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Risk Preference and New Technology Adoption Behaviors of Producers

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Abstract

This paper studies the role of producers' risk attitude and risk preference in production decision-making in Shanxi Province and Henan Province. Using economics experiment methods to obtain risk preferences, then study producers' risk preferences, individual characteristics, the understanding of genetically modified foods, and risk perception situations on the new technology adoption behavior of producers. In the analysis, the experimental design method of lottery selection is used to measure the individual's relative risk aversion coefficient; Shapley value decomposition method is used to explain contribution rate of each key variable. The experimental results show that producers who are more risk averse or more loss averse tend not to plant GM crops. At the same time, the key factor affecting producers' technology adoption behavior is not education, but subjective attitude and risk preference.

Keywords

Risk Preference; Relative Risk Aversion Coefficient; Shapley Value Decomposition.

1. Introduction

Innovation promotes the development of social economy, but innovation means risk, so human beings seem to have inherent resistance to "change". If an excellent technology is not applied in time, it will slow down the speed and quality of economic growth. In the 1990s, the experiments of insect resistant cotton in Henan and Shandong achieved great success. China has carried out transgenic research and achieved corresponding research results. However, there are not many varieties that are truly commercialized on a large scale.

On the one hand, consumers still have some doubts about the safety of GM food. Consumer demand affects farmers' production activities, so risk-averse producers may not accept it. On the other hand, transgenic crops have many excellent characteristics. Not only can transgenic technology greatly reduce the cost, but also reduce the adverse impact of pesticides on farmers' health. The difficulty of planting is similar to that of traditional crops, so some producers will be willing to grow them. Therefore, it is very suitable as a tool.

Through the method of field experiment, based on the relative risk aversion utility function, using the experimental design based on lottery selection and taking domestic producers as samples, this paper measures the individual risk aversion coefficient to study the relationship between the producer's acceptance of genetically modified crops and the individual related characteristics and relative risk aversion. Therefore, this paper puts forward the following hypothesis: H1: Risk aversion can inhibit technology adoption behavior; H2: Education level is not the most critical factor for producers' technology adoption behavior.

This paper is organized as follows: The second part introduces the design and process of economic experiments. The third part analyzes the regression results. The forth part is the conclusion.

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Table 1. Economic experiment

TL	option A	option B
	series1	
1	get 8 yuan with 30%,get 2 yuan with 70%	get 0.5 yuan with 90%,get 10 yuan with 10%
2	get 8 yuan with 30%,get 2 yuan with 70%	get 0.5 yuan with 90%,get 13 yuan with 10%
3	get 8 yuan with 30%,get 2 yuan with 70%	get 0.5 yuan with 90%,get 16 yuan with 10%
4	get 8 yuan with 30%,get 2 yuan with 70%	get 0.5 yuan with 90%,get 19 yuan with 10%
5	get 8 yuan with 30%,get 2 yuan with 70%	get 0.5 yuan with 90%,get 22 yuan with 10%
6	get 8 yuan with 30%,get 2 yuan with 70%	get 0.5 yuan with 90%,get 25 yuan with 10%
7	get 8 yuan with 30%,get 2 yuan with 70%	get 0.5 yuan with 90%,get 28 yuan with 10%
8	get 8 yuan with 30%,get 2 yuan with 70%	get 0.5 yuan with 90%,get 33 yuan with 10%
9	get 8 yuan with 30%,get 2 yuan with 70%	get 0.5 yuan with 90%,get 38 yuan with 10%
10	get 8 yuan with 30%,get 2 yuan with 70%	get 0.5 yuan with 90%,get 45 yuan with 10%
11	get 8 yuan with 30%,get 2 yuan with 70%	get 0.5 yuan with 90%,get 55 yuan with 10%
12	get 8 yuan with 30%,get 2 yuan with 70%	get 0.5 yuan with 90%,get 65 yuan with 10%
13	get 8 yuan with 30%,get 2 yuan with 70%	get 0.5 yuan with 90%,get 80 yuan with 10%
14	get 8 yuan with 30%,get 2 yuan with 70%	get 0.5 yuan with 90%,get 100 yuan with 10%
	series 2	
1	get 8 yuan with 90%,get 6 yuan with 10%	get 0.5 yuan with 30%,get 9 yuan with 70%
2	get 8 yuan with 90%,get 6 yuan with 10%	get 0.5 yuan with 30%,get 10 yuan with 70%
3	get 8 yuan with 90%,get 6 yuan with 10%	get 0.5 yuan with 30%,get 11 yuan with 70%
4	get 8 yuan with 90%,get 6 yuan with 10%	get 0.5 yuan with 30%,get 12 yuan with 70%
5	get 8 yuan with 90%,get 6 yuan with 10%	get 0.5 yuan with 30%,get 13 yuan with 70%
6	get 8 yuan with 90%,get 6 yuan with 10%	get 0.5 yuan with 30%,get 14 yuan with 70%
7	get 8 yuan with 90%,get 6 yuan with 10%	get 0.5 yuan with 30%,get 15 yuan with 70%
8	get 8 yuan with 90%,get 6 yuan with 10%	get 0.5 yuan with 30%,get 17 yuan with 70%
9	get 8 yuan with 90%,get 6 yuan with 10%	get 0.5 yuan with 30%,get 19 yuan with 70%
10	get 8 yuan with 90%,get 6 yuan with 10%	get 0.5 yuan with 30%,get 21 yuan with 70%
11	get 8 yuan with 90%,get 6 yuan with 10%	get 0.5 yuan with 30%,get 23 yuan with 70%
12	get 8 yuan with 90%,get 6 yuan with 10%	get 0.5 yuan with 30%,get 25 yuan with 70%
13	get 8 yuan with 90%,get 6 yuan with 10%	get 0.5 yuan with 30%,get 29 yuan with 70%
14	get 8 yuan with 90%,get 6 yuan with 10%	get 0.5 yuan with 30%,get 35 yuan with 70%
	series 3	
1	get 12 yuan with 50%,lose 2 yuan with 50%	get 15 yuan with 50%,lose 10 yuan with 50%
2	get 2 yuan with 50%,lose 2 yuan with 50%	get 15 yuan with 50%,lose 10 yuan with 50%
3	get 0.5 yuan with 50%,lose 2 yuan with 50%	get 15 yuan with 50%,lose 10 yuan with 50%
4	get 0.5 yuan with 50%,lose 2 yuan with 50%	get 15 yuan with 50%,lose 8 yuan with 50%
5	get 0.5 yuan with 50%,lose 4 yuan with 50%	get 15 yuan with 50%,lose 8 yuan with 50%
6	get 0.5 yuan with 50%,lose 4 yuan with 50%	get 15 yuan with 50%,lose 7 yuan with 50%
7	get 0.5 yuan with 50%,lose 4 yuan with 50%	get 15 yuan with 50%,lose 5 yuan with 50%

*percentage means probability, TL means transition line

2. Gambling experiment design and parameter selection

2.1. Survey object and survey method

The survey was conducted in the rural areas of Shanxi Province and Henan Province. There are 244 families in the sample, and the minimum reward is 5 yuan after that the survey participants completed the survey. The whole questionnaire is divided into three parts:

The first part is personal basic data. The purpose of this part of the experiment is to obtain the individual characteristics of the subjects. The subjects need to answer 10 questions about personal information. The second part studies the risk perception, risk preference and acceptance of genetically modified food. The subjects informed in advance that there was no

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right or wrong choice, but only according to the real own idea. The third part is economic experiment. A total of 35 groups of lottery choices in the whole economic experiment are divided into three series. Each series needs to select a row. Finally, in these three series, a row is finally selected by random number lottery. This lottery result determines their monetary return. Such an experimental method makes the subjects pay enough attention to every choice, because the subjects do not know which line of lottery will be selected in advance.

2.2. Data processing

This part of the question is deliberately designed to be very lengthy, and similar questions are asked many times, and some options are inversely coded to allow the items across the scale to be summed. Another advantage of this treatment is that it can reduce the contingency caused by one-time selection, or make random selection without carefully looking at the topic, making the experimental results untrue. It is worth noting that the setting and presentation of some topics exceed the knowledge scope and understanding ability of some farmers with relatively low education level, and need equivalent transformation.

2.3. Gambling experiment

It is assumed that the subjects are rational, so in each series, each subject can only switch once from lottery A to lottery B, or not once (only A or only B). The first two series have only positive benefits. Kahneman and Tversky's prospect theory (1979) holds that people's risk preference behavior in the face of gain and loss is inconsistent, and they become risk pursuit in the face of "loss", but risk aversion in the face of "gain". Therefore, set in series 3, there will be a certain probability that it will lead to negative return (see Table 1).

3. Experimental result

3.1. Descriptive statistics

270 questionnaires were distributed and 244 valid questionnaires were recovered, accounting for 91.4%.

3.1.1. Variable summary statistics

a. Setting of the explained variable:

The explained variable selects the acceptance degree and purchase intention of genetically modified food. There are four scale questions with a score of 1-5 respectively, after taking the mean value, round it to get the value of the explained variable. The higher the score, the higher the acceptance degree of genetically modified food;

b. Setting of dummy variables in explanatory variables:

Female=1, male=0; Family members less than 7 years old=1, otherwise=0; Family members over 60 years old=1, otherwise=0; Main person in charge of household food purchase=1, otherwise=0; Married=1, unmarried=0.

c. Setting of other explanatory variables:

(1) Number of family members; (2) Education level:primary school =1, Junior high school and technical secondary school=2, High school and technical school =3, Undergraduate and junior college =4, Master degree or above =5; (3) Monthly household income; (4) The degree of trust in Chinese food safety (1-5 points, the higher the score, the higher the degree of trust); (5) Number of food safety issues of concern (1-7 points, the higher the score, the more risk aversion), cognition of genetically modified food (1-11 points, the higher the score, the higher the understanding of genetically modified food); (6) Attitude towards genetically modified food (1-5 points, low score indicates risk preference); (7) Gene knowledge (0-4 points, the higher the score, the richer the gene knowledge); (8) Risk perception (1-5points, low score indicates

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risk preference); (9) rr1&rr2 (relative risk preference coefficient of series 1&2 in economic experiment).

3.1.2. Relative risk preference

According to the calculation formula of relative risk preference of Lusk (2005): $U(x) = x^{(1-rr)}/(1-rr)$, Combined with the probability and income of each row in Table 1, the range of relative risk preference coefficient of each row is calculated by using matlab2016 software. Take the average value to the relative risk preference coefficient of each line. The greater the relative risk preference coefficient, the more risk averse it is. In the first example, if option B is selected, it must be because U(B)>U(A),Then the following inequality can be obtained: $0.3\frac{8^{1-rr}}{1-rr} + 0.7\frac{2^{1-rr}}{1-rr} < 0.1\frac{10^{1-rr}}{1-rr} + 0.9\frac{0.5^{1-rr}}{1-rr}$ And so on for every subsequent line. Specific descriptive statistics are shown in Table 2.

From series1, it can be seen that most of the subjects are risk averse: they give up low rewards on small probability; however, with more and more benefits obtained by small probability, more and more people choose to "fight", which is in line with the "reflection effect" of prospect theory. From series2, the frequency distribution of relative risk coefficient in economic experiment series 2 is very different from that in series 1: sample of extreme risk averse and extreme risk preference account for the majority, which is not in line with daily cognition.

Table 2. Relative risk preference coefficient of series1&2 of economic experiment

TL	rr1	frequency	rr2	frequency
1	-3.93	15	-1.57	74
2	-2.675	5	-0.995	2
3	-1.19	4	-0.2	2
4	-0.74	5	0.145	4
5	-0.43	5	0.35	2
6	-0.275	7	0.49	5
7	-0.165	9	0.59	6
8	-0.065	9	0.7	16
9	0.03	7	0.805	8
10	0.11	13	0.875	12
11	0.195	27	0.935	13
12	0.27	17	0.98	13
13	0.33	28	1.03	8
14	0.39	37	1.09	13
Never	0.42	56	1.12	66
Sum		244		244

3.2. Regression results of risk aversion

3.2.1. Descriptive statistics

This paper selects and summarizes the questionnaire questions, and uses the methods of reverse coding and taking the mean to deal with the messy questions into 17 explanatory variables that can be analyzed quantitatively. From table4, we can intuitively draw the following conclusions: the proportion of gender in the sample is relatively balanced; The education level is mostly below senior high school, which is in line with the actual situation of Chinese producers at this stage; The proportion of major and non-major food buyers is also close to 1:1; The subjects lack genetic knowledge, which is also matched with their education level. (The second column of Table3)

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3.2.2. Based on the regression results of series1 and series 2 of economic experiments

Table 3. Regression result of series1&2 of economic experiment

Acceptance	Descriptive statistics	Ordered probit		Robustness test	
		series1	series2	series1	series2
rr		-.197***	-0.086	-0.094	-0.083
Gender	0.52(-0.5)	0.179	0.178	0.249	0.256
Age	0.51(-1.24)	-0.004	-0.004	-0.004	-0.003
Marriage	1.23(-0.44)	0.014	0.024	-0.031	-0.035
Member	3.9(-1.18)	0.002	-0.013	-0.016	-0.023
Under7	0.27(-0.45)	-0.006	0.004	0.085	0.094
Beyond 60	0.51(-0.5)	-0.193	-0.248	-0.099	-0.122
Education	2.93(-1.1)	.23***	.216***	.27***	.258***
Income	2.4(-1.87)	0.006	0.028	0.044	0.056
Buyer	0.55(-0.5)	-0.232	-.288*	-.456**	-.476**
Trust in Chinese food safety	3.1(-0.61)	0.282**	0.276**	0.131	0.127
Issues of concern	3.94(-2.19)	-0.052	-0.043	-.07*	-0.061
Cognition towards GM	4.79(-1.82)	-.095**	-.093**	-0.053	-0.048
Attitude towards GM	3.2(-0.68)	-.687***	-.677***	-.68***	-.673***
Gene knowledge	1.36(-1.1)	0.022	0.029	-0.094	-0.091
Risk perception	3.27(-0.85)	-0.046	-0.055	-0.109	-0.123
Pseudo r-squared		0.133	0.123	0.135	0.136

*** p<.01, ** p<.05, * p<.1 The second column :The first number is the mean value, the second number is the standard error.

From the regression results of economic experiment series 1 (columns 3 and 4 of table 3), we can draw the following conclusions:

(1) It is found that under other conditions unchanged, women's acceptance of GM crops is 17.9% higher than men, which is contrary to previous research conclusions. At present, families in Chinese agricultural areas are such a situation: women stay in hometown to engage in agricultural activities, men mostly work on construction activities in big cities as "migrant workers" to subsidize their families, and return home in busy agricultural seasons. Compared with the previous studies, women's rights and voice in the family have been greatly improved, so they are no longer so risk averse;

(2) With the increase of age, farmers' acceptance of GM crops is declining. In China's rural areas, the older generation has a lower level of education. In addition, the samples in this paper are from land-based workers in production activities such as Shanxi and Henan. From the perspective of psychology, producers who rely more on land tend to pursue stability and show stronger risk aversion than producers who rely on water;

(3) Compared with people with families, unmarried people are more adventurous. Therefore unmarried people have a higher acceptance level of 1.4% than married people; The greater the number of family members, the higher the acceptance; At the same time, if there are children under the age of 7 or the elderly over the age of 60 among family members, they tend to pay more attention to the families whose physical health is more vulnerable. These samples have a higher degree of risk aversion, and are more inclined to not accept GM crops;

(4) Subjects with the higher the education level and the richer the knowledge of genes, understand the advantages of GM crops better, and have the higher acceptance level of GM crops; People with higher income are more willing to accept GM crops, which is mutually confirmed with the previous point, because income is usually directly proportional to education, which will be explained in detail later. The more food safety issues concerned, the more

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cautious, in that the acceptance of GM is lower; Trust means buying habits, the higher score of it, the more confident about Chinese food safety, in other words, the higher the degree of acceptance of GM crops, which is in line with our expectations; The more cautious with the attitude towards GM crops represents that the stronger the ability to perceive risks, and the more worried about GM crops, which will reduce the degree of acceptance. Among them, education, trust in Chinese food, cognition of genetically modified food and attitude towards genetically modified food are significant in the regression of economic experiment series 1 and series 2. Hypothesis 1 is verified.

After regression of series 2, it is found that most results are consistent with series 1, but the relative risk coefficient is no longer significant, and Pseudo r-squared decreases, which may be related to the abnormal phenomena in the previous descriptive statistics. This is the deficiency of this paper, which can be improved in future research.

The more backward the transformation line is, the more sensitive it is to losses. It can be seen that most people are risk averse. In the lottery choice that will inevitably lead to negative returns, producers are more inclined to avoid risks when facing 50% loss probability than when there is only positive return.

3.2.3. Robustness test

Considering that in the process of the experiment, the gambling experiment is placed at the end of the whole experiment, at this time, the subjects' patience and attention have inevitably decreased, or they do not fully understand the rules of the game, result in some subjects only choose option A or option B, which will add noise to the regression. As a robustness test, 19% of individuals are excluded from the samples. The regression results are shown in rows 5 and 6 of table 3.

3.2.4. Shapley value decomposition

Shapley value decomposition method based on r-squared can group variables. This article divides the explanatory variables into five groups. See Table 4for decomposition results.

Table 4. Contribution rate of factors on Shapley Value decomposition(%)

	series1	series2		series1	series2
Individual characteristics	**16.15**	**17.5**	**Education level**	**16.13**	**17.46**
Gender	0.8	0.87	Education	12.63	13.67
Age	6.02	6.52	Cognition towards GM	2.69	2.91
Marriage	5.52	5.98	Knowledge	0.81	0.88
Buyer	3.81	4.13	**rr**	**11.28**	**4.93**
Family characteristics	**3.48**	**3.76**	**Preference**	**53.84**	**58.29**
Member	0.06	0.06	Trust in Chinese food safety	5.11	5.53
Under7	0.32	0.34	Issues of concern	6.3	6.82
Beyond60	2.51	2.72	Risk perception	2.43	2.63
Income	0.59	0.64	Attitude towards GM	40	43.31

After decomposing all variables, whether based on the relative risk coefficients of series 1 or series 2 of economic experiments, the contribution rates of attitude and education have decreased, but the proportion is still the largest (more than 40% and more than 12%), which is consistent with the results in Table 8. Hypothesis 2 is verified.

4. Conclusions

This paper finds that producers with high risk aversion tend not to grow GM crops, and producers with low risk aversion can accumulate more wealth through technological innovation. The results show that: firstly, most producers are risk averse; secondly, farmers'

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perceived risk and potential loss will affect their technology adoption decision-making. In the face of loss, subjects are more sensitive to risk aversion; thirdly, the degree of risk aversion varies with individual characteristics. Female producers have higher acceptance of GM food; the higher the level of education, the richer the knowledge of genes, and the higher the acceptance of genetically modified crops; with the increase of age, farmers' acceptance of GM crops is decreasing; people with higher income are more willing to accept GM crops.

This paper also has the following deficiencies and needs to be improved: First, we should pay attention to the education level of the subjects and transform the problems equivalently in order to obtain more real and objective experimental data. Second, the subjects are all producers who work on land. In the future, they can join fishery producers for comparison to explore the risk preferences of different types of producers.

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