Research on the Influence of Government Regulation on Green Technological Innovation of Strategic Emerging Industry

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Abstract. In the green economy, strategic emerging industries to implement Class II green technological innovation keep critical to obtain competitive advantages. The government regulation could effectively make up for the shortcomings of the negative externalities of green technological innovation. In order to further explore the impact of government regulation on Class I, II and III green technological innovation of strategic emerging industries, this article utilizes the strategic emerging industries as the main experimental subject. Through constructing a tripartite evolutionary game model of strategic emerging industries, the government and consumers, it reveals the process of the three-party discretionary selection in the process of green technology innovation, and acquires equilibrium strategies of the tripartite in the process of green technological innovation.

1 INTRODUCTION

Under the background of the new normal of economy, green development would become one of the main features of ecological civilization construction in the future[1]. On the premise of respecting the laws of nature and economic development, green technological innovation changes the traditional mode of technological innovation, reflecting the new form of technological innovation under the construction of ecological civilization and green development[2]. With the change of consumers' concepts of green consumption[3], enterprises begin to pay increasing attention to the impact of their technological innovation on the environment. As for the strategic emerging industry, one of industries leading the development trend of globally circular economy and low-carbon economy, it is indispensable to implement green technological innovation[4]. However, lots of industries believe that the process of green technological innovation of products will increase the cost, leading to their reluctance to take the initiative to undertake environmental protection responsibilities in the process of technological innovation. This requires the external force of government regulation to encourage and guide the industries to conduct green technological innovation on their initiative[5].

Government regulation and consumer supervision will affect the green technological innovation of strategic emerging industries[6]. It will be conducive to it that the government takes effective incentive and penalty measures, and puts some R&D subsidy[7], in which the government can force green technological innovation of enterprises by the environmental regulation[8], the measures of government punishment can also make strategic emerging industries consciously carry out green production[9]. In addition, the government can also incentive enterprises green technological innovation through increasing investment in R&D[10]; consumers' awareness of environmental protection is the driving factor of green technological innovation in strategic emerging industries, which is conducive to the improvement of the market share of green and innovative products and the increase of industrial profits[11]. Meanwhile, consumers' demand for green products can stimulate the industry's investment in green technology innovation[12].

Since the concept of green technology innovation proposed, most scholars have studied the impact of government regulation on whether the enterprise has created green technology innovation (Class I green technological innovation). However, the key for the development of the strategic emerging industry to keep high quality is switching from Class I green technological innovation to Class II green technological innovation, and Class III green technological innovation is only a transitional form. Hence, strategic emerging industries proactively conduct Class II green technological innovation in order to achieve sustainable development, which is crucial to improve the ecological environment. At present, there is a significant gap in existing researches. One is that most scholars believe that the industries will passively form green technological innovation in the pressure of government regulation and consumer demand, and generally ignore the effect of the consciousness of Innovation Initiator active pursuit of green technology innovation (Class II green technological innovation) in strategic emerging industry on the improvement of environmental performance. Besides, the behavior of green technological innovation of the strategic emerging

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industries is a complex system composed of several elements.

Each participating entity in the system confronts with the choice of different strategies. And the evolution game can fully analyze the situation of mutual constraints of different strategies and dynamic evolution among participants. The green technological innovation of strategic emerging industries mainly involves the three-party interest object, that is, the government, strategic emerging industries and consumers. Existing literature, right now, mobilizing evolutionary games to analyze is mostly based on the two-party game among strategic emerging industries, government and consumers. Less literature carries out research on the three-party stakeholders in green technological innovation simultaneously. In view of this, this paper, through constructing a tripartite evolutionary game model of strategic emerging industries, the government and consumers, analyzes the effect of strategic emerging industries under the government regulation on actively pursuing the transformation of green technological innovation. Furthermore, it also reveals the process of the three parties in green technological innovation game discretionary selection, and provides the corresponding countermeasure and suggestions focused on the government, strategic emerging industries and consumers three aspects of the transformation of green technological innovation in strategic emerging industry.

2 RESEARCH ON THE MECHANISM OF GOVERNMENT REGULATION IMPACT STRATEGIC EMERGING INDUSTRY IN GREEN TECHNOLOGICAL INNOVATION

2.1 Government regulation

Government regulation is that government provides financial and infrastructure support for industries that require funding, and guides industries and consumers to achieve policies taken by a social goal. It is of great significance to optimize the economic structure, maintain economic balance, overcome market failure and maximize the interests of people's interests[13]. According to the mode of management, it can be divided into incentive regulations and command-controlling regulations. Among them, incentive regulations are that the government, taking the market mechanism as a means, provide fundamentally economic assistance and encourage enterprises to reduce consumption of resource. It mainly includes directly providing preferential policy of subsidies for strategic emerging industries and increases R&D investment, while indirectly providing green subsidies for consumers to guide consumers to purchase green products. Moreover, command and control regulations refer to the government to enforce companies to comply with rule standards through formulating relevant laws, and punish the violations. In short, command and control regulations can make up for the defects of incentive regulations. And when the two effectively combined development, they can properly play the effects of government regulation[14].

2.2 Strategic Emerging Industry

Strategic emerging industries are industries with knowledge intensive technology, less material resources, large growth potential, and well integrated efficiency, and it is a critical area of transforming development, gaining a new round of competitive advantage. The development direction of strategic emerging industries is consistent with the green, efficient, energy-saving and environmentally friendly lifestyle pursued by the public. Constantly conducting green technological innovation is the core of strategic emerging industries to maintain competitive advantages[15]. At the same time, major countries in the world have also regarded development of strategic emerging industries as a major strategic initiative[16]. Therefore, promoting strategic emerging industries to take the initiative to implement green technological innovation is the key to obtaining advantages in international competition.

2.3 Green Technological Innovation

The theory of green technology innovation was first proposed by Ernest Braun (1994), advocating to reduce environmental pollution and improve resource utilization efficiency. Green technology innovation that aimed at protecting the ecological environment, saving resources and reducing environmental pollution, is a behavior of technological innovation that follows intrinsic laws in the ecological environment[17]. In terms of classification, it mainly surrounded green technology development and application of product. For instance, according to "method of bisection", green technology innovation is divided into innovation of green product and green technology; similarly, according to "rule of the third ", it is divided into technological innovation of terminal governance, innovation of green product and green technology[18]. In order to answer whether the innovative initiator consciously pursues environmental benefits, lots of scholars are based on two - dimensional standards for domestic and foreign scholars - saving resources and environmentally friendly, and divides green technological innovation into three categories, that is to say Class I green technological innovation, Class II green technological innovation and Class III green technological innovation[19], as shown in table 1.

Table 1 the concept of green technological innovation

Classification	Motivation	Innovation process	Innovative results
Class I green technological innovation	Passive form	Single externality	Resource savings
Class II green technological innovation	Active form	Dual externality	Friendly environment
Class III green technological innovation	Actively and passively mixed form	Single and dual externality	Resource savings and friendly environment

Strategic emerging industries implement Class II green technological innovation is the key to promoting sustainable development. The strategic emerging industry

that conducts Class I green technological innovation may lack initiative awareness to pursue environmental performance. However, it gradually transformed into Class III green technological innovation in the continuous development process, and finally transforms to Class II green technologies. Instead, the strategic emerging industry that has already selected II green innovation has fully low-carbon environmental awareness, which does not turn to Class I green technological innovation in the short term. And the conversion process is shown in figure 1.
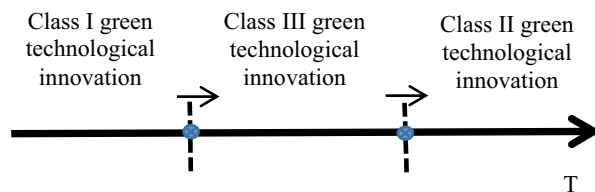

Figure 1 Evolutionary process of strategies of strategic emerging industries in green technological innovation

2.4 The impact of government regulation on green technological innovation in Strategic Emerging Industry

Green technology innovation under the government regulation is that the government restricts the use of environmental resources through the implementation of a series of public measures, and adopts funding policies forward to the green technological innovation of the R&D personnel[20]. The strategic emerging industry serves as the main body of green development, and represents the direction of the new round of scientific revolution and industrial development. Therefore, we must put the strategic emerging industries more prominent positions in sustainable development of economy and society, and vigorously construct the system of green technological innovation[21]. Green technology utilizes new materials that promote the environmental improvement, which reduces resource consumption and increases the economic benefits of industries[22]. Nevertheless, it is also accompanied by risks such as high costs, cycle length and uncertainty[23]. This externality of green technology innovation leads to the lack of inherent power of green technological innovation in strategic emerging industries[24], which requires the government to supervise it and motivate industries for green technical innovation[25]. For instance, government policies of R&D funding can decrease the role of industrial costs; meanwhile, the industry is forced to the pressure of punishment of government system, thus seeking more environmentally friendly activities of green technological innovation[26]. Consumers for the cognitive level of green product determined the consumer's own green consumption, and the government's propaganda to green consumption is significant to consumers to improve the level of green product cognition[27]. In addition, due to the use of new processes, techniques and raw materials to produce green products, it contributes to 20% -25% higher than traditional products. This leads that consumers even support industries to conduct green technological

innovation, but the product premium will also affect the actual behavior of consumers to purchase green products[28]. Only when the government gives green subsidies to consumers, most consumers will take actions to purchase green products, thereby promoting green technology innovation in the industries. The green preferences of consumers under government subsidies will make market demand changes, which will affect the environmental decision-making of the industry. Consequently, the government's environ-mental regulation will not increase the burden to the industries, but to help the industries reduce unnecessary production costs when conducting green technological innovation, so that the industries have lowered the sales price of green products, and motivate more consumers to purchase green products, thus increasing the actual benefit of the industry.
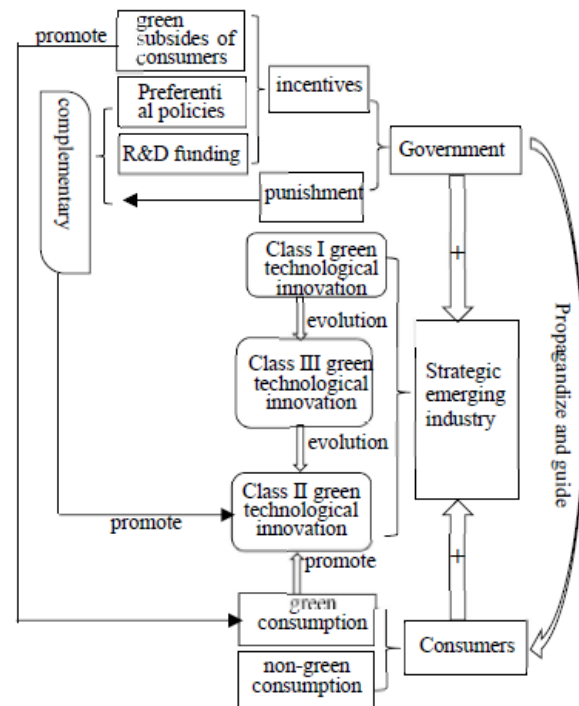

Figure 2 Government regulation impact mechanism for the innovation of green technological innovation of strategic emerging industries

3 ANALYSIS OF EVOLUTIONARY GAME OF STRATEGIC EMERGING INDUSTRY AND CONSUMERS UNDER THE GOVERNMENT REGULATION

3.1 Model Hypotheses

In the traditional game theory, it is often assumed that the behavior subject is absolutely rational, but in the realistic society, it is difficult to achieve complete rationality when facing more cumbersome problems, can only do bounded rationality. Therefore, in the green innovative ecosystem, the subject of the evolutionary game, such as strategic emerging industries, government and consumers is limited rationality. Due to differences in the goals pursued by the game, they also have different resources and information,

which makes them find the optimal strategy at the beginning. They constantly learn and improve during the game and ultimately achieve the maximum interests. Supposing the strategies of strategic emerging industries are Class I green technological innovation, Class II green technological innovation and Class III green technological innovation; the government is regulation and non-regulation; consumers are green consumption and non-green consumption. The probability of strategic emerging industries for Class I green technological innovation is x_1, for Class II green technological innovation is x_2; the probability of government regulation is y; the probability of consumers to purchase green products is z. The model is assumed as follows:

First, strategic emerging industries choose the income of the original technology to produce activities to π_1, and the costs given after the choice for green technology activities are C_{12} and C_{13}, respectively.

Under the regulation of the government, consumers purchase green products, which enables the industry to get extra benefits π_{11}. Similarly, under the non-regulation of the government, consumers purchase green products, and the industry receive additional profits π_{12} ($\pi_{11} > \pi_{12}$). When consumers do not buy green products, there are no supplementary benefits in the industry.

Second, when intervening choices of the green technology of strategic emerging industries, the government has taken the measures mainly including government R&D investment, policy concessions and subsidies and fine. The government's subsidies for selecting activities of green technology are W_{12} (Class II green technological innovation) and W_{13} (Class III green technological innovation), respectively. And its subsidies of consumption for consumers who purchase green products are W_{21} (Class I green technological innovation), W_{22} (Class II green technological innovation) and W_{23} (Class III green technological innovation). At the same time, the government puts a certain resource for publicity, monitoring, etc., the cost of the required payment is C_2. Subsequently, the government fines the industries who do not take the initiative to make green technological innovation, and the industries who conduct Class II green technological innovation and Class III green technological innovation make the green benefits of society increased, and the increasing is π_{21} and π_{22}, separately. Δv indicates that the government will improve the public's consciousness of environmental protection when investing in the industrial investment. Similarly, provided that the industry selected Class I green innovation and the government was not regulated, this would contribute to loss of government credit to $-\Delta v$.

Third, consumers' utility to purchase non-green products is π_3, and the cost of green consumption of the public needs to be C_{31} (Class I green technological innovation), C_{32} (Class II green technological innovation) and C_{33} (Class III green technological innovation), respectively. At the same time, the condition $C_{32} > C_{33} > C_{31}$ is satisfied. After that Consumers enjoy the green products brought by strategic emerging industries that conduct Class II green technological innovation and III green technological innovation, thereby improving supplementary utility, and the increasing of it is π_{31} and π_{32}, in turn.

3.2 Payoff matrix of tripartite evolutionary game model

According to the above basic hypotheses, this article constructs the payoff matrix of the tripartite evolutionary game, as shown in table 2.

Table 2 payoff matrix of the tripartite evolutionary game

Strategic emerging industry	Government	Consumer (green consumption) z	Consumer (non-green consumption) 1-z
Class I green technologic-al innovation x_1	Regulation y	π_1-F	π_1-F
		Δv+F-C_2-W_{21}	Δv+F-C_2
		π_3+W_{21}-C_{31}	π_3
	non-regulation 1-y	π_1	π_1
		-Δv	-Δv
		π_3-C_{31}	π_3
ClassII green technologic-al innovation x_2	Regulation y	π_1+π_{11}-C_{12}+W_{12}	π_1-C_{12}+W_{12}
		π_{21}+Δv-C_2-W_{12}-W_{21}	π_{21}+Δv-C_2-W_{12}
		π_3+π_{31}+W_{21}-C_{32}	π_3
	non-regulation 1-y	π_1+π_{12}-C_{12}	π_1-C_{12}
		π_{21}	π_{21}
		π_3+π_{31}-C_{32}	π_3
ClassIII green technologic-al innovation $1-x_1-x_2$	Regulation y	π_1+π_{11}-C_{13}+W_{13}	π_1-C_{13}+W_{13}
		π_{22}+Δv-C_2-W_{13}-W_{22}	π_{22}+Δv-C_2-W_{13}
		π_3+π_{31}+W_{22}-C_{33}	π_3
	non-regulation 1-y	π_1+π_{12}-C_{13}	π_1-C_{13}
		π_{22}	π_{22}
		π_3+π_{31}-C_{33}	π_3

3.3 Establish the replicated dynamic equation

When the strategic emerging industry conduct Class I green innovation, its expected return is:

$$E_{11} = yz(\pi_1 - F) + y(1-z)(\pi_1 - F) + (1-y)z\pi_1 + (1-y)(1-z)\pi_1 \quad (3\text{-}1)$$

When the strategic emerging industry implement Class II green innovation, its expected return is:

$$E_{12} = yz(\pi_1 + \pi_{11} - C_{12} + W_{12}) + y(1-z)(\pi_1 - C_{12} + W_{12})$$
$$+ (1-y)z(\pi_1 + \pi_{12} - C_{12}) + (1-y)(1-z)(\pi_1 - C_{12}) \quad (3\text{-}2)$$

When the strategic emerging industry execute Class III green innovation, its expected return is:

$$E_{13} = yz(\pi_1 + \pi_{11} - C_{13} + W_{13}) + y(1-z)(\pi_1 - C_{13} + W_{13}) \quad (3\text{-}3)$$
$$+ (1-y)z(\pi_1 + \pi_{12} - C_{13}) + (1-y)(1-z)(\pi_1 - C_{13})$$

Its average excepted returns is:

$$E_1 = x_1 E_{11} + x_2 E_{12} + (1 - x_1 - x_2)E_{13} \quad (3\text{-}4)$$

The replicated dynamic equation for the strategic emerging industry in conducting Class II green technological innovation is:

$$F(x_2) = \frac{dx_2}{dt} = x_2(E_{12} - E_1) = [(2F - 2\pi_1)yz + (W_{12} - W_{13} + F)y \quad (3\text{-}5)$$
$$- \pi_1 - C_{12} - C_{13}]x_2(1 - x_2)$$

Similarly, the replicated dynamic equation for the government regulation is:

$$F(y) = \frac{dy}{dt} = y(E_{21} - E_2) = [x_1 z(2\Delta v + F - C_2 - W_{21} + W_{22}) - x_1(\Delta v - C_2 \quad (3\text{-}6)$$
$$- W_{13}) - x_2 z W_{21} + x_2(W_{13} - W_{12}) - zW_{22} + \Delta v - C_2 - W_{13}]y(1-y)$$

The replicated dynamic equation for consumers in choosing green consumption is:

$$F(z) = \frac{dz}{dt} = z(E_{31} - E_3) = [(W_{21} - W_{22} + C_{33} - C_{31})x_1 y + (C_{33} - C_{31})x_1 \quad (3\text{-}7)$$
$$+ (W_{21} - W_{22})x_2 y + (C_{33} - C_{32})x_2 + yW_{22} + \pi_{31} - C_{33}]z(1-z)$$

3.4 Analyze the evolutionary equilibrium points

Let $F(x_2) = 0$, $F(y) = 0$, $F(z) = 0$, we can obtain eight equilibrium points, such as $E_1(0,0,0)$, $E_2(0,1,0)$, $E_3(0,0,1)$, $E_4(1,0,0)$, $E_5(1,1,0)$, $E_6(1,0,1)$, $E_7(0,1,1)$, $E_8(1,1,1)$. According to the study of Friedman, the solution of evolutionary equilibrium of the replicated dynamic equation is obtained by the analysis from local stability of Jacobion matrix of the system. Then partial derivatives of $F(x_2)$, $F(y)$, $F(z)$ could acquire Jacobian matrix.

$$J = \begin{bmatrix} \dfrac{\partial F(x_2)}{\partial x_2} & \dfrac{\partial F(x_2)}{\partial y} & \dfrac{\partial F(x_2)}{\partial z} \\ \dfrac{\partial F(y)}{\partial x_2} & \dfrac{\partial F(y)}{\partial y} & \dfrac{\partial F(y)}{\partial z} \\ \dfrac{\partial F(z)}{\partial x_2} & \dfrac{\partial F(z)}{\partial y} & \dfrac{\partial F(z)}{\partial z} \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix}$$

$$A_{11} = [(2F - 2\pi_1)yz + (W_{12} - W_{13} + F)y - \pi_1 - C_{12} - C_{13}](1 - 2x_2) \quad (3\text{-}8)$$

$$A_{12} = [(2F - 2\pi_1)z + W_{12} - W_{13} + F]x_2(1 - x_2) \quad (3\text{-}9)$$

$$A_{13} = (2F - 2\pi_1)yx_2(1 - x_2) \quad (3\text{-}10)$$

$$A_{21} = (W_{13} - W_{12} - zW_{21})y(1 - y) \quad (3\text{-}11)$$

$$A_{22} = [x_1 z(2\Delta v + F - C_2 - W_{21} + W_{22}) - x_1(\Delta v - C_2 - W_{13}) - x_2 zW_{21} \quad (3\text{-}12)$$
$$+ x_2(W_{13} - W_{12}) - zW_{22} + \Delta v - C_2 - W_{13}](1 - 2y)$$

$$A_{23} = [x_1(2\Delta v + F - C_2 - W_{21} + W_{22}) - x_2 W_{21} - z]y(1 - y) \quad (3\text{-}13)$$

$$A_{31} = [(W_{21} - W_{22})y + C_{33} - C_{32}]z(1 - z) \quad (3\text{-}14)$$

$$A_{32} = [(W_{21} - W_{22} + C_{33} - C_{31})x_1 + (W_{21} - W_{22})x_2 + W_{22}]z(1 - z) \quad (3\text{-}15)$$

$$A_{33} = [(W_{21} - W_{22} + C_{33} - C_{31})x_1 y + (C_{33} - C_{31})x_1 + (W_{21} - W_{22})x_2 y \quad (3\text{-}16)$$
$$+ (C_{33} - C_{32})x_2 + yW_{22} + \pi_{31} - C_{33}](1 - 2z)$$

According to the evolutionary game theory, stable points of the replicated dynamic equation that meets eigen value of Jacques matrix are negative conditions. Thus, these points are brought into Jacobian matrix, and the corresponding eigen value are λ_1, λ_2, λ_3, as shown in table 3.

From table 3, there is at least one positive number corresponding to the point $E_4(1,0,0)$, $E_6(1,0,1)$, so they are not local asymptotic stable points.

For the point $E_1(0,0,0)$, when conditions $\Delta v < C_2 + W_{13}$ and $x_1 < \dfrac{C_{33} - \pi_{31}}{C_{33} - C_{31}}$ are satisfied, it is a local asymptotic stable point; for $E_2(0,1,0)$, when conditions $W_{12} - W_{13} + F < \pi_1 + C_{12} + C_{13}$, $\Delta v > C_2 + W_{13}$ and $x_1 < \dfrac{C_{33} - W_{22} - \pi_{31}}{W_{21} - W_{22} + 2C_{33} - 2C_{31}}$ are satisfied, it is a local asymptotic stable point; for $E_3(0,0,1)$, when conditions $\Delta v + F < W_{21} - W_{22} - W_{13}$ and $x_1 < \dfrac{\pi_{31} - C_{33}}{C_{31} - C_{33}}$ are satisfied, it is a local asymptotic stable point; for $E_5(1,1,0)$, when conditions $\pi_1 + C_{12} + C_{13} < W_{12} - W_{13} + F$, $x_1 < \dfrac{\Delta v - W_{12} - C_2}{\Delta v - C_2 - W_{13}}$ and $x_1 < \dfrac{C_{32} - W_{21} - \pi_{31}}{W_{21} - W_{22} + 2C_{33} - 2C_{31}}$ are satisfied, it is a local asymptotic stable point; for $E_7(0,1,1)$, when condition $2F - 3\pi_1 < C_{12} + C_{13}$, $x_1 < \dfrac{\Delta v - C_2 - W_{13} - W_{22}}{W_{21} - W_{22} - W_{13} - F}$ and $(W_{22} - W_{21})x_1 - (1 + x_1)(C_{33} - C_{31}) < \pi_{31} + W_{22} - C_{33}$ are satisfied, it is a local asymptotic stable point; for $E_8(1,1,1)$, when conditions $3\pi_1 - 3F < W_{12} - W_{13} - C_{12} - C_{13}$, $x_1 < \dfrac{\Delta v - C_2 - W_{12} - W_{21} - W_{22}}{W_{21} - W_{22} - W_{13} - F - \Delta v}$ and $(W_{22} - W_{21})x_1 - (1 + x_1)(C_{33} - C_{31}) < \pi_{31} + W_{21} - C_{32}$ are satisfied, it is a local asymptotic stable point.

Table 3 Eigen value of Jacobion Matrix corresponding to partial equilibrium points

partial equanteq-uation	λ_1	λ_2	λ_3
E_1 (0,0,0)	$-\pi_1 - C_{12} - C_{13}$	$(1-x_1)$ $(\Delta v - C_2 - W_{13})$	$(C_{33} - C_{31})x_1$ $+\pi_{31} - C_{33}$
E_2 (0,1,0)	$W_{12} - W_{13} + F$ $-\pi_1 - C_{12} - C_{13}$	$(x_1 - 1)$ $(\Delta v - C_2 - W_{13})$	$(W_{21} - W_{22})x_1$ $+2(C_{33} - C_{31})$ $x_1 + W_{22} + \pi_{31} - C_{33}$

E_3 (0,0,1)	$-\pi_1-C_{12}-C_{13}$	$x_1(\Delta v+F-W_{21}$ $+W_{22}+W_{13})$	$(C_{31}-C_{33})x_1$ $-\pi_{31}+C_{33}$
E_4 (1,0,0)	$\pi_1+C_{12}+C_{13}$	$(1-x_1)(\Delta v-C_2$ $-W_{13})$	$(C_{33}-C_{31})x_1$ $+\pi_{31}-C_{32}$
E_5 (1,1,0)	$\pi_1+C_{12}+C_{13}$ $-W_{12}+W_{13}-F$	$x_1(\Delta v-C_2-W_{13})$ $+W_{12}-\Delta v+C_2$	$(W_{21}-W_{22})x_1$ $+2(C_{33}-C_{31})$ $x_1+W_{21}+\pi_{31}-C_{32}$
E_6 (1,0,1)	$\pi_1+C_{12}+C_{13}$	(x_1-1) $(\Delta v+W_{21}+W_{22})+x_1(F+W_{13})$ $-C_2$	$(C_{31}-C_{33})x_1$ $-\pi_{31}+C_{32}$
E_7 (0,1,1)	$2F-3\pi_1$ $-C_{12}-C_{13}$	$x_1(W_{21}-W_{22}-W_{13}-F)+C_2+$ $W_{13}+W_{22}-\Delta v$	$(W_{22}-W_{21})x_1$ $-(1+x_1)(C_{33}-C_{31})$ $-\pi_{31}-W_{22}+C_{33}$
E_8 (1,1,1)	$3\pi_1-3F-W_{12}$ $+W_{13}+C_{12}+C_{13}$	$x_1(W_{21}-W_{22}-W_{13}-F-\Delta v)+$ $C_2+W_{12}+W_{21}$ $+W_{22}-\Delta v$	$(W_{22}-W_{21})x_1$ $-(1+x_1)(C_{33}-C_{31})$ $-\pi_{31}-W_{21}+C_{32}$

4. EQUILIBRIUM STRATEGIES OF STRATEGIC EMERGING INDUSTRY, GOVERNMENT AND CONSUMERS

4.1 Equilibrium strategies of strategic emerging industry

From formula 2-5, when the condition $z=\dfrac{\pi_1+C_{12}+C_{13}-(W_{12}-W_{13}+F)y}{(2F-2\pi_1)y}$ is satisfied, it can be seen that $F(x_2)\equiv 0$. Consequently, all strategies of strategic emerging industry are in equilibrium state.

When the condition $z\neq\dfrac{\pi_1+C_{12}+C_{13}-(W_{12}-W_{13}+F)y}{(2F-2\pi_1)y}$ is satisfied, let $F(x_2)=0$, we can get two stable points $(x_2=0,\ x_2=1)$.

When the condition $z>\dfrac{\pi_1+C_{12}+C_{13}-(W_{12}-W_{13}+F)y}{(2F-2\pi_1)y}$ is satisfied, $F'(x_2=1)<0$, $F'(x_2=0)>0$, so $x_2=1$ is a stable strategy. At this point, strategic emerging industries start Class II green technological innovation.

When the condition $z<\dfrac{\pi_1+C_{12}+C_{13}-(W_{12}-W_{13}+F)y}{(2F-2\pi_1)y}$ is satisfied, $F'(x_2=1)>0$, $F'(x_2=0)<0$, so $x_2=0$ is a stable strategy. And they do not conduct Class II green technological innovation.

4.2 Equilibrium strategies of government

From formula 3-6, when the condition $z=\dfrac{x_1(\Delta v-C_2-W_{13})-x_2(W_{13}-W_{12})-\Delta v+C_2+W_{13}}{x_1(2\Delta v+F-C_2-W_{21}+W_{22})-x_2W_{21}-W_{22}}$ is satisfied, it can be seen that $F(y)\equiv 0$. Hence, all strategies of government are in equilibrium state.

When the condition $z\neq\dfrac{x_1(\Delta v-C_2-W_{13})-x_2(W_{13}-W_{12})-\Delta v+C_2+W_{13}}{x_1(2\Delta v+F-C_2-W_{21}+W_{22})-x_2W_{21}-W_{22}}$ is satisfied, let $F(y)=0$, we can get two stable points $(y=0,y=1)$.

When the condition $z>\dfrac{x_1(\Delta v-C_2-W_{13})-x_2(W_{13}-W_{12})-\Delta v+C_2+W_{13}}{x_1(2\Delta v+F-C_2-W_{21}+W_{22})-x_2W_{21}-W_{22}}$ is satisfied,

$F'(y=1)<0, F'(y=0)>0$, so $y=1$ is a stable strategy. At present, the government regulates.

When the condition $z<\dfrac{x_1(\Delta v-C_2-W_{13})-x_2(W_{13}-W_{12})-\Delta v+C_2+W_{13}}{x_1(2\Delta v+F-C_2-W_{21}+W_{22})-x_2W_{21}-W_{22}}$ is satisfied，

$F'(y=1)>0$，$F'(y=0)<0$, so y=0 is a stable strategy. And it does not regulate.

4.3 Equilibrium strategies of consumers

From formula 3-7, when the condition $x_2=\dfrac{C_{33}-yW_{22}-\pi_{31}-(W_{21}-W_{22}+C_{33}-C_{31})x_1y-(C_{33}-C_{31})x_1}{(W_{21}-W_{22})y+C_{33}-C_{32}}$ is satisfied, it can be seen that $F(z)\equiv 0$. Accordingly, all strategies of consumers are in equilibrium state.

When the condition $x_2\neq\dfrac{C_{33}-yW_{22}-\pi_{31}-(W_{21}-W_{22}+C_{33}-C_{31})x_1y-(C_{33}-C_{31})x_1}{(W_{21}-W_{22})y+C_{33}-C_{32}}$ is satisfied, let $F(z)=0$, we can get two stable points $(z=0,z=1)$.

When the condition $x_2>\dfrac{C_{33}-yW_{22}-\pi_{31}-(W_{21}-W_{22}+C_{33}-C_{31})x_1y-(C_{33}-C_{31})x_1}{(W_{21}-W_{22})y+C_{33}-C_{32}}$ is satisfied, $F'(z=1)<0$, $F'(z=0)>0$, so $z=1$ is a stable strategy. At the moment, consumers purchase green products.

When the condition $x_2<\dfrac{C_{33}-yW_{22}-\pi_{31}-(W_{21}-W_{22}+C_{33}-C_{31})x_1y-(C_{33}-C_{31})x_1}{(W_{21}-W_{22})y+C_{33}-C_{32}}$ is satisfied, $F'(z=1)>0$, $F'(z=0)<0$, so $z=0$ is a stable strategy. And they purchase non-green products.

4.4 Discussion on the results of Equilibrium strategies

Through the above analysis, it is not difficult to find that the strategic emerging industry execute Class II green technological innovation, which is closely related to the proportion of government regulation y and consumers to purchase green products z.

When the condition $z>\dfrac{\pi_1+C_{12}+C_{13}-(W_{12}-W_{13}+F)y}{(2F-2\pi_1)y}$ is satisfied, strategic emerging industries execute Class II green technological innovation. Therefore, the proportion

of government supervision has increased. While raising the punishment of industries that do not take the initiative to execute technological innovation, increasing the subsidies for Class II green technological innovation and reducing subsidies to Class III green innovation can promote industries to transform to Class II green technological innovation.

Equally, when the condition

$$y > \frac{\pi_1 + C_{12} + C_{13}}{(2F - 2\pi_1)z + W_{12} - W_{13} + F}$$

is satisfied, strategic emerging industries implement Class II green technological innovation. It is self-evident that an increasing amount of consumers purchase green products, which improves transformation of industries to Class II green technological innovation.

Similarly, when the condition

$$z > \frac{x_1(\Delta v - C_2 - W_{13}) - x_2(W_{13} - W_{12}) - \Delta v + C_2 + W_{13}}{x_1(2\Delta v + F - C_2 - W_{21} + W_{22}) - x_2 W_{21} - W_{22}}$$ is satisfied,

the administration regulates. Consequently, strategic emerging industries spontaneously pursue improvement in green technological innovation. While reducing government R & D costs and cutting down subsidies for Class III green technological innovation can prompt government to transform the direction of strict regulation.

Likewise, when the condition

$$x_2 > \frac{C_{33} - yW_{22} - \pi_{31} - (W_{21} - W_{22} + C_{33} - C_{31})x_1 y - (C_{33} - C_{31})x_1}{(W_{21} - W_{22})y + C_{33} - C_{32}}$$

is

satisfied, consumers take green consumption. Thus, the proportion of government regulation has increased. And increasing consumers to purchase subsidies for products of Class II green technological innovation enables consumers to buy green products.

5 GOVERNMENT REGULATION GUIDES THE COUNTERMEASURES OF GREEN TECHNOLOGICAL INNOVATION IN STRATEGIC EMERGING INDUSTRIES

Based on the above conclusions, in order to promote the transformation of strategic emerging industries into Class II green technological innovation, this paper proposes targeted countermeasures based on three levels of government, consumers and strategic emerging industries.

5.1 Government level

At present, there is a lack of initiative awareness of green technological innovation and the dynamics are lacking in strategic emerging industries. In this situation, the government regulation can directly affect the production cost of strategic emerging industries, so that the industry will make a choice in green technological innovation. The incentive regulation of it could forward encourage them to conduct Class II green technological innovation. Among them, the main incentives of the government include government R & D investment and subsidies for the innovation of Class II green technologies in strategic emerging industries. In addition, command-controlling regulations can reversely promote strategic emerging

industries to take the initiative for Class II green technological innovation. The strategic emerging industries are forced to the pressure of measures of government punishment, and will improve the willingness to implement Class II green technological innovation.

5.1.1 Enhance the mechanism of green subsidies

According to the above model, the government strict regulatory efforts Y, and the subsidy policy for II green technology innovation will make the strategic emerging industries to actively carry out the increasing proportion of green technology innovation. The government should start from the market demand of green products and encourage strategic emerging industries to actively carry out the development of green technology. By reducing tax, green subsidies, loans and other measures to cut down the unnecessary cost of Class II green technological innovation and promote the application of green technology. At present, the government has issued legal and management regulations related to green technology innovation, as well as supporting subsidies. However, whether the industry could make full use of green subsidies of government after obtaining it, the government also needs to be investigated. Based on this, the government should establish a sound policy of subsidy and post-monitoring system, from environmental protection funds to specifically conduct to carry out a comprehensive review. At the same time, it should strengthen the punishment measures of industries that do not forwardly innovate green technology, and lead strategic emerging industries to carry out sustainable development, which prompted them to achieve low consumption, less pollution and high cycles while producing operations.

5.1.2 Improve the investment efficiency of government R&D

Current economic development faces dual oppression of shortages of resources and environmental pollution. The government needs to increase R&D investment in encouraging strategic emerging industries for activities of green technological innovation. At the same time, in order to avoid waste and loss of resources, the government can promote the green development of strategic emerging industries by reducing R&D cost C2. Accordingly, the government should be brave enough to break the traditional research and development system and improve the investment efficiency of government R&D. First of all, the government has to transform the purpose of technology research and development, pay attention to the application of the market-oriented green technology, and break out the obstacles of traditional mechanisms. In addition, it should fully mobilize the enthusiasm of the government, strategic emerging industry, universities, and research institutes, enhance industry-university-research cooperative innovation and establish a rational system of green technology research and development. Last but not least, the government is supposed to strengthen management of R&D investment. Although it has a large

investment in green technology, the output is exceedingly low. Consequently, the government should strengthen the management of R&D funding, comprehensively evaluate R&D input results, and feedback these results to the adjustment of corresponding strategies.

5.1.3 Cultivate compound talents of green technological innovation

The green technological innovation will deeply integrate sustainable development, ecological civilization and economic theory, and there are lots of disciplines such as environmental science, ecology and economics. Thus, this requires cultivating interdisciplinary integrated talents to ensure the input of green technological talents. To begin with, the government clearly develops targets for talents mainly based on green technological innovation, and helps schools to open cross-course and optimize teaching curriculum systems, such as adopting combined methods of cases and discussions. What's more, it should promote the cooperation between schools and strategic emerging industries, and strengthen practical teaching, for instance, through the school's green technological innovation knowledge contest, practice competition, etc., so that students can better utilize theoretical knowledge and cultivate the composite talents needed by the industry.

5.2 Strategic emerging industries level

In the context of sustainable development, the strategic emerging industries that implement activities of green technological innovation will increase production costs in the short term. Nevertheless, the energy-saving and environmentally friendly lifestyle advocated by modern people is in line with strategic emerging industries. Long-term development will improve consumers' recognition, and promote the rapid growth of industrial profits. Therefore, the industries should proactively establish a relatively environmental system, increase the research and development investment of green technology, and create social benefits while achieving rapid economic development.

5.2.1 Actively establish a system of green technological innovation

Green technological innovation is the main direction of future economic development. As the main body of green development, strategic emerging industries should actively construct a system of green technological innovation in combination with the actual situation of the industries. To start with, strategic emerging industries itself should improve the sense of responsibility of environmental protection, cultivate employee's environmental awareness, actively promote the relevant policies of the government regulation, and aggressively implement green technological innovation. Besides, they strictly supervise the application of green technology during production in order to reduce resource consumption. The industries should also apply green and efficient production methods to reasonably configure

existing resources, seeking economic growth and friendly environment of balanced development. Finally, they could improve the level of green technological innovation to produce competitive green products by carrying out intelligent processes, which seizes market opportunities and enhances public approval, thus improving the market share and economic benefits of industries.

5.2.2 Strengthen research and development investment of green technology

The high investment in the Green Technology R&D of strategic emerging industries is the key to obtaining competitive advantages and economic benefits. Therefore, the industries should strengthen the research and development of green technology. In the beginning, the R&D strategy should be developed to reasonably deployed research content, which contributes to efficiently utilize R&D funding. And through introducing advanced technology and high quality talents, it will improve the research and development capabilities of the industries. What's more, it is accelerating the research and development breakthrough in key technologies, and the appropriate equity incentive mechanism for critical technical talents to reduce personnel flow, which provides guarantees for green technological innovation of strategic emerging industries. At last, it is indispensable to take advantage of external resources to strengthen interaction with colleges and universities. The ways to learn exchanges through sending internal employees in the industry to colleges and universities could strengthen knowledge sharing and improve research and development efficiency.

5.3 Consumers level

Consumers, as the market entity, are especially important for the concept of consumption of green products. Since the green technological innovation and process is used in producing, the cost of green products is obviously high, which leads to consumers who are hesitant to face the product premium. At this point, the government will enhance the willingness to purchase products of Class II green technological innovation by increasing subsidies to consumers to purchase these products. Furthermore, in the process of cultivating the public to establish a concept of green consumption, the government ought to play a dominant role in creating better environment of consumption, which will also enable industries to implement Class II green technological innovation.

5.3.1 Construct concepts of green consumption

When helping consumers establish concepts of green consumption, the government should play a leading role. Firstly, by strengthening publicity of green purchase, the government is based on an official platform, more use of online marketing, publicity through online media, and prompts the public to recognize the concepts. For instance, through public service advertisements, low-carbon logo and so on, they could improve the awareness of green

consumption and cultivate the habit of it, so that consumers cultivate habits and promote the public to purchase green products. Secondly, the government should mobilize various measures and ways to play the role in the main position of the school, strengthen the education of knowledge of green consumption and popularize green knowledge, which promotes the society's consumption environment to transform to "green consumption". Besides, it could encourage consumers to purchase green products, which will lead to improving the market share and industrial profits of green products, thus laying the foundation for the choice of green technological innovation for strategic emerging industries.

5.3.2 Promote the public consciously practice green consumption

The government's green subsidy (W_{22}) is increased, which promotes consumers to purchase green products, thereby improving the market share of green products and enhancing industrial income. The intention of green consumption of consumers is relatively low at the moment, mainly due to product premium issues from green technological innovation. At the beginning, in order to decrease the risk of green consumption, the government requires raising subsidies of consumers who purchase green products of Class II green technological innovation and improve consumers satisfaction, which promotes consumers to consciously practice behavior of green consumption. Furthermore, the government can establish sound laws and regulations that encourage consumers' green consumption to protect consumer legitimate rights and interests. This initiative will drive green consumption of the public and Class II green technological innovation of strategic emerging industry to integrate development.

6 CONCLUSION

In order to further explore the impact of government regulation on Class I, II and III green technological innovation of strategic emerging industries, this article utilizes the strategic emerging industries as the main experimental subject. Through constructing a tripartite evolutionary game model of strategic emerging industries, the government and consumers, it reveals the process of the three-party discretionary selection in the process of green technology innovation, and acquires equilibrium strategies of the tripartite in the process of green technological innovation. The results discouraged that government R&D investment, policies and subsidies of green preference, punitive measures, and consumers' preferences of green consumption will have a significant impact on green technological innovation of strategic emerging industries. And accordingly, it is targeted to propose the implementation path of the strategic emerging industry to Class II green technological innovation, providing the theoretical basis for the government regulation guided the development of the green technological innovation of strategic emerging industries.

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