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STUDY ON SUBSIDY STRATEGY OF E-COMMERCE CONSUMERS CHOOSING GREEN PACKAGING FROM THE PERSPECTIVE OF SOCIAL NETWORK

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Abstract. *Under the environment of electronic commerce, the use of express packaging is increasing, which not only pollutes the environment but also causes waste of resources. From the rational perspective of people, consumers do not have the motivation to choose green packaging, unless the government subsidizes consumers' choice of green packaging, or consumers choose green packaging taking non-economic factors into account such as social networks. To solve this problem, scholars usually use statistical methods to study the social influencing factors of consumers' choice of green packaging from a macro perspective, and few scholars reveal the formation mechanism behind these behaviors. This paper describes the formation mechanism of consumers' choice of green packaging behavior from the perspective of micro individual behavior choice. Therefore, based on the Hotelling model, this paper constructs the behavior model of consumer's choosing green packaging under the government subsidies considering social networks, and constructs a multi-agent simulation model to simulate the government subsidy quota, subsidy mode and the choice of subsidy withdrawal time. The results show that government subsidies play a major role in the choice of green packaging, and social network effect plays a secondary role; when the subsidy quota is insufficient, the key groups should be subsidized to make full use of the network effect, and Generalized System of Preference subsidy (short for GSP subsidy) should be adopted when the subsidy quota is sufficient: If the government subsidy wants to withdraw, it must improve the start-up coefficient of social network, which is the occurrence mechanism of green packaging choice behavior based on social network effect.*

Keywords: Social network, E-commerce consumers, Green packaging, Subsidy strategy

1. **Introduction.** Logistics is the basis of the development of e-commerce, the coordinated development of the two has been widely concerned by scholars [1,2]. With the development of e-commerce, express delivery industry is developing rapidly. According to relevant reports, the volume of express delivery in 2017 reached 40.06 billion pieces, consuming 19.2 billion packing boxes, 5.8 billion woven bags, 15 billion plastic bags and 30 billion meters of tape [3,4]. Express packaging has caused serious pollution to the environment. Promoting green packaging in express delivery industry is the fundamental way to control express pollution. On March 2nd, 2018, the State Council promulgated The Provisional Regulations on Express Delivery to encourage enterprises and senders to use "degradable and reusable environmental protection packaging materials". And in recent years, many famous e-commerce enterprises have been promoting the green express packaging. For example, Jingdong started to promote the "Clear Flow Plan" from 2017, Ali Group launched the "Green Logistics 2020 Plan", and Suning put forward the "Shared

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Express Box Plan". All these e-commerce enterprises' efforts are to make express packaging green, reduced, degradable, but the key role of e-commerce consumers in the process of greening express packaging cannot be ignored. This is because on the one hand, the cost of green express packaging needs consumers to bear part of the cost, such as buying books in Dangdang, choosing green packaging will charge a small amount of express fees; on the other hand, express packaging green will affect convenience to some extent, for example, packaging recycling takes consumers' time. Scholars' research shows that subsidies to consumers' green consumption behavior can effectively promote consumers' green purchase behavior [5-7]. While how to carry out the subsidies, the intensity of the subsidies, the withdrawal time of the subsidy and the relationship between these factors and the effect of subsidies are the key links in the study of subsidy strategies. At the same time, the purchase behavior of e-commerce consumers has a strong socialized attribute, and has been widely concerned by scholars [8,9]. Therefore, this paper will study how the subsidy mode, subsidy intensity, exit time, etc., affect the behavior of e-commerce consumers to choose green packaging from the perspective of the influence of social network on consumers.

The study of packaging and consumer behavior mainly focuses on how the characteristics of product packaging affect consumer's consumption decisions, for example, Farooq et al. suggested that design, graphics color and material have significant positive association with purchase intention [10]; Orquin et al. found that the visual ecology of product packaging is a strong driver of consumer attention independently of consumer goals [11]. Few scholars study the decision-making of consumers using green packaging. Wang et al. used evolutionary game theory to analyze the consumers' choice about environmental packaging in Take-Away Platform [12]. A similar research to this problem is aimed at consumer green purchase intention and purchase behavior. Zhao et al. thought that consumer price sensitivity and environmental awareness are the key factors affecting consumers' green purchase, but "friend influence" can significantly increase the market share of green goods [13]. Qi and Ploeger studied the Chinese consumers' intentions towards purchasing green food using the theory of planned behavior [14]. do Paço et al. proposed a new model to explain the relationship between green attitudes and individual behaviors based on prosocial theory [15]. Based on the theory of consumption values, consumption behaviors are a function of multiple factors, including quality, emotions, environmental impact, etc. [16]. Therefore, consumer's green purchase behavior is the rational choice behavior of consumers after comprehensive evaluation of product's green attributes, product functions and prices. For green packaging, when the packaging function is the same, the choice of green packaging would cost the consumers in economy and convenience, but it is beneficial to the natural environment and the whole society, and has a certain externality. Consumers have to balance costs and benefits of choosing green packaging [17]. Therefore, consumers' choosing of green packaging is an irrational and socialized behavior. Therefore, it is a suitable entry point to study the green packaging choice behavior of e-commerce consumers from the perspective of social network and government subsidies.

Consumers generally need to choose one of green packaging and non-green packaging. For this kind of choice behavior, the Hotelling model has a strong explaining power [18,19]. Hotelling traditional model belongs to mesoscopic model, which is used to describe the competition between enterprises, and the traditional model has strong certainty. As a result, this paper will introduce time-varying uncertain network effect factors into the Hotelling model to study the choice behavior of consumers at the micro level. However, this paper attempts to analyze the influence of subsidy strategy on consumers' overall green packaging choice behavior from the macro level. And the Agent-Based Model (ABM) provides the modeling philosophy from bottom to top which is a suitable research

tool in this paper. According to this, the overall research framework of this paper is that based on the Hotelling model, considering the impact of consumer's social network build a multi-agent simulation model, analyzing the impact of subsidy strategy on the green packaging choice behavior of e-commerce consumers, accordingly to provide the countermeasures and the suggestions for the related decision makers. Firstly, the traditional Hotelling spatial competition model is used to analyze the consumer's choice behavior under the condition of uncertainty, and secondly, under the condition of social network influence, the influence of subsidy policy on consumer's green packaging choice behavior is analyzed by constructing bottom-up multi-agent simulation model.

The structure of this paper is as follows: the first part is introduction, the second part is Hotelling model construction, the third part is multi-agent simulation model's construction and simulation, the fourth part is analysis of simulation results and suggestions, and the fifth part is conclusion.

2. The Hotelling Model of Consumers of E-Commerce Choosing Green Packaging Considering Social Networks and Government Subsidies.

2.1. **Model building.** Assume that consumers have different green preferences, uniformly distributed in linear space $[0, 1]$. Green Packaging (GP) and Traditional Packaging (TP), as two alternatives, are located in linear space: green packing at position 0, and traditional packaging at position 1. Meanwhile, assuming according to consumers' green preferences, the location of a certain consumer is x. $x - 0$ indicates the consumer's preferences and the degree of mismatch of green packaging in Hotelling models. In the same way, $1 - x$ indicates the consumer's preferences and the degree of mismatch of traditional packaging. In addition, let us say the e-commerce companies fix a price P_G for green packaging, and P_T for traditional packaging. The unit cost of green packaging is C_G. The unit cost of traditional packaging is C_T. In this case, the prices of the two packages fixed by e-commerce companies would affect the consumers' green preferences, which then affects the probability of the consumers choosing different packages, and further would affect the profits of the e-commerce enterprises. Hence this is a typical Bertrand competition model. The framework of the model can be illustrated by Figure 1.

FIGURE 1. The framework of Hotelling model

In Figure 1, if x is the Nash equilibrium of the Bertrand game, the consumers located in the preference space $[0, x]$ will choose the green packaging, and the consumers located in the space $[x, 1]$ will choose the traditional packaging. Based on the above assumptions, we can build the following game model.

First of all, the utility function of the consumers choosing green packaging at location x is

$$U_G = v_G - tx - P_G + \delta$$

Among them, v_G is one part of the two parts combined of the traditional logistics value which is the intact value of the goods shipped from the merchant to the consumer, which is equal to the reserved value v_T of the traditional packaging. The other part is the value $\bar{v}_N$ brought by the social attributes of consumers. Its size is related to the social network where consumers are. In the social network, the state of consumers' neighbors is time-varying and uncertain from the perspective of enterprise decision-making. Therefore, here

is the evaluation value of consumers' social attributes of the e-commerce enterprises, which is $v_G = v_T + \alpha\bar{v}_N$, where α is the start-up coefficient of social network effect. The larger the startup coefficient is, the more significant the influence of social network would be. δ represents status of the government subsidies for consumers to choose green packaging. t represents the resistance coefficient of consumers' choice of green packaging. The larger the value is, the greater the resistance would be, and the smaller the value is, the more convenient it would be.

Secondly, the utility function of the consumer at the location x choosing traditional packaging is

$$U_T = v_T - t(1-x) - P_T$$

Among them, v_T represents the reserve value of choosing traditional packaging, which is the intact value of the goods shipped from the merchant to the consumer.

2.2. **The Nash equilibrium of Bertrand game.** The typical solution of Bertrand game Nash equilibrium is a reverse solution, which is firstly to solve the non-differential points of consumer selecting GP and TP, and then solve the pricing of GP and TP, so as to find the Nash equilibrium.

Firstly, assuming that the consumer is located at x whose choice of GP and TP is not different, then

$$v_G - tx - P_G + \delta = v_T - t(1-x) - P_T$$

Put $v_G = v_T + \alpha\bar{v}_N$ in the upper formula and get

$$x^* = \frac{1}{2} + \frac{\alpha\bar{v}_N - (P_G - P_T - \delta)}{2t}$$

x^* is the ratio of consumers who choose green packaging, and $1 - x^*$ is the ratio of consumers who choose traditional packaging.

Secondly, maximize the profit of e-commerce enterprises, and get the price P_G and P_T.

The profits of enterprises in green packaging business are

$$\pi_G = (P_G - C_G) \cdot x^* = (P_G - C_G) \cdot \left[\frac{1}{2} + \frac{\alpha\bar{v}_N - (P_G - P_T - \delta)}{2t}\right]$$

The profits of enterprises in traditional packaging business are

$$\pi_T = (P_T - C_T) \cdot (1 - x^*) = (P_T - C_T) \cdot \left[\frac{1}{2} - \frac{\alpha\bar{v}_N - (P_G - P_T - \delta)}{2t}\right]$$

Total profits of the enterprise are

$$\Pi = \pi_G + \pi_T$$

Consider the actual situation of e-commerce enterprises. At present, most commodity package postage is not charging consumers packaging fees, so $P_T = 0$, and at the same time internalizing the cost C_T in the commodity price which is $C_T = 0$, and then $\pi_T = 0$. E-commerce enterprises do not make profits in traditional packaging business. Therefore, the final decision of e-commerce enterprises is to choose a price P_G, so that the use of green packaging enterprises is in the best state:

$$\pi'_G = 0$$

So $P_G = \frac{t + \alpha\bar{v}_N + \delta + C_G}{2}$. So the Nash equilibrium is

$$x^* = \frac{1 + \alpha\bar{v}_N + \delta - C_G}{4}$$

Put $P_G = \frac{t+\alpha\bar{v}_N+\delta+C_G}{2}$ and $x^* = \frac{1+\alpha\bar{v}_N+\delta-C_G}{4}$ in U_T and U_G:

$$U_G = -tx + \frac{2v_t + \alpha\bar{v}_N - t + \delta - C_G}{2} \tag{1}$$

$$U_T = tx + v_t - t \tag{2}$$

Formula (1) and Formula (2) are the utility functions of consumers when the Nash equilibrium is reached.

2.3. **Analysis of consumer green packaging choice behavior.** Because the social network effect v_N of consumers is time-varying, while e-commerce enterprises use evaluation values $\bar{v}_N$ to calculate Nash equilibrium, from the perspective of e-commerce enterprises, when consumers are in the interval $[0, x^*]$, consumers will choose green packaging, while consumers will choose traditional packaging when they are located in $[x^*, 1]$. However, because the network effect of consumers is different at different times, the consumers in $[0, x^*]$ may not choose green packaging because of the influence of social network effect, and the consumers in $[x^*, 1]$ in the same way may also choose green packaging. See Figure 2 for details. Assuming that there are four consumers in x_1, x_2, x_3 and x_4, the green preference and social network effect of the consumers in these four positions are replaced by Formulae (1) and (2) respectively. Eight coordinate points are formed in Figure 2, which are divided into four pairs: (a, b), (c, d), (e, f) and (g, h). Although $x_1 \in [0, x^*]$, the height of a is higher than the height of b, so the consumer will choose traditional packaging rather than green packaging; similarly, the consumer at x_2 will choose green packaging, the consumer at x_3 will choose green packaging, and the consumer at x_4 will choose traditional packaging.

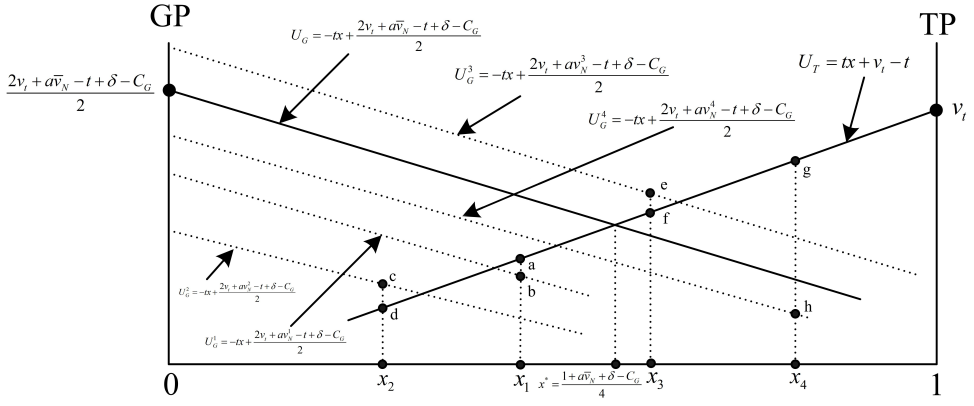

FIGURE 2. Analysis of consumer green packaging choice behavior

According to the above, whether consumers choose green packaging is not only related to consumers' green preference, but also to consumers' social network effect. Therefore, this paper will construct a multi-agent simulation model based on consumers' green packaging choice behavior, which is used to analyze how the government should subsidize, how much should be subsidized and when the subsidy should be withdrawn.

3. **Construction and Simulation of Multi-Agent Simulation Model.** Based on the multi-agent simulation model, the decision individuals in the complex system can be mapped to Agent, whose characteristics and behavior rules are mapped to the attributes and methods of the agents, taking advantage of the autonomy, reasoning of the Agent, together with the interaction and coordination among the Agents, to promote the evolution of the model and discover the macro behavior of the system [20].

The simulation steps of this paper are as follows.

Step 1, generate a consumer group with a specific network structure with amount N of nodes. In this paper, the social network effect is considered, while the small world network can describe the social network well, so this paper chooses to generate a small world network with amount N of nodes to represent the social relationship among consumers.

Step 2, embed an intelligent agent for each node and configure the attributes of the model and intelligent agent. The properties of the model and agent include the total number of consumers (Number_of_Agent), the structure of social network (Social_network), green packaging unit cost (Cost_of_Green Packing), consumer evaluation value of the social network effect (v_bar_net), consumers' social network effect coefficient α, subsidies quota (delta), resistance coefficient (t) of consumers choosing the green packaging, traditional packaging reserve value (v_t), whether consumers would choose green packaging (GP_T-1) at the time of T-1, whether consumers select the green packaging (GP_T-2) at the time of T-2, and whether consumers select the green packaging (GP_T-3) at the time of T-3.

Step 3, according to Formula (1) and Formula (2), the attribute value of each agent, and the social network relationship between each agent, calculate U_G^i and U_T^i, $(i \in N)$, where at i of the time T, calculation formula of the social network effect of the consumer is $v_N^i = \frac{\sum_{j \in M} \frac{1}{3}\left(GP_{T-1}^j + GP_{T-2}^j + GP_{T-3}^j\right)}{\#M}$, in which, M represents the set of consumers i of all neighbor nodes of the consumer and $\#M$ represents the number of individuals contained in the set. If $U_G^i > U_T^i$, then the ith consumer chooses green packaging, if $U_G^i < U_T^i$, then the ith consumer chooses traditional packaging, if $U_G^i = U_T^i$, then the ith consumer chooses traditional packaging with the probability $\frac{1}{2}$, and chooses green packaging with probability $\frac{1}{2}$. Update the attribute value of each agent.

Step 4, determine the condition of termination: whether to reach the limit of the number of iterations. If true, then go to Step 5, otherwise return to Step 3.

Step 5, record the data and terminate the simulation program.

4. **Analysis of Simulation Results and Suggestions.**

4.1. **Simulation process.**

This paper uses Python language to write the whole simulation program, and the main use of third-party libraries include Mesa, pandas, Networkx and so on.

First of all, the network structure of the social network used to generate this paper contains 1000 nodes. Each node is placed with an Agent, representing a consumer. The network topology and degree distribution are shown in Figures 3 and 4. The average shortest path of the small world social network is 6.078 and the clustering coefficient is

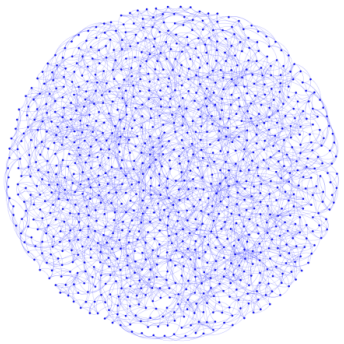

FIGURE 3. Topology structure of the social network used in this paper

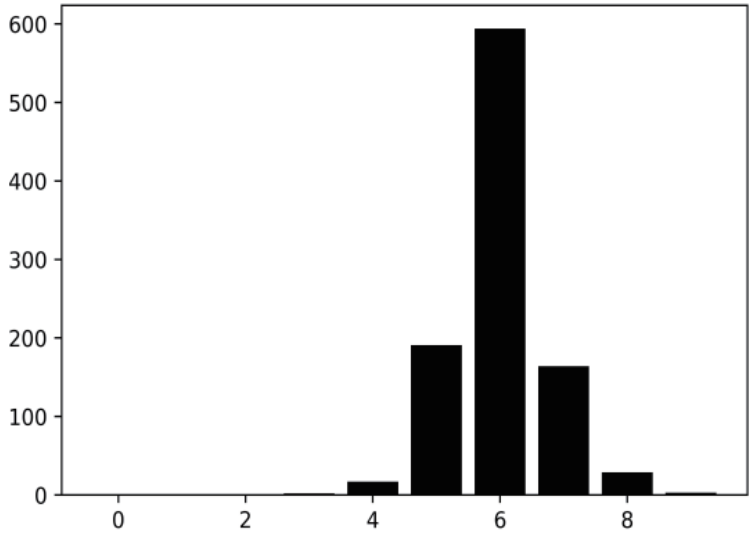

FIGURE 4. Degree distribution of social networks used in this paper

TABLE 1. Configuration of model and attribute values for each agent

Number	Name	Variable name	Value
1	Total number of consumers	Number_of_Agent	1000
2	Structure of social networks	Social_network	1000×1000
3	Unit cost of green packaging	Cost_of_Green Packing	1.5
4	Evaluation value of consumer social network effect	v_bar_net	0.5
5	Consumer subsidy quota	delta	$[0, 4]$
6	Resistance coefficient for consumers to choose green packaging	t	1
7	Reserve value of traditional packaging	v_t	5
8	Whether consumers choose green packaging or not at time of T-1	GP_T-1	0 or 1
9	Whether consumers choose green packaging or not at time of T-2	GP_T-2	0 or 1
10	Whether consumers choose green packaging or not at time of T-3	GP_T-3	0 or 1
11	Conditions of termination	STOP	10

0.449. The consumers of each node are affected by the consumer behavior of the neighbor nodes.

Secondly, we configure the attribute value of each agent. In order to calculate simply without affecting the conclusion of the analysis, we take the figures as follows: $C_G = 1.5$, $\bar{v}_N = 0.5$, $\alpha = 5$, because of $x^* \in [0, 1]$, $\delta \in [0, 4]$, and assume $t = 1$. The initialization configuration for all parameters is shown in Table 1.

4.2. **Analysis of simulation results.**

First, the policy effect simulation analysis of government subsidies intensity.

With the other attributes kept unchanged, let the subsidy quota for each period of a single consumer be $[0, 1, 2, 3, 4]$, which means the total subsidy quota for each period is 0, 1000, 2000, 3000 and 4000 respectively. The simulation results are shown in Figure 5.

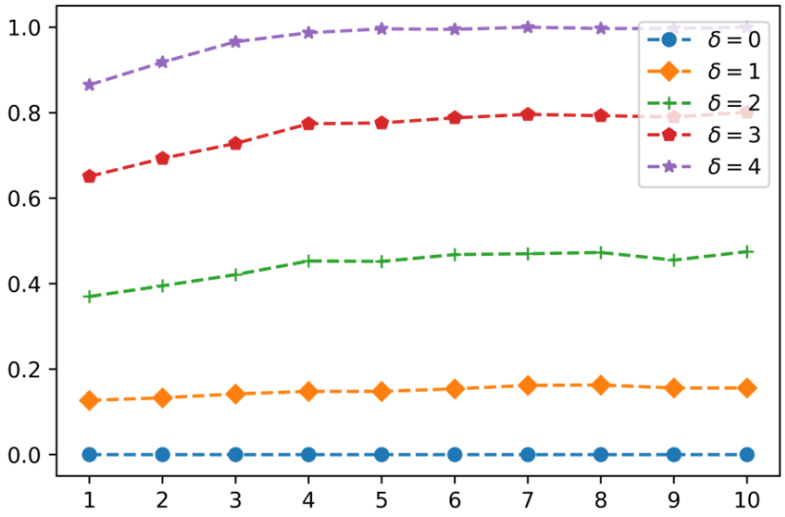

FIGURE 5. Proportion of consumers choosing green packaging under different subsidy levels

It can be seen from Figure 5 that government subsidies play a major role in the choice of green packaging and social network effects play a secondary role. With the increase of subsidy quota, the proportion of consumers choosing green packaging in each period has been greatly increased; after government subsidies, with the advance of time, the effect of social network effect gradually appears, under the same subsidy quota, the proportion of consumers choosing green packaging further increased.

Secondly, the policy effect simulation analysis of government subsidies mode.

There are two kinds of subsidies designed in this paper: GSP (Generalized System of Preference) subsidies and key groups subsidies. GSP subsidy refers to the subsidy of green packaging consumption for all consumers, and the subsidy of key groups refers to the subsidy of individuals with great network influence in the whole social network. In order to compare the effect of subsidy policy, this paper assumes that the total quota of subsidy Δ is equal in each period under different subsidy modes. Δ is equal to 1000, 2000, 3000, 4000 respectively. The number of subsidized people is N_s, N_s is a subset of N, which means all consumers in the social network whose degree is greater than a certain value, and then the amount of subsidy received by everyone is $\delta = \frac{\Delta}{N_s}$. According to the social network initialized in this paper, the number of consumers with different degrees is shown in Figure 4 and Table 2.

During the simulation, this paper takes Δ as 1000, 2000, 3000 and 4000 respectively, corresponding to the total government subsidies under GSP subsidy mode when δ is equal to 1, 2, 3 and 4 respectively. If you choose to subsidize consumers with degrees greater

TABLE 2. Distribution table of consumer social network degree

Serial number	Degree (D)	Number of consumers (N_s)
1	3	2
2	4	17
3	5	191
4	6	594
5	7	164
6	8	29
7	9	3

than 3, then the scheme is exactly the same as the GSP subsidy scheme. In turn, this paper respectively would take the simulation experiments of government subsidies are carried out for consumers with degrees greater than 9, degrees greater than 8, degrees greater than 7, degrees greater than 6, degrees greater than 5 and degrees greater than 4. When the consumer subsidy groups are different, then the amount of subsidies that individual consumer receives varies. For example, if consumers are subsidized with a degree greater than 7, then the total number of people requiring subsidies is 196. If the total subsidy is 4000, then 20.41 is for each person. At this point, the amount of subsidies per person far exceeds the upper limit of 4 when the model has an equilibrium solution. The model has no internal solution, but there is a boundary solution, which is, in reality, the government can offer enough subsidies, so that all consumers would choose green packaging. The simulation results are shown in Figures 6-9.

As can be seen from Figures 6-9, firstly, when the total scale of subsidy is small, the way of selecting key groups subsidy is better than GSP, but when the scale of subsidy is larger, the way of GSP subsidy is better than that of key groups subsidy. Specifically, at the time when $\Delta = 1000$, subsidies to consumers of $D \geq 7$ could achieve the best

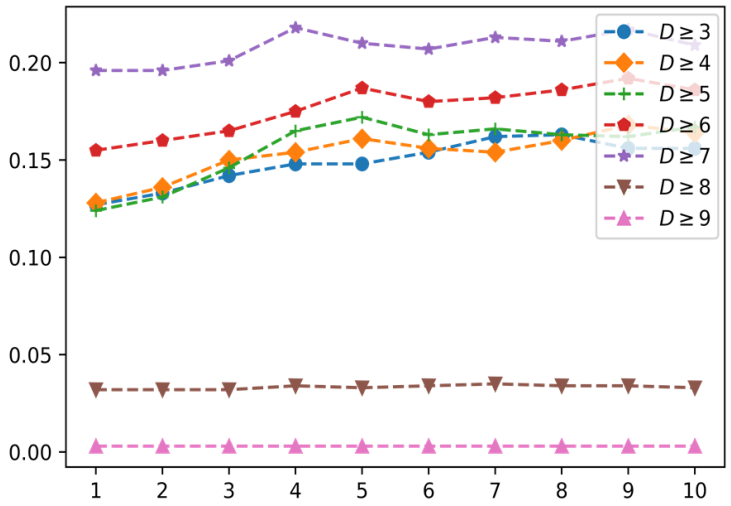

FIGURE 6. Total subsidies per period when $\Delta = 1000$

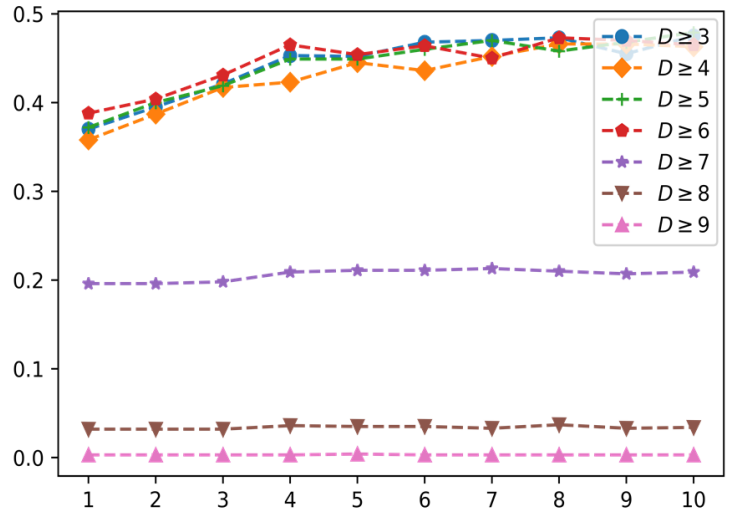

FIGURE 7. Total subsidies per period when $\Delta = 2000$

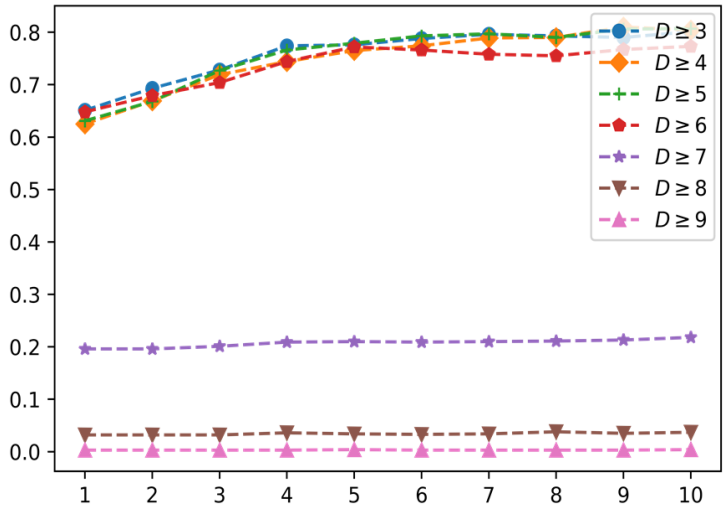

FIGURE 8. Total subsidies per period when $\Delta = 3000$

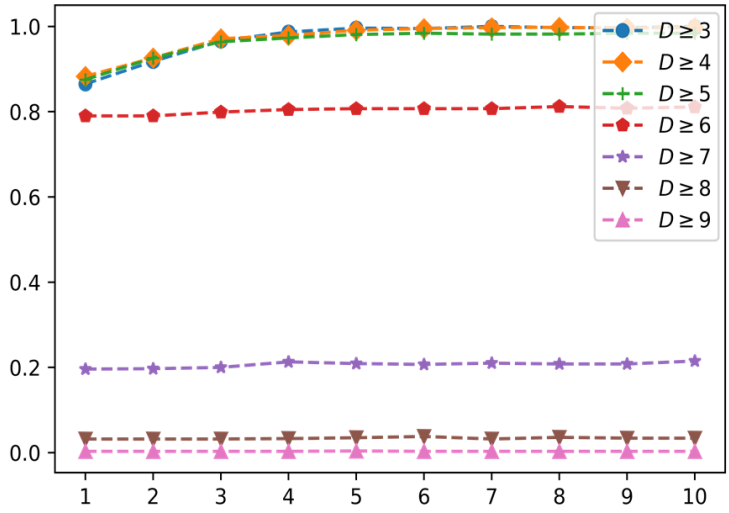

FIGURE 9. Total subsidies per period when $\Delta = 4000$

effect of subsidies; if the consumers of $D \geq 6$ were subsidized, the effect of subsidies was better than that of GSP subsidies (the condition of $D \geq 3$); but the effect of subsidies to consumers of $D \geq 4$ and $D \geq 5$ did not significantly exceed the GSP situation; and the effect of subsidies to consumers of $D \geq 8$ and $D \geq 9$ was much lower than that of the GSP. When $\Delta = 2000$, $\Delta = 3000$, the effect of subsidizing consumers of $D \geq 4$, $D \geq 5$ and $D \geq 6$ is not much different from the GSP and sometimes exceeds the GSP. When $\Delta = 4000$, subsidies to key groups were completely unnecessary and GSP should be adopted. Therefore, if the total amount of subsidy is large enough, the government should adopt the GSP subsidy method. If the total amount of subsidy is not large, the effect of choosing the key groups subsidy will be better. Secondly, the size of the key groups subsidy cannot be too small, only when the appropriate size of the subsidy population can be well effective. Specifically, no matter how large the total subsidy scale is, if only subsidized to the consumer of $D \geq 8$ and $D \geq 9$, because the number of subsidies is too small, the social network effect does not play any role.

Finally, the policy effect simulation and suggestion of government subsidies exit time.

Government subsidies are the correction of market failure, and the ultimate purpose is to form a mechanism for the market to automatically drive the development of green packaging. Therefore, the withdrawal of subsidy is a necessary link in the formulation of subsidy policy. This paper takes the subsidy quota fixed as $\Delta = 4000$, the GSP subsidy is adopted, and the subsidy is set to withdraw from the first $T = 1$, second $T = 2$, third $T = 3$, fourth $T = 4$ and fifth $T = 5$ periods respectively. The simulation results are shown in Figure 10.

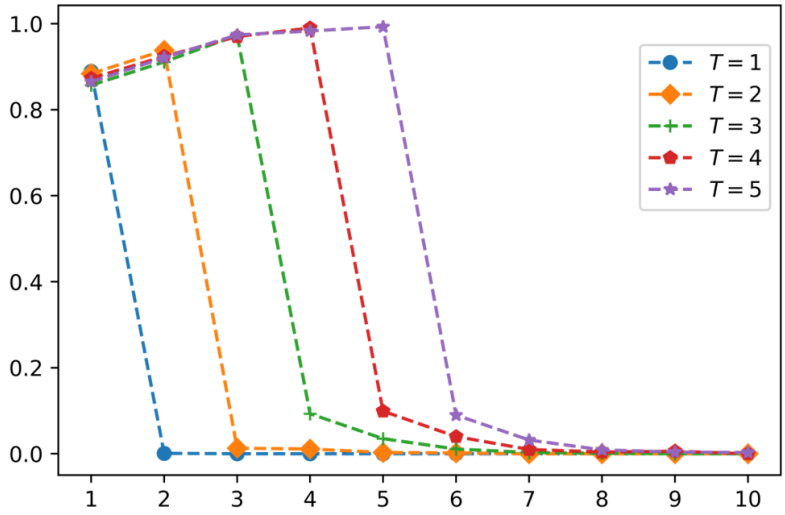

FIGURE 10. Impact of different subsidy exit times on consumer green packaging choices

As can be seen from Figure 10, at any time, as long as the proportion of subsidies withdrawn from consumers to buy green packaging decreases rapidly, the later the withdrawal, the greater the likelihood that consumers will maintain green purchases after withdrawal. However, after 2-3 periods, consumer green packaging purchases disappear, indicating that government subsidies determine whether consumers choose green packaging. At the same time, the social network effect can maintain the consumer green packaging choice behavior to a certain extent. The magnitude of this maintenance is closely related to the startup coefficient of social network effect. Based on this, this paper assumes that the social network start-up coefficients α are equal to 5, 10, 20, 30, 40 and 50 respectively, and carries out the simulation experiments. The results are shown in Figure 11.

It can be seen from Figure 11 that after the subsidy period 3, if the government chooses to withdraw from the subsidy, when $\alpha = 5$, $\alpha = 10$ and $\alpha = 20$, the proportion of consumers choosing green packaging decreases gradually until it decreases to 0, but when $\alpha = 30$, $\alpha = 40$ and $\alpha = 50$, even if the government subsidies exit, the proportion of consumers choosing green packaging can be maintained at a higher level. Therefore, if the government wants to withdraw the subsidy, it must increase the start-up coefficient of the social network effect, which is not only related to the structure of the social network, but also to the value orientation of the whole society, the public interest idea, and the green consumption idea of consumers and so on.

5. **Conclusions and Future Research Prospect.** With the rapid development of e-commerce, express packaging has caused a non-negligible impact on the environment and wasted a lot of resources. Based on the Hotelling model, this paper constructs the behavior model of consumers choosing green packaging under the government subsidies considering social network. From the simulation results the following conclusions are drawn.

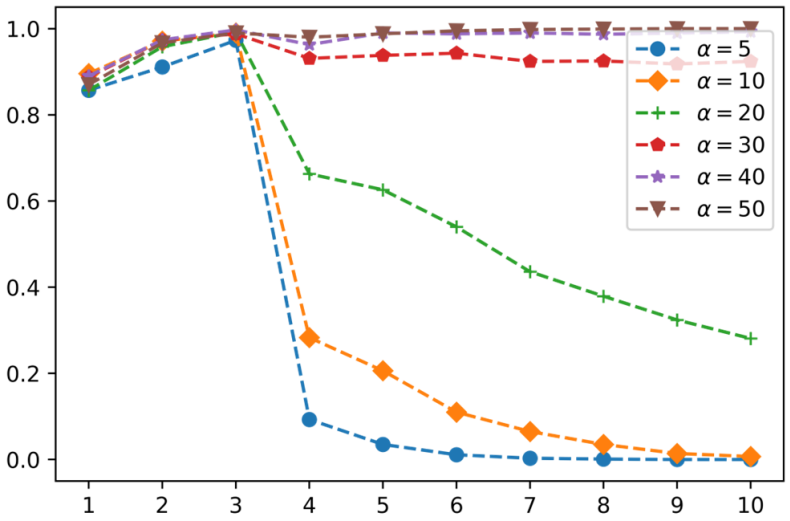

FIGURE 11. Effects of subsidy withdrawal on consumers under different social network effect start-up coefficient

1) In the choice of green packaging, government subsidies play a major role and social network effects play a secondary role. With the increase of subsidy quota, the proportion of consumers choosing green packaging in each period has been greatly increased; after government subsidies, with the advance of time, the effect of social network gradually appears, under the same subsidy quota, the proportion of consumers choosing green packaging further increased.

2) When the total size of the subsidy is small, it is better to choose the key groups subsidy than the GSP (GSP subsidy refers to the subsidy of green packaging consumption for all consumers, and the subsidy of key groups refers to the subsidy of individuals with great network influence in the whole social network.), but when the subsidy scale is large, the GSP subsidy is better than the key groups subsidy. The population size of the key groups' subsidy should not be too small, only when the appropriate subsidy population size can play a good effect.

3) If the government wants to withdraw from the subsidy, it must increase the start-up coefficient of the social network effect, which is not only related to the structure of the social network, but also to the value orientation of the whole society, the public interest idea, and the green consumption idea of consumers and so on.

First, the network structure of consumers in this paper adopts the small world model, how other network structures affect the effect of subsidies? Second, the government subsidies consumers in this paper, if the government directly subsidizes e-commerce enterprises, what is the effect? These are the research directions of the authors in the future.

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