Modeling Risk Behavior of Agricultural Production

in Chinese Small Households

Wencong Lu, Aiqin Xi, Jian Ye

Centre for Agricultural and Rural Development (CARD),
Zhejiang University, Hua-Jia-Chi Campus, 310029 Hangzhou, China
Tel: +86-571-86971587; Fax: +86-571-86971646; Email: wenclu@zju.edu.cn

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Abstract: This paper analyzed Chinese small-scale farmers' response to agricultural risks by using MOTAD model. Based on the households' data from the two villages Wangjia and Damao in Zhejiang province, we established "representative rural household" for each of the sampling villages. The results show that farmers in Zhejiang are quite sensitive to agricultural risks. However, different farming systems, the ratio of agricultural income to total family income, as well as the size of arable land, differentiates their risk response. The decision maker's risk preference not only affects the type of agricultural activities and corresponding scales they selected, but also have further effects on the micro agricultural production structure and stable growth of households' income. Given the amount of productive resources such as arable land, capital and labor force, the combination of production activities with a higher level of expected income/risk would be selected if the decision maker is willing to take risks. In a higher level of risks, capital is invested prior to manpower, implying that the latter has a much higher opportunity cost. For those combinations with a lower risk level, diversification might reduce risks to some extent at a cost of total return. Current agriculture structure needs to be adjusted and improved.

Key words: Farming household, agricultural risks, risk response, MOTAD Model

JEL codes: D1, C6, D2

1. Introduction

As well-known, there was a significant institutional reform of Chinese agriculture initiated in the early 1980s, to transform from collective-farming to the household responsibility system (HRS), which makes Chinese households' agricultural income directly bear relations to their production. The past two decades has witnessed gradual market reform towards liberalization and globalization, together with far-reaching changes in agriculture and overall economic developing environment, where the changes in both domestic and international markets play increasingly important roles in Chinese agricultural production. Against this backdrop, Chinese farmers face with risks from market. Moreover, agriculture itself is susceptible to natural risks due to the biological characteristics and exposure to nature, especially for crops prone to damages caused by unfavorable climate, weather, disease and

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insect pests. In addition, agricultural technology, institution and policy also influence on agricultural production. Therefore, agriculture is a typically risky sector. The type and severity of risks confronting farmers vary with farming systems, climatic, technological, policy and institutional settings, thus making the problem complicated. The variety of agricultural risks which farmers faced makes their incomes unstable from year to year.

Agricultural risks seem to be prevalent throughout most of the world. Ignoring risk in farm planning models often leads to results that are unacceptable to the farmer, or that bear little relation to the decision he actually makes. Farmer's response to risks has become focus of study in agricultural economics for a long time. Several techniques for incorporating risk in mathematical programming models have been developed in recent years. For example, Quadratic Programming (QP) model, which was originally proposed by Freund, an America economist, in the mid of 1950s, has been adopted widely in practice since then. The QP model, though "a useful method to consider gross margin uncertainty in farm planning", "but application of the technique depends on access to a special computer code of which there are few in existence with the desired features and capacity" (Hazell, 1971). To solve this problem, Hazell (1971) developed a linear alternative to QP model, the MOTAD (Minimization Of Total Absolute Deviation) model, which has computational advantages and provides an efficient set of farm plans quite similar to the results obtained by quadratic programming. And furthermore, "MOTAD is theoretically as valid as quadratic programming in solving expected utility problems under the previously outlined assumptions (Johnson & Boehlje, 1981)''. Therefore, the MOTAD model is extensively used in international studies in recent decades (Boisvert & McCarl, 1990; Hanf, 1996; Hardaker, 1997; McCarl, 1998; Bechtel & Young, 1999; Ridier,1999; Harwood, 1999; Stott, 2003; Ahmad et.al., 2005).

Contrasting with the abundant international research, Chinese domestic study on farmer's reaction to agricultural risks is quite few. Most studies focus on conceptual or describing discussion on agricultural risks, and only very few gave empirical analysis. Below are three most representative studies on Chinese small households' decision-making under risks. Ren et. al. (1995) empirically discussed the impact of price risk on self-sufficient production of wheat and corn in Chinese undeveloped areas. Zhang (1996) analyzed households' decision-making under different policy conditions. Yang (1999) explored the influences of agricultural policy risk on farming households in Northwest loess plateau using Mean-Gini risk programming model. All these above studies examined only one type of risks and did not fully take into account of the impact of diversified production in agriculture. And furthermore, these studies were made several years ago and at that time some agricultural products were not allowed to enter market freely, which was quite different from those of nowadays.

Since 2001, all agricultural products are subjected to market except that grain is partially restricted in some areas. Zhejiang is the first province to lift all policy restrictions on grain production and distribution. Therefore, farmers in Zhejiang are free to make their own decisions in agriculture, while at the same time, they must face and bear agricultural risks mostly by themselves. Under these circumstances, what are farmers' responses to agricultural risks? What impacts on their decision-making? How to optimize factor allocation in agricultural production? To answer these questions will not only help to explore the micro decision-making mechanism in Chinese agriculture, but also provide feasible suggestions to improve income for small-scale farmers. As market reform towards liberalization for all agricultural products, the empirical studies from farmers in Zhejiang province surely provide predicting and insightful views on risk response from farmers of other provinces.

The objective of this paper is to analyze Chinese small-scale farmers' response to agricultural risks by applying MOTAD model, explore the micro decision-making mechanism in Chinese agricultural production, and analyze the interlinks between expected income, risk and the associated inputs. At first we will briefly review the formulations of the MOTAD model, then establish "representative rural household (RRH)" based on our farm investigation from two villages in Zhejiang province, and then follow the results of the MOTAD model analysis. Finally, it concludes with some policy implications.

2. Model Structure

The MOTAD (Minimization Of Total Absolute Deviation) model developed by Hazell in 1971 has been widely used for modeling farming risky decision. It depicts tradeoffs between expected income and the absolute deviation of income, which is a measure of agricultural risks. The expected income—mean absolute deviation criterion leads to a linear model that can be solved by parametric linear programming, yet retains many of the desired features of the expected income—variance criterion (Hazell, 1971).

The TAD (Total Absolute Deviation) is the sum of the absolute values of the total gross margin deviations around the expected return based on sample mean gross margins. And since there is an exact equivalency between the sum of the values of the positive and the negative total gross margin deviations around the expected return based on sample mean gross margins, it is therefore sufficient to minimize either of those two sums and to multiply the result by 2 to obtain TAD. The MOTAD model can therefore be defined as follows in terms of activity gross margins:

$$\min TAD/2 = \sum_{h=1}^{s} y_h^-$$

subject to

$$\sum_{j=1}^{n} (c_{hj} - \overline{c}_j) x_j + y_h^- \geq 0 \qquad \text{(for all } h, j, h = 1 \text{ to } s; j = 1 \text{ to } n) \qquad (1)$$

$$\sum_{j=1}^{n} \overline{c_j} \quad x_j = \lambda \qquad (2)$$

$$\sum_{j=1}^{n} a_{ij} x_j \leq b_i \qquad \text{(for all } i, i = 1 \text{ to } m) \qquad (3)$$

$$x_j, \quad y_h^- \quad \geq 0 \qquad \text{(for all } j, h, j = 1 \text{ to n}; h = 1 \text{ to } s)$$

where y_h^- is the sum of the absolute values of the negative total gross margin deviations around the expected return based on sample mean gross margins; c_{hj} is the gross margins of the *j*th sample observations; $\overline{c}_j$ is the expected gross margin of the *j*th activity; x_j is the level of the *j*th activity; a_{ij} is the technical requirements of the *j*th activity for the *i*th resource or constraint; b_i is the *i*th constraint level; s is the number of states of nature; m is the number of constrains; n is the number of activities; and λ is a scalar.

The objective function is to minimize Total Absolute Deviation (TAD) or the Mean Absolute Deviation (MAD), in which MAD=TAD/*h*.

In the first constraint, $(c_{hj} - \overline{c}_j)$ is the coefficient of income deviation, which is the margin per unit of the *i*th activity across all states of nature, and $(c_{hj} - \overline{c}_j)\ x_j$ is the gross margin thereof. And in the constraint (2), the sum of $\bar{c}_j\ x_j$ is the expected total gross margin *E,* and which is set equal to a parameter λ. By varying λ over its feasible range through parametric procedures, a sequence of solutions is obtained, including increasing total gross margin and the associated minimized TAD/MAD. There will be no feasible solution when the maximum possible total gross margin under the resource constraints has been obtained. The concrete steps for determining the sequence of λ and TAD/MAD are referred in the following text.

The third restriction consists of a sequence of constraints, such as the resource constraints of labor, arable land and capital. In addition to the essential productive factors constraints, cropping system, grain ration and feed grain can also serve as constrains if necessary.

Several steps are essential to constructing rural household decision-making MOTAD model when agricultural risks are considered. First the MOTAD model analysis requires farm-specific data about production, consumption and family characteristic information, including cropping system, the price, income and associated cost of every production enterprises, as well as the amount of production factors that households possess, such as arable land, capital and labor, etc. In order to obtain the required data, we made a face-to-face investigation from door to door in two villages in the province of Zhejiang. Details about our investigation are described in section 3.

The MOTAD model can also be established as a profit maximizing model by changing the expected income constraint to an objective function to be maximized, and allowing total absolute deviations to be unconstrained, and this maximizing expected profit is subject to constraints of (3). By this means, we get the maximized possible expected income, E_0, the first value that scalar λ represents. Then, by making sensitivity analysis of LP model on λ, the second expected income, E_1 is determined. Repeat the procedure until there is no solution for MOTAD model or the value of λ equals to zero or there is no solution for sensitivity analysis. Thus we get a sequence of expected income/risk pairs, denoted by E/MAD. The ranking pairs of E and MAD represent possible risky farm plans, each of them represents a combination of agricultural activities or enterprises. Thus the interlinks between gross return and risks are made clear, and meanwhile, we can get all feasible choices that the decision maker can choose from in line with the labor force, capital and other factors his/her family possesses, as well as his/her risk attitude. Input the above mathematical equations, parameters and other concerning information into GAMS, then it can generate solutions, including the expected income/risk level and the associated capital and manpower input for every efficient farm plan, as well as the optimized scales of all possible agricultural production activities under risks.

3. Data source and "Representative rural households (RRH)"

In order to obtain data for empirically analyzing households' optimized productive response to agricultural risks, we did through on-the-spot investigations in Wangjia Village and Damao Village in Jiaxing city, Zhejiang province. The investigator sat face-to-face with the housemaster of sampled households, and started the interview with topics such as the climate, members of his/her family, number of labors and their occupations, or the way crop is growing, etc.. This way made the interview friendly and the informant feel relaxed and comfortable. By gradual guidance, the investigator got all the information required, including the family characteristics, all the agricultural business his/her household engaged in, as well as the return and associated cost and manpower that they input in 2004. By this means, we investigated about 20% of the total rural households in Wangjia Village and Damao Village, which is around 60 and 40 households, respectively. As shown above, this investigation is much time-consuming, and lasted intermittently for four months, form April to July in 2005.

The province of Zhejiang is located in the developed east-coasted area of China. The average per capita GDP in Zhejiang was US$ 2750 in 2004, which is very close to that of middle income countries in the world. The economy has grown by over 13% per year since 1978, providing rural labor force with off-farm employment opportunities and reducing the importance of agriculture for the regional economy. However, agricultural employment still intakes a large number of rural labor forces, especially in labor-intensive activities, such as cultivating vegetables in plastic greenhouse[1] which is engaged in by most farmers in Wangjia

[1] Plastic greenhouse is a building with a plastic roof and front side to absorb sunshine and keep humidity for crops and vegetables.

Village.

The two villages we chose for investigation, Wangjia Village and Damao Village lies respectively in the east and south of Jiaxing city, which enjoyed the fame of “the land of fish and rice” from of old. There is no distinct difference on natural conditions, or even natural risks for the two villages, which are mainly typhoon, drought, flood as well as diseases and insect pests. Nevertheless, the cropping system and agricultural production structure are village-specific due to cultivating traditions and customs. For example, cultivating vegetables in plastic greenhouse is the main production activity in Wangjia Village, while in Damao Village; farmers are accustomed to breeding woolly rabbits and silkworm. In addition, grain, silkworm and sow are also produced in Wangjia Village while grain, vegetable and hog in Damao Village. Fig 1 and 2 shows the main cropping systems of two villages respectively.

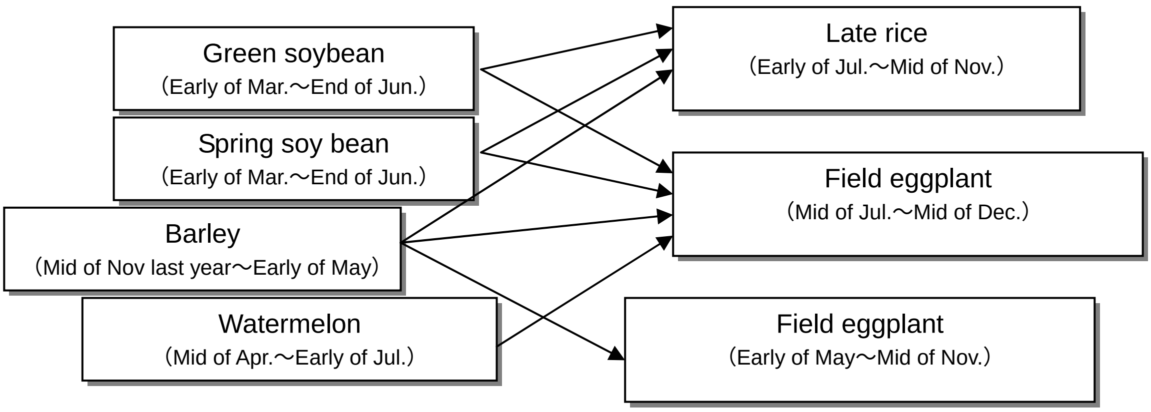
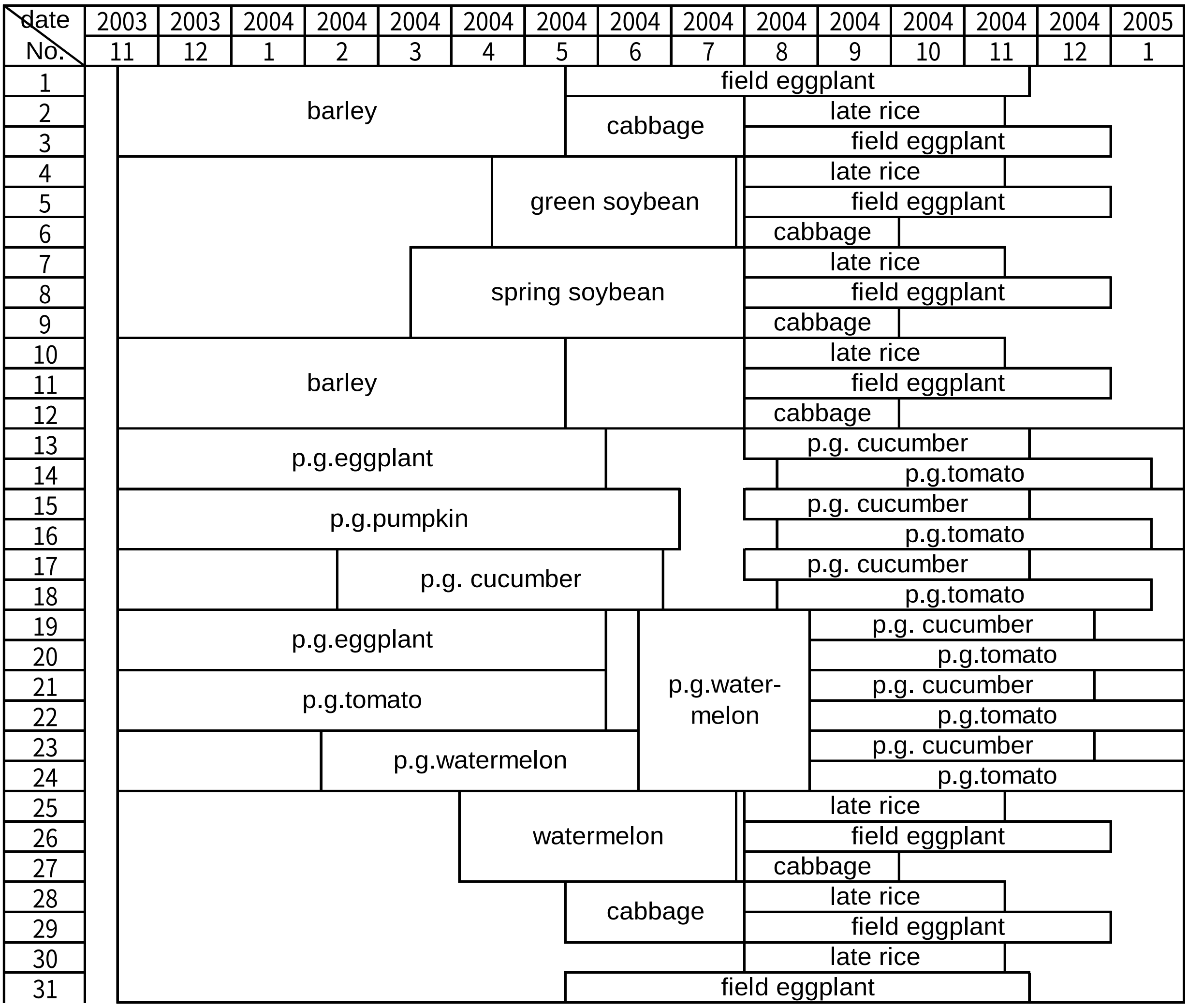


Fig.1: Farming systems of Damao Village, Jiaxing, Zhejiang.

In order for a representative and generalized analysis, the household we discussed here is an abstract one, which is called “representative rural household” (RRH), rather than any of the concrete sampled households. “RRH” is established on the basis of averaging sampled households’ indices. More information about “RRH” is referenced in the following text. Here we discuss all the feasible cropping systems “RRH” can select, as Fig 1 and 2 shows respectively. Multiple cropping systems make it possible to diversify production and the agricultural risks thereof. In order to fully reflect the impact of all the possible agricultural production activities on decision-making, we define the feasible production choices of the “RRH” as those adopted by at least 10% of the sampling households. Thus the feasible production choices of Wangjia “RRH” includes 12 activities, late rice, barley, spring soybean, cabbage, field eggplant, p.g. eggplant, p.g. cucumber, p.g. tomato. p.g. pumpkin, watermelon and sow, while there are only 9 agricultural activities in Damao “RRH”, which are late rice, spring soybean, field eggplant, watermelon, barley, silkworm, sow, hog and woolly rabbit. Note that for late rice, the households often sign contracts with the grain enterprise prior to growing, therefore the price or its boundary is somewhat fixed. While for other products, the prices are subjected to the market.



Note: “p.g.” is the abbreviation of “plastic greenhouse”.

Fig.2: Farming systems of Wangjia Village, Jiaxing, Zhejiang.

Two RRHs are constructed and each represents all rural households in one village. The indices of RRH, such as family characters and resources possessed, as well as the cost, yield, price and gross income of an agricultural activity, equal to the mean values of corresponding indices of all sampled rural households in each village, 60 of Wangjia and 40 in Damao village. Table 1 provides an overview and a comparison of the main characteristics of the two RRHs. It is clear that there is no marked difference between the two “RRHs” in some indices, such as member of the family, number of family labor, total area and plots of arable land, as well as the education that the housemaster received. While both the total family income and agricultural income of the “RRH” in Wangjia Village are much higher than those of Damao Village, and the latter earns more than half of family income from off-farming employment. It is obvious that the householder, often as the principal labor force and decision-maker, just had education of less than 7 years in both of Wangjia and Damao “RRH”, meaning they did not finish their education of junior middle school.

Table 1: Descriptive statistics of the RRHs in 2004

	Wangjia village	Damao village
Members of the family	3.98	4.55
Total labors of the family	2.68	2.88
Number of labors engaging farming perennially	1.77	1.47
Education housemaster received (years)	6.24	6.35
Total arable field (mu)	9.84	8.86
Total family income (yuan)	30033.16	23423.25
Agricultural income (yuan)	20164.3	11363.5
Agricultural income/total income (%)	67.1	48.5

Source: Own calculation.

4. Estimated results

By linear programming algorithm, we get the combinations of expected income and risk, as well as the associated optimized scales of each activity, manpower and capital input. To illustrate the household’s response to agricultural risks, Table 2 and 3 shows respectively the results of optimized scales under different risk levels and those of regardless of risks, also provides a clear contrast between actual scales and the MOTAD results. And Fig.3 illustrates interlinks between risk, expected income, capital income and manpower.

4.1 Production response to agricultural risks

As showed in Table 2, it is reasonable to deduct that a rational decision-maker in

Wangjia Village should improve the levels of cabbage and p.g. cucumber by a big margin, increase the acreage of barley, p.g. tomato and pumpkin as well as the numbers of silkworm and sow by a modest scale, while reduce the acreage of late rice, spring soybean, field eggplant and watermelon by 50% or so, on the ground of maximizing return despite of risks. The results therefore imply that the cabbage and p.g. cucumber have more comparative advantages while late rice, spring soybean, field eggplant and watermelon have less advantages, and so the agricultural return is possibly to be improved if the DECISION MAKER adjust production structures by changing scales of some businesses.

As seen form column 6 and 8 that if risks are concerned in decision-making, the scales of barley, cabbage, p.g. tomato, p.g. pumpkin, silkworm and sow should be extended with differentiated increase, while for the acreage of late rice, spring soybean, field eggplant, p.g. eggplant and watermelon, it is necessary to reduce by different proportions in order to make the best use of productive resources and obtain the highest possible income under such constraints. Note that the optimized scales remain stable under different risk levels for late rice, barley, spring soybean, field eggplant, p.g. eggplant, watermelon and sow, which are consistent with those of when risks are ignored. It therefore implies that for these businesses, the decision maker is indifferent to risks, and risk levels do not have any impact on production decision-making. To be contrasted with, for most vegetables, watermelon and silkworm, the optimized scales vary quite frequently according to risk levels, especially those of silkworm, which shows an obviously declining tendency with the increased expected income, from 10.9 sheets to 0.6. While there is an increasingly extension on the optimized acreages of cabbage, p.g. cucumber, p.g. tomato and p.g. pumpkin along with the improvement of expected income. Therefore, the return will be markedly improved if the decision maker is willing to take more risks, but for breeding silkworm, only the risk averters would choose to extend the existing scale, which means a much lower return level.

Table 2: Comparison of Optimized acreages and Actual acreage of "RRH" of Wangjia village

(units：mu, head, sheet)

Activity	MOTAD model results under risk scenarios					Optimized scale regardless of risks	Actual scale
	Different combinations of "risk-income"				Range of optimized scales		
	Pair I	Pair II	Pair III	Pair IV			
Late rice	2.3	2.3	2.3	2.3	2.3	2.3	4.6
Barley	0.3	0.3	0.3	0.3	0.3	0.3	0.2
Spring soybean	0.3	0.3	0.3	0.3	0.3	0.3	0.6
Cabbage	7.6	3.3	2.1	0.5	0.5～7.6	7.5	0.4
Field eggplant	0.5	0.5	0.5	0.5	0.5	0.5	1.0
p.g. eggplant	0.3	0.3	0.3	0.3	0.3	0.3	0.8
p.g. cucumber	0.8	0.5	0.5	0.5	0.5～4.2	4.8	0.8
p.g. tomato	2.7	2.5	0.5	0.5	0.5～2.7	0.5	0.3
p.g. pumpkin	1.9	0.3	0.3	0.3	0.3～1.9	0.3	0.2
Watermelon	0.3	0.3	0.3	0.3	0.3	0.3	0.6
Silkworm	0.6	6.1	10.9	9.6	0.6～10.9	0.6	0.5
Sow	2	2	2	2	2	2	1.3

Note: In the interest of space, not all "expected income/risk" pairs are listed in the table, the "risk/income" value that Pair I, II, III and IV represents are "9018/18805", "7118/15073", "5517/11299", "5055/10000" respectively; "range of the optimized acreage" refers to the range covered by all the results of MOTAD estimation; "Optimized acreage regardless of risks" is got by the deterministic model ignores risks which aims to profit maximization. Source: Own estimation and calculation.

Table 3: Comparison of Optimized acreage and Actual acreage of "RRH" of Damao village

(units：mu, head, sheet)

Activity	MOTAD model results under risk scenarios					Optimized scale regardless of risks	Actual scale
	Different combinations of "risk-income"				Range of optimized scales		
	Pair I	Pair II	Pair III	Pair IV			
Late rice	3.7	3.2	2.4	2.4	2.4～3.7	2.9	5.0
Spring soybean	0.3	0.3	0.3	0.3	0.3	0.3	0.5
Field eggplant	0.9	0.5	0.5	0.5	0.5～0.9	3.1	0.4
Watermelon	3.6	2.9	0.4	0.3	0.3～3.6	5.3	0.1
Barley	0.7	0.7	0.7	0.3	0.3～0.7	0.5	0.3
Silkworm	9.3	10.8	11.5	10.4	6.1～11.5	6.1	4.2
Sow	6	6	6	3	3～6	4	1.6
Hog	0	1	0	0	0～2	5	4.1
Woolly rabbit	0	0	3	35	0～35	0	8.7

Note: In the interest of space, not all "expected income/risk" pairs are listed in the table, the "risk/income" value that Pair I, II, III and IV represents are "10682/19036","9402/17180","6074/12820", "4694/10000" respectively; "range of the optimized acreage" refers to the range covered by all the results of MOTAD estimation; "Optimized acreage regardless of risks" is got by the deterministic model ignores risks which aims to profit maximization. Source: Own estimation and calculation.

If the DM of Damao village aims to get maximized profit under existing restraints, as can be seen from column 7 and 8 in Table 3, there should have a much larger scales of watermelon, field eggplant, sow, hog and silkworm, a reduced acreage for late rice and spring soybean, while an absolute exclusion of woolly rabbit If agricultural risk is concerned, the actual acreage of late rice, spring soybean and numbers of sow are already over the upper bound of the range covered by all the possible optimized scales, but the actual scales of others activities just in the range, as it is shown in Table 3.

Note that under risks the acreage of late rice, field eggplant, watermelon, barley and number of sow tend to increase, while those of woolly rabbit and silkworm decline with the increase of expected income, meaning that a risk-taking decision maker will get higher return by reducing the numbers of woolly rabbits and silkworm, and at the same time, increasing the scales of late rice, field eggplant, watermelon, barley and sow. If we compare column 6 and 7 of Table 3, it is easy to find that the decision maker in Damao village is rather sensitive to risks in commercial activities such as field eggplant, sow, hog and woolly rabbit, during which the number of woolly rabbit varies most under different risk/income levels.

In table 2 and 3, both of the actual acreages of late rice are much more than the optimized results of MOTAD models, mostly due to the reduced fluctuation in prices by contracting with grain enterprises prior to growing. It shows that contract between produces and purchasers, if carried out, can reduce price risk and iron income fluctuation.

4.2 Agricultural risks, expected income and the associated inputs

In a given farming plan, there are many possible income outcomes in line with the input level of resources, such as arable land, capital and man-hours. Also the decision maker’s willingness of risk-taking plays an important role in decision-making. Fig. 3 shows interlinks between expected income, risk and input of capital and man-hours. It is clear that the curve of expected income is increasing as risk level improves, while by a reduced margin, either in Wangjia or Damao, meaning that in order to get the equal margin, the decision maker needs to take more risks with the increase of expected income/risk level. By comparing the expected income curve of two villages, we can find that there is a larger margin in Wangjia than that of Damao along with the increased risk levels, that is, under the same risk level, the decision maker of Wangjia is able to obtain better income outcome than that of Damao.

Note that in the lower part of expected income curves in Fig.3, when the values of expected income are smaller, their fluctuations are minor for Damao “RRH” compared with those of Wangjia, which means the business combinations of the former are less risky than the latter, as denoted by A and A*, both expected income of which are around 10000 yuan, while the MAD of Wangjia “RRH”, 5055 is higher than that of Damao “RRH”, 4694. However, with the increase of expected income, the situations are changing, e.g. for the pairs of “risk/income” that B and B* denote, the value of MAD is 9018 and 9402, while the associated expected income 18805 and 17180 respectively, it is obvious that the decision maker will get a higher income while face less risk if he adopts the business combination of B than which would be adopted combination that B* represents. It shows that compared with that of Wangjia village, the decision maker in Damao, who engages in a less diversified agricultural production and earns more off-farm income, is more willing to take risks, and on the other hand, diversification in agricultural production, as the producers of Wangjia did, is able to reduce risks and stabilize income effectively when the risks are in a higher level.

In the case of input for productive factors, as we can see form Fig. 3 that generally there is no obvious correlativity between the expected income/risk levels and input of either man-hours or capital, meaning that in two villages, the decision maker’s attitude toward risks account for their decision-making to a large extend subjected to the existing labor and capital constraints, or rather a risk-taking decision-maker surely obtain a much higher return from agricultural businesses than a risk averter. While in the lower risk levels, the increase of expected income mainly rely on the input of capital and man-hours, as it is shown in the lower left corner of Fig. 3. There is a little increase in capital input with the improvement of expected income/risk level, the input of man-hours, however, remain unchanged, either in Wangjia or Damao Village, implying a higher opportunity cost for labors than for capital.

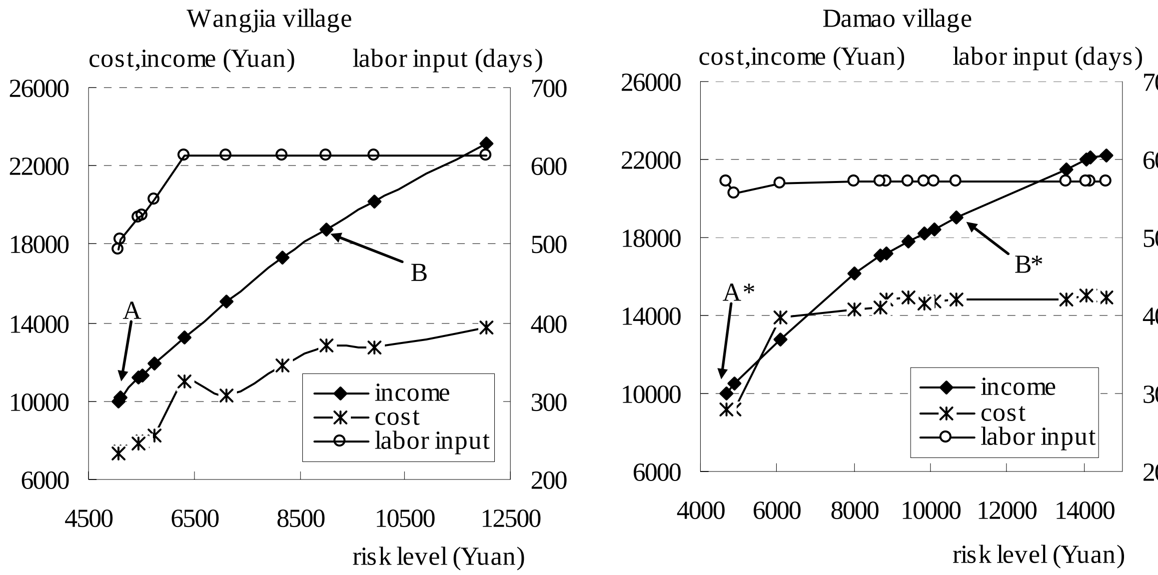


Fig.3: Agricultural incomes under different risk levels and the associated inputs

Source: Own estimation.

As shown in Fig.3, the largest expected income of the "RRH" in Wangjia is much more than that of Damao "RRH" subjected to the existing labor force and capital constrains, also the former need to input more man-hours. The econometric analysis confirms the information we get by simple statistic analysis as shown in the Table 1 and from the face-to-face investigation as described above, that the most households of Wangjia Village mainly engage in cultivating vegetables in plastic greenhouse, this is more time-and-labor consuming while more profitable, compared with breeding silkworm and woolly rabbit that mainly engaged in Damao Village.

5. Conclusion and policy implications

From the above empirical model results, it is reasonable to conclude that the micro-response to agricultural risks in the two selected Chinese villages shows rational decision-making that the decision maker made in line with their risk attitude after weighing comprehensively the expected production cost, return and the associated risk level, so as to make the best of productive factors and obtain the highest possible profit. The farmers in Zhejiang are quite sensitive to agricultural risks in an open environment after fulfilling the market-oriented reform. However, cropping systems, the ratio of agricultural income to total family income, as well as the area of arable land, differentiates households' risk response to a certain degree. For example, those who possess less arable land, with a lower ratio of agricultural income to total family income or a simpler farming system, are facing a higher risk level in comparison with those who not.

The decision maker's risk attitude not only influences what production activities and how much the corresponding scales are, but also have further effects on the micro agricultural production structure and stable growth of households' income. Severer risk aversion can lead households to use resources less intensively than would be the case if they were indifferent to risk. Given the amount of productive resources such as arable land, capital and labor force, the combination of production activities with a higher level of expected income/risk would be selected provided that the decision maker is willing to take risks. In a higher level of risks, capital is input prior to manpower, implying there is a much higher opportunity cost for the latter.

A diversification in agricultural production from basic staples, principally grain, can reduce risks efficiently only when the risk level is at a higher point. For those combinations of production activities with a lower risk level, agricultural diversification might be efficient in reducing risks to some extent; however, it is likely to lead to a decreased total return. Although there is a much more reasonable allocation of productive factors compared with that of under planning system, there is still much room to be improved, e.g. the acreage of some grain such as late rice, spring soybean should be cut down by a relatively large scale in order to optimize distribution of productive resources and adjust micro production structures in light of comparative advantage principle.

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