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Research on Decision-Making Behavior of Social E-Commerce Marketing Subject

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Abstract: *As a new value-added online business model in the field of e-commerce, understanding consumer behaviour in the interactive social e-commerce environment provides new opportunities for businesses to develop marketing strategies to increase profits. Aiming at the bounded rational behaviour of participants in social e-commerce, an evolutionary game model is constructed, this paper analyses the behaviour interaction and strategy selection mechanism between merchant's choice of opinion leader, product recommendation and consumer's purchase decision by evolutionary game theory, and further discusses it with numerical simulation. The results show that the bigger or smaller the proportion of the transaction, the smaller the recommendation cost and the bigger the psychological effect of the consumer, the faster the players reach the equilibrium.*

Keywords: *Social E-commerce, Opinion Leader, Consumer Purchase Intention, Evolutionary Game*

1. Introduction

In the era of digital economy, social media has narrowed the distance between people and expanded the power of consumer dialogue in the market [1]. The use of social media and social network elements combined with the process of buying and selling products and services on online platforms has formed a new marketing method: social e-commerce [2]. As an emerging online marketing method, it has attracted widespread attention from e-commerce consumers due to its unique high interactivity.

Whether it is a celebrity, an internet celebrity or an anchor, through content promotion or live broadcast, it brings attention and sales to the corresponding products, and provides a valuable reference for the purchase of e-commerce consumers. However, in the context of social e-commerce becoming the new normal, its long-term marketing effect and life cycle are still the focus of discussion.

In recent years, social e-commerce has become an important branch of e-commerce research [2,3], and the influence of opinion leaders on the decision-making of actors has gradually become a key research issue in various fields. Ko et al. defined social e-commerce as business activities completed in a social media environment, where consumers can connect and interact with other people before and after purchase [4]. The latest research by Wang et al. believes that social e-commerce is a new retail model centered on customers [5].

At present, many researches involve different fields related to social commerce, including business model, social commerce structure, user behavior, trust in social commerce platform and so on [6]. Online consumers are more inclined to find various ways to learn from other consumers' experience to obtain more information, and then they choose to make effective purchasing decisions [7].

At the same time, merchants in e-commerce platforms realize that they can use social e-commerce to attract and motivate community members to share shopping experiences on social platforms [8]. Opinion leaders were first proposed by Lazarsfeld. He believes that opinion leaders provide information to others and influence their behavior, and they are a bridge between two levels of information dissemination [9]. Unlike traditional celebrity endorsement marketing methods, opinion leaders will interact with potential customers and share their product experience [10].

At present, there is a lack of research on the influence of opinion leaders on consumers in the context of social e-commerce, and there is no theoretical discussion on the prominent role of opinion leaders in product recommendation in social e-commerce. This article explores the related issues of the social e-commerce marketing game in which opinion leaders participate. That is, based on the existing

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social e-commerce research, the key influence object of the opinion leader is introduced as the main body of the game, and the evolutionary game theory is used to investigate social E-commerce marketing issues. Based on this perspective, a game model is constructed to analyze the dynamic system analysis and evolutionary stability strategy composed of three stakeholders of merchants, opinion leaders and consumers, and to put forward relevant countermeasures and suggestions in combination with numerical analysis.

2. Evolutionary Game Model

2.1. Model Aassumptions

The marketing process of social e-commerce is composed of multiple participants. In this paper, merchants, opinion leaders and consumers are considered as game participants in the process of social e-commerce. In order to study the evolutionary game model effectively, this paper proposes the following hypotheses:

Hypothesis 1: Merchants, opinion leaders and consumers are all bound and rational, and the purpose is to maximize their respective interests. Merchants have two strategic choices in the social e-commerce marketing process, support or not support opinion leaders to recommend products. The strategy of opinion leaders is to recommend or not recommend products. And the strategy of consumers is to buy or not buy.

Hypothesis 2: The probability of the merchant supporting the opinion leader is $x(0 \le x \le 1)$, the probability of not supporting is 1-*x*; the probability of the opinion leader choosing to recommend is $y(0 \le y \le 1)$, the probability of not recommending is 1-*y* ; the probability of consumers choose to buy is $z(0 \le z \le 1)$, the probability of choosing not to buy is 1-*z*.

Hypothesis 3: When the merchant supports the opinion leader strategy, it needs to pay the cost C_1. When the opinion leader chooses the recommendation strategy, the merchant will get additional benefits U_1 such as the increase in the number of store fans; when the merchant chooses the support strategy, the consumer purchases the product. In the case of whether there is an opinion leader recommendation, the merchant's income is R_1 and R_2 respectively. The opinion leader's recommendation of the product will receive the corresponding commission E and the sales revenue share ratio α; Under the recommendation of opinion leaders, the merchants earn R_3 and R_4 respectively.

When the opinion leaders are supported by the merchants to recommend the corresponding products, the consumer groups are more likely to engage in blind purchase behavior, which increases the sales volume of the products. Therefore, the revenue for the merchants is $R_1 > R_2$. Opinion leaders still recommend products without support from merchants. Due to the lack of incentives from merchants, the final income is $R_3 < R_2$. And we know $R_4 < R_3$.

Hypothesis 4: The opinion leader chooses the "recommend" strategy to pay the cost C_2; the merchant supports the opinion leader, and the opinion leader recommends additional benefits U_2, such as increased status and influence. On the contrary, if the "not recommended" strategy is selected, U_2 will be lost; the opinion leader makes product recommendation and Consumers will get extra attention *S* when they buy, on the contrary not recommend but consumers will lose the corresponding attention *S* when purchasing goods.

Hypothesis 5: When merchants choose support, consumers' purchase costs are r_1 and r_2 respectively when opinion leaders recommend and do not recommend. When opinion leaders recommend, merchants will offer additional price discounts. Thus $r_1 < r_2$. When merchants do not support consumers, the purchase cost is r_3; The time cost C_3 when consumers are recommended by opinion leaders, and the perceived value benefits U_3 based on psychological utility, such as the recognition that consumers will get when choosing purchasing strategies.

2.2. The Income Matrix of the Tripartite Game

Based on the above assumptions, the return matrix of the tripartite game among merchants, opinion leaders and consumers are constructed, as shown in Table 1.

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Table 1: Profit matrix for merchants, opinion leaders, and consumers.

Game participant		Consumers: Buy z opinion leaders — Recommend y	Consumers: Buy z opinion leaders — Not recommend $1-y$	Consumers: Not buy $1-z$ opinion leaders — Recommend y	Consumers: Not buy $1-z$ opinion leaders — Not recommend $1-y$
Merchants	support x	$(1-\alpha)R_1+U_1-E-C_1$	R_2-C_1	U_1-E-C_1	$-C_1$
		$\alpha R_1+U_2+E+S-C_2$	$-U_2-S$	U_2+E-C_2	$-U_2$
		$U_3-r_1-C_3$	$-r_2$	$-C_3$	0
	Not support $1-x$	R_3+U_1	R_4	U_1	0
		$S-C_2$	$-S$	$-C_2$	0
		$U_3-r_3-C_3$	$-r_3$	$-C_3$	0

3. Construction Model Analysis

3.1. Evolutionary Stability Strategy Analysis

Assuming that the expected revenue of a merchant who chooses to support opinion leaders for marketing strategies is E_x, the expected revenue of choosing the no support strategy is E_{1-x}, and the average expected revenue of merchants is E_1, then the replication dynamic equation of the merchant is:

$$F(x)=\frac{dx}{dt}=x(E_x-E_1)=x(1-x)\left[z\left[y(1-\alpha)R_1-yR_3+(1-y)(R_2-R_4)\right]-yE-C_1\right] \quad (1)$$

By solving the replication dynamic equation and based on the stability theory, it can be known that for the merchant's strategy x, the strategy is in a stable state if and only if $f(x)=0$ and $F'(x)<0$ are both true.

Similarly, the dynamic replication equations of opinion leaders and consumers can be obtained as follows:

$$F(y)=\frac{dy}{dt}=y(E_y-E_2)=y(1-y)\left[x(z\alpha R_1+2U_2+E)+2zS-C_2\right] \quad (2)$$

$$F(z)=\frac{dz}{dt}=z(E_z-E_3)=z(1-z)\left[y(-r_1+r_2+U_3)+x(-r_2+r_3)-r_3\right] \quad (3)$$

3.2. Evolutionary Game Equilibrium Analysis

A three-dimensional dynamic system consisting of a copy of dynamic equations selected by businessmen, opinion leaders and consumers, is solved to obtain equilibrium points: $E_1(0,0,0), E_2(1,0,0), E_3(0,1,0), E_4(0,0,1), E_5(1,0,1), E_6(1,1,0), E_7(0,1,1), E_8(1,1,1)$ and $E_9(x^*,y^*,z^*)$, which represent a set of possible strategic solutions. Where $E_9(x^*,y^*,z^*)$ represents a set of possible strategy solutions.

Because only the pure strategic equilibrium point in the evolutionary game can become the stable equilibrium point of the system, only the asymptotic stability of the first eight pure strategic equilibrium points is discussed. Take the partial derivatives of $F(x)$, $F(y)$ and $F(z)$, with respect to x, y and z, construct the Jacobian matrix, and obtain the eigenvalues of the above eight equilibrium points as shown in Table 2.

Table 2: Eigenvalue of equilibrium point.

Equilibrium point	Eigenvalues
$E_1(0,0,0)$	$\lambda_1=-C_1<0$, $\lambda_2=-C_2<0$, $\lambda_3=-r_3<0$
$E_2(1,0,0)$	$\lambda_1=C_1>0$, $\lambda_2=2U_2+E-C_2$, $\lambda_3=-r_2<0$

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E_3	$0,1,0$	$\lambda_1 = -E - C_1 < 0$, $\lambda_2 = C_2 > 0$, $\lambda_3 = U_3 - r_3$
E_4	$0,0,1$	$\lambda_1 = R_2 - R_4 - C_1$, $\lambda_2 = 2S - C_2$, $\lambda_3 = r_3 > 0$
E_5	$1,0,1$	$\lambda_1 = -R_2 + R_4 + C_1$, $\lambda_2 = \alpha R_1 + 2U_2 + E + 2S - C_2$, $\lambda_3 = r_2 > 0$
E_6	$1,1,0$	$\lambda_1 = E + C_1 > 0$, $\lambda_2 = -2U_2 - E + C_2$, $\lambda_3 = U_3 - r_1$
E_7	$0,1,1$	$\lambda_1 = (1-\alpha) R_1 - R_3 - E - C_1$, $\lambda_2 = -2S + C_2$, $\lambda_3 = -U_3 + r_3$
E_8	$1,1,1$	$\lambda_1 = -(1-\alpha) R_1 + R_3 + E + C_1$, $\lambda_2 = -\alpha R_1 - 2U_2 - E - 2S + C_2$, $\lambda_3 = -U_3 + r_1$

The necessary and sufficient condition for the equilibrium points of the system to be a progressively stable point is that all its corresponding eigenvalues must be negative. The results in Table 2 show that, and may become evolutionary stable points.

Since this article mainly studies the evolution mechanism of the main decision-making behavior strategy of social e-commerce marketing, and mainly explores the influence of opinion leaders' product recommendation and consumers' purchase decision-making, only the numerical analysis of the evolution and stability of the two points is carried out.

4. Numerical Analysis of Evolutionary Stable Points

The initial parameters are respectively set as : $\alpha = 10\%/30\%$, $C_1 = 2$, $C_2 = 3$, $C_3 = 1$, $U_1 = 5$, $U_2 = 5$, $U_3 = 10$, $R_1 = 40$, $R_2 = 30$, $R_3 = 20$, $R_4 = 10$, $E = 10$, $S = 2$, $R_r = 4$, $R_R = 3$, $R_r^{'} = 2$, $R_R^{'} = 1$.

4.1. *Numerical Analysis of the Evolution Path when the Parameter Value Changes*

4.1.1. Change the Evolutionary Path of α Value Merchants' Decision-Making Behaviour

Keep other parameter values unchanged, set the sales share ratio α to 10%, 15%, 20%, 25% and 30%, and the evolution path of the business decision-making behavior is shown in Figure 1.

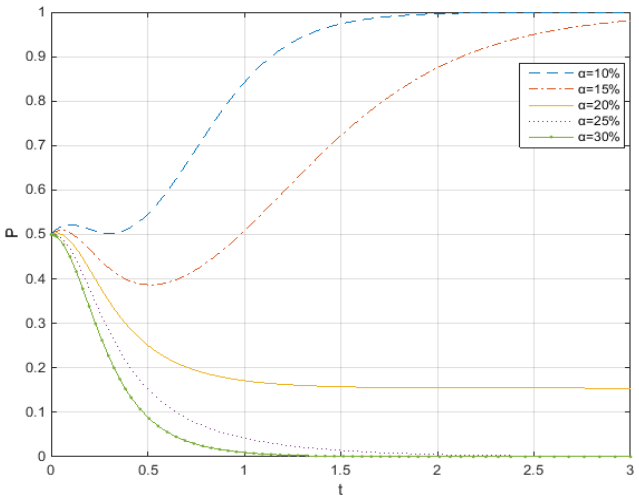

Figure 1: Change the evolutionary path of α value merchants' decision-making behavior.

From the results in Figure 1, it can be concluded that when α=20%, the merchant's strategy selection probability neither tends to 0 nor tends to 1, which means that it cannot converge to an equilibrium state at this time; when α<20%, The selection probability of merchants choosing "support" opinion leader strategy tends to 1, when the value of α is smaller, the speed tends to be faster; when α>20%, the evolution path of merchants choosing "no support" tends to 0, when the value of α is larger.

The faster the evolution path tends to be, the shorter the time it will take to reach equilibrium. This

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shows that for merchants in social e-commerce, if they need to support opinion leaders to carry out recommendation marketing to attract consumers to buy, they can consider increasing the sales share of opinion leaders to achieve a win-win situation.

4.1.2. Change the Evolutionary Path of C_2 Value Opinion Leaders' Decision-Making Behaviour

Take α=10% as an example. When other parameter values remain unchanged, set the C_2 value of the opinion leader to choose the "recommend" strategy to pay: 2, 3, 4, 5 and 6, to get the evolution of the opinion leader's decision-making behaviour. The path is shown in Figure 2.

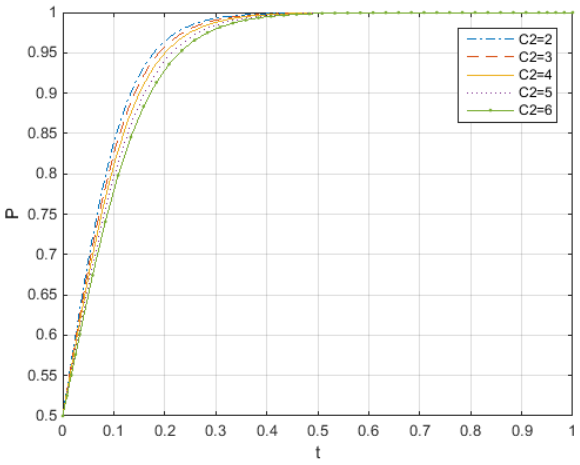

Figure 2: Change the evolutionary path of C_2 value opinion leaders' decision-making behavior.

When C_2 = 2, the evolution path of the opinion leader choosing the "recommendation" strategy tends to the fastest speed. With the increase of the value of C_2, the trend speed gradually slows down, and eventually all can reach equilibrium. This shows that for opinion leaders, product recommendation is to attract more consumers. The cost of opinion leaders' display of products as much as possible, formulation of plans and selection of appropriate platforms for marketing are all included in the cost of opinion leaders' recommendation, so only When the cost of time and manpower spent in the recommendation process is controlled within a certain range, more benefits can be obtained.

4.1.3. Change the Evolutionary Path of U_3 Value Consumers' Decision-Making Behaviour

Take α=10% as an example, and when other parameter values remain unchanged, set the value of the perceived value benefit *U3* obtained by consumers to purchase goods as: 6,7, 8, 9 and 10, the evolution path of consumer decision-making behaviour is shown in Figure 3.

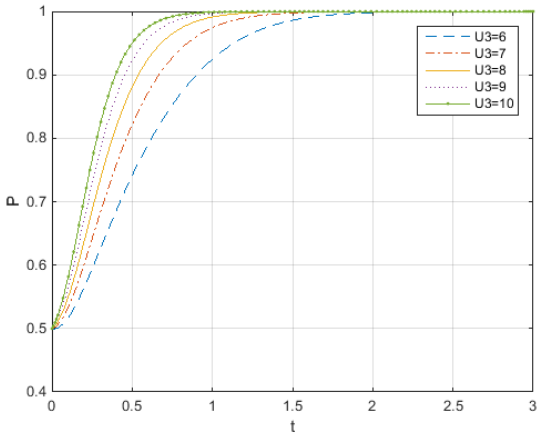

Figure 3: Change the evolutionary path of U_3 value consumers' decision-making behavior.

It can be seen from Figure 3 that the evolutionary path of consumers choosing a "buy" strategy tends to be the slowest at time. As U_3 increases, the adjustment speed of consumer decision-making gradually accelerates. When the psychological effect obtained by consumers increases to a certain extent, for example, the adjustment path at 9 and 10 tends to be the same, which shows that the

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contribution of the psychological effect of the opinion leader's recommendation to the consumer's purchase decision is gradually reduced, showing a marginal utility Law of decline.

When consumers' psychological expectations for products recommended by opinion leaders gradually increase, simple product recommendations may not arouse consumers' strong desire to buy. Therefore, merchants should choose opinion leaders that are consistent with their product positioning to recommend products, cover a wider group of consumers, and promote products more effectively to increase sales.

4.2. Numerical Analysis of Evolution Path when Changing Initial Value

Under the circumstance that the values of other parameters remain unchanged, suppose that the initial probability value of the decision-making behavior strategy of the subject of the three-party game is $x_0 = y_0 = z_0$, and the step length is set to 0.05 within the value range (0,1), and the three-dimensional evolution path is obtained as shown in Figure 4. (α = 10%) and Figure 5 (α = 30%).

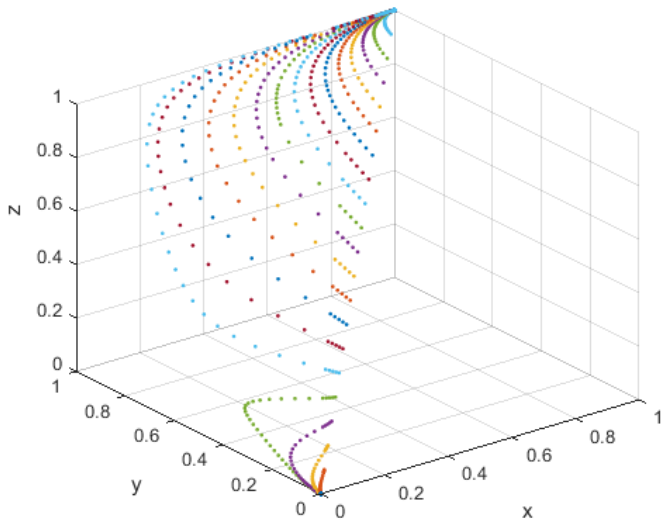

Figure 4: Change the initial value when α=10%.

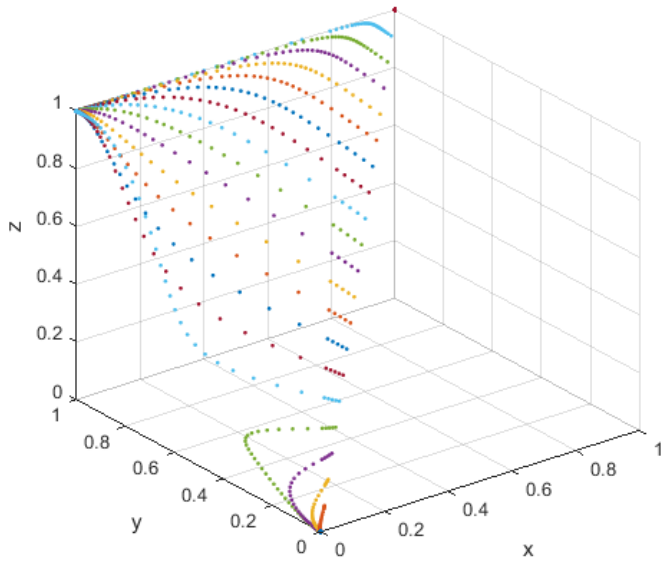

Figure 5: Change the initial value when α=30%.

The initial probability value shown in the evolution path in Figure 4 increases sequentially from

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bottom to top. As the probability value increases, the adjustment time for merchants to choose support, opinion leaders to choose recommend strategy, and consumers to choose buy strategy is shorter, the end of the evolution path will reach a stable point. The initial probability value shown in the evolution path in Figure 5 increases from bottom to top. It can be seen that with the increase of the probability value, the greater the initial probability x_0, the longer the time required for the merchant to adjust the no support strategy increases, and the initial value The greater the y_0 and z_0, the faster the adjustment speed of opinion leaders' choice of recommendation and consumers' choice of purchase strategy, and the evolutionary path will eventually stabilize at a point.

5. Conclusions

Opinion leader recommendation marketing is universal in current social e-commerce marketing activities, and product recommendation through opinion leaders is one of the main promotion methods for businesses in social e-commerce. This article constructs a tripartite decision-making behavior evolutionary game model of merchants, opinion leaders, and consumers in the social e-commerce marketing environment, and analyzes the decision-making behavior strategy selection mechanism of game players.

Specifically, the conclusions drawn in this article are as follows:

First, for merchants in social e-commerce, if opinion leaders are supported to carry out product recommendations for marketing, they need to appropriately increase the sales share ratio of opinion leaders to achieve a win-win situation.

Second, when opinion leaders make product recommendations, they need to control the time and manpower and other costs within a certain range in order to obtain more benefits.

Third, when consumers' psychological expectations for products recommended by opinion leaders gradually increase, simple product recommendations may not be able to arouse consumers' strong desire to buy and thus produce purchase behavior.

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