Risk perception, insurance recognition and agricultural insurance behavior—An empirical based on dynamic panel data in 31 provinces of China

Fei Liu⁎, Charles P. Corcoran, Jianping Tao, Jing Cheng

ABSTRACT

Farmers’ agricultural insurance decision-making is affected by behavioral factors. The paper using provincial panel data in Chinese 31 provinces and GMM dynamic panel data model examined the effect of five group variables on agricultural insurance decision making: risk perception and management, agricultural insurance recognition, trust, affordability and affection in agricultural production. The results show that agricultural insurance affordability, risk perception and management are the major influencing factors; agricultural insurance has the highest elasticity on household net income, which is 9.813, followed by elasticity on year-end total rural power machinery and cash expenditure on health care, which are 7.719 and 5.567 respectively, yet negative. Measures like raising household net income, building sound rural health care system, strengthening governments’ subsidy on agricultural machineries, improving the educational level of farmers can effectively boost agricultural insurance demands.

1. Introduction

China implemented policy-oriented agricultural insurance in 2004. Since then agricultural insurance market has made significant progress. Agricultural insurance revenue in 2004 was CNY 377 million, and in 2014 this number has climbed up to 32.58 billion, realizing a 56% annual compound rate. However, there is, in aggregate, very little insurance relative to the per capita income of farmers. Agricultural insurance depth (defined by agricultural insurance revenue divided by agricultural output) in China in 2014 is only 0.56%, while the insurance depth of the whole insurance industry is 3.18%, which is 5.7 times of agricultural insurance. Agricultural insurance density (defined by agricultural insurance revenue divided by rural population) in China in 2014 is CNY 52.66 per capita, while that of the entire industry is 1479, which is over 28 times of agricultural insurance. The low level of agricultural insurance depth and density restricts the development of agricultural insurance in terms of its ability to ensure food safety and safeguard farmer income.

The reasons for insufficient agricultural insurance depth and density might be various and different. Scholars home and abroad have carried out studies from different perspectives. Recently the focus is on how to improve the effective demand of agricultural insurance. Improving demand for agricultural insurance may need to increase farmers’ agricultural risk perception, agricultural insurance recognition and their affordability, turning this potential needs into a real purchase. Thus studying influencing factors of farmers’ agricultural insurance behavior and exploring the mechanism of risk perception and insurance recognition in the process of insurance decision-making are of great importance in improving the agricultural insurance depth and density. The paper constructs five categories of variables and employs generalized moment method/dynamic panel data (GMM/DPD) to study the influencing factors and mechanism of farmers’ insurance decision-making using panel data in Chinese 31 provinces from year 2004 to 2013, hoping to provide some clue to improving the effective demand of agricultural insurance in China.

2. Literature review

By studying the literature on agricultural insurance home and abroad, no united conclusions have been found regarding to the insufficient agricultural insurance depth and density. Early study was focused on the feature of agricultural insurance product, agricultural
insurance was regarded as quasi-public goods: there would be insufficient supply without government subsidies [1–5]. However Siamwalla and Valdes [6] thought the cost of agricultural insurance subsidies is higher than the increase in the total welfare, and agricultural insurance itself is not a public good. Thus government shouldn’t subsidize agricultural insurance.

The second perspective is the asymmetric problem in the market of agricultural insurance. Farmers have information advantage over insurance companies, and they could benefit from adverse selection and moral hazard, which leads to the continuous loss of insurers and their ultimate exit from the market [1,7,8]. In the meantime, high systematic risk in the market blunts the effect of ‘law of large numbers’, thereby exacerbating the market failure and market shrinkage. Innovations like coinurance, reinsurance, policies with deductibles, area-yield crop insurance and index-based weather insurance could to some extent reduce this risk [9–15].

Others studied agricultural insurance from the demand side. These researches mostly are based on the premise of rational being on expected utility theory, using Probit or Logit model to study the farmers’ willingness to pay on agricultural insurance [16–18]. Factors like social and cultural structure, economic condition, demographic factors, insurance factors and government relief and subsidy etc. influence their agricultural insurance decision-making [19–23].

To sum up, study of the agricultural insurance is mainly focused on the product feature, asymmetric information problems and factors affecting effective supply and demand of the product. Study on agricultural insurance demand mostly uses micro data binary choice model, however ignores the endogeneity of these variables. Most variables which are connected to insurance decision-making were treated as controlled variables, overlooking some essential information and distorting the regression results. The paper uses China’s provincial panel data, employs systematic GMM, which could avoid the possible endogeneity bias, to analyze influencing factors of farmers’ insurance demand and help to understand the mechanism of risk perception, insurance recognition and affordability etc. on agricultural insurance decision-making.

3. Analytic modeling, variable selection and hypotheses construction

3.1. Analytic modeling

Using panel data of 31 provinces in China from year 2004 to 2013 and constructing the GMM/DPD model, the paper examines the influencing factors of agricultural insurance. Macro panel data could effectively eliminate individual differences of macro samples and preserve those common factors of agricultural insurance. The major procedure of the model is: firstly build the following regression model, 

\[
Y_i = \sum_{j=1}^{p} \beta_{ij} Y_{i-j} + X_i \beta + \delta + \epsilon_i, \quad i = 1, \ldots, 31, \quad t = 1, 2\ldots 10
\]

Where \( Y_i \) is the dependent variable which is agricultural insurance revenue; \( X_i \) are the influencing factors, \( \delta \) is the effect of those ignored variables reflecting individual difference; \( \epsilon_i \) is stochastic error, which indicates the effect of those ignored variables that varies from cross section and time.

Secondly take a first-order different to eliminate individual effect, and get the new equation,

\[
\Delta Y_i = \sum_{j=1}^{p} \beta_{ij} \Delta Y_{i-j} + \Delta X_i \beta + \Delta \epsilon_i
\]

Thirdly, choose instrumental variables, normally lagged dependent variables are effective instrumental variables. And we get the instrumental variables as follows,

\[
W = \begin{bmatrix}
Y_1 & Y_2 & \ldots & 0 \\
Y_1 & Y_2 & \ldots & 0 \\
\vdots & \vdots & \ddots & \vdots \\
Y_1 & Y_2 & \ldots & Y_{12}
\end{bmatrix}
\]

Build the optimum weighted matrix and then get it used in one-step Arellano-Bond estimation. Extract the residual in one-step estimation and by computing we get white period covariation matrix, replace the weighted matrix with it. And finally use this matrix in two-step Arellano-Bond estimation, and then we get the parameters estimators.

3.2. Variable selection, data source and variables descriptive analysis

3.2.1. Variable selection

Agricultural insurance decision making is a continuous process of searching, absorbing and analyzing all the risk and insurance factors and making the final decision. Agricultural insurance revenue reflects the extent or scale to which farmers translate this potential needs into real demand, and thus we chose this index to represent the dependent variable. To improve agricultural insurance consumption, we have to study the factors that affect farmers’ insurance decision making, and here we group these factors into five categories:

1. (1) risk perception and management variable

Farmers’ subjective judgment of risk probability is always inconsistent with real risk probability. When risk probability is under some subjective threshold, they choose to ignore this risk or self-insure; Samaritan’ dilemma indicates peoples’ opportunism behavior tendency when facing natural risk, and they tend to rely on government relief and do not buy agricultural insurance.

We chose the following variables in this category:

a. Crop disaster area (DA): Crop disaster area is the most straightforward factor, availability bias makes farmers give a high value to the recent disaster, and when their subjective risk probability is above some threshold, they will consider agricultural insurance, and when the cost of insurance, including transaction cost and psychological cost is reasonable to them, and when they expect buying insurance could yield a positive gain, they will buy agricultural insurance.

b. Year-end total rural power machinery (PM): Farmers rely on their experience, production combination, technology etc. to manage agricultural risk. When risk is under control, they wouldn’t consider insurance. Year-end total rural power machinery could reflect this ability to manage risk by relying on machinery and technology.

c. Average rural household scale (HS): Average rural household scale could to some extent indicate farmers’ ability to resist risk. Suppose production experience and skills could be accumulated, households of high scale could accumulate more experiences and skills. Besides when disaster occurs, they reserve a higher capacity of rescue. Moreover, a large household scale may indicate more sources of income. All these combined add to their ability to manage risk.

d. Natural disaster relief (DR): Government’s and social relief might lead to Samaritan’ dilemma, since farmers anticipate that when disaster occurs, government will come to rescue, their incentive to buy agricultural insurance will diminish. And therefore, government’s disaster relief could contribute to farmers’ agricultural insurance decision making.

(5) Agricultural insurance recognition variable

The fact that farmers’ subjective risk probability judgment surpasses the threshold does not necessarily lead to their buying action. The premise is they know about agricultural insurance and acknowledge the function of it. Here we chose the following variables to represent their agricultural insurance recognition:
a. Rural population with college degrees or above (E1): Farmers with higher educational background tend to know more about agricultural insurance and meanwhile they are more likely to embrace new things. Moreover, the production and insurance behavior of those with high educational background will bring in demonstration effect, especially in remote areas, which guides others' behavior.

b. Percentage of rural illiteracy population to population aged 15 or above (E2): Farmers who receive less education know less about insurance, and they are more likely not to accept new things. From this standpoint, illiteracy is most unlikely to accept agricultural insurance. Compared to the above variable, this one is relative index and its effect on agricultural insurance is negative.

(6) Agricultural insurance trust variable

Farmers' buying insurance is based on their trust in insurance companies, expecting when disaster occurs they would get compensation is the only prerequisite for them to buy insurance. The trust index here includes insurance companies' good reputation and their investment in P & R and ads. However, due to the availability of the relevant data, here we chose agricultural insurance claim (CE) to represent this index. Farmers could rely on the historical claim of the company to know the reputation and whether it would pay if disaster really occurs. And these data could be found from China's yearbooks.

(7) Agricultural insurance affordability variable

One crucial factor that constraints farmers' purchase of agricultural insurance is affordability. The affordability of agricultural insurance includes both insurance premium and transaction cost during the buying process, psychological cost included as well. Here we chose the following variables:

a. Household net income (HR): Household net income could effectively indicate households' purchasing power. Purchasing power translates needs into demand; agricultural insurance, as a special goods, its market size depends on the purchasing power of its potential customers. According to Milton Friedman's permanent income hypothesis, households' consumption is not determined by the current income, but the permanent income, which means that farmers' agricultural insurance decision-making is dependent on their judgment on permanent income. Since agricultural insurance only accounts for a small proportion of their disposable income and their expectation of the future is always myopic, for simplicity we choose the current income and discuss the effect of it on agricultural insurance consumption.

b. Producer price index of major agricultural products (PPI): The production price could affect farmers' purchase of agricultural insurance to some extent through two effects: income effect and substitution effect. Imagine production inputs and agricultural insurance as two commodities, under income effect more consumption of one goods indicates less on the other; and if they are complimentary goods, more consumption of one means more of the other.

c. Cash expenditure on health care (ME): Health care and agricultural insurance are goods of similar function, and the difference is that health care insures the risk of body and health, while agricultural insurance insures that of natural disaster. Since budget constraints limits consumption on both health care and agricultural insurance, and they compete for capital, there is a trade-off between health care consumption and agricultural insurance consumption.

(8) Agricultural production affection variable

Affection variable affects insurance behavior, which has been ignored by traditional economics. When agricultural production plays an important role in households, farmers might worry the possibility of natural disaster undermining household income and their welfare, thus have a high incentive to buy insurance. Here the affective variable we chose is percentage of household operating net income to household net income (PRP).

| Table 1 |
| Variables and data source. |
| Denote | Variables | Unit | Data Source |
| Y | Agricultural insurance revenue | Million CNY | < China's Insurance Yearbook > |
| Risk perception and management variable |
| DA | Crop disaster area | Thousand hectares | < China's Rural Statistics Yearbook > |
| PM | Year-end total rural power machinery | Million Kilowatt | < China's Rural Statistics Yearbook > |
| HS | Average rural household scale | People per household | < China's Population Statistics Yearbook > |
| DR | Natural disaster relief | Ten thousand CNY | < China's Rural Statistics Yearbook > |
| Agricultural insurance recognition variable |
| E1 | Rural population with college degrees or above | People | < China's Population Statistics Yearbook > |
| E2 | Percentage of rural illiteracy population to population aged 15 or above | percent | < China's Population Statistics Yearbook > |
| Agricultural insurance trust variable |
| CE | Agricultural insurance claim | Million CNY | < China's Insurance Yearbook > |
| Agricultural insurance affordability variable |
| HR | Household net income | CNY per capita | < China's Rural Statistics Yearbook > |
| PPI | Producer price index of major agricultural products | | < China's Rural Statistics Yearbook > |
| ME | Cash expenditure on health care | CNY per capita | < China's Rural Statistics Yearbook > |
| Agricultural production affection variable |
| PRP | Percentage of household operating net income in household net income | percent | < China's Rural Statistics Yearbook > |

Note: The PPI in Tibet in some years are lost, we assign the value of national average; the PRP of Tibet in 2004 is lost, we assign the value of national average; the DA of some provinces in some years is less than one thousand hectare and in the beginning years of policy-oriented agricultural insurance the revenue and/or claim were less than one million CNY, the values in yearbook are zero, in view of the need of logarithmic treatment later, we assign the value 0.01.

3.2.2. Data source and variables descriptive analysis

Data we use come from various China's statistics yearbooks with definition of all variables seen in Table 1 and simple descriptive statistic analysis seem Table 2.

Considering the possible collinearity of the model, we conducted correlation test of all the independent variables. In view of the fact that Pearson correlation coefficient requires the continuity, normal distribution and linearity feature of data, we chose Spearman correlation coefficient to test the correlation among the independent variables, the Correlation matrix seen Table 3.

From the correlation matrix we see the correlation coefficient of cash expenditure on health care and agricultural insurance claim is 0.71, since there is no internal economic tie between the two, we still preserve these two variables in the model. Cash expenditure on health care has a high correlation with household net income with a coefficient of 0.86, indicating some internal connections between the two: medical care has a high elasticity on household income. However, considering these effects on agricultural insurance consumption may be opposite: higher income implies high demand for agricultural insurance while high medical care expenditure to some extent leads to insufficient consumption of agricultural insurance. Here we preserve both. Building the following regression model:
Hypothesis 2. Agricultural insurance recognition variables affect farmers’ recognition and understanding of agricultural insurance. Farmers’ agricultural insurance decision making might be affected by five categories of variables. Each chosen variable might have different effects on farmers’ insurance behavior. We construct the following theoretical hypotheses:

**Hypothesis 1.** Risk perception and management variables affect farmers’ judgment on agricultural risk and their risk management ability, of which crop disaster area has a positive effect on agricultural insurance while year-end total rural power machinery, average rural household scale and natural disaster relief have a negative effect. 

**Hypothesis 2.** Agricultural insurance recognition variables affect farmers’ recognition and understanding of agricultural insurance. Rural population with college degrees or above has a positive role in agricultural insurance decision making while the role of Percentage of Rural illiteracy population to population aged 15 or above is negative. 

**Hypothesis 3.** Agricultural insurance trust variables affect farmers’ trust in insurance companies and even the whole industry, agricultural insurance claim has a positive effect on agricultural insurance behavior. We construct a new dynamic panel as follows:

\[ Y_t = \sum_{j=1}^{P} \beta_{1j} Y_{t-j} + \beta_{2j} DA + \beta_{3j} PM + \beta_{4j} HS + \beta_{5j} DR + \beta_{6j} E1 + \beta_{7j} E2 + \beta_{7j} CE + \beta_{8j} HR + \beta_{9j} PPI + \beta_{10j} ME + \beta_{11j} PRP + \delta_i + \epsilon_{it}, i = 1, \ldots, 31, t = 1, 2, \ldots, t, \]

3.3. Hypotheses construction

We conduct a log transformation to all the variables to eliminate heteroscedasticity and smooth data fluctuation. Then stationary test is carried out to the panel data, and the result shows that the first-order difference of the dependent variable is stationary, thus we add dependent variable lag one to the independent variables. Take first-order different transformation to eliminate fixed effect of cross sections. Build a new dynamic panel as follows:

\[ \text{ln} Y_t = \rho_i \text{ln} Y_{t-1} + \beta_{1i} \text{ln} DA + \beta_{2i} \text{ln} PM + \beta_{3i} \text{ln} HS + \beta_{4i} \text{ln} DR + \beta_{5i} \text{ln} E1 + \beta_{6i} \text{ln} E2 + \beta_{7i} \text{ln} CE + \beta_{8i} \text{ln} HR + \beta_{9i} \text{ln} PPI + \beta_{10i} \text{ln} ME + \beta_{11i} \text{ln} PRP + \epsilon_{iti}, i = 1, \ldots, 31, t = 1, 2, \ldots, t, \]

In view of the fact that adding instrumental variables could generate more reasonable parameter estimators in expended GMM model [25], and using horizontal instrumental variables yields more accurate parameter estimators [24], here we chose lag 2, 3 and 4 of the dependent variables as instrumental variables to estimate parameters, and regression results are showed in Table 4. The J statistics in Sargan Test is 15.96, indicating the model setting is correct.

The result shows that of all the 11 independent variables four are insignificant: crop disaster area, percentage of rural illiteracy population to population aged 15 or above, producer price index of major agricultural products and percentage of household operating net income has a positive role in agricultural insurance revenue.

4. Empirical study and results

4.1. GMM model

As dynamic panel model could effectively correct the omitted variable bias and reverse causality problems by controlling fixed effect, we use this model here and run the empirical analysis. Firstly we conduct a log transformation to all the variables to eliminate heteroscedasticity and smooth data fluctuation. Then stationary test is carried out to the panel data, and the result shows that the first-order difference of the dependent variable is stationary, thus we add dependent variable lag one to the independent variables. Take first-order different transformation to eliminate fixed effect of cross sections. Build a new dynamic panel as follows:

\[ \text{ln} Y_t = \rho_i \text{ln} Y_{t-1} + \beta_{1i} \text{ln} DA + \beta_{2i} \text{ln} PM + \beta_{3i} \text{ln} HS + \beta_{4i} \text{ln} DR + \beta_{5i} \text{ln} E1 + \beta_{6i} \text{ln} E2 + \beta_{7i} \text{ln} CE + \beta_{8i} \text{ln} HR + \beta_{9i} \text{ln} PPI + \beta_{10i} \text{ln} ME + \beta_{11i} \text{ln} PRP + \epsilon_{iti}, i = 1, \ldots, 31, t = 1, 2, \ldots, t, \]

4.2. Descriptive analysis of each variable.

**Table 1**

<table>
<thead>
<tr>
<th>Variable</th>
<th>average</th>
<th>median</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Std. Dev.</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>376.83</td>
<td>111.31</td>
<td>2832.90</td>
<td>0.01</td>
<td>562.36</td>
<td>310</td>
</tr>
<tr>
<td>DA</td>
<td>601.91</td>
<td>521.00</td>
<td>3187.00</td>
<td>0.00</td>
<td>555.53</td>
<td>310</td>
</tr>
<tr>
<td>PM</td>
<td>2742.28</td>
<td>2079.60</td>
<td>12739.80</td>
<td>95.30</td>
<td>2704.83</td>
<td>310</td>
</tr>
<tr>
<td>HS</td>
<td>3.37</td>
<td>3.29</td>
<td>8.77</td>
<td>0.47</td>
<td>0.79</td>
<td>310</td>
</tr>
<tr>
<td>DR</td>
<td>56687.43</td>
<td>26302.75</td>
<td>3908248.00</td>
<td>167.00</td>
<td>23467.50</td>
<td>310</td>
</tr>
<tr>
<td>E1</td>
<td>467.33</td>
<td>250.23</td>
<td>5089.00</td>
<td>1.00</td>
<td>734.54</td>
<td>310</td>
</tr>
<tr>
<td>E2</td>
<td>11.51</td>
<td>9.32</td>
<td>47.90</td>
<td>2.70</td>
<td>7.79</td>
<td>310</td>
</tr>
<tr>
<td>CE</td>
<td>222.60</td>
<td>71.77</td>
<td>3246.60</td>
<td>0.01</td>
<td>360.15</td>
<td>310</td>
</tr>
<tr>
<td>HR</td>
<td>5729.24</td>
<td>4906.65</td>
<td>19595.00</td>
<td>1721.55</td>
<td>3225.78</td>
<td>310</td>
</tr>
<tr>
<td>PPI</td>
<td>107.62</td>
<td>106.29</td>
<td>141.88</td>
<td>90.20</td>
<td>6.23</td>
<td>310</td>
</tr>
<tr>
<td>ME</td>
<td>337.46</td>
<td>264.71</td>
<td>1990.70</td>
<td>28.93</td>
<td>239.53</td>
<td>310</td>
</tr>
<tr>
<td>PRP</td>
<td>51.07</td>
<td>52.45</td>
<td>87.77</td>
<td>4.20</td>
<td>15.80</td>
<td>310</td>
</tr>
</tbody>
</table>

3.3. Hypotheses construction

Farmers’ agricultural insurance decision making might be affected by five categories of variables. Each chosen variable might have different effects on farmers’ insurance behavior. We construct the following theoretical hypotheses:

**Hypothesis 1.** Risk perception and management variables affect farmers’ judgment on agricultural risk and their risk management ability, of which crop disaster area has a positive effect on agricultural insurance while year-end total rural power machinery, average rural household scale and natural disaster relief have a negative effect.

**Hypothesis 2.** Agricultural insurance recognition variables affect farmers’ recognition and understanding of agricultural insurance. Rural population with college degrees or above has a positive role in agricultural insurance decision making while the role of Percentage of Rural illiteracy population to population aged 15 or above is negative.

**Hypothesis 3.** Agricultural insurance trust variables affect farmers’ trust in insurance companies and even the whole industry, agricultural insurance claim has a positive effect on agricultural insurance behavior.

**Hypothesis 4.** Agricultural insurance affordability variables affect farmers’ purchasing power, of which household net income has a positive role, while producer price index of major agricultural products, and cash expenditure on health care have a negative role.

**Hypothesis 5.** Agricultural production a

Farmers’ affection on agricultural production and thus on their demand for agricultural insurance, percentage of household operating net income to household net income has a positive role in agricultural insurance revenue.

4. Empirical study and results

4.1. GMM model

As dynamic panel model could effectively correct the omitted variable bias and reverse causality problems by controlling fixed effect, we use this model here and run the empirical analysis. Firstly we conduct a log transformation to all the variables to eliminate heteroscedasticity and smooth data fluctuation. Then stationary test is carried out to the panel data, and the result shows that the first-order difference of the dependent variable is stationary, thus we add dependent variable lag one to the independent variables. Take first-order different transformation to eliminate fixed effect of cross sections. Build a new dynamic panel as follows:

\[ \text{ln} Y_t = \rho_i \text{ln} Y_{t-1} + \beta_{1i} \text{ln} DA + \beta_{2i} \text{ln} PM + \beta_{3i} \text{ln} HS + \beta_{4i} \text{ln} DR + \beta_{5i} \text{ln} E1 + \beta_{6i} \text{ln} E2 + \beta_{7i} \text{ln} CE + \beta_{8i} \text{ln} HR + \beta_{9i} \text{ln} PPI + \beta_{10i} \text{ln} ME + \beta_{11i} \text{ln} PRP + \epsilon_{iti}, i = 1, \ldots, 31, t = 1, 2, \ldots, t, \]

In view of the fact that adding instrumental variables could generate more reasonable parameter estimators in expended GMM model [25], and using horizontal instrumental variables yields more accurate parameter estimators [24], here we chose lag 2, 3 and 4 of the dependent variables as instrumental variables to estimate parameters, and regression results are showed in Table 4. The J statistics in Sargan Test is 15.96, indicating the model setting is correct.

The result shows that of all the 11 independent variables four are insignificant: crop disaster area, percentage of rural illiteracy population to population aged 15 or above, producer price index of major agricultural products and percentage of household operating net income has a positive role in agricultural insurance revenue.
variables have been neglected.

Note: *, **, *** stands for 10%, 5% and 1% significant level respectively; time dummy variables have been neglected.

### Table 4

GMM/DPD results of farmers' agricultural insurance behavior.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>Significance</th>
<th>Consistent with Hypotheses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lagging Variable</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y(t−1)</td>
<td>0.763</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td><strong>Risk perception and management variable</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DA</td>
<td>−0.422</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>PM</td>
<td>−7.719</td>
<td>*</td>
<td>Yes</td>
</tr>
<tr>
<td>HS</td>
<td>−0.646</td>
<td>**</td>
<td>No</td>
</tr>
<tr>
<td>DR</td>
<td>−0.524</td>
<td>*</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Agricultural insurance recognition variable</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E1</td>
<td>0.395</td>
<td>***</td>
<td>Yes</td>
</tr>
<tr>
<td>E2</td>
<td>1.092</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td><strong>Agricultural insurance trust variable</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE</td>
<td>0.687</td>
<td>***</td>
<td>Yes</td>
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<tr>
<td><strong>Agricultural insurance affordability variable</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>HR</td>
<td>9.813</td>
<td>***</td>
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</tr>
<tr>
<td>PPI</td>
<td>−2.074</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>ME</td>
<td>−5.567</td>
<td>***</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Agricultural production affection variable</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRP</td>
<td>−0.695</td>
<td></td>
<td>No</td>
</tr>
</tbody>
</table>

Note: *, **, *** stands for 10%, 5% and 1% significant level respectively; time dummy variables have been neglected.

income in household net income, and the coefficients of the four except producer price index of major agricultural products are not consistent with hypotheses. The remaining seven are significant under 10% significant level and their effects on dependent variable are consistent with hypotheses.

One possible explanation of the insignificant effect of crop disaster on agricultural insurance revenue is the weighting between availability bias and gambler’s fallacy. Availability bias makes the current disaster more salient, and high crop disaster area implies higher agricultural risk, thus triggers higher agricultural insurance demand. Gambler’s fallacy makes farmers believe that the probability of the occurrence of another disaster right after one is extremely low, thus a lower demand for agricultural insurance. When these two psychologies play a role on farmers risk perception, their insurance behavior depends on which one dominates.

Rural population with college degrees and above has a significant effect on farmers’ agricultural insurance decision making while the percentage of rural illiteracy in population aged 15 or above does not. One possible explanation is that the active audience of agricultural insurance are those with college degree or above, and those with low educational background has low recognition of agricultural insurance. They might not know much of the risk spreading function of agricultural insurance or they couldn’t understand the complex clauses in agricultural insurance contract. The agricultural insurance elasticity of rural population with college degrees or above is 0.395, which is less than one, indicating that famers’ recognition of agricultural insurance couldn’t be 100% translated into buying action, agricultural insurance trust and affordability could be other factors that affect farmers’ insurance behavior.

The effect of producer price index of major agricultural products on agricultural insurance is not significant but consistent with hypothesis, indicating PPI affects farmers’ agricultural insurance behavior through income effect and substitution effect, both effects are negative. But the data we used here or the model setting couldn’t provide sufficient proof to say that PPI is a significant factor on farmers’ agricultural insurance decision making.

Percentage of household operating net income to household net income is the only variable here we used to reflect farmers’ affection to agricultural insurance, and the result shows that the effect is not significant and negative. It might be because households with larger proportion of operating net income are those households with less revenue, and those with less household revenue have low agricultural insurance recognition, and moreover according to Maslow’s hierarchy of needs, it is only when their basic biological needs and necessities of living are met that they begin to think about consuming stuff like insurance. All combined lead to a negative effect of Percentage of household operating net income to household net income on agricultural insurance.

The remaining seven significant variables are (according to absolute elasticity to order): household net income (9.813), year-end total rural power machinery (−7.719), cash expenditure on health care (−5.567), agricultural insurance claim (0.687), average rural household scale (−0.646), natural disaster relief (−0.524) and rural population with college degrees and above (0.395). An increase in household net income by 1% leads to an increase of agricultural insurance revenue by almost 10%, and an increase in year-end total rural power machinery by 1% leads to a decrease of agricultural insurance revenue by 7.719%, and an increase in cash expenditure on health care by the same amount leads to a decrease in agricultural insurance revenue by 5.567%. While the absolute elasticity of other variables is less than 1, indicating of all the factors agricultural insurance affordability, risk perception and management are the primary, while the effects of agricultural insurance trust and of agricultural insurance recognition are relatively low.

### 4.2. Extension of model

In the above model we chose agricultural insurance claim as farmers’ agricultural insurance trust variable. Since their trust in agricultural insurance is based on historical claim, a more realistic model should use lagged variable to reflect trust, and the cross correlogram of agricultural insurance revenue and claim echoes this point(Fig. 1 left). In the meantime, we chose the current year-end total rural power machinery to represent risk management ability, which is also not realistic. Farmers’ insurance decision-making is not based on the year-end risk management ability, but on the current ability or the ability when he makes the decision. And therefore choosing year-end total rural power machinery lag 1 which is the management ability at the beginning of the current period is more accurate, and the cross correlogram of agricultural insurance revenue and year-end total rural power machinery also mirrors this point (Fig. 1 right). The panel data regression using lagged variables of agricultural insurance claim and year-end total rural power machinery can be found in Table 5 model 3.

Model 1 preserves four independent variables which are not significant and the formulation here only shows those that are significant, model 2 only uses those seven significant variables plus one lagging dependent variable, and model 3 uses year-end total rural power machinery lag one and agricultural insurance claim lag one instead. From the J statistics we can tell the settings in all 3 models are correct, since model one uses four more variables than model 2 and 3 and preserves more information, it has the best regression of all.

From the radar chart we can find that the elasticities of average
rural household scale, natural disaster relief, rural population with college degrees and above and agricultural insurance claim under three different setting are not of significant difference. They all have low elasticity, which means agricultural insurance revenue is not sensitive to the change of the four variables. (Fig. 2).

The effect of year-end total rural power machinery on agricultural insurance decision varies from models: the agricultural insurance elasticity of current PM variable is negative, which indicates agricultural insurance consumption will decline if year-end total rural power machinery increases, while under lagged variable setting, this elasticity is positive, showing that an increase in the year-end total rural power machinery of last period leads to an increase in insurance consumption of current period. One possible explanation is from the point of income effect and substitution effect. An increase in PM of previous period improves the productivity of agricultural production thus bringing more income to farmers at the end of the year, which enables them to spend more, and therefore a potential increase in agricultural insurance consumption. While an increase in PM of the current period means additional investment in agricultural production, on the one hand it improves the productivity and farmers’ ability to manage risk, on the other hand the budget might get tight and they can’t spare additional money to buy insurance. Moreover farmers’ investment in agricultural machine is often discontinuous, investment in last period indicates no more investment in this period. The budget will get loose or there might be surplus, and they are more likely to make agricultural investment if the budget allows. Thus relieve the pressure in agricultural machinery investment will release capital, and promote agricultural insurance consumption.

The elasticities of household net income vary significantly. Model 1 has the highest followed by model 2 and 3, which are 9.813, 4.975, 2.148 respectively, indicating household net income is negatively correlated to the four variables excluded in model 2 and 3. Particularly the correlation coefficient of household net income and percentage of household operating net income to household net income is as high as −0.66. Excluding these variables could better reflect household net income’s effect on agricultural insurance consumption. Using year-end total rural power machinery lag 1 and agricultural insurance claim lag 1 could further decrease the elasticity of household net income, which could be explained by the above income effect of year-end total rural power machinery, the positive income effect of previous year-end total rural power machinery could to some extent offset the income effect of current household net income on agricultural insurance consumption, leading to a lower coefficient of household net income. Although three models have different elasticities on household net income, they are all greater than one, indicating a 1% increase in household net income leads to more than 1% agricultural insurance revenue. Thus improving household net income could effectively promote farmers buying agricultural insurance.

Like household net income, elasticities of cash expenditure on health care in three models are significantly different: model 1 has the highest, followed by model 2 and 3, which are 9.813, 4.975, 2.148 respectively, indicating household net income negatively correlated to the four variables excluded in model 2 and 3. Particularly the correlation coefficient of household net income and percentage of household operating net income to household net income is as high as −0.66. Excluding these variables could better reflect household net income’s effect on agricultural insurance consumption. Using year-end total rural power machinery lag 1 and agricultural insurance claim lag 1 could further decrease the elasticity of household net income, which could be explained by the above income effect of year-end total rural power machinery, the positive income effect of previous year-end total rural power machinery could to some extent offset the income effect of current household net income on agricultural insurance consumption, leading to a lower coefficient of household net income. Although three models have different elasticities on household net income, they are all greater than one, indicating a 1% increase in household net income leads to more than 1% agricultural insurance revenue. Thus improving household net income could effectively promote farmers buying agricultural insurance.

The effect of cash expenditure on health care in three models are significantly different: model 1 has the highest, followed by model 2 and 3, yet negative. The explanation is similar to that of household net income. Health care can be regarded as a substitute to agricultural insurance, they both compete for capital, and health care are usually more important to households than agricultural insurance, only the need of basic health care is satisfied, will farmers consider buying agricultural insurance. The elasticity of cash expenditure on health care in three models is less than −1, indicating a decrease of cash expenditure on health care by 1% leads to an increase of agricultural insurance revenue by more than 1%. Thus
cutting health care expenditure could effectively improve farmers’ demand of agricultural insurance.

5. Conclusion and policy proposals

The paper uses GMM/DPD model and studies the behavioral factors of China’s farmers’ agricultural insurance consumption. By constructing different models we compared agricultural insurance elasticities of various factors. It shows that in the process of agricultural insurance decision-making, insurance affordability and risk perception and management are the primary factors. The major conclusions are:

(1) Agricultural risk perception and management affects farmers’ agricultural insurance consumption, of which year-end total rural power machinery, average rural household scale and government natural disaster relief have a significant effect. Average rural household scale and natural disaster relief have a negative effect with a low elasticity. Year-end total rural power machinery lag 1 has a positive promoting effect while the current variable has a negative effect, and both are of high elasticity.

(2) Educational background affects farmers’ perception and recognition of agricultural insurance. However, the active audiences of agricultural insurance are those with college degree or above, the agricultural insurance demand is not sensitive to the change of rural population with college degrees or above though.

(3) Farmer’s trust in insurance companies and the industry has a role in their agricultural insurance decision-making. In the model agricultural insurance claim is used to represent the trust variable and it’s found that the role of trust is significant, yet it is very difficult for farmers to turn this trust into real consumption.

(4) Agricultural insurance affordability is the primary factor in farmers’ agricultural insurance decision-making, of which household net income boosts agricultural insurance consumption while cash expenditure on health care restraints it. Agricultural insurance consumption is very sensitive to these two factors. Thus by adjusting the two we can improve agricultural insurance demand.

(5) Affection variable doesn’t influence farmers’ agricultural insurance decision significantly, farmers’ don’t buy insurance just because household operating income accounts much for their household net income.

Based on the model and results, we can put forward the following proposals to influence farmers’ agricultural insurance decision-making and improve the effective demand of it.

Firstly, enrich the income sources of farmers to elevate their agricultural insurance purchasing power. Household net income is the primary factor in their agricultural insurance decision-making, by stabilizing their operating income, improving fiscal transfer income and increasing rural residents’ property income we can effectively promote their agricultural insurance demand.

Secondly, build sound rural public health care system to release farmers’ agricultural insurance investment fund. Health care and agricultural insurance compete for fund, and health care consumption always comes first. Public health care system could spare farmers’ fund for agricultural insurance and at the same time it frees them from worrying about health issues and gives peace of mind for agricultural production.

Thirdly, strengthen governments’ support on and subsidy to agricultural machinery investment and reduce their pressure on it. The use of agricultural machinery could improve productivity one the one hand, and equip farmers’ ability to resist agricultural risk on the other hand. Strengthening governments support on the subsidy to agricultural machinery could increase farmers’ agricultural production

enthusiasm, relieve their budget pressure and improve their purchasing power of agricultural insurance.

Lastly, elevate rural residents’ educational level and enhance their agricultural insurance recognition. Government could on the one hand establish teaching resource sharing and security system of high education to provide them opportunities to receiving high education, on the other hand actively guide college students to work and found their agricultural business in rural areas. An improvement in their own education or demonstration effect from college students will lead to a higher recognition of agricultural insurance and thus a higher demand.

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