Market equilibrium of the agricultural product target price insurance and its moral hazard premium

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Abstract: In the study, an expected revenue model was built for the farmers and insurance institutes in China, with the aim of researching the realization conditions of the target price insurance market equilibrium; analysing the reasons and consequences of the moral hazards; obtaining a paradox and elaborating the reason; measuring the moral hazard premium and researching positions, as well as the role of government in the target price premium; and also discussing the relationship between the target price and the cost price. The conclusions found were that the market risk was the major risk in agriculture; the target price insurance implementation relies on the government subsidy, which shall be equivalent to the sum of the farmers' moral hazard premium and social costs; the moral hazard premium has a negative externality; the insurance companies are also the beneficiaries of the farmers' moral hazard; and the best target price should be smaller than the total cost price of the agricultural products.

Keywords: target price, agricultural insurance, moral hazard premium, perspective of institutional economics

In 2014, the "No. 1 Central Document" emphasized the necessity to adhere to the market-set price principle, to gradually establish the agricultural product target price mechanism, and then to carry out the target price insurance experiments of agricultural products, including vegetables and pigs. Agricultural risk is the main risk of the agricultural product market, and the target price insurance is a feasible method to address this risk. The target price insurance plays an important role in the stabilizing the fluctuations in the agricultural product market prices, as well as the farmers' income. Our company is exploring and implementing the target price insurance in different cities. However, we must overcome a series of problems. One problem is that whether an equilibrium or not between the farmers and the insurance institutes can be realized through the target price insurance system. Several questions still exist regarding what conditions are required for the equilibrium; what the reasons and influences are for the farmers' moral hazard; if any externality exists in the target price insurance system; and the government's role in the system. Therefore, the aim of this study is the realization of the conditions of the target price insurance market equilibrium, as well as the manifestation, degree, and characteristics of the moral hazard during its implementation. Also included is a discussion of the underlying reasons, and the possible resolutions are put forward.

LITERATURE REVIEW

Production and market risks are listed as the main risks in agriculture. Most countries throughout the world withstand the natural agricultural risks with the crop yield and weather index insurance, and the market risks with the income insurance (Zeng 2006; Wei et al. 2010). Cortignani et al. (2012) develop an innovative Positive Mathematical Programming model that takes into explicit consideration the risk aversion behaviour to investigate the implications of participating in the crop revenue insurance scheme, and proposes a quadratic mix integer program to simulate the impact of changes on a small group of crop farms

in Italy in the level of the insurance premium. At the present time, China has adopted the risk management tool equipment (greenhouse) insurance, along with the yield insurance, in order to avoid such natural risks as snowstorms, flood, drought, and so on. Most provinces implement the policy-based insurance for field crops such as wheat, corn, and cotton (Tuo and Xie 2013). Policy-based agricultural insurance, as a type of the risk management tool, plays a key role in reducing the hazard loss, protecting the farmers' income, and stabilizing the fluctuations in market prices (Zhang 2006). However, the insurance products for market risks have relatively lagged behind. Shanghai has attempted to implement a target price insurance, and has obtained certain achievements. However, with the aim of "addressing risks during slack seasons", this insurance has been found to be weak in the coverage, degree and influence (Sun 2012).

Target price insurance, as an emerging agricultural insurance, also has some problems. These include information asymmetry (Arrow 1953); moral hazard (Pauly 1974; Holmstrom 1979); adverse selection (Rothschild et al., 1976); market mechanism; subject behaviour change; and insurance systems (Liang 2001; Cao 2005). Yu (2007) analysed the influences of the crop yield insurance on the expected incomes and profits of farmers from the perspective of economics, and revealed the family characteristics and relationship between the moral hazards and adverse selection. Liu and Wu (2003) regarded insurance claims as a key procedure for the performance of insurance contracts, and utilized the game theory for the quantitative analysis of the related theories. Robert and Chambers (2002) proposed that the moral hazard increased the risk behaviours of farmers during agricultural production.

Agricultural Insurance applied in the United States includes the price issues insurance, the production issues insurance and the income issues insurance currently. Price issues insurance is in majority used to avoid the risk of price fluctuations, and the target price insurance is one of them. Its form is similar to options and pays the difference between the target price and the actual price according to the loss of production. Because the prices of soybeans, corn and wheat have increased significantly since 2006 and it is difficult to determine their target price as well as updates timely, so few farmers choose it (Wang 2014).

Agricultural insurance applied in Europe includes a single and multi-risk insurance. Both focus on the production but there is nothing related to the type of the price insurance. However, the agricultural support policies in the EU involve the target price which means the upper of the market price fluctuation permitted by the government (Wang 2011).

In summary, many research studies have focused on the agricultural production and disaster insurance. In China, the target price insurance is still in its infancy, and there have only been a few research studies conducted in this field, and in particular, from the perspective of moral hazards and market equilibrium. Differing from other insurance modes (products), the market equilibrium conditions are related to the target price during the implementation of the target price insurance, and the latter is closely associated with the total cost during production. Also, the main body and bearer of the moral hazard in the target price insurance have obviously externalities, which is different from other agricultural insurances. The government and society assume the responsibilities for the externalities in the target price insurance, and play important roles.

ANALYTICAL FRAMEWORKS

Theoretical basis

Market risk mainly refers to the deviations in the market price from the expected direction, and is reflected in price fluctuations. Due to the long plantation cycle of crops, the supply of agricultural products is always influenced by the prices of the early-stage products. Under the combined action of the lagging effects of agricultural produce prices on yields, and the irrational speculation of the market mass, the fluctuations of supply and prices in the agricultural product market will continue to worsen.

Target price insurance means that the insurance institutes will pay profit losses to the farmers in accordance with the insurance contracts, when the actual market price is lower than the target price stated in the contract, following the contract coming into force. The implementation of the target price insurance can effectively reduce the farmers' losses arising from the fluctuations in market prices. In this

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[1]Economic intervention refers to government subsidies for the strategic agricultural insurance, which will be later elaborated in detail.

way, the market problems can be resolved through use of a market tool (insurance), and the government can intervene in the economy in reasonable ways, such ways as the subsidies, and so on[1].

The economic effects of the target price insurance are mainly divided into three parts: (1) farmers, due to the reduction of the expected market risks, will increase the investment into the agricultural production elements, in order to enhance the yield and to realize profit maximization; (2) the target price insurance can stabilize the increases of the farmers' income, the aggregate national income and the distribution equalization degrees, and enhance the social welfare; (3) the government can reduce the risks to the agricultural production, attract more agricultural production elements, adjust the national/regional industrial structure, and realize the objective of redistribution of the national income through fiscal subsidies for the agricultural product price insurance.

Model and assumption

In the actual plantation area of the farmers, per unit yield: q; actual total output: $A = aq$; profit variables of insurance institutes and farmers: π; and the target price: p_a. When the market price p is higher than the target price p_a, the farmers' income is guaranteed without any insurance compensation. When p is lower than p_a, the farmers will receive the insurance compensation, $pay = (p_a - p)nA$. The premium rate: c; premium price: insurance price of unit product, p_c. We carry out the necessary research assumptions before building the theoretical model, as follows.

1. The transaction cost and expense of the insurance contract are not considered. The insurance contract is established by a farmer, insurance institute, and the government and every party must pay a transaction cost during the establishment of the contract. For the government, the transaction cost, as a type of administrative cost, includes the monitoring and publishing of the market price data. Moreover, expenses of this kind belong to a social cost[2], and are mandatory whether or not there is an insurance contract. For the farmers, the transaction cost mainly includes the time and opportunity costs. At the present time, the services of insurance institutes in China cover

all town and county-level administrative units. An access to the nearby insurance can greatly reduce the insurance costs for the farmers. In addition, most farmers choose a large-area collective insurance, and therefore the insurance scale within the unit of a village or cooperative can also decrease the individual costs for the farmers. For the insurance institutes, a fixed input mainly refers to the precipitation input due to the expansion of service networks and the increase of the sales networks. The transaction prices of insurance are a type of variable cost, and are quite low when compared with the fixed cost prices.

2. The farmers' input of the element costs during agricultural production is not considered. The agricultural production cost is equivalent to the product of a weighted average of the total costs per unit and plantation area. The larger the plantation area is, the higher the total costs will be. In this study, the weighted average of the total costs is an exogenous variable, and it will not be considered in order to simplify the theoretical analysis. It will be admitted into the research system during the final discussion of the relationship between the cost price and the target price.

3. Farmers and insurance institutes are rational, and they pursue the maximization of profit. They may have moral hazards and perform arbitrage behaviours in cases of no supervision or audit mechanisms being in place.

4. Both the market price and the target price are actual prices. Some researchers have suggested converting the prices into indexes, as a basis of the insurance implementation. This study utilized the actual prices as variables, with the principle being the same as the indexes. The indexes and actual prices had very highly similar properties: (1) both the indexes and prices were continuous variables; (2) the *PI* (price index) was the function of the price beam of the products of the same kind, $PI = F(p_1, p_2, ...)$, and its direction and price were positively correlated; (3) the difference change relationship of the *PI* was the same as the operation mechanism of the target price insurance. Also, compared with the indexes, the price variables had the advantages of being intuitive, rapid and correct, and could directly be multiplied by the quantity of the insured agricultural products for the insurance income during the determination of the insurance compensation.

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[2]Expenses arising from governmental monitoring and publishing of costs, prices, and other data are also the government's payment for social goods (services).

5. In an insurance region[3], the agricultural products of the same kind in different parcels had the same quality, and the unit yields of the agricultural products of the same kind were approximately the same.

6. Market prices are continuous, and the probability of price = p_a is 0, $P(p = p_a) \approx 0$. The probability of a market price being lower than a target price (market risk) is $(1 - \rho)$, $P(p \le p_a) = 1 - \rho$; the probability of a market price being higher than a target price (market risk) is ρ, $P(p \ge p_a) = \rho$.

The theoretical model was built under the premise of the above research assumptions. There were two options for the farmers (insurance or no insurance), with different expected revenues. The expected revenue of no insurance was:

$$E_f^0(p) = \rho pA + (1-\rho)pA = pA \qquad (1)$$

The expected revenue of insurance was different from Equation 1. The farmers would definitely utilize the insurance tool for arbitrage in the cases of no insurance supervision or audit mechanisms. Therefore, the moral hazard must be considered, and the actual insured yield is nA; in which $n > 0$ (the concrete value range will be analysed and demonstrated in the sections below). The expected revenue of insurance:

$$E_f^1(p) = \rho pA + (1 - \rho)[pA + (p_a - p)nA] - cnAp_c \\ = pA + (1 - \rho)(p_a - p)nA - cnAp_c \qquad (2)$$

The meaning of each symbol in the formula 2 is the same as mentioned above, and the same symbols appear below, without any special explanation, all represent the same meaning. Then according to the first order condition of profit maximization of the farmers, we can obtain the formula 3:

$$dE_f^1(\pi)/dA = p + (1 - \rho)(p_a - p)n - cnp_c \qquad (3)$$

For the insurance institutes, the following expenses are not considered: signing expense of the insurance cost; labour expenses; operational maintenance expenses; and the expenses arising during the hazard verification and loss determination. The insurance income of no insurance is 0, $E_c^0 = 0$; and the expected revenue of the price insurance with the consideration of the farmers' moral hazard is:

$$E_c^1(p) = \rho cnAp_c + (1-\rho)[cnAp_c + (p_a - p)nA] \\ = cnAp_c - (1-\rho)(p_a - p)nA \qquad (4)$$

The first order condition of the profit maximization of the insurance institutes is:

$$dE_c^1(\pi)/dA = cnp_c - (1-\rho)(p_a - p)n = 0 \qquad (5)$$

In conclusion, the theoretical model of the expected revenue functions of the farmers and insurance institutes was built before or after the insurance contract was signed, respectively. Meanwhile, a series of problems were caused based on the target price insurance, which will be analysed and demonstrated one at a time.

Analysis and demonstration

Theorem 1: In the insurance systems only composed of farmers and insurance institutes, the equilibrium between the target price insurance of agricultural products cannot be realized.

Demonstration: According to Equation 3, the premium rate of the farmers:

$(c_f^1 = [p + (1-\rho)(p_a - p)n]/np_c)$; according to Equation 5, the premium rate of the insurance institutes: $(c_c^1 = (1 - \rho)(p_a - p)p_c)$. When the equilibrium between the two is reached, the farmers and insurance institutes shall have the same premium rate. Therefore, $c_f^1 = [p + (1 - \rho)(p_a - p)n]/np_c = c_c^1 = (1 - \rho)(p_a - p)p_c)$

According to the above formula, $p = 0$; this means that the equilibrium can be realized only when the premium rate is 0, which is not an actual situation. In other words, if the premium rate exceeds the expected value, then the farmers will not choose the insurance, even if the premium rate exists in theory. Then, it is necessary to carry out a weighting of the premium rate. Assume the multiplier is r; the actual premium rate assumed by the farmers is smaller than the nominal premium rate, with the residual premium rate $(1 - r)$ assumed or subsidized by a third party (governmental department)[4]. Then the revenue function of the farmers is:

$$E_{fn}^1(\pi) = rpA + (1 - \rho)[pA + (p_a - p)nA] - crnAp_c \\ = pA + (1 - \rho)(p_a - p)nA - crnAp_c \qquad (6)$$

The first order condition of the profit maximization is:

$$dE_{fn}^1(\pi)/dA = p + (1-\rho)(p_a - p)n - crnp_c = 0 \qquad (7)$$

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[3]Insurance region: neighboring villages or towns sign an operational price insurance contract with an insurance institute.
[4]Agricultural insurance subsidies: proportional subsidies from the government for agricultural insurance businesses.

The premium rate of the insurance institutes does not change, so that the profit function remains unchanged.

The subsidies of the target price insurance are similar to those of the agricultural insurances of other kinds. There are no regulations on the upper limit of the expenses. The subsidies of the target price insurance belong to the indirect agricultural subsidies allowed in the WTO green-box policy, which interprets the policy constraints of the agricultural insurance subsidies, and becomes an important system framework of the agricultural insurance policy system.

Theorem 2: Necessary and sufficient condition of establishment of target price insurance contract (insurance market equilibrium):

$(1 - \rho)(p_a - p)/p_c \leq c \leq (1 - \rho)(p_a - p)rp_c$

Demonstration: When the farmers select the insurance, an insurance contract is completed. The equilibrium is realized for both the insurance institutes and farmers. The farmers will select the insurance only when the expected revenue of the insurance is not smaller than the expected revenue with no insurance. Therefore, according to Equation 6:

$(1 - \rho)(p_a - p)/nA - crnApc \geq 0$

$0 \leq c \leq (1 - \rho)(p_a - p)rp_c$　　　　　　(8)

When the above conditions are satisfied, the farmers will select the insurance. This means that these conditions are sufficient for the farmers to select the target price insurance. Meanwhile, if the farmers select the insurance, the expected revenue will be larger than 0, ($E_{fn}^1 (\pi) \geq 0$).

$pA + (1 - \rho)(p_a - p)nA - crnAp \geq 0$

$0 \leq c \leq [pA + (1 - \rho)(p_a - p)]/rp_c$　　　(9)

If the farmers select the insurance, then the conclusions of Eq. 9 will be obtained. Therefore, Eq. 9 is a necessary condition for the farmers to select the target price insurance. According to the comparison between Eq. 8 and Eq. 9, Eq. 8 is a compact constraint condition of Eq. 9, and the conditions for meeting Eq. 8 will definitely meet Eq. 9. In conclusion, the premium rate conditions listed in Eq. 8 are necessary and sufficient conditions for the farmers to select the insurance.

In regards to the insurance institutes, the establishment of contracts shall ensure that the expected revenue of the insurance will be larger than expected revenue with no insurance: $E_c^1(\pi) \geq E_c^0(\pi) = 0$. Therefore, according to Equation 4:

$cnAp_c - (1 - \rho)(p_a - p)nA \geq 0$

$c \geq (1 - \rho)(p_a - p)/p_c$　　　　　　(10)

If the conditions of Eq. 10 are satisfied, then the insurance institutes will obtain revenues larger than 0, and will be willing to sign the insurance contracts. Therefore, Eq. 10 is a sufficient condition for the insurance institutes to select the insurance. Meanwhile, both parties (insurance institutes and farmers) shall obtain the minimal expected revenue, in order to realize the equilibrium of the insurance market. The profits of the insurance institutes are the increasing function of the premium rate[5], while the revenue of the farmers is the decreasing function of the premium rate. Therefore, the constraint condition of the premium rate shall not increase infinitely based on Equation 10. When the constraint condition increases to Equation 9, the insurance institutes and farmers can still realize the supply and demand equilibrium. If the premium rate exceeds $[pA + (1 - \rho)(p_a - p)]/rp_c$ then the farmers will choose to abandon the insurance, and the revenue of the insurance institute remains 0. Therefore, the premium rate shall meet the following equation so that the insurance institutes can obtain the revenue larger than 0, and the insurance contracts can be established:

$(1 - \rho)(p_a - p)/p_c \leq c \leq (1 - \rho)(p_a - p)/rp_c$　　(11)

Eq. 11 is a necessary condition for the insurance institutes to establish insurance contracts. Eq. 11 is a compact constraint condition of Eq. 10, so that the premium rate conditions listed in Eq. 11 are the necessary and sufficient conditions for the insurance institutes to select the insurance.

In conclusion, the necessary and sufficient conditions for the equilibrium of the target price insurance market or the establishment of insurance contracts is that the premium rate shall meet Eq. 11.

Theorem 3: Target price insurance will lead to reduction of actual plantation area (yield) (n ≫ 1)

Demonstration: The first order condition of the profit maximization of farmers (Eq. 6):

$n = p/[crp_c - (1 - \rho)(p_a - p)]$　　　　(12)

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[5]In Eq. 4, first obtain the derivative of the profit of the insurance institutes to the premium rate c, which is larger than 0.

In the insurance contract establishment conditions listed in Theorem 2, the premium rate shall meet the constraint condition in Eq. 11; put this into Eq. 12, and replace premium rate *c*:

$$n = \frac{p}{crp_c - (1 - \rho)(p_a - p)} \geq$$

$$\geq \frac{p}{(1 - \rho)(p_a - p)rp_c/rp_c - (1 - \rho)(p_a - p)} \gg 1 \quad (13)$$

Eq. 13 indicates that $n \to \infty$ in the case of no other constraint conditions. From the perspective of mathematics, the value of *n* is considerably larger than 1. This indicates that, under the above assumptions, the larger the value of *n* is, the larger the probability of moral hazards and arbitrage of the farmers will be. This is also applicable to the insurance institutes. According to Eq. 4, in the case of the moral hazards of the farmers, the profits of the insurance institutes shall be larger than 0, so that the insurance contracts can be established. After the deformation of Eq. 4, the insurance institutes are also beneficiaries of the farmers' moral hazard[6], and the insurance institutes will obtain more benefits when the value of *n* increases.

Eq. 13 indicates that the farmers will choose the insurance for the largest plantation areas in order to obtain hedging benefits in case of no other constraint conditions. However, in fact, the total land and plantation area, and the total yield in an insurance region is limited. According to the Theorem 3, the rational farmers will still make full use of the dredging tools. In this case, the plantation area was determined, the insured area could not be infinitely increased, and the farmers would choose to reduce the actual plantation area. The question remained as to how to determine the actual plantation area for the maximization of profits by the farmers. The existing plantation area: *A*; the actual plantation area: *mA*, $(0 \leq m \leq 1)$; the area multiplier: *m*; then the function of the expected revenue of the farmers is rebuilt as follows:

$$E_{fn}^2(\pi) = rpmA + (1 - \rho)[pmA + (p_a - p)A] - crAp_c$$
$$= pmA + (1 - \rho)(p_a - p)A - crAp_c \quad (14)$$

The first order condition of the profit maximization of the farmers is:

$$dE_{fn}^2(\pi)/dA = pm + (1 - \rho)(p_a - p) - crp_c = 0 \quad (15)$$

The selection parameter of the plantation area of the farmers is:

$$m = [crp_c - (1 - \rho)(p_a - p)]/p$$

According to the necessary and sufficient conditions of Theorem 2:

$$m = [crp_c - (1 - \rho)(p_a - p)]/p$$
$$\leq \{[(1 - \rho)(p_a - p)]/rp_c/rp_c] - (1 - \rho)(p_a - p)\}/p = 0 \quad (16)$$

According to Eq. 16, the selection parameter of the plantation area of the rational farmers: $m = 0$. This indicates that the rational farmers will select the price insurance while not carrying out agricultural work.

According to the above analysis, there is a paradox: in the case of no target price insurance, (expected) the revenue of the farmers will decrease. As a result, the agricultural production development will be hindered. However, the production behaviours of the farmers are still inhibited after the implementation of the target price insurance.

In case of no price insurance, the expected market prices of farmers: $P = P(A)$. Following the implementation of the price insurance, the rational farmers will judge the supply of the agricultural product market according to the agricultural product plantation area (insured area). In accordance with the supply and demand theory, when other conditions remain unchanged (especially the short-term demand of agricultural products), and the expected market prices of agricultural products become $P^* = P^*(nA)$, then the expected market supply will increase sharply, the price will drop a great deal, and the insured farmers will obtain the compensation in accordance with the price insurance. Under the same conditions, the greater the market supply is[7], the lower the prices will be, the higher the insurance benefits obtained by farmers, and the more obvious the incentive function of dredging will be. Therefore, driven by the rational expectation, the farmers will choose to decrease the plantation areas and to increase the insured areas, in order to obtain the minimal dredging benefits. The moral hazards of the farmers will not lead to losses for the insurance institutes, and the partial moral hazards will cause negative externalities, with the size equivalent to the moral hazard premium degree.

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[6]$cnAp_c - (1 - \rho)(p_a - p)nA > 0$, so $cAp_c - (1 - \rho)(p_a - p) A > 0$ is workable.

[7]Market supply expectations by vegetable growers can be judged through the total insured area stated in the price insurance contract.

Theorem 4: The total premium subsidies of the government shall be equivalent to the sum of the moral hazard premium and social cost (of farmers and insurance institutes), *GPS = MHP + SC*

Demonstration: According to the results of Eq. 13, the results of the interaction between the insurance institutes and the farmers are as follows: the expected revenues of both parties will increase in the cases of moral hazards of the farmers. In the market system, there will definitely be a party experiencing benefit losses. According to the conclusions of Theorem 1, the main body of the premium subsidies, for example, the government needs to introduce a model. Meanwhile, the moral hazard produces negative social externalities, so that society shall also be brought into the insurance system as a main body.

The moral hazard premium degree of the farmers' dredging is the same as size of the externality arising from it. According to the above analysis, Eq. 2 shows the expected revenue of the farmers in the cases of moral hazard. The difference after deducting the expected revenue in cases of no moral hazard from Eq. 2, is that the moral hazard premium is as follows:

$$PE_f(\pi) = E^1_{fn}(\pi) - \rho pA - (1-\rho)[pA + (p_a - p)] + crAp_c$$
$$= (n-1)A[(1-\rho)(p_a - p) - crp_c] \qquad (17)$$

Similarly, the moral hazard premium of the insurance institutes is:

$$PE_c(p) = E^1_c(p) - cAp_c + (1-\rho)(p_a - p)A$$
$$= (n-1)A[cp_c (1-\rho)(p_a - p)] \qquad (18)$$

In conclusion, in the insurance system, both the farmers and the insurance institutes are beneficiaries of moral hazards. Eq. 17 and Eq. 18 show the total premium of the moral hazards in the price insurance system, for example, negative externalities:

$$MHP = PE_f(\pi) + PE_c(\pi) = (n-1)Acp_c(1-r) \qquad (19)$$

Some of the premium subsidies of the government for farmers are used as expenses of the negative externalities, for example, payments for the risk hazard premiums. The residual value after deducting the moral hazard premiums from the total subsidies is the payment of the government for social costs, which is equivalent to the premium subsidies of the government for the actual plantation area of every farmer:

$$SC = nAcp_c(1-r) - (n-1)Acp_c(1-r) = Acp_c(1-r)$$

Here, the social costs refer to cost of the government for the auditing of the data (including the plantation areas of the farmers), and the statistics of the total plantation areas of the insurance subject within insurance region. This also includes the expenses of statistics, auditing, and publishing of the market and cost prices. However, the above-mentioned data are not listed in the operational and transaction costs of the insurance institutes. Also, the insurance institutes are beneficiaries of the moral hazards, and thereby they will not pay any extra supervision costs. For the insurance market, these costs have the properties of public goods, and thereby belong to social costs. Therefore, the total subsidies of the government for price insurance shall be equivalent to the sum of the moral hazard premiums and social costs.

$$GPS = MHP + SC$$

DISCUSSION

Analysis of the above paradox

According to the above research assumptions, the target price insurance paradox was obtained. The reason lies in the arbitrage space between the actual plantation area and the insured area. The reason for the non-existence of the condition described in the study is that the governmental statistical department had established a periodical inspection and the statistical system for the total land area and plantation areas of the different agricultural products within the insurance region, and the data information of this type belongs to public goods. The target price insurance can be implemented based on the data information. However, two prominent problems still exist as follows: (1) even if there are statistical data regarding the existing plantation or land areas within the insurance region, the arbitrage can still be carried out by making use of the annual variations in the plantation areas due to the plantation type adjustments arising from the land conversion, or by the farmers' decisions led by the market; (2) the actual plantation areas of the individual farmers were unknown, and the fragmented family operation mode increased the insured farmer supervision and audit costs.

Some provinces and cities in China have implemented the yield insurance for food crops such as wheat, corn, and so on, and have also encountered the above problems. However, the primary cooperative organizations or the village-level administrative units have carried out statistics and verification of the annual plantation areas of the farmers, and

distributed subsidies in accordance with the direct food subsidy policy, which also provides the conveniences of the food yield insurance. The merits are listed as follows: (1) a full use of the functions of primary cooperative organizations and the village-level administration subsidies are made in order to establish a price insurance system involving four parties, including the farmers, insurance institutes, cooperatives, and the government. The role played by the primary cooperative organizations in the direct food subsidy is transplanted into the target price insurance; (2) the admittance level of the farmers is approximately enhanced, and the farmers are encouraged to reach certain plantation scales in order to select the insurance, in order to make the statistics and audits more convenient and to reduce the supervision costs.

Determination of target price

In the actual operation of the price insurance, the target price p_a is quite important. It is the result of the interactions between the farmers and the insurance institutes, which is influenced by various factors which include the risk probability, the premium rate, and the coverage. When the target price is too high, the risks of the price fluctuation will mainly be assumed by the farmers. However, when the target price is not high, the risks of the price fluctuation will mainly be assumed by the insurance institutes. At present, the target price is mainly determined based on the production cost prices of the insurance products. Some researchers have proposed that the target prices should be higher than the cost prices in order to guarantee the partial production profits of the farmers through the insurance. Other researchers believe that the target prices should be lower than the cost prices in order to only guarantee the partial production cost. Still others suggest using the cost prices as the target prices, and guaranteeing the plantation cost of the farmers through the insurance. Disputes among the above three opinions are mainly reflected in the definition or accounting of the cost prices.

This study proposes that the cost prices only refer to the total cost input by farmers during the plantation, they and do not include the opportunity costs and labour wages. The expected revenue function, including the production costs of the farmers based on Eq. 6, was built as follows:

$$E_{fn}^3(\pi) = rpA + (1-\rho)[pA + (p_a - p)nA] - crnAp_c - \hat{p}A$$

$$pA + (1-\rho)(p_a - p)nA - crnAp_c - \hat{p}A \qquad (20)$$

in which the production cost price: $\hat{p} = \Sigma\ p_i x_i/q$; indicating the average total cost of the unit yield. p_i shows the price of the production elements of type i; x_i shows the average mu input of the production elements of type i; and the first order condition of the profit maximization is as follows:

$$E_{fn}^3(\pi)/dA = p + (1-\rho)(p_a - p)n - crp_c n - \hat{p} = 0 \qquad (21)$$

Establish equation set with Eq. 21 and Eq. 5; eliminate p; and build the function relation including the target price p_a and the cost price as follows:

$$p_a = \hat{p} + \frac{cp_c + crnp_c(1-\rho) - cnp_c(1-\rho)}{(1-\rho)} \qquad (22)$$

Obtain the linear function of p_a to cost price $\hat{p}$ according to Eq. 22. The best target price is different when the value of n is different, as shown in Figure 1.

When, $n < \dfrac{1}{(1-\rho)(1-r)}$ according to the market equilibrium results of the farmers and insurance institutes, $p_a < \hat{p}$, then the best target price is lower than the cost price. Similarly, when $n = \dfrac{1}{(1-\rho)(1-r)}$ and $p_a = \hat{p}$, the best target price is equal to the cost price; and when $n > \dfrac{1}{(1-\rho)(1-r)}$, $p_a > \hat{p}$, the best target price is higher than the cost price. This indicates that the best target price increases when the value of n is added.

In theory, according to a further analysis, the implementation of the target price insurance needs a strict statistical and audit mechanism. However, in
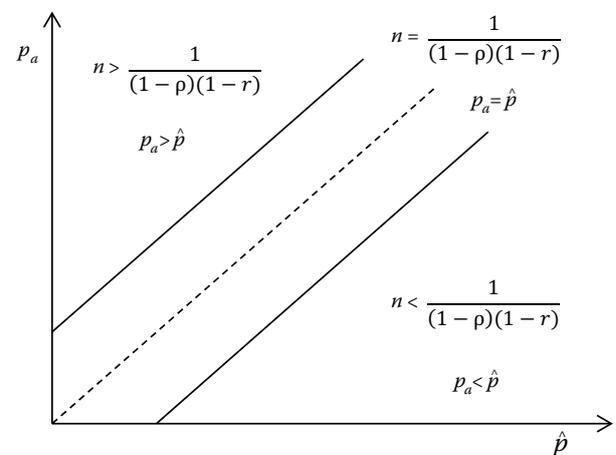
Figure 1. Distribution of the best target prices under different conditions

fact, the moral hazard or the arbitrage behaviour may still occur, which arises from the land conversion and the changes of the plantation types. As a result, *n* > 1. Even so, *n* is definitely within a reasonable range. Therefore, the best target price should be lower than the total cost price, with a constant improvement of the price insurance mechanism.

It established the target prices insurance of vegetables on green vegetables and Hang cabbages in Shanghai, China. Taking the Hang cabbages as an example, its implementation is as follows: The insurance yields of the Hang cabbages are 21ton per hectare and the overall cost is 800 Chinese Yuan (130.72 dollar) per ton, so the insurance value is 16 800 Chinese Yuan per hectare. The premium rate is 10% of the output value per hectare and the premium is 1680 Chinese Yuan (274.51 dollar) per hectare. Calculating the formula for the amount of claims:

Insuranced Value = (total costs per ton – the average retail price during insurance period) × insurance yields per hectare × insurance area

CONCLUSIONS

This study discusses the problems of the implementation of the target price insurance, and analyses the related reasons from an economic perspective. This study analyses and demonstrates the necessary and sufficient conditions of the price insurance market equilibrium, by building an expected revenue function for the farmers and insurance institutes. Also, the reasons and consequences of moral hazards of the farmers were researched, and a paradox was obtained. This study attempted to discover a resolution on this basis. The research conclusions are as follows:

First of all, the market risk is the main agricultural risk, and the violent fluctuations of prices are the main manifestation of the market risk. The target price insurance can effectively stabilize the farmers' revenue. At present, the price insurance is only implemented in some areas of China, and its current influence and guarantee degree are not sufficient. Therefore, it is imperative to comprehensively implement the target price insurance.

Secondly, the price insurance requires government subsidies, and the subsidies should be equivalent to the sums of the moral hazard premiums and social costs. The moral hazard premiums are negative social externalities. The insurance institutes are also benefi-

ciaries of the moral hazards of the farmers. Therefore, they should not pay extra costs for the supervision and audits. It is necessary to make a full use of the target price insurance and risk management tools, in order to maintain the agricultural development. A matching supervision and audit mechanism is required, which is the responsibility of the government.

Finally, the best target price should be lower than the total cost price. The concrete differences require a further empirical testing.

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