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Analysis on the Impact of Value and Risk Perception on Investment Behavior of Agriculture Product Quality and Safety

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ABSTRACT
The prospect theory is introduced into the evolutionary game to construct the profit perception matrix of the decision-maker of quality and safety investment which is more in line with the actual situation, and deduces the sufficient conditions and influencing factors for the production enterprises not to carry out the quality and safety investment behavior, which is verified by numerical simulation.

Keywords*: prospect theory, value perception, quality and safety, evolutionary game*

1. INTRODUCTION

In recent years, agricultural product quality and safety incidents have occurred frequently, caused serious harm to consumers health, Although once again emphasized. However, the quality and safety of agricultural products in my country is still not optimistic at present[1]. The quality and safety of agricultural products are closely related to human health and even life safety, attention is also increasing. Therefore, to ensure the quality and safety of agricultural products, is of great significance to the development of my country's social economy [2].

Scholars mainly study the causes of agricultural product quality and safety problems from two aspects. First, from the perspective of information asymmetry. For example, Akerlof[3], Darby Mr, Kari E[4] concluded that it is agricultural products with the characteristics of "experience and trust", which makes the information asymmetry between the supply and demand sides. According to the characteristics of "experience and trust" of agricultural products, McCluskey[5] analyzed the game between producers and customers under asymmetric information. Second, from the perspective of inadequate supervision and management. For example, arrow and ante [6,7] think that when the market fails, government regulation can effectively make up for it, but government regulation is not in place. Weidong Xi, Qi, Qiao & Shao Fang Sun [8] used the circular model to identify the defects that mainly focused on the supervision after the safety incident but ignored the prior risk control.

In the game analysis, most scholars ignore the value perception of enterprise quality and safety investment, that is, the prospect value, which may lead to the deviation between the research results and the actual results. Therefore, this paper combines the game model and prospect theory, and introduces risk perception factors, constructs the income perception matrix of enterprises and regulatory authorities, and explores the influencing factors and conditions for enterprises to choose quality and safety investment.

2. CONSTRUCTION OF GAME MODEL BETWEEN PRODUCTION ENTERPRISES AND SUPERVISION DEPARTMENTS

2.1 Model Assumptions and Construction

Based on the analysis of the above problems, this article proposes the following hypotheses:

(1) The main body of the game is only agricultural product production enterprises A and regulatory authorities B, And all are bounded rationality. The subject's strategy selection is mainly based on the value perception of the strategy's profit and loss, rather than the direct profit and loss of the strategy itself. This perceived value behavior conforms to the prospect theory. According to Kahneman and Tversky, the perceived value of the game player can be measured by the prospect

value. By function $V(\varphi)$ sum and weight function $\omega(\rho)$ Decide , such as (1)formula shown:

$$V = \sum \omega(\rho)V(\varphi) \quad (1)$$

$V(\varphi)$As a value function, it has the characteristics of income preference and risk aversion. Weight function $\omega(\rho)$ has fixed characteristics:$\omega(0) = 0;\ \omega(1) = 1.$

$$V(\varphi) = \begin{cases} \varphi^{\alpha}\varphi \geq 0 \\ -\delta(-\varphi)^{\alpha}\varphi < 0 \end{cases} \quad (2)$$

among them, α indicates the risk preference coefficient of decision makers, δ indicates the risk aversion coefficient of the decision maker for loss.

(2) The main players in the game have only two strategies, among which: The corporate strategy is {choose quality and safety investment A_1, Do not choose quality and safety investment A_2}, Regulatory strategy is {active supervision B_1 , Negative regulation B_2}.Costs incurred when enterprises choose quality and safety investment strategies(The cost mainly includes time, labor, energy, opportunity cost and psychological cost, etc.) c_1, The corresponding prospect value is C_1. If the supervisory authority actively supervises the cost of c_2, The corresponding prospect value is C_2; If a company chooses not to invest in quality and safety and causes physical harm to consumers, the regulatory authorities will punish it as follows: p, the corresponding prospect value is P.

(3) If the enterprise does not choose quality and safety investment, its economic loss is t, and the prospect value of risk loss is T. Considering that the enterprise and the regulatory authorities form a community of interests to some extent, they have a joint relationship, and there is a linear correlation between them. The product quality and safety risk cost borne by the enterprise is T, and the risk cost borne by the regulatory department is ε T (ε is the risk transmission coefficient, and ε is variable).

(4) When the main strategy of the game is $\{A_2, B_1\}$. At the time, the discount coefficient of the risk loss assumed by both parties of the game is μ, when $\{A_1, B_2\}$At the time, the discount coefficient of the risk loss assumed by both parties of the game is θ.

(5) The probability that an enterprise chooses safety and quality investment is x, The probability of not choosing safety and quality investment is $1-x$, when the supervisory authority chooses active supervision, the probability is y, the probability of negative supervision is $1-y$; And $x, y \in [0,1]$.

According to the above assumptions, construct the income perception matrix, as shown in the table 1:

Table 1. Profit Perception Matrix of Production Enterprises and Product Supervision Departments

Manufacturer	Regulatory Authorities	
	Active	Negative
Choose	$-C_1, -C_2$	$-C_1$ $-\theta T, -\theta\varepsilon T$
not choose	$-P-\mu T, P-C_2-\mu\mu\varepsilon T$	$-T, -\varepsilon T$

2.2 Model Solving

The expected prospect value of enterprises choosing quality and safety investment is:

$$E_{A1} = -yC_1 + (1-y)(-C_1 - \theta T) = -C_1 - \theta T + y\theta T \quad (3)$$

The expected prospect value of enterprises not choosing quality and safety investment is:

$$E_{A2} = y(-P-\mu T) + (1-y)(-T) = -yP - T + (1-\mu)yT \quad (4)$$

The average expected prospect value of enterprises choosing quality and safety investment is:

$$\overline{E_A} = xE_{A1} + (1-x)E_{A2} = x(-C_1 - \theta T + y\theta T) + (1-x)[-yP - T + (1-\mu)yT] \quad (5)$$

Therefore, the enterprise chooses the replication dynamic equation of product quality and safety investment as:

$$F(x) = \frac{dx}{dt} = x(E_{A1} - \overline{E_A}) = x(1-x)[yP - C_1 + (\mu+\theta-1)yT + (1-\theta)T] \quad (6)$$

In the same way, the dynamic equation of replication that the regulatory authority actively supervises is:

$$F(y) = \frac{dy}{dt} = y(E_{B1} - \overline{E_B}) = y(1-y)[P - C_2 + (1-\mu)\varepsilon T - Px + (\mu+\theta-1)x\varepsilon T \quad (7)$$

Make$F(x) = 0, F(y) = 0$available equilibrium point of evolutionary game $A(0,0), B(1,0), C(0,1), D(1,1)$, among them $E(x_0, y_0)$: $x_0 = \frac{C_2 - P + (\mu-1)\varepsilon T}{(\theta+\mu-1)\varepsilon T - P}, y_0 = \frac{(\theta-1)T + C_1}{(\mu+\theta-1)T+P}$.

Table 2. cal stability analysis results

Equilibrium point	Determinant	Trace	result
$A(0,0)$	+	+	Unstable point
$B(1,0)$	−	indefinite	Saddle point
$C(0,1)$	−	indefinite	Saddle point
$D(1,1)$	+	−	Stable point
$E(x_0, y_0)$	indefinite	0	Unstable point

Note: table 2 The constraints of the mid-equilibrium point are:

$$\begin{cases} C_1 \le (1-\theta)T \\ C_1 \le P + \mu T \\ C_2 \le \theta \varepsilon T \\ C_2 \le P + (1-\mu)\varepsilon T \end{cases}$$

3. MODEL SIMULATION ANALUSIS

3.1 Model Parameter Setting and Simulation Analysis

Simulation with MATLAB assumed initial value $x = 0.3, y = 0.3, \varepsilon = 1, \theta = 0.4, \mu = 0.6, P = 0.5, T = 1$; $C_1 = 1, C_2 = 1$

3.1.1. The cost of enterprises choosing quality and safety investment C_1 The impact of changes in evolution

As can be seen from the below figure, C_1 The threshold is at 0.6-0.7 between. Therefore, helping enterprises to reduce the cost of quality and safety investment can enable enterprises to adopt safety investment behaviors.

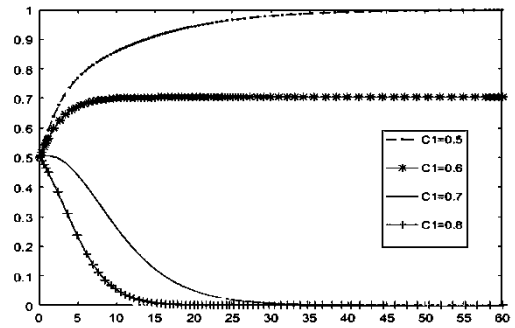

Fig.1 Costs paid by enterprises to invest in quality and safety C_1 The impact of changes in evolution

3.1.2. Regulatory agency's supervision cost of corporate behavior C_2 The impact of changes in evolution

From the picture 2 Knowable, C_2 the threshold is at 0.8-0.9 Between. So with C_2 the decrease in the rate of supervision by the supervisory authority has increased.

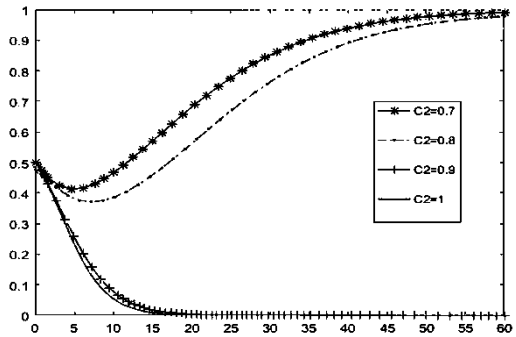

Fig.2. Regulatory costs C_2 The impact of changes in evolution.

As can be seen from the third figure, ε the threshold is at 1.4-1.6 between. So, companies will be more inclined to invest in quality and safety under various measures.

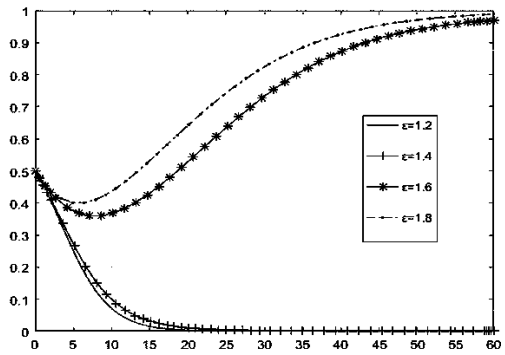

Fig.3. Risk transfer coefficient ε The impact of changes in evolution

4. CONCLUSION

The main conclusions of this article are:

(1) This paper combines prospect theory and evolutionary game to improve the application of evolutionary game theory in the quality and safety of agricultural products. It can truly reflect the characteristics of the subject of the game's bounded rationality, and it can also explain the phenomenon of the game of agricultural product manufacturers.

(2) The cost will affect the behavior choices of manufacturers and regulatory agencies.

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