricultural production is confronted with dual pressure from natural risks and market risks. The implementation of agricultural insurance is to provide safety for agricultural production, decrease the uncertainty of farmers' production and management, reduce damage degree and guarantee the basic incomes of agriculture[5]. Overall, agricultural insurance has the functions of dispersing, avoiding and reducing agricultural risks, compensating agricultural loss, as well as activating and financing rural funds. Agricultural insurance can improve farmers' ability of resisting production risks, increase the input of agricultural production factors, decrease social loss, increase farmers' incomes and promote agricultural development[6]. The current literatures involve some qualitative researches on the functions of agricultural insurance.

The empirical researches on the impact of agricultural insurance on damage degree and analysis of the relationship between agricultural insurance and agricultural output with anti-risk ability as the mediator variable are in demand. Kraft[7], taking Japan as the example, made empirical analysis and worked out that agricultural insurance increased farmers' anti-risk ability and exerted some favorable impact on the stability of agricultural net income.

Knight and some others[8] studied American agriculture and discovered the significance of agricultural insurance in resisting production and management risks, affecting agricultural production and farmers themselves. Zhang Yuehua[9] believes that agricultural insurance is beneficial for farmers to adopting more advanced but risky production tools and technology, enlarging the scale of agricultural production as well as improving agricultural output with the function of disaster production and loss reduction. Wang Xiangnan[10] believes that agricultural insurance can transfer agricultural production risks, compensate disaster loss, effectively reduce risks for agricultural producers, keep the stability of agricultural production and management as well as increase farmers' enthusiasm. Wang used the large sample panel data of 307 prefecture – level units in China between 2005 and 2009 and concluded through empirical analysis that the development of agricultural insurance markedly improved the agricultural output. Li Ting and some others[11] discovered through the investigation into Zhejiang province and Jiangsu province that political agricultural insurance could strengthen the ability of resisting natural risks and farmers had relatively high evaluation on this impact.

The past researches mainly focus on that agricultural insurance can improve farmers' anti-risk ability, reduce damage degree, promote agricultural output and ensure farmers' basic incomes. They also study the relationship between agricultural insurance and agricultural output or farmers' incomes, explore the importance of developing agricultural insurance and financial support. However, there are less researches on the impact of agricultural insurance on damage degree. This article analyzes the impact of agricultural insurance on agricultural output and farmers' incomes from the perspective of reducing damage and increasing farmers' anti-risk ability to further explore the necessity of governmental financial support.

2 Empirical analysis on the relationship between agricultural insurance and damage degree

This article introduces insurance as the variable to measure agricultural insurance depth, which is equal to the proportion of gross income of agricultural insurance premium and gross output value. Disaster is used as variable to measure agricultural damage degree and also react farmers' anti-risk ability, which is equal to the proportion of no harvest area and disaster area. Analytical data are from *Guangdong Statistical Yearbook* (1998 – 2011), *Guangdong Rural Statistical Yearbook* (1998 – 2011) and *Guangdong Insurance Yearbook*. In order to eliminate the possible heteroscedasticity and ensure that changes in natural logarithm of variable data will not affect the original coordination of variables, this research took natural logarithm of agricultural insurance variable and damage degree variable and gained agricultural insurance depth (InIS) and agricultural damage degree (InDS). (Fig. 1)

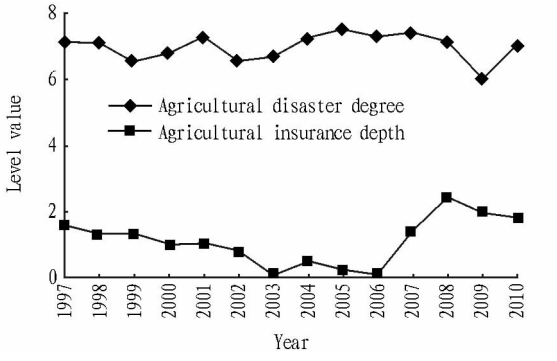

Fig. 1 Agricultural insurance depth and agricultural disaster degree

2.1 Test on the stability of variable Before the co – integration analysis of agricultural insurance depth and agricultural damage degree, the stability should be first tested. That is to test whether there is unit root stability or not. Only when the result of both ADF test and PP test can justify the stability of sequence can we judge each sequence is stable. The testing result (shown in Fig. 1) shows that ADF value and PP value of both InIS and InDS in original level sequence are higher than the critical values under the 10% significance level, which means failure in significance test and shows non-stationary property. After first order differ-

ence, both ADF testing value and PP testing value of agricultural insurance depth are less than the critical value under the 10% significance level, showing stationary property. ADF testing value of agricultural damage degree is less than the critical value under the 10% significance level while PP testing value is less than the critical value under 1% significance value, showing stationary property. It can be seen that each sequence is integrated series of order 1.

Table 1 Unit-root test of variable

Variable sequence	ADF test			PP test		
	Testing value (C,T,L)	Critical value	Stationarity	Testing value(C,T,L)	Critical value	Stationarity
InDS	-2.9243 (C,T,0)	-3.3630*	Non-stationary	-2.8690 (C,T,0)	-3.3630*	Non-stationary
△lnDS	-3.9287 (C,0,1)	-3.4200*	Stationary	-5.4360(C,T,0)	-4.9923***	Stationary
InIS	-1.5046(C,T,0)	-3.3630*	Non-stationary	-1.3734 (C,0,0)	-3.3630*	Non-stationary
△lnIS	-3.6166(C,0,1)	-3.4200*	Stationary	-3.5126 (C,0,0)	-3.3883*	Stationary

Note: If there is unit root in variable and the statistical value is higher than critical value, null hypothesis is accepted. △ stands for first order difference operator. C, T and L in (C,T,L) means constant term, trend term and lag involved in unit-root test. *, ** and *** means critical value under 10%, 5% and 1% significance level.

2.2 Co-integration analysis Cointegration test is a way to discover whether there is long-term stable equilibrium relationship between variables. The result of stationarity detection of the two sequences shows that each sequence is integrated series of order 1, namely InIS ~ I(1) and InDS ~ I(1), which means they satisfy the presumption of cointegration test. The methods of cointegration test mainly involve EG two-step method and Johansen cointegration test while this research adopts the Johansen cointegration test method. VAR model should be first established and the VAR model of agricultural insurance depth and agricultural disaster degree should be tested to gain VAR(3) model. AIC value and SC value are relatively small. Taking lag order as 2 (Lag order selected in the integration test equals the optimal lag coefficient of unrestricted VAR model minus 1), the Johansen cointegration test result shows that there is cointegration equation under the 95% confidence level, which means there is long-term equilibrium relationship between agricultural insurance depth and agricultural disaster degree (Table 2).

Table 2 Johansen cointegration test of agricultural insurance depth and agricultural damage degree

Null hypothesis (cointegration)	Trace examination			Maximum eigenvalue examination		
	Statistics	Critical value	Adjoint probability	Statistics	Critical value	Adjoint probability
No	29.169 7**	15.494 7	0.000 3	26.658 1**	14.264 6	0.000 4
No more than one	2.511 6	3.841 4	0.113 0	2.511 6	3.841 5	0.113 0

Note: ** means null hypothesis is refused under the 5% significance level.

2.3 Error correction model Based on Table 2, there is long-term equilibrium relation between agricultural insurance depth and agricultural damage degree, thus error correction model can be established to further analyze their long-term equilibrium relation and short-term fluctuation relation. The long-term equilibrium relation of InIS and InDS is

$$et = \ln DSt + 5.424\,3^{***} - 0.229\ln ISt + 0.160\,5\ln DS_{t-1} + 0.576\ln IS_{t-1}^{***}$$
(1.397 4) (0.184 8) (0.241 9) (0.195 5)

$R^2 = 0.5296$, $D.W = 2.32$

First order difference sequence of InIS and InDS is △lnIS and △lnDS and the error correction model is

$$\Delta\ln DSt = -0.026\,7 + 0.248\,9\Delta\ln ISt + 0.019\,9\Delta\ln DS_{t-1} + 0.567\,7\Delta\ln IS_{t-1}^{***} - 1.446\,2e_{t-1}^{***}$$
(0.094 4) (0.1594) (0.2146) (0.159 7) (0.361 3)

$R^2 = 0.827\,0$, $D.W = 1.866\,9$

In error correction model, the fluctuation of explained variable InDS mainly contains short-term fluctuation and long-term equilibrium. The short-term fluctuation of InDS can be explained by the short-term fluctuation of explanatory variable InIS and the long-term equilibrium error of these two variables. et-1 is error correction term and its coefficient means adjustment of long-term equilibrium on short-term fluctuation. The coefficient of error correction term is negative, which is in accordance with reverse correction mechanism. The analysis shows that agricultural insurance depth can exert positive effect on reducing agricultural damage. If agricultural insurance depth increases by 1 per cent, agricultural damage degree will reduce by 0.4133 per cent in the long term while increase by 0.2489 per cent in the short term. When short-term fluctuation derives from long-term equilibrium, the adjustment will reach 144.62%. Therefore, it can be concluded that there is relatively obvious causality between agricultural insurance depth and agricultural damage degree and the relationship will be further analyzed with Granger causality test.

2.4 Analysis on causality Granger causality test discovers that there is unidirectional causality between agricultural insurance depth and agricultural damage degree. That is to say, agricultural insurance depth is the Granger reason for the decrease of agricultural damage while the reverse relation is not proved (Table 3). Therefore, orderly promotion of agricultural insurance is essential to the reduction of agricultural damage while reduction of agricultural damage is not the Granger reason for the promotion of agricultural insurance depth. The analysis shows that the promotion of agricultural insurance depth can increase farmers' anti-risk ability,

decrease the impact of agricultural disasters and further increase agricultural output as well as agricultural incomes. However, decrease of agricultural damage cannot promote agricultural insurance depth and the possible reason is that promotion of agricultural insurance depth is related to the supply mode of agricultural insurance as well as other factors.

3 Agricultural insurance and financial support

The empirical analysis shows that agricultural insurance depth can exert favorable impact on reducing agricultural damage in the long run, therefore the sustainable development of agricultural insurance is closely related to the stable and sustained improvement of agriculture. In recent years, however, average claim ratio of agricultural insurance in Guangdong province has achieved 71.32% and the figures in some years even surpassed 100%, causing low participation of commercial insurance companies in agricultural insurance. The reasons involve high risk in agriculture, low premium paid by farmers, wide and decentralized area of the countryside and high management costs of insurance. Moreover, agricultural insurance is confronted with problems like moral risks and adverse selection, which contributes to low enthusiasm of insurance companies in agricultural insurance and also shows the necessity of governmental financial support. The necessity of financial investment in agricultural insurance can be discussed from agricultural production features, the fundamental position of agriculture as well as agricultural insurance features.

Table 3 Result of Granger causality test

Null hypothesis	Lagtime	F statistics	Probability value	Conclusion
Agricultural insurance depth is not the Granger reason for reduction of agricultural damage degree.	1	7.1033	0.0237	Refused
Reduction of agricultural damage degree is not the Granger reason for agricultural insurance depth.	1	0.7620	0.4032	Accepted

3.1 Agricultural production features Agricultural production features mainly involve three aspects. Firstly, naturality of agricultural production. This is different from industrial production workshop. Agricultural production is affected by natural environment factors like soil and weather, causing natural risks. Secondly, seasonality of agricultural production. The objects of agricultural production have vital signs and the production of agricultural products cannot be controlled because of the seasonality. Long production period of agro-products, weak difference among agro-products and hysteresis of product supply intensify the fluctuation of prices and increase market risks of agricultural production. Lastly, the decentralized operation. Under the pattern of "small-scale production and big market" of Chinese market, farmers are usually in weak position during the trade. Besides, market disadvantages like information asymmetry force farmers to face the risks, such as counterfeit and inferior agricultural means as well as fraud. Agriculture is a typical risky industry due to the impact of climate, technology and market. Farmers, as the micro subject of agricultural production and management, are confronted with increasingly various and complex agricultural management risks[12]. So, the weakness of agriculture highlights the significance of agricultural insurance while commercial insurance tends to be away from agriculture due to agricultural production features, thus the development of agricultural insurance requires government support.

3.2 Fundamental position of agriculture Agriculture is the foundation of the existence and improvement of all nonproductive departments. The success of economic development depends in large measure upon agricultural department[13]. Agriculture has taken up the basic position in China's national economy. The functions of agriculture including food security, raw material supply and employment have been constantly strengthened and agriculture has borne increasingly important tasks of food supply, health and safety guarantee[14]. Considering the strategic position of agriculture, agricultural insurance development should be supported with public finance to motivate farmers' enthusiasm in agricultural insurance and guarantee national grain security. Public fiscal support in agricultural insurance development displays not only the necessity of national strategic safety but also a significant means of government back-feeding agriculture.

3.3 Features of agricultural insurance market Firstly, "publicity" of agricultural insurance products[15]. Agricultural production features and agricultural fundamental position bring social characteristics to the profit created by agricultural insurance, namely profit overflow. Agricultural insurance products are quasi-public goods, not public goods or private goods[16] while commercial insurance companies have instinctive rejection to the supply of public goods. Besides, high costs of agricultural insurance management. On the one hand, farmers' effective demand cannot support a commercialized agricultural insurance market and the low profit and even negative profit cannot help commercial insurance companies to supply agricultural insurance[17]. On the other hand, malpractice of agricultural insurance market. Due to agricultural production features, there are system risk, information asymmetry, moral risk and adverse selection in agricultural insurance market, which confronts agricultural insurance with high management costs and high settlement loss[18]. Therefore, commercial insurance companies are naturally not enthusiastic about agricultural insurance.

The above mentioned impact from three aspects highlights the significant practical meaning of agricultural insurance in agricultural development and the necessity of governmental financial support.

4 Conclusions

The healthy and sustained development of agriculture should be supported by agricultural insurance. Under the influence of many factors like market malpractice, agricultural insurance and development are required to be supported by governmental finance. There is close relationship between agricultural insurance depth and agricultural damage degree. The impact of agricultural insurance on reducing damage degree is theoretically analyzed. These two variables are measured and the dynamic relation is discussed with cointegration analysis, error correction model and Granger causality test. The result shows that agricultural insurance depth and damage degree have been stationary since 1997 and both are first-order sequence. The long-term equilibrium relation has been proved. In the long run, there is positive corelation between agricultural insurance depth and the reduction of damage degree. It is tested that agricultural insurance depth is the Granger reason for damage reduction while there is negative correlation in the short term. Moreover, this research also discusses the significance of fiscal support in agricultural insurance development from agricultural production features, fundamental position of agriculture as well as agricultural insurance features. However, what is worth mentioning is that the unstable development of agricultural insurance market is not beneficial to reducing damage. Government should pay attention to modes of financial support, proper selection and perfection of related regulations. Furthermore, governmental intervention in agricultural insurance market may exert unfavorable impact. Excessive intervention and agricultural insurance subsidy may cause huge financial burden, distort the functions of agricultural insurance and decrease the effectiveness of social funds.

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