The Evolutionary Game of Agricultural Products E-Commerce Platform Under the Background of Government Investment Blockchain Technology

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Abstract. In view of the uncertainty of the quality of agricultural products in the agriculture-related e-commerce platform, the introduction of blockchain technology can share the initial real information of agricultural products and improve the trust of agricultural products. Based on the evolutionary game theory, a tripartite evolutionary game model of local government, agricultural product suppliers and agriculture-related e-commerce platforms is constructed to analyze the behavior selection and evolution of the tripartite entities under the background of government's active participation in the investment and introduction of blockchain technology. After that, Matlab simulation is used to show the impact of blockchain technology characteristics and government participation on agricultural products and e-commerce platforms. The results show that the income of agricultural product suppliers and agriculture-related e-commerce platforms is related to the additional income brought by government investment and their investment strategy selection; Both the advantages brought about by the government's leading participation in the investment in blockchain technology and the indirect benefits to the government from it can promote the system to reach the ideal state of evolutionary stability relatively quickly.

Keywords: blockchain technology agricultural products supply chain e-commerce platform evolution game

1 INTRODUCTION

With the advancement of agricultural modernization, the application of information technology in the production, management and sales of agricultural products has gradually become a research focus [1]. As an important part of the application of information technology in the agricultural field, the agriculture-related e-commerce platform provides a new means for the circulation and sales of agricultural products. However, the quality and safety of agricultural products has always been the focus of consumers' attention. The Law of the People's Republic of China on the Quality and Safety of Agricultural Products, which came into effect on January 1, 2023, emphasizes the connec

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tion with the food safety law from the production link to the processing and consumption link, and realizes the supervision of the whole process of agricultural products from the field to the people's table [2]. By utilizing the decentralized, distributed storage and non-tamper characteristics of blockchain technology [3], the agriculture-related e-commerce platform can ensure the quality traceability and traceability system of agricultural product suppliers, and establish a reliable e-commerce platform, which can comprehensively guarantee the quality and safety of agricultural products, reduce the cost of agricultural product suppliers, and enhance the brand influence of agriculture-related platforms. The improvement of consumer satisfaction and the improvement of government credibility are of great significance.

At present, some scholars have applied blockchain technology to the research field of agricultural e-commerce supply chain. Zhong Haiyan established an evolutionary game model between agricultural suppliers and processors based on blockchain technology input by introducing the government subsidy mechanism, and solved the problem of "free riders" among enterprises [4]. Yang et al. solved the problems of trust, responsibility and quality in the production process of agricultural products by using the characteristics of blockchain technology such as imtamability, and pointed out the direction for the standardized production of agricultural products [5].Zheng et al. believe that the decision to adopt blockchain technology traceability can improve brand image and develop a sustainable agricultural supply chain[6]. Starting from transaction security, Sun proposed that the use of blockchain technology can effectively improve the credibility of agricultural product information sources [7].

In recent years, with the continuous improvement and development of e-commerce platforms, agricultural products have become an important force to promote rural development by conducting various business modes such as transactions through agriculture-related e-commerce platforms [8]..For example, the e-commerce platform of Tiktok helped sell 4.73 billion agricultural products only the year 2023, with an average of 13 million packages containing agricultural products sold across the country every day [9].By introducing the blockchain technology of agricultural product suppliers and agriculture-related platforms, we can not only record the production source of agricultural products, form supervision over the entire production process, reduce the impact of information asymmetry, and enhance consumers' purchase desire [10], but also do not rule out the agriculture-related e-commerce platform as a commercial platform, with profit as the primary purpose, in order to increase platform transactions. We will lower the threshold for the examination of agricultural products, and increase the commission and percentage of the deduction. This means that the agricultural product e-commerce supply chain model still requires the participation of the government, and the government can take the form of investment in blockchain technology to agricultural product suppliers and agriculture-related e-commerce platforms, and obtain benefits through taxation. Due to the complex interweaving and mutual influence among the three entities, it is necessary to study the evolution law of the relevant entities of the agricultural products e-commerce platform from the perspective of government-driven investment in blockchain technology.

To sum up, based on blockchain technology, this paper builds a tripartite evolutionary game model of agricultural product suppliers, e-commerce platform and government, analyzes the changes in the income of agricultural product suppliers and e-commerce platform before and after the introduction of this technology and the impact of the system evolution and stability strategy, and conducts numerical simulation to simulate the advantages of blockchain technology and the impact from the perspective of government participation and investment. We look forward to better application of blockchain technology in the field of agricultural product e-commerce.

2 HYPOTHESIS AND CONSTRUCTION OF EVOLUTIONARY GAME MODEL OF AGRICULTURAL E-COMMERCE PLATFORM UNDER THE BACKGROUND OF GOVERNMENT INVESTMENT BLOCKCHAIN TECHNOLOGY

2.1 Basic Assumptions of the Model

Hypothesis 1: The tripartite suppliers of agricultural products, the e-commerce platform and the government are all limited rational agents in the game process; When making decisions, game players must make mistakes, learn, and find the optimal strategy through multiple games.

Hypothesis 2: The strategy of the agricultural product supplier is a= (a1, a2) = (introduce blockchain technology, do not introduce blockchain technology), the probability of adopting the introduction of blockchain technology a1 is x, and the probability of adopting strategy a2 is (1-x); The strategy of the e-commerce platform is b= (b1,b2) = (introduce blockchain technology, do not introduce blockchain technology), the probability of adopting strategy b1 is y, and the probability of adopting strategy b2 is (1-y); The government's strategy is c= (c1, c2) = (invest in blockchain technology, do not invest in blockchain technology), the probability of adopting strategy c1 is z, and the probability of adopting strategy c2 is (1-z). Where x, y, z$\in$ [0,1].

Hypothesis 3: The normal income of agricultural product suppliers is R1, and the additional income of agricultural product suppliers introduction of blockchain technology is E1. The continuous expenditure of agricultural product suppliers after the introduction of blockchain technology, such as equipment maintenance and technical consultation is C1, agricultural product suppliers not introduce it, and the investment of e-commerce platform leads to free-rider behavior. Set as p1, agricultural product suppliers introduce it. The coefficient of subsidy given by the government is α1.

Hypothesis 4: The normal income of the e-commerce platform is R2, the additional income of the e-commerce platform introducing blockchain technology is E2, the continuous expenditure of the e-commerce platform after the introduction of blockchain technology, such as equipment maintenance, technical consultation. is C2, the introduction of agricultural products suppliers, the e-commerce platform does not introduce, resulting in free-riding behavior, set as p2, the introduction of e-commerce platform, and the subsidy coefficient given by the government is α2.

Hypothesis 5: The basic income of the local government (credibility, performance assessment and regional economic benefits, etc.) is Gg, the cost formed by the government's participation in the investment of blockchain technology is Cg, the government actively participates in the investment, drives the investment of agricultural suppliers and e-commerce platforms, and brings additional income to the government for Eg, the government does not invest in blockchain technology, and the negative effect on the government regulatory departments is Ni. The indirect return rate brought by the government's active investment for agricultural suppliers and e-commerce platforms is b. When agricultural suppliers and e-commerce platforms choose to introduce blockchain technology strategy, they will give both parties part of the financial subsidy as Rg, and the government subject will profit from the blockchain technology investment behavior of e-commerce platforms and agricultural suppliers in the form of tax, and the tax rate is set at e.

2.2 Establishment of Evolutionary Game Model

Based on the above assumptions, the income matrix of agricultural product suppliers, e-commerce platforms and the government can be obtained, as shown in Table 1.

Table 1. Tripartite income matrix

strategy profile	Supplier of agricultural products	e-commerce platform	government
(a1，b1，c1)	(1-e)*(1+b)*(R1+E1)+α1*Rg-C1	(1-e)*(1+b)*(R2+E2)+α2*Rg-C2	e*(1+b)*(R1+R2+Gg+Eg+E1+E2)-Cg-α1*Rg-α2*Rg
(a1，b1，c2)	(1-e)*(R1+E1)-C1	(1-e)*(R2+E2)-C2	e*(R1+R2+Gg+E1+E2)-Ni
(a1，b2，c1)	(1-e)*(1+b)*(R1+E1)+α1*Rg-C1	(1-e)*(R2+p2)	e*(1+b)*(R1+R2+Gg+E1+p2)-Cg-α1*Rg
(a1，b2，c2)	(1-e)*(R1+E1)-C1	(1-e)*(R2+p2)	e*(R1+R2+Gg+E1+p2)-Ni
(a2，b1，c1)	(1-e)*(R1+p1)	(1-e)*(1+b)*(R2+E2)+α2*Rg-C2	e*(1+b)*(R1+R2+Gg+E2+p1)-Cg-α2*Rg
(a2，b1，c2)	(1-e)*(R1+p1)	(1-e)*(R2+E2)+α2*Rg-C2	e*(R1+R2+Gg+E2+p1)-Ni
(a2，b2，c1)	(1-e)*R1	(1-e)*R2	e*(1+b)*(R1+R2+Gg)-Cg
(a2，b2，c2)	(1-e)*R1	(1-e)*R2	e*(R1+R2+Gg)-Ni

(1) Expected income function and replication dynamic equation of agricultural product suppliers

Using E11 and E12 to represent the income function of agricultural product suppliers choosing "introduce" and "do not introduce" strategies, representing the average income, we can get:and to represent the income function of agricultural product suppliers choosing "introduce" and "do not introduce" strategies, representing the average income, we can get:

The expected income function of agricultural product supplier choosing "introduction" strategy is as follows:

E11=y*z*((1-e)*(1+b)*(R1+E1)+α1*Rg-C1)+y*(1-z)*((1-e)*(R1+E1)-C1)+(1-y)*z*((1-e)*(1+b)*(R1+E1)+α1*Rg-C1)+(1-y)*(1-z)*((1-e)*(R1+E1)-C1)

The expected income function of agricultural product supplier choosing "no introduction" strategy is as follows:

E12=y*z*((1-e)*(R1+p1))+y*(1-z)*((1-e)*(R1+p1))+(1-y)*z*((1-e)*R1)+(1-y)*(1-z)*((1-e)*R1)

The average expected income function of agricultural product suppliers is as follows:

$$\bar{E} = \mathrm{x}E_{11} + (1-\mathrm{x})E_{12}$$

Replication dynamic equation for agricultural product suppliers:

$$F(\mathrm{x}) = \frac{d\mathrm{x}}{dt} = \mathrm{x}(\mathrm{E}_{11} - \overline{E_1}) = \mathrm{x}(1\text{-}\mathrm{x})(\mathrm{E}_{11} - E_{12})$$

$F(\mathrm{x}) = \frac{d\mathrm{x}}{dt}$=x*(x-1)*(C1-E1+E1*e+p1*y-E1*b*z-Rg*α1*z-R1*b*z-e*p1*y+E1*b*e*z+R1*b*e*z)

(2) Expected revenue function and replication dynamic equation of e-commerce platform

Use E_{21} and E_{22} to represent the expected income of the e-commerce platform choosing "introduction" and "non-introduction", and represent the average income:

The expected income function of e-commerce platform choosing "introduction" strategy is as follows:

E21=x*z*((1-e)*(1+b)*(R2+E2)+α2*Rg-C2)+x*(1-z)*((1-e)*(R2+E2)-C2)+(1-x)*z*((1-e)*(1+b)*(R2+E2)+α2*Rg-C2)+(1-x)*(1-z)*((1-e)*(R2+E2)+α2*Rg-C2)

The expected income function of e-commerce platform choosing "no introduction" strategy is as follows:

E22=x*z*((1-e)*(R2+p2))+x*(1-z)*((1-e)*(R2+p2))+(1-x)*z*((1-e)*R2)+(1-x)*(1-z)*((1-e)*R2)

The average expected revenue function of e-commerce platform is

$$\overline{E_2} = yE_{21} + (1-y)E_{22}$$

The replication dynamic equation of e-commerce platform:

$F(y) = \frac{dy}{dt} = y(E_{21} - \overline{E_2}) = y(1-y)(E_{21} - E_{22})$=y*(y-1)*(C2-E2+E2*e-Rg*α2+p2*x-E2*b*z+Rg*α2*x-R2*b*z-e*p2*x-Rg*α2*x*z+E2*b*e*z+R2*b*e*z)

Government expected revenue function and replication dynamic equation：Id.

2.3 Stability Analysis of Equilibrium Points

From F(x)=0, F(y)=0, F(z)=0, the system equilibrium point can be obtained: O (0, 0), A (0, 1), B (0, 0), C (0,1,1), D (0, 1), En (1, 1), F (1, 0), G (1,1,1), evolutionary game system Jacobian matrix for the three parties:

$$\begin{bmatrix} \frac{dF(x)}{dx} & \frac{dF(x)}{dy} & \frac{dF(x)}{dz} \\ \frac{dF(y)}{dx} & \frac{dF(y)}{dy} & \frac{dF(y)}{dz} \\ \frac{dF(z)}{dx} & \frac{dF(z)}{dy} & \frac{dF(z)}{dz} \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$$

$\frac{dF(x)}{dx}$=(2*x-1)*(C1-E1+E1*e+p1*y-E1*b*z-Rg*α1*z-R1*b*z-e*p1*y+E1*b*e*z+R1*b*e*z)

$\frac{dF(x)}{dy}$=-p1*x*(e-1)*(x-1)

$\frac{dF(x)}{dz}$=-x*(x-1)*(E1*b+Rg*α1+R1*b-E1*b*e-R1*b*e)

$\frac{dF(y)}{dx}$=y*(y-1)*(p2+Rg*α2-e*p2-Rg*α2*z)

$\frac{dF(y)}{dy}$=(2*y-1)*(C2-E2+E2*e-Rg*α2+p2*x-E2*b*z+Rg*α2*x-R2*b*z-e*p2*x-Rg*α2*x*z+E2*b*e*z+R2*b*e*z)

$\frac{dF(y)}{dz}$=-y*(y-1)*(E2*b+R2*b-E2*b*e-R2*b*e+Rg*α2*x)

$\frac{dF(z)}{dx}$=-z*(z-1)*(E1*b*e-Rg*α1+Eg*e*y+b*e*p2-b*e*p1*y-b*e*p2*y+Eg*b*e*y)

$\frac{dF(z)}{dy}$=-z*(z-1)*(E2*b*e-Rg*α2+Eg*e*x+b*e*p1-b*e*p1*x-b*e*p2*x+Eg*b*e*x)

$\frac{dF(z)}{dz}$=-(2*z-1)*(Ni-Cg+Gg*b*e+R1*b*e+R2*b*e-Rg*α1*x-Rg*α2*y+b*e*p2*x+b*e*p1*y+E1*b*e*x+E2*b*e*y+Eg*e*x*y+Eg*b*e*x*y-b*e*p1*x*y-b*e*p2*x*y)

According to Lyapunov's first law, if all the eigenvalues of the Jacobian matrix have negative real parts, the equilibrium point is asymptotically stable. If the eigenvalue of the Jacobian matrix has a positive real part, then the equilibrium point is an unstable point, and the eigenvalue of each equilibrium point is shown in Table 2.

Table 2. Equilibrium points and eigenvalues

System equilibrium points and eigenvalues.			
	λ1	λ2	λ3
O(0, 0,0)	E1-C1-E1*e	E2-C2-E2*e+Rg*α2	Ni-Cg+(Gg+R1+R2)*b*e
A(0, 0,1)	E1-C1+E1*b-E1*e+Rg*α1+R1*b-E1*b*e-R1*b*e	E2-C2+E2*b-E2*e+Rg*α2+R2*b-E2*b*e-R2*b*e	Cg-Ni+(-Gg-R1-R2)*b*e
B(0, 1,0)	E1-C1-p1-E1*e+e*p1	C2-E2+E2*e-Rg*α2	Ni-Cg-Rg*α2+(E2+Gg+R1+R2+p1)*b*e
C(0, 1,1)	E1-C1-p1+E1*b-E1*e+Rg*α1+R1*b+e*p1-E1*b*e-R1*b*e	C2-E2-E2*b+E2*e-Rg*α2-R2*b+E2*b*e+R2*b*e	Cg-Ni+Rg*α2+(-E2-Gg-R1-R2-p1)*b*e
D(1, 0,0)	C1-E1+E1*e	E2-C2-p2-E2*e+e*p2	Ni-Cg-Rg*α1+(E1+Gg+R1+R2+p2)*b*e
E(1, 0,1)	C1-E1-E1*b+E1*e-Rg*α1-R1*b+E1*b*e+R1*b*e	E2-C2-p2+E2*b-E2*e+Rg*α2+R2*b+e*p2-E2*b*e-R2*b*e	Cg-Ni+Rg*α1+(-E1-Gg-R1-R2-p2)*b*e
F(1, 1,0)	C1-E1+p1+E1*e-e*p1	C2-E2+p2+E2*e-e*p2	Ni-Cg+Eg*e-Rg*α1-Rg*α2+(E1+E2+Eg+Gg+R1+R2)*b*e
G(1, 1,1)	C1-E1+p1-E1*b+E1*e-Rg*α1-R1*b-e*p1+（E1+R1）*b*e	C2-E2+p2-E2*b+E2*e-Rg*α2-R2*b-e*p2+(E2+R2)*b*e	Cg-Ni-Eg*e+Rg*α1+Rg*α2+(-E1-E2-Eg-Gg-R1-R2)*b*e

2.4 Stability Analysis of Evolutionary Game Model

Analysis of Strategic Stability of Agricultural Product Suppliers. According to the evolutionary game theory and the dynamic equation of the "import" behavior of agricultural products suppliers, the first derivative of x is obtained and set.

$$F'(x) = (1 - 2 * x)*\begin{bmatrix} -C1 + E1\text{-}E1*e\text{-}p1*y\text{+}e*p1*y\text{+} \\ Rg * \alpha1*z\text{-}(R1*e\text{-}R1\text{-}E1\text{+}E1*z)*b*e \end{bmatrix}$$

When agricultural product supplier strategy reaches stability, it must satisfy the stability theorem of differential equation, that is, F(x)=0 and $\frac{dF(x)}{dx} < 0$, when $y = y^* = \frac{C1-E1+E1*e-Rg*\alpha1*z+(R1*e-R1-E1+E1*z)*b*e}{e*p1-p1}$, At this time, F(x)=0 is constant in any interval of x, indicating that the agricultural product supplier cannot determine the stability strategy at this time.

If y≠y*, then x=0 and x=1 are the two possible equilibrium points of F(x).

(1) When $0 < y < y^* < 1$, , when x=0, $\frac{F(x)}{dx} > 0$, and when x=1, $\frac{F(x)}{dx} < 0$,,it indicates the evolutively stable strategy of agricultural product suppliers under this condition, that is, agricultural product suppliers will tend to choose not to introduce.

(2) When $0 < y^* < y < 1$, when x=0, $\frac{F(x)}{dx} > 0$, when x=1, $\frac{F(x)}{dx} < 0$, indicating that under this condition is the evolutively stable strategy of agricultural product suppliers, that is, agricultural product suppliers will tend to choose import.

Similarly, the strategic stability of e-commerce platforms and the government is analyzed as above.

3 ANALYSIS OF STRATEGIC STABILITY OF AGRICULTURAL PRODUCT SUPPLIERS

Typical equilibrium points (0,1,0), (1,0,0), (0,1,1) and (1,1,1) were selected for analysis, and Matlab software was used to simulate the replication dynamic process of the multi-agent strategy in these four cases respectively.

3.1 Equilibrium Point 1: B (0,1,0)

When $E1 - C1 - p1 - E1 * e + e * p1 < 0$, $C2 - E2 + E2 * -Rg*\alpha2< 0$, $Ni - Cg - Rg * \alpha2 + (E2 + Gg + R1 + R2 + (p1) * b * e < 0$, Parameter assignment meet the R1 = 78, E1 = 65, C1 = 76, α1= 0.5, α2 = 0.5, Rg = 98, p1 = 45, p2 = 58, R2 = 95, E2 = 74, C2 = 78, Gg = 105, Cg = 92, Eg = 98, Ni = 75, b = 0.5, e = 0.3, That is, when the benefits obtained by the agricultural product supplier in the introduction of blockchain technology are less than the costs, the benefits obtained by the e-commerce platform in the introduction of blockchain technology are more than the costs, and the government's benefits are less than the participation costs, the equilibrium point B (0,1,0) is the stable point of the system, and the corresponding strategy is (no introduction, introduction, no investment).

3.2 Equilibrium Point 1: D (1, 0, 0)

When $C1 - E1 + E1 * e < 0$, $E2 - C2 - p2 - E2 * e + e *p2 < 0$, $Ni - Cg - \alpha 1 + Rg * (E1 + Gg + R1 + R2 + p2) * b * e < 0$, Parameter assignment meet the R1 = 78, E1 = 75, C1 = 32, α 1 = 0.5, α 2 = 0.5, Rg = 92, p1 = 25, p2 = 58, R2 = 95, E2 = 74, C2 = 78, Gg = 105, Cg = 98, Eg = 98, Ni = 75, b = 0.5, e = 0.3, That is, when the benefits obtained by the agricultural product supplier in the introduction of blockchain technology are greater than the costs, the benefits obtained by the e-commerce platform in the introduction of blockchain technology are less than the costs, and the government's benefits are less than the participation costs, the equilibrium point D (1,0,0) is the stable point of the system, and the corresponding strategy is (introduction, no introduction, no investment).

3.3 Equilibrium Point 1: C (0,1,1)

When $E1 - C1 - p1 + E1 * b - E1* e + Rg*\alpha1+R1*b+e*p1-E1*b*e-R1*b*e < 0$, $C2-E2-E2*b+E2*e-Rg*\alpha2-R2*b+E2*b*e+R2*b*e<0$, $Cg-Ni+Rg*\alpha2+(-E2-Gg-R1-R2-p1)*b*e<0$, Parameter assignment meet the R1 = 78, E1 = 75, C1 = 32, α 1 = 0.5, α 2 = 0.5, Rg = 92, p1 = 25, p2 = 58, R2 = 95, E2 = 74, C2 = 78, Gg = 105, Cg = 98, Eg = 98, Ni = 75, b = 0.5, e = 0.3, That is, when the benefits obtained by the agricultural product supplier in the introduction of blockchain technology are less than the costs, the benefits obtained by the e-commerce platform in the introduction of blockchain technology are greater than the costs, and the government's benefits are greater than the participation costs, the equilibrium point C (0,1,1) is the stable point of the system, and the corresponding strategy is (no introduction, introduction, investment).

3.4 Equilibrium Point 1: E (1, 1, 1)

When $C1 - E1 + p1 - E1 * b + E1 * e - Rg*\alpha 1 - R1*- e * p1 + (E1 + R1) * b * e < 0$, $C2 - E2 + p2 - E2 * b + E2 * e - Rg*\alpha 2 - R2*b - e*p2 + (E2+R2)*b*e < 0$, $Cg - Ni - Eg*e + Rg*\alpha 1 + Rg*\alpha 2 + (-E1-E2-Eg-Gg-R1-R2)*b*e < 0$, Parameter assignment meet the $R1 = 78$, $E1 = 65$, $C1 = 76$, $\alpha 1 = 0.5$, $\alpha 2 = 0.5$, $Rg = 98$, $p1 = 45$, $p2 = 58$, $R2 = 95$, $E2 = 74$, $C2 = 78$, $Gg = 105$, $Cg = 78$, $Eg = 98$, $Ni = 75$, $b = 0.5$, $e = 0.3$, That is, when the benefits obtained by the agricultural product supplier in the introduction of blockchain technology are greater than the costs, the benefits obtained by the e-commerce platform in the introduction of blockchain technology are greater than the costs, and the government's benefits are greater than the participation costs, the equilibrium point E (1,1,1) is the stable point of the system, and the corresponding strategy is (introduction, introduction, investment).

4 NUMERICAL SIMULATION ANALYSIS

In order to verify the validity of the evolutionary stability analysis, the model is assigned numerical values according to the actual situation. $R1 = 78$, $E1 = 65$, $C1 = 76$, $\alpha 1 = 0.5$, $\alpha 2 = 0.5$, $Rg = 98$, $p1 = 45$, $p2 = 58$, $R2 = 95$, $E2 = 74$, $C2 = 78$, $Gg = 105$, $Cg = 78$, $Eg = 98$, $Ni = 75$, $b = 0.5$, $e = 0.3$, on the basis of an array of 1, The influence of E1, E2, Ni and Rg on the process and result of evolutionary game is analyzed.

4.1 Evolution Path of Stakeholders Under Different Values of E1

With other parameters unchanged, the additional benefit E1 for agricultural suppliers introducing blockchain technology is set to 25,45,65,85, and the simulation results are shown in the figure below. As can be seen from the figure, when $E1=25$, (no introduction, introduction, investment) is the evolutionarily stable strategy of the system. At this time, agricultural product suppliers will not introduce blockchain technology because of the small additional income from introducing blockchain technology, and the large continuous expenses and other costs after introducing blockchain technology. When $E1= 45,65,85$, (introduction, introduction, investment) is the only evolutionarily stable strategy for the system, and with the increase of additional benefits, the time required for the system to reach stability becomes significantly shorter, indicating that the introduction of blockchain technology increases its benefits and obtains more excess benefits, and the speed of cooperation among the three parties is accelerated, and finally agricultural product suppliers choose to introduce blockchain technology.

4.2 Evolution Paths of Stakeholders Under Different Values of E2

Under the condition that other parameters remain unchanged, E2 of the additional benefit of introducing blockchain technology to the e-commerce platform is set to 34,54,74,94, and the simulation results are shown in the figure below. As can be seen from the figure, when E2=34, (introduction, non-introduction, investment) is the evolutionarily stable strategy of the system. At this time, the e-commerce platform chooses not to introduce blockchain technology because of the small additional income from the introduction of blockchain technology and the large continuous expenses and other costs after the introduction of blockchain technology. When E1= 54,74,94, (introduction, introduction, investment) is the only evolutionarily stable strategy for the system, and with the increase of additional benefits, the time required for the system to reach stability becomes significantly shorter, indicating that the introduction of blockchain technology increases its benefits, obtains more excess benefits, accelerates the formation of cooperation among the three parties, and finally the e-commerce platform chooses to introduce blockchain technology.

4.3 Evolution Path of Stakeholders Under Different Ni values

With other parameters unchanged, the negative effect of government not investing in blockchain technology on government regulators is set to Ni= 35,55,75,95, and the simulation results are shown in the figure below. When Ni= 35,55, the negative effect caused by the government's non-investment in blockchain technology is not enough to offset the additional benefits brought by non-investment, so the government chooses not to invest because of the maximum benefit, at this time (no introduction, introduction, no investment) is the evolutionarily stable strategy of the system. When Ni= 75,95, the negative effects caused by the government not investing in blockchain technology gradually increase, indicating that at this time the government has large negative effects and small profits, and finally chooses to invest in blockchain technology, at this time the system has the only evolutionarily stable strategy (introduction, introduction, investment).

4.4 Evolution Path of Stakeholders Under Different Rg values

Under the condition that other parameters remain unchanged, when the government adopts a favorable strategy for both parties, part of the financial subsidy is set to Rg=68,98,128,158. The simulation results are shown in the figure below. As can be seen from the figure, when Rg=68,98, agricultural product suppliers and e-commerce platforms can get subsidies from the government to help them obtain higher economic benefits, and the willingness to participate is enhanced. The stability strategy is introduction, and the government's financial expenditure is within a certain range, and the stability strategy is investment. Investment is the only evolutionarily stable strategy of the system; With the increase of subsidy intensity, when Rg=128,158 and the government input cost exceeds a certain limit, the increase of subsidy intensity will lead to the increase of the government's financial expenditure, and the government's investment willingness will be reduced, thus reducing the probability of tripartite cooperation.

5 CONCLUSION

Based on the perspective of the introduction of blockchain technology, this paper discusses the strategy evolution process of agricultural product suppliers and e-commerce platforms under the active introduction of blockchain technology by the government, and conducts numerical simulation to analyze the influence of the strategy evolution of the three parties under different conditions, and focuses on the selection of blockchain technology and relevant parameters of government behavior on the introduction of blockchain technology. The results show that whether agricultural product suppliers and e-commerce platforms introduce blockchain technology is related to the additional benefits brought by blockchain technology; The natural advantages of blockchain technology, the reduction of the negative effects of the government, and the improvement of the indirect rate of return of the government can promote the development of the three parties in the game faster like the ideal equilibrium state. Whether the government's financial subsidies can make up for the financial expenditure of suppliers and platforms and their own interests is the key to their decision-making. The research results are conducive to promoting the government to actively invest in blockchain technology, and it is of great significance to promote the better application of blockchain technology in agricultural products and e-commerce platforms. However, there are also some shortcomings, such as not considering the impact of farmers and e-commerce platforms on green development, nor the impact of consumers' unreasonable behavior, which will be our next research direction.

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