The Study on Incentive Effects of Agricultural Insurance's Subsidies under the Social Welfare Maximization

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(Abridged)

1. Research Background

Agricultural insurance is a kind of quasi-public goods with strong positive externality. By purchasing such kind of insurance, farmers can achieve risk dispersal and stable income, which ensures agricultural production without obstruction. At the same time, the whole society can benefit from the steady development of agriculture and the low price of products. However, according to welfare economics, agricultural insurance is not exchanged at equal values of goods due to positive externality. In this way, the equilibrium quantity of agricultural insurance is lower than that of social optimum, leading to market failure. In addition, owing to information asymmetry between insurance companies and farmers, it's likely to arouse serious moral hazard and adverse selection. The two factors combined with agricultural risk for catastrophe property characterize agricultural insurance as a high risk, high loss ratio and high loss rate one, which curbed insurance companies' enthusiasm about expanding agricultural insurance. Properties and characteristics of agricultural insurance decide that it is only policy-based insurance, namely, agricultural insurance must change the cost-income ratio of agricultural products through some stimulating policy provided by the government, leading the whole market to a balanced state. The government can internalize positive externalities of agricultural insurance by providing subsidies to farmers to improve the social welfare. In the mean time, the government can also give subsidies on the insurance company’s operation and management costs to motivate it to develop agricultural insurance business.

China begins to carry out policy-guided agricultural insurance supported by the central finance from 2007. The latest *Agricultural Insurance Act* points out that "The principle of the government guidance, market operation, voluntariness, cooperative advance shall be practiced in agricultural insurance". To policy holder, the central finance and local finance will give them appropriate premium subsidies, while to insurance institutions operating agricultural insurance business, the government can give appropriate subsidies on operation and management costs. In the case of limited financial funds, one of the main problems ,which we are facing nowadays when selecting the subsidy of policy-guided agricultural insurance, is how to find a efficient way through equitable distribution of the financial subsidies to farmers and the insurance companies, by which we can maximize the stimulation coming from government subsidies, improve the efficiency in using fiscal fund and maximize social welfare by means of utilizing fiscal levers

2. Research Significance

Agricultural insurance not only reduces the risk that farmers take, but also accelerates the increasing of agricultural production. Being easily quantified, agricultural production can be served as a useful indicator of efficiency of policy agricultural insurance. In this paper, we use “the Beijing Pattern” of policy agricultural insurance as an example to study the fiscal subsidies, which the government gives to farmers and insurance companies, how to affect agricultural production, under the conditions of social welfare maximization. And then we will explore the optimal ratio of the fiscal subsidies that the government gives to farmers and insurance companies, which matters for maximizing the incentive role of government subsidies, improving the utilization efficiency of financial funds and optimization of the existing agricultural insurance

subsidies incentive policy.

On the other hand, agriculture, the basic industry of the national economy, ensures the growth of the national economy to a certain degree. Policy agricultural insurance is a very important tool, which benefits to countryside, agriculture and farmers and promotes agriculture production. And in recent years, with China's food imports surging and the degree of dependence on import continuing to increase, food security is facing serious challenges. Agricultural insurance can prompt agricultural production and then is in favor of improving domestic food production, increasing food self-sufficiency and ensuring food security in China. Therefore, it has a great strategic significance on optimization of the agricultural insurance subsidies incentive policy and the growth of the national economy and food security by studying the influence of the fiscal subsidies to farmer's enthusiasm of production and agricultural production.

3. Modeling Specification

Basing on the latest *Agricultural Insurance Act* and "the Beijing Pattern" of policy agricultural insurance, the model of agriculture insurance is constructed from insurance companies, reinsurance companies and the government's point of view. We use farmers producing effort (q) as the basic variable to study the values of the two variables--the extent of the government subsidization on farmer's premium (α) and the costs of operation and management of insurance companies (β) under the case of all sectors of social welfare maximization. And then we explore how the two variables—α and β affect agricultural production. Finally, basing on our findings, we provide reasonable suggestions on the choice of agricultural insurance subsidies incentive policy.

In this paper, our research idea is to choose suitable farmers producing effort q, the government subsidies to farmers in agricultural insurance premium α, the government subsidies to insurance companies in operation and management costs β, and the level that the insurance company maintains to discover the false loss farmers asking for v, which maximizes the social welfare. Due to the additional costs C_E only depends on v, there are four endogenous variables in the model. So we can respectively model farmers' profit, the original insurance company's profit, the reinsurance company's profit, and the total social welfare, so as to get those variables' values.

3.1 The Farmer's Profit Function

$$\pi_1 = Y(q) - C(q) - (1-\alpha)I - pL(q) + p[vL(q) + (1-v)Z]$$

Where q is farmers' producing effort, which can also be regarded as a method to measure the farmer's production conditions.

$Y(q)$ is the amount of the agricultural production, viewed as the function of q. As the farmer works harder, the production becomes relevantly larger. With the degree of the farmer's producing effort raising, according to the principle of diminishing marginal productivity, the marginal increase of the production decreases by degrees. Therefore, $Y(q)$ subjects to $Y(q)' > 0$ and $Y(q)'' < 0$, i.e. $Y(q)$ with the respect to q is a concave function.

$C(q)$ is the farmer's cost of production, including the fixed cost C_0 and the working cost C_q. The fixed cost is the basic and constant production cost which does not change with the degree of the farmer's producing effort. While the working cost is the cost spent to increase the production and prevent disasters and loss, which shows correlation with the degree of the farmer's

producing effort. And the higher the degree of the farmer's producing effort is, the larger the working cost is. As the rate of marginal cost increases by degrees, the working cost for increasing the production and preventing disasters and loss gradually increases by unit, showing that C_q with the respect to q is a convex function, i.e. $C_q^{'} > 0, C_q^{''} < 0$.

α represents the level of the government's subsidies for the farmer's premium; I is the premium of agricultural insurance. The premium paid by the government is αI, the part paid by the farmer is $(1-\alpha)I$. According to the law of large number, $I = E(p \cdot L(q))$.

p is the probability of the occurrence of agricultural disasters, of which is mainly natural calamity. Therefore, we assume that the probability of the occurrence of agricultural disasters is a constant value.

$L(q)$ is the actual loss caused by agricultural disasters, viewed as the function of q. When the degree of the farmer's producing effort is higher, he will prevent and decrease loss with more positivism, making the actual loss after the disasters smaller.

Here we assume that with the information asymmetry existing, all the farmers have a motive to misrepresentation their loss, which is a proportion of the actual loss, i.e. $Z = z \cdot L(q)$, and that z is a constant value.

v is the probability that the insurers find out that the farmers' misrepresentation. If the insurers do, they will compensate according to the actual loss $L(q)$, otherwise they will compensate according to the misrepresented loss Z.

Let the three endogenous variables in the farmer's profit function q, α, v subject to

$$\frac{\partial \pi_1}{\partial q} = 0$$

And we can conclude the formula of q, α and v under the condition of the farmer's profit maximizing

$$q = f_1(\alpha, v)$$

.....（1）

3.2 The Insurer's Profit Function

$$\pi_2 = (1+\beta)I - C_M - p[v \cdot \min\{b_1 I, L(q)\} + (1-v) \cdot \min\{b_1 I, Z\}] - C_E(v)$$

β is the level of the government's subsidy for the insurer's operation and management costs, and the all subsidy βI is paid according to the income of the premium.

C_M is the insurer's general running costs, which is an exogenous e constant value.

$b_1 I$ is the insurer's loss ratio limit. The loss below it is paid by the insurer , while the loss above it is paid by the reinsurance company or the agricultural catastrophe risk reserve fund.

$C_E(v)$ is the extra cost the insurer pays for finding out the farmer's misrepresentation, which is a concave function with the respect to v, i.e. $C_E(v)' > 0, C_E(v)'' > 0$. This is easy to understand. To find more facts about the farmer's misrepresentation, the insurer has to pay more extra costs. And the larger the probability that the insurers find out that the farmers' misrepresentation is, the larger the cost for the finding will be.

There are four variables α, β, v and q in the insurer's profit function. Here we introduce Model Stackelberg to analyze the optimal solution to the function. We assume that double information asymmetry exists, the first one has been mentioned before, the farmer's control over the information of the amount of the loss, which leads to the arouse of the misrepresentation

of the loss Z. The second one is the relative informative advantage that the insurer has over the farmers in underwriting and settlement of claims, which shows in the making of the probability of finding out the farmer's misrepresentations. We believe that farmers are the negative price receivers in agricultural insurance, so the insurer can see the farmer's choice for the degree of producing effort under the lever of v.

Therefore, Stackelberg equilibrium is actually formed between the insurer and the farmer. The insurer can adjust his setting of v according to the farmer's choice for q under different levels of v, achieving profit maximization. And in the insurer's profit model, q is used as a exogenous value decided by α、v in the farmer's profit model. Now we can take formula (1) in.

As a result, in the analysis of the insurer's profit function, let

$$\frac{\partial \pi_2}{\partial v} = 0$$

And we can get a relation concerning α、β、v

$$v = f_2(\alpha, \beta)$$

.....（2）

3.3 The Reinsurance Company’s Profit Function

$$\pi_3 = R - p[v \cdot \min\{(b_1 - b_2)I, L(q) - b_1 I\} + (1-v) \cdot \min\{(b_1 - b_2)I, Z - b_1 I\}]$$

R stands for excess of loss ratio reinsurance premiums, paid by the government, in this model as an exogenously given constant value.

b_2 stands for loss ratio limit of the reinsurance company. The loss greater than $b_1 I$ but less or equal to $b_2 I$ shall be compensated by the reinsurance company, while the part beyond $b_2 I$ shall be compensated by agricultural catastrophe risk reserve set up by the government.

In this profit function, there are only three variables R, q and v, while q is still seen as an exogenously given constant value. Besides, v decided by the original insurance company, is also seen as an exogenously given value. As a matter of fact, the reinsurance company's profit function merely depends on the premium R of excess of loss ratio reinsurance. In another word, the profit function of the reinsurance company is entirely up to premium negotiated with the government.

3.4 Social Welfare Function

$$SWF = \pi_1 + \pi_2 + \pi_3 - \alpha I - \beta I - R - S$$

SWF is the function of four variables α, β, v, q. As q can be represented by α and v, and β will be removes from *SWF* after addition and subtraction, which in some cases, the government's subsidy for the insurance company's operation and management costs actually is a kind of transfer payments which will not affect the total social welfare. So *SWF* in fact is the function for α and v. Under the condition of social welfare maximization, v satisfying:

$$\frac{\partial SWF}{\partial v} = 0$$

$$v = f_3(\alpha)$$

..... (3)

To sum up, according to (1)(2)(3), the expressions q of α and β can be obtained under the optimal conditions of different departments.

$$q = g(\alpha)$$
$$q = g(\beta)$$

And then according to $Y(q)$, we can respectively get agricultural production expressions about α, β.

$$Y = h(\alpha)$$
$$Y = h(\beta)$$

Thus, we can analyze the influence of agricultural production output, on which the government's subsidies to farmers' agricultural insurance premium and to insurance companies' operation and management costs have, under the conditions of the social welfare maximization. Finally, we can provide some reasonable suggestions on the government's subsidies incentive policy for agricultural insurance.

4. References

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