Empirical Analysis on the Effect of Agricultural Insurance on Production——Based on panel data of 31 provinces and cities in China from 2008 to 2018

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Abstract: This paper uses panel data of Insurance Statistics Yearbook and the National Bureau of Statistics of China in 31 provinces and cities from 2008 to 2018. The random effects model is used to study the direction and intensity of agricultural production impacts from agricultural insurance and its compensation. The collinearity robustness and endogeneity tests are carried out as the empirical results. It shows that agricultural insurance has a significant promotion effect on the agricultural output, and its influence will increase with the growth of risks. From the regional sub-sample regression results, agricultural insurance in the central and eastern of China is more significant than the western. Therefore, China should continue to vigorously promote the reform and innovation of agricultural insurance and its system, expand the coverage of agricultural insurance, and accelerate its high-quality.

1 Introduction

On October 9, 2019, the Ministry of Finance, the Ministry of Agriculture and Rural Affairs, the China Banking Regulatory Commission, and the Forestry and Grass Bureau jointly issued the "Guiding Opinions on Accelerating the Development of High-Quality Agricultural Insurance", clearly stating "Agricultural insurance is an important means of decentralizing agricultural production and operation. It plays an important role in promoting the agricultural modernization and the revitalization of rural industries, improving rural social governance, and protecting farmers' income." Agricultural insurance is an important measure for the state to support the industry, guide the active input of production factors, and adjust the industrial structure. In addition, it is an indispensable component and tool in modern agricultural support and protection systems. Studying the impact of agricultural insurance on the output has a positive effect on building disaster compensation system and improving the forestry financial subsidies.

Insurance is the basic means of risk management under the conditions of the market economy. It is the "booster" of economy and the "stabilizer" of society. 2020 is the year to achieve the goal of building a well-off society in an all-round way in China, and it is also the year to end the battle of poverty. Because insurance can disperse the risks of production and lives of the poor, and leverage and integrate the poverty alleviation resources of other financial institutions. Poverty alleviation is naturally related to the nature of the insurance industry, especially agricultural insurance. It is an important way to implement targeted poverty alleviation for achieving a well-off society in an all-round way against poverty in the new era.

According to the data of the "China Agricultural Insurance Guarantee Research Report (2019)", although China's agricultural insurance guarantees increased to 23.21% in 2018, a year-on-year increase of 19%, the driving force in most provinces is just the guarantees promotion. The depth of China's agricultural insurance protection is still relatively low. The overall protection is about one-fifth of the United States, one-half of Japan, and one-third of Canada. It is not difficult to find that although China's agricultural insurance density (absolutely) has been steadily improved on the whole, there is still a gap between China's insurance depth (relatively) and the world's major developed countries from the micro point of view. The 16 centrally subsidized agricultural insurance products in China account for 80% of the total premium income, and the protection in Beijing and Shanghai is about 45 times the national average. This shows that there is still an uneven regional distribution in China. Therefore, rigorously demonstrating the impact of agricultural insurance on production is important, whether it is to improve our country's central financial subsidy policy system or to avoid and protect farmers from agricultural risks.

2 Literature review

Agriculture is the foundation of the national economy, and rural areas are the "ballast stones" for stable social

development. China is a traditional agricultural country, and agriculture has played an important role in China's economic and people's lives. Cao KH (2013) constructed a two-sector general equilibrium model by using China 's micro-data from 1991 to 2009. It shows that the growth of agricultural TFP is significant in China 's national economy since the reform and opening up. The problems of agricultural insurance and production have attracted the attention of many scholars at home and abroad. Many of them have studied the relationship between agricultural insurance and production from theoretical and empirical perspectives, which is mainly focused on the following two aspects:

A. Whether agricultural insurance can improve the production. Richard E. (1999) used the cross-section data from the annual survey of the FCRS by the U.S. Bureau of Agriculture Statistics to demonstrate that even in moral hazard and adverse selection in the market, participating farmers still have higher returns than those not. Cai H (2009) selected the relevant data of 480 villages in animal husbandry as a sample and discussed the impact of small agricultural insurance on subsequent production. The experiment found that after obtaining formal agricultural insurance, farmers would increase their willingness to raise sows, which was beneficial to agricultural follow-up production. XU J (2014) established a risk model and a risk insurance model to study the output impact of risks, crop insurance and premium subsidies based on the economic growth mode. It found that crop premium subsidies have a more obvious promotion effect on output. Most scholars agree that agricultural insurance can improve the agricultural output. However, some scholars are skeptical of the above views. Based on the traditional theory, Zhang Yue-hua (2006) conducted an empirical analysis on how agricultural insurance affects farmers and national welfare, especially how it affects crop yield by using the survey data from Shanghai. It found that the impact of agricultural insurance on local rice yield is not significant.

B. The relationship between agricultural insurance and modernization. Wu Yu and Jiang Xinhui (2013) sorted out the current situation and contradictions in insurance in China, and discussed the inherent opportunities brought by the rich connotation of agricultural modernization to the transformation, and innovation of the industry. Cao Weifang (2013) stated that the agricultural insurance has brought about the welfare effect of agricultural modernization as an important booster. Tang Jin (2013) showed that the establishment of an agricultural insurance system is a necessary guarantee to meet the industrialization. Chinese and foreign scholars have revealed the inevitable interaction between insurance and modernization from different research.

In summary, scholars at home and abroad have demonstrated the relationship between agricultural insurance and production from different perspectives, providing reference and inspiration for the study. Based on the above considerations, this article selects data from the National Bureau of Statistics of China with more observation samples and more complete indicators, and uses a static panel random effect model to set control variables from agricultural capital investment, labor, arable land, and production technology to increase the accuracy.

3 Data and theoretical models

3.1 Source and processing of data

This paper selects panel data samples from 31 provinces and cities in China from 2008 to 2018. The relevant data of agricultural insurance premium income and compensation amounts are from the China Insurance Statistical Yearbook. The total output value and employees of agriculture, forestry, animal husbandry and fishery, and the number of rural population, the total sown area of crops, the proportion of urban population, the total power of machine, and the damage area are all from the National Bureau of Statistics of China. In this paper, the two data sets are matched and combined. After removing outliers and calculating the values of each indicator, 341 valid samples are retained, and subsequent research is performed based on this sample.

3.2 Build the main variable metrics

3.2.1 Explained variable

Agricultural production(Y): It represents agricultural production. This paper selects the per capita value of agriculture, forestry, animal husbandry and fishery as the measurement index. This indicator characterizes the per capita scale and results of production. The greater added value of agriculture, forestry, animal husbandry and fishery per capita is, the higher output per capita.

3.2.2 Explanatory variable

① Prem: This article selects agricultural insurance density (that is, per capita agricultural insurance premium income) as the basic indicator to measure the insurance protection. The calculation formula is insurance premium income / number of employees in forestry, and animal husbandry. Generally speaking, the larger the value, the higher insurance development.

② Loss: This article selects the agricultural insurance compensation rate to measure the agricultural insurance compensation, and its calculation formula is the insurance payment amount / insurance premium income. Agricultural risk is the loss caused to farmers by various natural disasters and man-made risks during the production and management. From the historical data, the probability and scale of losses incurred by China's insurance are higher than those of ordinary insurance types. The higher the agricultural risk is, the greater the loss of production.

3.3 Controlled variable

(1) Area: The total area of crops sown per capita measures the scale of agricultural output. It is an important factor affecting the agricultural output per

capita. Under the conditions where production and technology remain stable, the larger the average sown area of crops per capita, the greater the added value of agriculture, forestry, animal husbandry and fishery per capita.

(2) Affected: The damage area measures the negative impact of natural disasters on output. China has a vast area, and the terrain and climatic conditions in different areas are relatively complicated. The occurrence of agricultural disasters is an important factor affecting production. The larger the affected, the lower the agricultural production.

(3) Illiteracy rate: Illiteracy rate measures the quality of labor force engaged in production. The improvement of the quality of labor will help increase agricultural labor productivity and reduce production costs. The higher the illiteracy rate, the lower the efficiency of production.

(4) Machine: The total power of agricultural machinery refers to the sum of the rated power of all. It measures the technology of production and reflects the modernization in China. With conditions unchanged, the machine per capita will bring about an increase in output.

(5) Urbanization: Urbanization rate measures the scale of labor force engaged in production. Under normal circumstances, the higher the urbanization rate is, the greater the number of rural labor force shifting to the primary and secondary industries.

3.4 Descriptive statistics and analysis of variables

Descriptive statistical analysis of the explanatory and control variables selected can find that the maximum and minimum of per capita value-added of agriculture, forestry, animal husbandry and fishery are decided. It indicates that the output and insurance varies greatly across provinces and cities. It can be seen that the insurance in Hainan is relatively low, while strong in Sichuan and Shandong. The standard deviation of the total area and machine per capita is relatively large, which indicates that the arable land and power in various provinces and cities has fluctuated greatly.

Table 1 Descriptive statistical table of each variable

Variable name	Sample	Average	Standard deviation	Maximum	Minimum
y	341	883.838	1396.25	19.612	13424.86
prem	340	288.475	553.022	1.671	6149.16
loss	340	0.69	0.499	.002	6.572
area	341	1368.501	1720.607	35.57	15824
machine	310	873.464	1232.209	22.341	7854.706
urbanization	341	53.944	14.752	21.9	89.6
illiteracy	309	2.788	6.505	0.291	61.748
affected	305	999.289	945.499	3	7394

4 Econometric models and estimation methods

4.1 Benchmark model

In order to estimate the impact of insurance on production, this paper adopts the following benchmark measurement model:

$$\ln y_{it} = \alpha_{\mathrm{t}} + \beta_1 \ln prem_{it} + \beta_2 \ln loss_{it} + x_{it}'\gamma + \mu_i + \varepsilon_{it}$$

The paper mainly researches agricultural production and security and agricultural insurance compensation. Among them, y_t is the explained variable related to production, which is mainly measured by the gross output value of agriculture, forestry, animal husbandry and fishery per capita to measure the relevant indicators of insurance security. $\ln prem_{it}$ is insurance security related indicator, measured by the density index of insurance. $\ln loss_{it}$ is about the insurance reimbursement level correlation index. β_1 and β_2 are regression coefficients for the core variable. μ_i is the intercept term of individual heterogeneity, and ε_{it} is a disturbance term that changes with individual time. x_{it} is a collection of control variables, including area, affected, illiteracy, machine, urbanization.

4.2 Estimation method

Considering that the data is panel data of 31 provinces from 2008 to 2018, due to the characteristics of the selected sample data, the explanatory variables do not contain the lag item of the explained variables, and a static panel measurement model is established. In the selection of fixed effects, random effects, and mixed regression models, this paper makes the following considerations: intuitively, the sample data of China Insurance Yearbook and the National Bureau of Statistics database from 31 provinces, municipalities and autonomous regions in China. The heterogeneity index of each province and city in the sample interval changes. Using the random effect, the regression coefficient of the original fixed is regarded as a random variable, and the estimation results take into account the heterogeneity of the provinces, so that the degree of freedom of the model

becomes smaller. The random effects set individual as part of the interference term, requiring that the explanatory variables are not related to individual. The paper uses the Hausman test, and the null hypothesis is not rejected at the significance of 0.01according to $\chi^2(p) = 0.257$. Therefore, the paper uses a random effects to avoid col-linearity. The paper introduces related control variables in turn for regression. To explore the impact of insurance on output more comprehensively, this paper selects the regression results of five models for analysis.

5 Empirical analysis results

5.1 The baseline return of output

In this paper, a random effect model is established to regress the agricultural production. Table 2 reports the results of the stepwise regression. Among them, column (1) is the result of regression of only adding the core variable of insurance. Column (2) is the result of regression of only adding the core variable of agricultural insurance compensation. Columns (3) and (4) are the regression results after adding the control variable, and column (5) is the regression result after considering all the above core and control variables.

Table 2 Baseline regression results for agricultural output

	Random effect model				
	(1)	(2)	(3)	(4)	(5)
	output	output	output	output	output
prem	0.457***		0.143***		0.128***
	(34.88)		(9.82)		(8.08)
loss		0.0649		0.312***	0.123*
		(1.03)		(5.46)	(2.22)
area			0.480***	0.557***	0.480***
			(8.96)	(9.49)	(9.02)
machine			0.382***	0.417***	0.377***
			(7.73)	(7.62)	(7.68)
urbanization			1.211***	1.846***	1.245***
			(8.64)	(14.72)	(8.86)
illiteracy			-0.00961	-0.0126	-0.0105
			(-1.37)	(-1.60)	(-1.51)
affected			-0.0418***	-0.0521***	-0.0434***
			(-3.47)	(-3.89)	(-3.63)
_cons	3.875***	6.064***	-4.616***	-7.144***	-4.642***
	(24.00)	(29.65)	(-8.43)	(-14.93)	(-8.51)
N	340	340	274	274	274

Note: t means statistics; *, **and*** respectively stand for the significance at 0.1, 0.05, and 0.01; and all variables are logarithms.

It can be seen from the regression results that the control variables of per capita area, total per capita machine, and urbanization have a significant effect on output. Among them, per capita area, per capita machine and the original intention of the prediction of covariates are same. However, the urbanization is contrary to the original intention, which shows that the transfer of agricultural surplus labor in China to the secondary and tertiary industries will also expand the scale of production with a positive impact. Illiteracy on output is not significant, which shows that under the current situation of twelfth-year compulsory education in China, the quality of labor can basically meet the requirements of production in China.

Agricultural insurance will significantly increase output, which is due to the economic compensation of insurance. For producers, insurance can effectively resolve the economic losses caused by risks and increase the enthusiasm of producers to re-enter production after disasters. This also shows that if an insurance system with a sound model is built, it can escort the sustainable development of agricultural health. Different agricultural insurance policy systems can also promote and guide the types and scales of agricultural products produced in a differentiated manner, thereby adjusting the structure of industries and promoting national economy.

Agricultural insurance compensation is significantly weaker from the regression results. This is because after the agricultural producers purchase insurance, the economic losses will be reduced. It will tend to use higher-risk new production materials, new technologies, etc., to stimulate insurance market to generate adverse selection when insuring.

6 Endogeneity and robustness test

6.1 Robustness test

Considering the impact of agricultural insurance on output, there are regional heterogeneity and agricultural risk heterogeneity. This paper tests the robustness of the regression results from the following two dimensions: first, due to regional heterogeneity, sub-sample regression is carried out in the eastern, central and western respectively. The second is to consider the sensitivity of the data index selection, and use the total value of agriculture, forestry, animal husbandry and fishery production, insurance turnover and insurance operating profit to re-run the full sample regression.

6.1.1 Sample robustness test

Considering the regional differences of provinces and cities, the provinces are divided into the eastern, central and western for sub-sample regression. They are shown in the following table:

Table 3 Sample regression results in different regions

	(1) east	(2) central	(3) west	(4) nationwide
	output	output	output	output
prem	0.178***	0.0625**	0.164***	0.128***
	(6.41)	(2.36)	(7.55)	(8.08)
loss	-0.0456	0.325***	0.0938	0.123**
	(-0.44)	(3.59)	(0.96)	(2.22)
control variables	Y	Y	Y	Y
N	140	81	53	274

Note: t means statistics; *, **and*** respectively stand for the significance at 0.1, 0.05, and 0.01; and all variables are logarithms.

From the results of regional regression, it can be seen that insurance significantly promotes the output in the west, central and eastern, which is consistent with the regression results of the original random effect model. From the estimation of the coefficient of random effect, the insurance in the eastern is more obvious than that in the central and western. However, the eastern and western of China have no significant effect on the output.

6.1.2 Full sample robustness test

Considering the sensitivity of data index selection, the insurance transaction amount of gross product of agriculture, forestry, animal husbandry and fishery, and the operating profit amount of agricultural insurance is used to conduct full sample regression as follows.

Table 4 Full sample regression results

	Per capita added value				Gross value		
	(1)	(2)	(3)		(1)	(2)	(3)
prem	0.143***		0.128***	***transaction***	0.173***		0.176***
	(9.82)		(8.08)		(5.95)		(5.69)
loss		0.312***	0.123***	***profit***		-0.0594*	0.00552
		(5.46)	(2.22)			(-1.65)	(0.16)
control variables	Y	Y	Y	***control variables***	Y	Y	Y
_cons	-4.616***	-7.144***	-4.642***	***_cons***	-2.533***	-2.812***	-2.594***
	(-8.43)	(-14.93)	(-8.51)		(-3.52)	(-3.58)	(-3.49)

N	274	274	274	***N***	249	249	249

Note: t means statistics; *, **and*** respectively stand for the significance at 0.1, 0.05, and 0.01; and all variables are logarithms.

From the regression results of the robustness test of the full sample, the insurance turnover has a significant effect on output, while the insurance operating profit is not significant.

6.2 Endogeneity test

The main way to control endogeneity is to use the main control variables at output, such as per capita area, disaster area, illiteracy, per capita machine, urbanization. However, this method can only solve the endogeneity caused by the missing variable, and it cannot solve the reverse causal angle. Therefore, this paper considers using the instrumental variable method to solve the endogenous. In reality, it is difficult to find the instrumental variables of insurance guarantee and compensation, so this paper uses the explanatory variables with a lag period as the instrumental variables for endogenetic test by referring to the practice of Cheng Huifang (2014). On the one hand, the insurance that lags one period has a high correlation with the current indicators; on the other hand, the way that the indicators affects the output is through the current agricultural insurance. Therefore, the index of the explanatory variable lagging one period satisfies the relevance and exclusivity of the instrument variable, which is more reasonable.

Table 5 Instrumental variables estimate results

		RE-VI	
	(1) output	**(2)** output	**(3)** output
prem	0.182***		0.141***
	(7.46)		(4.28)
loss		0.116	0.219
		(0.51)	(1.12)
area	0.498***	0.622***	0.497***
	(8.59)	(9.87)	(8.97)
machine	0.319***	0.352***	0.287***
	(5.96)	(5.97)	(5.45)
urbanization	0.937***	2.118***	1.324***
	(5.18)	(13.84)	(5.73)
illiteracy	-0.00741	-0.00884	-0.00949
	(-1.07)	(-1.17)	(-1.43)
affected	-0.0413***	-0.0440***	-0.0413***
	(-3.29)	(-3.30)	(-3.47)
_cons	-3.431***	-8.286***	-4.591***
	(-4.61)	(-11.83)	(-3.09)
N	244	244	244

Note: t means statistics; *, **and*** respectively stand for the significance at 0.1, 0.05, and 0.01; and all variables are logarithms.

Columns (1) and (2) are the estimation results using the per capita premium income and the lag period of insurance compensation rate as instrument variables. Column (3) is using a combination of the two instrument variables. Comparing the results of tool variable and benchmark regression, it can find that the coefficients and significance of each variable are same. It can be considered that this paper better controls the endogenous caused by missed variables.

7 Conclusions and recommendations

Based on China's inter-provincial panel data from 2008 to 2018, this paper empirically describes the agricultural insurance from two perspectives: insurance protection and compensation. The main conclusions of this research are as follows:

(1) Agricultural insurance has a significant promotion effect on output, and its impact will increase with the growth of risk. (2) Per capita area, per capita machine, and urbanization is significant in output. (3) The affected has a negative impact on the output, while

the labor quality has no significant impact on the output. (4) Judging from the regional sub-sample regression results, the effect of agricultural insurance on output in the central and eastern of China is more significant than that in the western. Based on the above analysis, it can be seen that accelerating the high-quality insurance in China, and solving the low protection, limited coverage, and the lack of national-level co-ordination in China's insurance are of positive significance for improving the output. China can proceed from the following aspects to ensure the implementation of supporting policies, so that insurance can serve the real economy and help the agriculture and rural industries:

(2) Expand the coverage of agricultural insurance actively guide insurance institutions to go deep into the border areas of the poor to provide services timely break the old and bring forth the new, actively try to release new types of insurance such as meteorological index insurance, go beyond the limits of low premiums and low insured amount, and develop the first type of insurance to effectively meet the requirements of new agricultural operators on risk diversification. (2) Improve the security of insurance. Insurance protection shows the extent to which insurance provides risk protection for the entire industry from a macro and industrial perspective. Agricultural insurance has the problems of complicated payment process and long payment cycle. Insurance companies should actively use advanced comprehensive information technologies such as remote sensing, satellite, communication and strive to "reduce the complexity" and improve the compensation. (3) Promote the insurance technology. Agricultural insurance technology can change the extensive characteristics of insurance, with the support of science and technology to achieve reduced standard underwriting, accurate claims, and the operating costs of insurance companies. It is necessary to strengthen the awareness of insurance technology innovation, explore together, make the technology be applied, and actively build an technology ecosystem.

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