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Do government regulations prevent greenwashing? An evolutionary game analysis of heterogeneous enterprises

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ABSTRACT

Due to the contradictions between environmental protection and the contemporary means of producing material-economic growth, companies are increasingly being placed on the Greenwashing List in China. The increasingly severe problem of greenwashing needs to be solved urgently. Government regulation plays a critical role in the prevention of greenwashing. Therefore, we introduce government regulation as a factor in the decision-making process of an enterprise's adoption of greenwashing, thus enriching the literature on the prevention of greenwashing and the validity of government regulations for greenwashing. Centered on heterogeneity, this paper divides enterprises into two types, i.e., dominant and inferior enterprises. In terms of game modeling, this study builds two evolutionary models that are influenced by a government punishment mechanism and tax subsidy mechanism for greenwashing and green innovation strategies and analyzes the evolutionarily stable strategy (ESS) of the models and the evolutionary process of dominant and inferior enterprises. This study found that the government punishment mechanism has an excellent inhibitory effect on the greenwashing practices of both dominant and inferior enterprises. However, the government tax subsidy mechanism is not able to suppress the greenwashing practices of inferior enterprises. In addition, the heterogeneities difference may determine whether green innovation strategies can be diffused and the speed of diffusion. As illustrated above, these results provide proposals for reducing the rate of greenwashing behaviors and for improving the effectiveness of the government regulation of companies' greenwashing behaviors.

1. Introduction

In 1986, the US environmentalist Jay Westerveld first coined the term “greenwash” to indicate the false environmental protection claims of enterprises (Koh et al., 2010). The Oxford English Dictionary (2012) defines greenwashing from the perspective of information communication. It considers greenwashing to be disinformation that is disseminated by an organization to present an environmentally responsible public image. Based on corporate social responsibility (CSR), greenwashing is viewed as an advertisement or a label for dishonest companies (Lee et al., 2018). In the marketing activities of a company, greenwashing results from overpositioning and inconsistent communication (Self et al., 2010; Smith and Font, 2014). In the broad sense, propaganda, communication behaviors, and environmental practices related to products and services that mislead consumers can be called greenwashing (Parguel et al., 2015).

The greenwashing behaviors of enterprises may be motivated by different stakeholders, such as consumers (Berrone et al., 2017; Becker-Olsen and Potucek, 2013) and government departments (Chen et al., 2006). Additionally, greenwashing behaviors improve the financial performance of enterprises (Aguilera-Caracuel and Ortiz-De-Mandojana, 2013), promote their green brand image (Chen, 2008), and enhance their competitive advantage (Chiou et al., 2011; Albort-Morant et al., 2016).

However, greenwashing is quite harmful to consumers, enterprises and society. For consumers, greenwashing affects consumer skepticism (Rahman et al., 2015.), perceived risk (Chang and Chen, 2014), and negatively affects green brand equity (Chang and Chen, 2014) and purchasing intention (Zhang et al., 2018). For enterprises, greenwashing negatively influences the organization's credibility, the corporate performance perceived by consumers (Nyilasy et al., 2014) and the corporate market value (Parguel et al., 2015); at the same time, those who are loyal to the green mission will lose their competitive advantage (Furlow, 2010). For society, greenwashing

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has a negative impact on public engagement with broader environmental issues (Gillespie, 2008). When there are contradictions between environmental protection and the contemporary way of producing material-economic growth (Rees, 2003), the problem of greenwashing needs to be solved urgently, because it is seriously harmful to consumers, enterprises and society. Additionally, increasing numbers of companies are being placed on the Greenwashing List in China (Du, 2015).

Government regulations play an important role in developing the economy because they can maintain the balance of economic aggregates, promote major structural optimization and correct the inherent flaws in the market. Therefore, we focus on the government regulation of greenwashing (Larson, 2015). Government regulation of greenwashing means that the government uses public power to regulate the greenwashing behaviors of enterprises. Domestic and foreign scholars explain the critical role of government regulation in deceptive practices or the stable development of the market from the perspective of Market Failure Theory (Ostrom et al., 2012), Natural Monopoly Theory (Posner, 1970), Asymmetry of Information Theory (Kolodinsky, 2012), Externality Theory (Bairam and Ward, 1993), and Public Interest Theory (James, 2000). According to greenwashing research by scholars, government regulation plays an essential role in reducing the rate of greenwashing behaviors from the perspective of green supply chain management (Rui et al., 2012) and the corporate social responsibility (Lee et al., 2018). Nevertheless, it is unclear whether government regulation is always effective in the practice, Scholar David Markham (Markham et al., 2014) believes that current government regulation of greenwashing does not effectively reduce the incidence of greenwashing behaviors. Feinstein (2012) holds a similar view that the existing laws are not sufficient to prevent greenwashing.

The existing studies on greenwashing governance mostly focuses on the necessity of government regulations, but how to prevent greenwashing and achieve effective governance sustainably, which is a severe problem in practice, is rarely discussed in depth. Therefore, we use evolutionary game theory to study the greenwashing behaviors of enterprises from the perspective of government regulation. Evolutionary game theory is a new theory that combines game theory with dynamic evolution process analysis. Evolutionary game takes a variety of system factors and the causality among the factors as the basis for its modeling and reflects the dynamic behaviors of the system through these causal relationships (Tesfamariam and Lindberg, 2005). In the dynamic and repeated games of enterprises, players with limited information can constantly adjust their strategies, to improve their own interests based on their vested interests, and they can constantly replace less satisfactory situations with more satisfactory solutions, and finally achieve an evolutionary equilibrium strategy that performs better than any new strategy (Tomkins and Hazel, 2007). Therefore, we observe the various possible results of the stable state of evolution and the evolution processes of enterprises, and we explore the conditions for continuous and effective government regulation of greenwashing issues. In addition, this study will overcome the homogeneity hypothesis of players in previous game research because this assumption is too idealistic. From a dynamic point of view, enterprises are heterogeneous because of the long-term accumulation of knowledge and ability (Pennings and Garcia, 2004). In market competition, the different natures of enterprise scale (Zhu et al., 2013), property rights (Hart and Moore, 1990) and entrepreneurs' value (Brettel et al., 2013) determine the strategic preferences of different enterprises. Therefore, based on the heterogeneity of enterprises, this paper builds the evolutionary game models of superior and inferior enterprises.

The rest of the paper is organized as follows: Section 2 presents the problem description, research hypotheses and parameters in the evolutionary game models. Section 3 provides a game model influenced by the government punishment mechanism and then gives the corresponding analysis. Section 4 provides a game model that is influenced by the government tax subsidy mechanism and then gives the relevant analysis. Section 5 focuses on the impact of different influencing factors in the evolution process. Section 6 discusses the results according to real-world issues. Section 7 summarizes the conclusions, and several policy suggestions are proposed.

2. Problem description, research hypotheses, and parameters

In this section, the background of this model is described, and three research hypotheses are proposed. Additionally, the parameters involved in the models are accurately defined.

2.1. Problem description

The China Greenwashing List promulgated by “Southern Weekend” has been published for 8 years and has the following advantages that make it an appropriate choice for use in our study: publicly available information, typical case, and high public participation. It provides an opportunity for us to study the problem of greenwashing. We manually sorted the Chinese “Greenwashing list” of “Southern Weekend” covering eight years, i.e., from 2009 to 2016. The characteristics of the enterprises’ greenwashing practices are summarized in terms of frequency, business nature, industry attribution, and greenwashing style.

(1) In terms of the frequency of the Greenwashing List, there are a total of 151 companies listed, including 76 selected enterprises and 39 candidates. Some companies appear on the list many times. There are 14 enterprises that have been on the list 2 times and 5 companies that appear on the list 3 times. They have a habit of greenwashing.
(2) In terms of the greenwashing style, there are ten greenwashing styles in the Chinese Greenwashing List including “public deception”, “empty promise”, “take the branch for the root”, “policy interference”, “before loosening”, “sound to the west”, “intentional concealment”, “fuzzy sight”, “opposite”, and “double standards”. Among them, “public deception” and “intentional concealment” account for more than 50% of the total offenses. The commonality of these two greenwashing styles is that the companies fail to actually provide green products, but the greenwashing enterprises conceal or deceive consumers.
(3) In terms of the nature of enterprises, companies on the “Greenwashing List” include multinational enterprises in China and local Chinese enterprises. In the early days (2009–2011), most of the companies on the “Greenwashing List” were cross-national companies. Moreover, the number of Chinese local enterprises has increased significantly since the year of 2014.
(4) In terms of industry attribution, there is a more obvious industry greenwashing feature. The selected companies are concentrated in mass consumer goods (32.89%), energy (17.11%), chemicals (14.47%), electronics (10.5%), and medicines (9.21%), while other industries only account for 15.79%.

This paper is based on the bounded rationality of evolutionary game theory. Bounded rationality exists between perfect rationality and incomplete rationality. Simon first proposed the idea of bounded rationality. He considered the limited information acquisition and the computational (cognitive) ability of the players

and believed that they did not pursue utility maximization in the decision-making process, but followed the "satisfaction rule", which means that they achieve a satisfactory value (Simon, 1955). Considering that it is difficult for enterprises to obtain all the information about the rival enterprises in reality, they make decisions based on limited information, and the decisions may be influenced by psychological factors (Badenhorst and Hughes, 2009). Therefore, enterprises can only achieve bounded rationality. Accordingly, this paper assumes that there are two bounded rational players, Enterprise-A and Enterprise-B, in this game model. In addition, their strategic choices have a certain behavioral preference.

According to the above, two greenwashing styles, i.e., "green deception" and "intentional concealment", occur at a higher frequency. Therefore, this paper mainly discusses greenwashing practices focused on these two styles, which means that the enterprises do not produce green products but conceal their practices or deceive consumers into believing that they provide green products or services. The provision of green products or services by companies is often the result of applying green technologies, so this paper assumes that the green innovation strategy is another strategic choice as opposed to corporate greenwashing. Green innovation has been recognized as one of the key factors to achieve growth, environmental sustainability, and better quality of life (Pujari, 2010). Green innovation provides authentic green products for consumers (Triebswetter et al., 2008). Furthermore, this article excludes situations in which some sellers sell both real and fake products because it is a special case that can interfere with the results of the general situation. Therefore, the same firm cannot use green innovation and greenwashing together. In summary, this article assumes that companies can only choose one of two strategies to acquire a competitive advantage and expand their market share. Additionally, the greenwashing strategy and green innovation strategy are mixed strategies, which means that the enterprises participating in the game randomly select the greenwashing strategy or the green innovation strategy with a certain probability value.

At this stage, the government introduced two regulations, which include punishment for greenwashing enterprises and tax subsidy mechanisms for green innovation enterprises to prevent greenwashing. Taking the Chinese punishment mechanism as an example, there are many punishments in different situations. From the perspective of enterprise marketing methods, according to article 28 of the "People's Republic of China Advertising Law", we know that fraudulent or misleading green environmental protection content is one style of fake advertisement. If enterprises violate this article, then the administrative department will punish the greenwashing enterprises according to article 56. First, the greenwashing advertiser is ordered to eliminate the influence within the corresponding scope. Second, the greenwashing advertiser should pay 3–5 times the advertising cost as a penalty. However, if the advertising cost is difficult to calculate, then the greenwashing enterprise must pay a fine of more than 200,000 yuan but less than 1 million yuan. From the perspective of greenwashing enterprises' pollution results, there are as many as 23,173 punishment mechanisms. For instance, Anshan Iron and Steel Co., Ltd. was administratively punished because of environmental violations, and the total penalty was more than 4.2 million yuan in 2017. These environmental violations mainly include "laws that are suspected of violating the environmental pollution prevention measures for solid wastes", "suspected for violating the dust management system", "suspected illegal discharge of pollutants" and "excessive discharge of water pollutants", etc. In addition to these punishments, government departments give green environmental protection enterprise tax incentives as rewards. The Enterprise Income Tax Law was officially implemented in 2008. For example, from 2008 to the end of 2015, the accumulated tax reduction and exemption of income tax for environmental protection and energy-saving enterprises reached more than 80 billion RMB. Therefore, this paper divides government regulations into two situations and compares the different effects of the two mechanisms on preventing enterprises from using greenwashing strategies.

This model will overcome the homogeneity hypothesis of players in previous game research because the enterprise is a complex and structured combination of capabilities and resources. The resource-based theory holds that heterogeneity implies that there are differences in the efficiency of resources owned by enterprises. These differences in efficiency lead to different value creations and generate economic rent. This is necessary for companies to gain competitive advantages (Foss, 1996). Enterprises continue to accumulate knowledge in production operations and expand into production. Due to the specific historical conditions, social complexity, different initial resources of the enterprise, and different problems encountered in the process of enterprise development, the core knowledge and abilities that are accumulated by each enterprise in solving problems are unique. In the specific application, the core knowledge and ability form a dynamic advantage of differentiation. These heterogeneous, scarce, and inimitable knowledge and capabilities are strategic assets of the company, and they create a sustainable competitive advantage for the company. Enterprises are the micromain body of macroeconomics, and the intrinsic characteristics of enterprises have important impacts on enterprises' decision-making behaviors, overall economic development, and government regulation of greenwashing. Therefore, introducing the heterogeneity of enterprises into this model is very meaningful in theory and in practice.

In this model, it is assumed that Enterprise-A has accumulated knowledge in production and operation and has strong advantages in the field of green production. Compared with Enterprise-A, the core knowledge of Enterprise-B is scarce and weak. Therefore, Enterprise-A is the dominant enterprise, and Enterprise-B is the inferior enterprise due to heterogeneity. Even if they choose the same strategy, they will have different incomes and costs because of the differences in the use of capabilities and resources (Ryzhkova and Pes, 2015; Chen and Huang, 2009). Therefore, the heterogeneity proportional coefficient in this model indicates the heterogeneity between Enterprise-A and Enterprise-B. Enterprise-A is the dominant enterprise, and its heterogeneity difference ratio coefficient is between 0.5 and 1. The Enterprise-B heterogeneity difference ratio coefficient is between 0 and 0.5.

2.2. Research hypotheses

This article studies the evolutionary games between heterogeneous enterprises influenced by the government punishment mechanism and the tax subsidy mechanism. The following assumptions are proposed:

(1) We assume that the strategies of two bounded rational players, Enterprise-A and Enterprise-B, are {green innovation, greenwashing}.
(2) Enterprise-A and Enterprise-B have different levels of capabilities and resources, so there exists heterogeneity between the two enterprises. It is assumed that the heterogeneity difference ratio coefficient determines the market return and the cost of conflict shared by players.
(3) It is assumed that, under the influence of the constraints of governance mechanisms, green innovation and greenwashing behaviors will all be discovered and are subject to the corresponding punishment or tax incentives.

2.3. Parameters

Due to the externalities of green products, the companies choose either the greenwashing strategy or green innovation strategy, and the game process where enterprises try their best to maximize profits is similar to the classic Hawk–dove game (Cressman, 1992). The hawk-dove game studies the strategic balance of internal competition and conflict. In this game, the hawk represents the "aggressive" strategy and the dove represents the "peaceful" strategy. When the players of this game compete with each other instead of using the "peaceful" strategy, the player taking the attack strategy will gain more benefits than adopting a peaceful strategy. If both players adopt an aggressive strategy, they will fail and both will lose resources.

In the game system of two enterprises greenwashing, there are three circumstances that occur if we do not take governmental regulation of greenwashing into consideration.

In the first case, when both players choose the green innovation strategy, that is a peaceful strategy; both players will share the benefits, and their market income is determined by the proportional heterogeneity coefficient. Therefore, the respective incomes of Enterprise-A and Enterprise-B are $mR - C_1, (1 - m)R - C_1$.

In the second case, both players choose greenwashing. Considering the social responsibility of the enterprises, there is a certain psychological cost for enterprises that greenwash. Corporate social responsibility (CSR) means that while creating profits and benefiting shareholders and employees, enterprises must also pay attention to external factors, such as consumers, communities and the environment (Carroll, 1991). The cost of psychological loss is reflected in the sense of guilt when the greenwashing enterprises cause harm to the real green innovative enterprises and consumers because the amount consumers pay does not match the expected level. This model uses C_2 to represent the psychological loss cost of greenwashing enterprises ($C_2<C_1$). At this time, if both players have chosen the greenwashing strategy, then the players will fail and lose market income. This model uses "c" to represent market losses. Therefore, the respective incomes of Enterprise-A and Enterprise-B are $m(R - c) - C_2, (1 - m)(R - c) - C_2$.

In the third case, if one player adopts the green innovation strategy and another player adopts the greenwashing strategy, then greenwashing as a speculative behavior will appropriate part of the income of the enterprise that originally chose the green innovation strategy. In this model, the predation coefficient "v" indicates the phenomenon where the income will be transferred to the fraudulent participants. Therefore, the incomes of Enterprise-A and Enterprise-B are $(m+v)R-C_2, (1-m-v)R-C_1$ or $(m-v)R - C_1, (1 - m + v)R - C_2$.

In addition, parameter "P" is added to represent the penalties for the greenwashing enterprises in the model of government punishment mechanisms, and the punishment includes fines, the loss of reputation, etc.; these are converted into fines in this model because they are easy to calculate and compare. Additionally, parameter b, which represents the tax incentives for green innovative companies, is added to the model of the government tax incentive mechanism. The parameters are described in Table 1.

3. A game model influenced by the government punishment mechanism

3.1. This model

Assume that the ratio of dominant Enterprise-A adopting the green innovation mixed strategy is X ($0 \le X \le 1$) and the ratio of adopting the greenwashing mixed strategy is 1-X. The ratio of Enterprise-B adopting the green innovation mixed strategy is Y ($0 \le Y \le 1$), and the ratio of adopting the greenwashing mixed strategy is 1-Y. The payment matrix is shown in Table 2.

Under the premise that Enterprise-A chooses the green innovation strategy when Enterprise-B adopts the strategy of green innovation and greenwashing, the sum of Enterprise-A's expected income value is as follows (Li et al., 2014):

$$\pi_A^X = (mR - C_1) + (1 - Y)(-vR) \tag{1}$$

Under the premise that Enterprise-A chooses the greenwashing strategy when Enterprise-B adopts the strategy of green innovation and greenwashing, the sum of Enterprise-A's expected income value is as follows:

$$\pi_A^{1-X} = Y(vR + cm) + (R - c)m - C_2 - P \tag{2}$$

Therefore, the average value of Enterprise-A's income is as follows:

$$\pi_A = \pi_A^X X + \pi_A^{1-X}(1 - X) \tag{3}$$

Under the premise that Enterprise-B chooses the green innovation strategy when Enterprise-A chooses the strategy of green innovation and greenwashing, the sum of Enterprise-B's expected income value is as follows:

$$\pi_B^Y = R(1 - m) + (X - 1)Rv - C_1 \tag{4}$$

Under the premise that Enterprise-B chooses the greenwashing strategy when Enterprise-A chooses the strategy of green innovation and greenwashing, the sum of Enterprise-B's expected income value is as follows:

$$\pi_B^{1-Y} = X(vR + c - mc) + (1 - m)(R - c) - C_2 - P \tag{5}$$

Therefore, the average value of Enterprise-B's income is as follows:

$$\pi_B = \pi_B^y Y + \pi_B^{1-Y}(1 - Y) \tag{6}$$

According to the basic principles of the evolutionary game, from formulas (1) and (3), Enterprise-A chooses the green innovation strategy's duplicate replication dynamic equation as follows:

$$\frac{dX}{dt} = X(1 - X)(-vR - C_1 + C_2 + cm - Ycm + P) \tag{7}$$

According to the basic principles of the evolutionary game, from formulas (4) and (6), Enterprise-B chooses the green innovation strategy's duplicate replication dynamic equation as follows:

$$\frac{dY}{dt} = [(1 - m)c + C_2 - Rv - C_1 - (1 - m)Xc + P] \times Y(1 - Y) \tag{8}$$

Therefore, the system's Jacobian matrix is as follows (Jin et al., 2018):

$$J = \begin{pmatrix} J_1 & J_2 \\ J_3 & J_4 \end{pmatrix}$$

$$J_1 = (1 - 2X)(-vR - C_1 + C_2 + cm - Ycm + P)$$
$$J_2 = X(1 - X)(-cm)$$
$$J_3 = Y(1 - Y)(m - 1)c$$
$$J_4 = (1 - 2Y)[(1 - m)c + C_2 - Rv - C_1 - (1 - m)Xc + P]$$

By analyzing the Jacobian matrix of the system, the following five singularities of the system are available: A(0,0), B(0,1), C(1,0), D(1,1), and E(X′, Y′).

Table 1
Parameter setting.

Parameter	Definition	Value range
X	The probability of Enterprise-A choosing the green innovation strategy.	$0 \le X \le 1$
Y	The probability of Enterprise-B choosing the green innovation strategy.	$0 \le Y \le 1$
R	Benefits from green innovation in the market.	$R > 0$
c	Market losses.	$c > v$
m	Heterogeneity difference ratio coefficient of Enterprise-A.	$0.5 \le m < 1.0$
1-m	Heterogeneity difference ratio coefficient of Enterprise-B.	$0 < 1\text{-}m \le 0.5$
v	Plunder coefficient that indicates the phenomenon where the income will be transferred to the fraudulent participants.	$0 < v < (1\text{-}m)$
C_1	The cost of selecting green innovation strategy.	$C_1 > 0$
C_2	The psychological loss cost of selecting greenwashing strategy.	$C_2 > 0$, $C_2 < C_1$
P	Penalties for companies that implement greenwashing behavior (including fines, the loss of reputation, etc.; these are converted into fines in this model).	$P > 0$
b	Tax compensation coefficient.	$0 \le b \le 1$

Table 2
The payoff matrix under the government punishment mechanism.

		Enterprise-B	
		Green innovation (Y)	Greenwashing (1-Y)
Enterprise-A	Green innovation (X)	$mR - C_1, (1-m)R - C_1$	$(m-v)R - C_1, (1-m+v)R - C_2 - P$
	Greenwashing (1-X)	$(m+v)R - C_2 - P, (1-m-v)R - C_1$	$m(R-c) - C_2 - P, (1-m)(R-c) - C_2 - P$

$$X' = \frac{(1-m)c + C_2 - Rv - C_1 + P}{(1-m)c}, Y' = \frac{-Rv - C_1 + C_2 + mc + P}{mc}$$

3.2. Model analysis

Regarding the contents in Section 2, under the government punishment mechanism, three cases are possible in this game according to the size relationships between the costs and benefits of the players. The state analysis of the local equilibrium points (LEP), the evolutionarily stable strategy (ESS) and the evolutionary state are shown in Table 3.

(1) Case 1: As depicted in Table 3, the mixed strategy space of this game is denoted as area ABCD, A(0, 0) is the ESS. In this case, their strategies will evolve in the same direction of greenwashing. This case is unfavorable for the government and is not viable for the market.
(2) Case 2: As depicted in Table 3, the evolutionary game system converges to point C(1,0); point C is the dominant strategy of the players. At this time, the difference in the market returns between green innovation and greenwashing determines that the enterprises have different selections. The dominant Enterprise-A would tend to be a green and innovative enterprise, and the inferior Enterprise-B would tend to greenwash. In this case, Enterprise-B has lower motivations to select green innovation, and the government punishment would be ineffective. Enterprise-B would choose greenwashing, although government punishment plays an important role in preventing Enterprise-A from greenwashing.
(3) Case 3: As depicted in Table 3, the evolutionary game system converges to point D(1,1), D is the dominant strategy in this process. In this case, their strategies will evolve in the same direction of green innovation. In this case, the cost of green innovation is less than the cost of greenwashing. Therefore, based on the idea of bounded rationality, Enterprises-A and Enterprises-B will both choose the green innovation strategy.

3.3. System simulation analysis

In this section, the MATLAB system is used to simulate the

Table 3
The evolutionary stability state under the government punishment mechanism.

Cases	LEP	detJ	trJ	state
Case 1:	A(0,0)	+	−	ESS
$C_2 + cm + P < Rv + C_1$	B(0,1)	−	−	saddle
	C(1,0)	−	−	saddle
	D(1,1)	+	+	unstable
	E(x,y)	+	0	saddle
Case 2:	A(0,0)	−	+	unstable
$C_2 + P + (1-m)c < Rv + C_1 < P + C_2 + mc$	B(0,1)	−	−	saddle
	C(1,0)	+	−	ESS
	D(1,1)	+	+	unstable
	E(x,y)	+	0	saddle
Case 3:	A(0,0)	+	+	unstable
$C_2 + P > Rv + C_1$	B(0,1)	−	uncertain	saddle
	C(1,0)	−	uncertain	saddle
	D(1,1)	+	−	ESS

dynamic evolution to observe the evolution process of the enterprises' strategies more intuitively. The parameters are set as follows:

In case 1, R = 300, c = 100, C_1 = 70, C_2 = 10, v = 0.1, m = 0.7, and P = 10, as shown in Fig. 1.

In case 2, R = 300, c = 100, C_1 = 50, C_2 = 10, v = 0.1, m = 0.7, and P = 30, as shown in Fig. 2.

In case 3, R = 300, c = 100, C_1 = 60, C_2 = 10, v = 0.1, m = 0.7, and P = 100, as shown in Fig. 3.

(1) Case 1: When X and Y are given five different initial values of 0.1, 0.3, 0.5, 0.7, and 0.9 at the same time, point A(0,0) is the ESS in this system. At this time, the cost of greenwashing is lower than the cost of green innovation. Based on bounded rational thinking, Enterprise-A and Enterprise-B both choose greenwashing strategies, and this result is consistent with the model result.
(2) Case 2: When X and Y are simultaneously given five different initial values, point C(1,0) is the ESS in this system, and this result is consistent with the model result.
(3) Case 3: When X and Y are simultaneously given five initial values of 0.1, 0.3, 0.5, 0.7, and 0.9, point D(0,1) is the ESS in this system, and this result is consistent with the model result.

In summary, the government punishment mechanism can effectively control the problem of greenwashing of both dominant and inferior enterprises, and the responses of the dominant enterprises to the punishment mechanism are more evident and rapid.

4. A game model influenced by the tax subsidy mechanism

4.1. This model

This part mainly discusses the game model under the government tax subsidy mechanism. The government implements a tax compensation policy for enterprises that carry out green innovation. This policy will directly or indirectly reduce the cost of green innovation. In this model, b explains the tax subsidy coefficient. Under the tax subsidy mechanism, the payment matrix of the heterogeneous enterprises is shown in Table 4.

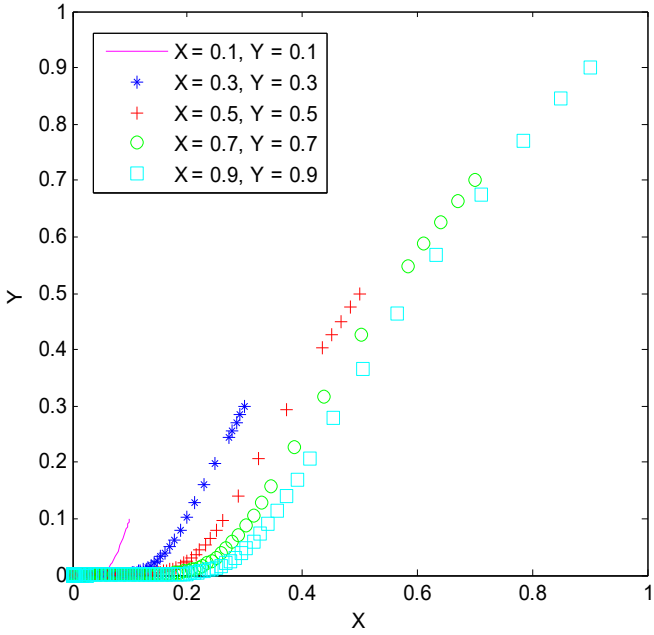

Fig. 1. ESS analysis of case 1.

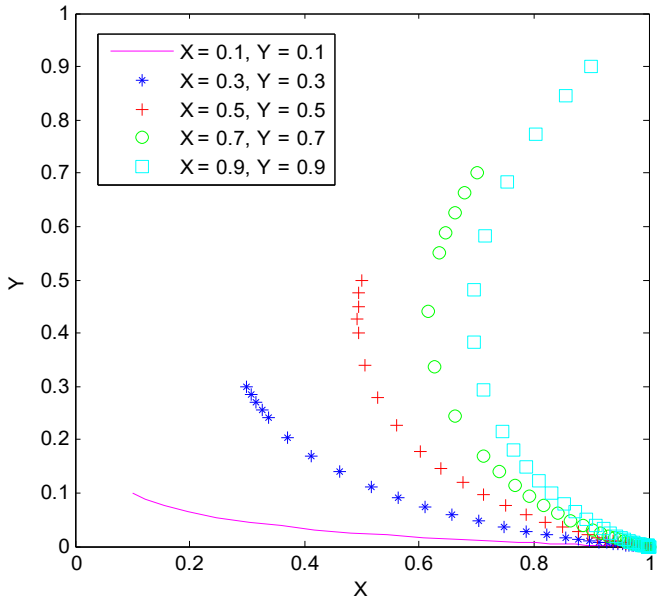

Fig. 2. ESS analysis of case 2.

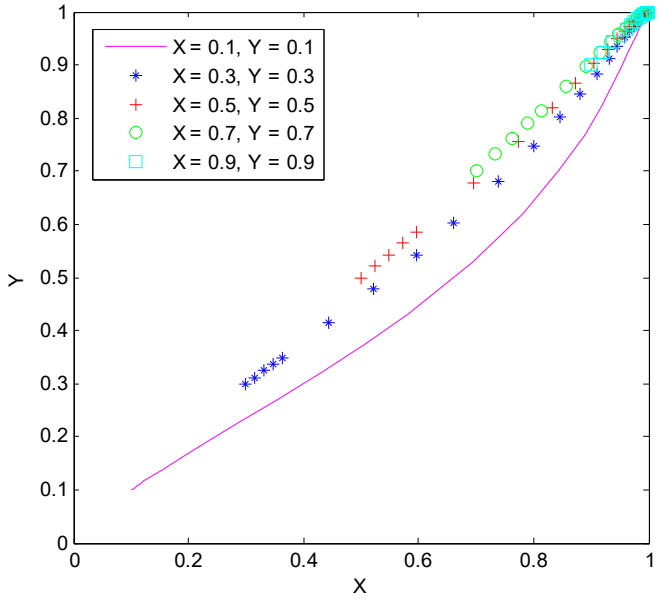

Fig. 3. ESS analysis of case 3.

Under the premise that Enterprise-A chooses the green innovation strategy when Enterprise-B adopts the strategy of green innovation and greenwashing, the sum of Enterprise-A's expected income value is as follows (Li et al., 2014):

$$\pi_A^X = [mR - C_1(1-b)] + (1-Y)(-Rv) \quad (9)$$

Under the premise that Enterprise-A chooses the greenwashing strategy, when Enterprise-B adopts the strategy of green innovation and greenwashing, the sum of the Enterprise-A's expected income value is as follows:

Table 4
The payoff matrix under the tax subsidy mechanism.

		Enterprise-B	
		Green innovation (Y)	Greenwashing (1-Y)
Enterprise-A	Green innovation (X)	$mR - C_1(1-b), R(1-m) - C_1(1-b)$	$(\mathrm{m}-\mathrm{v})R - C_1(1-b), (1-\mathrm{m}+\mathrm{v})R - C_2$
	Greenwashing (1-X)	$R(m+v) - C_2, (1-m-v)R - C_1(1-b)$	$(R-c)m - C_2, (1-m)(R-\mathrm{c}) - C_2$

$$\pi_A^{1-\mathrm{X}} = Y(vR + cm) + (R-c)m - C_2 \tag{10}$$

Therefore, the average value of Enterprise-A's income is as follows:

$$\pi_A = X\pi_A^{\mathrm{X}} + (1-X)\pi_A^{1-\mathrm{X}} \tag{11}$$

Under the premise that Enterprise-B chooses the green innovation strategy, when Enterprise-A chooses the strategy of green innovation and greenwashing, the sum of Enterprise-B's expected income value is as follows:

$$\pi_B^{\mathrm{Y}} = (1-c)R - R\mathrm{v} - C_1(1-b) + XR\mathrm{v} \tag{12}$$

Under the premise that Enterprise-B chooses the greenwashing strategy, when Enterprise-A chooses the strategy of green innovation and greenwashing, the sum of the Enterprise-B's expected income value is as follows:

$$\pi_B^{1-\mathrm{Y}} = (R\nu - m\mathrm{c} + \mathrm{c})X + (R-\mathrm{c})(1-m) - C_2 \tag{13}$$

Therefore, the average value of Enterprise-B's income is as follows:

$$\pi_B = Y\pi_B^{\mathrm{Y}} + (1-Y)\pi_B^{1-\mathrm{Y}} \tag{14}$$

According to the basic principles of the evolutionary game, from formulas (1) and (3), Enterprise-A chooses the green innovation strategy's duplicate replication dynamic equation as follows:

$$\frac{dX}{dt} = X(1-X)[-R\nu - C_1(1-b) + C_2 + cm - Ycm] \tag{15}$$

According to the basic principles of the evolutionary game, from formulas (4) and (6), Enterprise-B chooses the green innovation strategy's duplicate replication dynamic equation as follows:

$$\frac{dY}{dt} = Y(1-Y)[(1-m)c + C_2 - R\mathrm{v} - C_1(1-b) - (1-m)Xc] \tag{16}$$

Therefore, the system's Jacobian matrix is as follows (Jin et al., 2018):

$$J = \begin{pmatrix} J_1 & J_2 \\ J_3 & J_4 \end{pmatrix}$$

$$J_1 = (1-2X)(-R\nu - C_1(1-b) + C_2 + cm - Ycm)$$
$$J_2 = X(1-X)(-cm)$$
$$J_3 = Y(1-Y)c(1-m)$$
$$J_4 = (1-2Y)[(1-m)c + C_2 - C_1(1-b) - (1-m)Xc]$$

By analyzing the Jacobian matrix of the system, the following five singularities of the system are available: A (0,0), B (0,1), C (1,0), D (1,1), and E (x', y')

$$\mathrm{x}' = \frac{(1-m)c + C_2 - R\mathrm{v} - C_1(1-b)}{(1-\mathrm{m})\mathrm{c}},$$
$$\mathrm{y}' = \frac{-\mathrm{vR} - C_1(1-b) + C_2 + \mathrm{cm}}{\mathrm{cm}}\Big)$$

4.2. Model analysis

Under the government tax subsidy mechanism, three cases are possible in this model. The evolutionary stability of the local equilibrium points is shown in Table 5.

(1) Case 1: Point A(0,0) is the ESS in this case. At this time, the cost of greenwashing is less than the cost of green innovation. Based on bounded rational thought, Enterprise-A and Enterprise-B would both select the “greenwash” strategy. Unfortunately, the tax subsidy mechanism would not affect the enterprises.
(2) Case 2: Point C(1,0) is the dominant strategy in this system. Compared with inferior enterprises, the dominant enterprises have a greater market share because of their dominant position in the market. The low-level tax compensation can effectively encourage the dominant enterprises to pick a green innovation strategy. Therefore, the dominant Enterprise-A would tend to choose the “green innovation” strategy over time, while the inferior Enterprise-B would tend to choose the greenwashing strategy.
(3) Case 3: Point D(1,1) is the ESS in this case. Both Enterprise-A and Enterprise-B would tend to select the green innovation strategy. In case 3, the preconditions are more demanding. First, it has to ensure that the predation coefficient is small. On one hand, this means that the speculative enterprises have little influence on the market share belonging to the green and innovative enterprises. On the other hand, consumers must have a higher discrimination ability for green products to reduce the predation coefficient. Second, the psychological loss cost of the greenwashing enterprises should be at a high level, and the cost of green innovation should be relatively lower than it was before. Only in this way would the differential cost between the two selections be small. In reality, the cost of green innovation is higher than the cost of ordinary production activities, so it is difficult to satisfy this precondition. Additionally, the tax subsidy coefficient should be relatively high. In contrast, a higher tax compensation coefficient implies that the government should invoke higher financial pressure. Higher financial pressure may reduce the enthusiasm of officials. Therefore, in reality, it is difficult to meet the preconditions in case 3. In summary, the tax subsidy mechanism cannot effectively control the greenwashing practices of inferior enterprises.

4.3. System simulation analysis

The MATLAB system is used to simulate the dynamic evolution.

Table 5
The evolutionary stability state under the government tax subsidy mechanism.

Cases	LEP	detJ	trJ	state
Case 1: $C_2 + cm < Rv + C_1(1-b)$	A(0,0)	+	−	ESS
	B(0,1)	−	−	saddle
	C(1,0)	−	−	saddle
	D(1,1)	+	+	unstable
	E(x,y)	+	0	saddle
Case 2: $C_2 + (1-m)c < Rv + C_1(1-b) < C_2 + mc$	A(0,0)	−	+	saddle
	B(0,1)	−	−	saddle
	C(1,0)	+	−	ESS
	D(1,1)	+	+	unstable
	E(X,y)	+	0	saddle
Case 3: $C_2 > Rv + C_1(1-b)$	A(0,0)	+	+	unstable
	B(0,1)	−	uncertain	saddle
	C(1,0)	−	uncertain	saddle
	D(1,1)	+	−	ESS

Its purpose is to test the model results and observe the evolution path more vividly. The parameters are set as follows:

In case 1, R = 300, c = 100, C_1 = 70, C_2 = 10, v = 0.1, m = 0.7, and b = 0.1, as is shown in Fig. 4.

In case 2, R = 300, c = 100, C_1 = 50, C_2 = 10, v = 0.1, m = 0.7, and b = 0.1, as is shown in Fig. 5.

In case 3, R = 200, c = 100, C_1 = 50, C_2 = 30, v = 0.01, m = 0.7, and b = 0.5, as is shown in Fig. 6.

(1) Case 1: X and Y are given the five different initial values of 0.1, 0.3, 0.5, 0.7, and 0.9 at the same time. The evolutionary game system converges to the point A(0,0), and this result is consistent with the model result.
(2) Case 2: X and Y are simultaneously given five different initial values. The evolutionary game system converges to the point C(1,0), and this result is consistent with the model result.
(3) Case 3: X and Y are simultaneously given five different initial values. The evolutionary game system converges to point D(1,1). At this time, the cost of green innovation is less than the cost of greenwashing. Enterprise-A and Enterprise-B would choose green innovation, and this result is consistent with the model result.

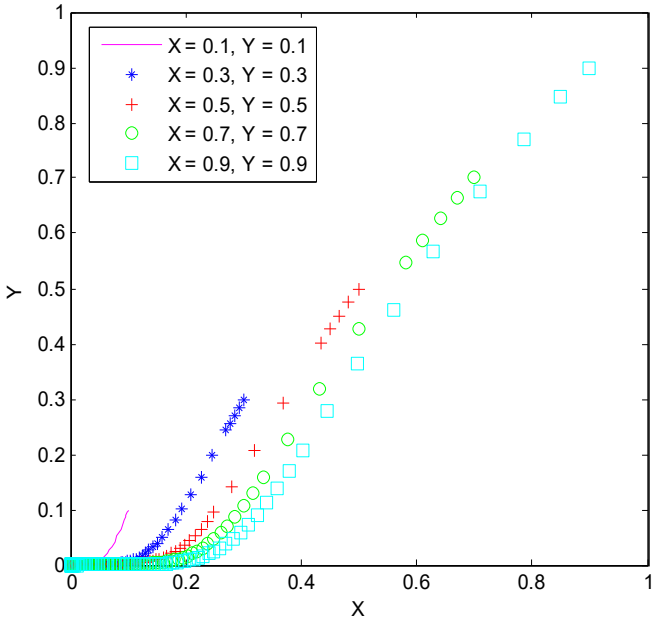

Fig. 4. ESS analysis of case 1.

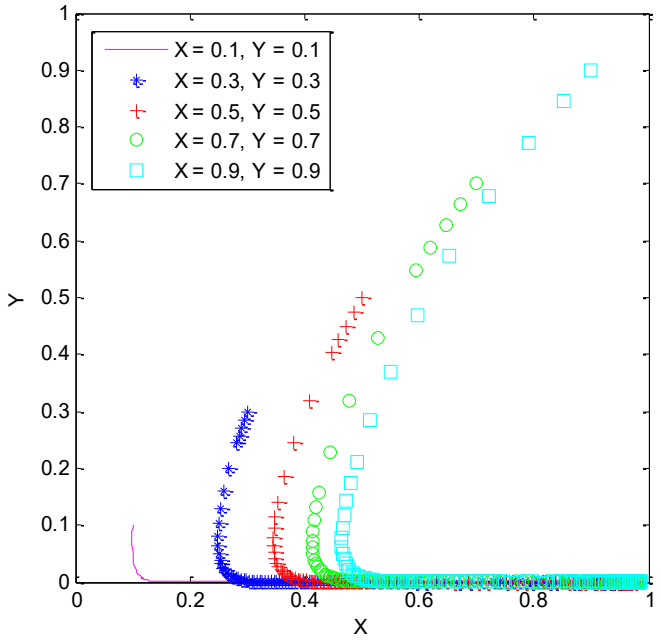

Fig. 5. ESS analysis of case 2.

Based on the above three cases, it is more likely that a tax subsidy mechanism can control the greenwashing behaviors of heterogeneous enterprises in a more effective way; once the predation coefficient becomes small, the cost difference between the two strategies becomes small, and the tax compensation coefficient becomes high. Therefore, the government tax subsidy mechanism can effectively govern the greenwashing practices of inferior enterprises only under certain circumstances. Luckily, the government tax subsidy mechanism has a good effect on dominant enterprises because of the proportional heterogeneity coefficient.

5. System simulation analysis

This chapter focuses on the impact of different influencing factors on the evolution of the system. Based on the above, the factors affecting the ESS of heterogeneous enterprises include the enterprise proportional heterogeneity coefficient, the total market returns, the cost of green innovation, the cost of psychological loss,

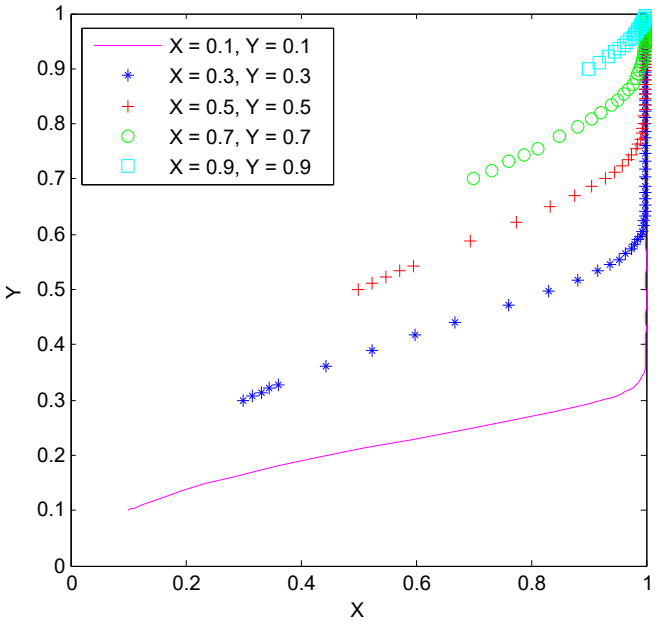

Fig. 6. ESS analysis of case 3.

the predation coefficient, the market losses, the government punishment amount and the tax compensation coefficient. To avoid redundancy, we will not analyze them separately. Therefore, we use a sensitivity analysis method by Hu and Rao (2009) to analyze the influence of the proportional heterogeneity coefficient, government penalty amount and tax subsidy coefficient on the ESS of the enterprises.

5.1. The influence of the heterogeneity difference ratio coefficient of on the ESS of enterprises

In this section, we change the value range of the proportional heterogeneity coefficient under the government penalty mechanism and observe the ESS change.

Model 1: $R = 300$, $c = 100$, $C_1 = 50$, $C_2 = 5$, $v = 0.1$ and $P = 10$; the ESS analysis is presented in Fig. 7.

Model 2: $R = 300$, $c = 100$, $C_1 = 50$, $C_2 = 10$, $v = 0.1$ and $P = 90$; the ESS analysis is presented in Fig. 8.

According to Fig. 7, as m increases continuously, the ESS changes from point A(0,0) to point C(1,0). The heterogeneous proportion coefficient has a more significant effect on the evolutionary process of dominant enterprises than other enterprises. Inferior enterprises in particular are not affected by it.

In this example, it is shown that increasing m leads to the deceleration of the convergence rate when m is less than 0.65. The ESS would change when the critical value is 0.65. Considering the heavy punishment pressure caused by greenwashing, dominant enterprises would select the green innovation strategy. When m is more than 0.65, increasing m leads to an accelerating convergence rate.

According to Fig. 8, although m is increasing, the ESS is still point D(1, 1). In this case, the proportional heterogeneity coefficient does not influence the strategy selection of the enterprises. The underlying reason is the high penalties for greenwashing enterprises by the government. Compared with dominant enterprises that occupy a high market share, inferior enterprises gain fewer benefits from green innovation and invest with less enthusiasm because of the inferior market position. However, faced with the great punishment caused by greenwashing, inferior enterprises only select the

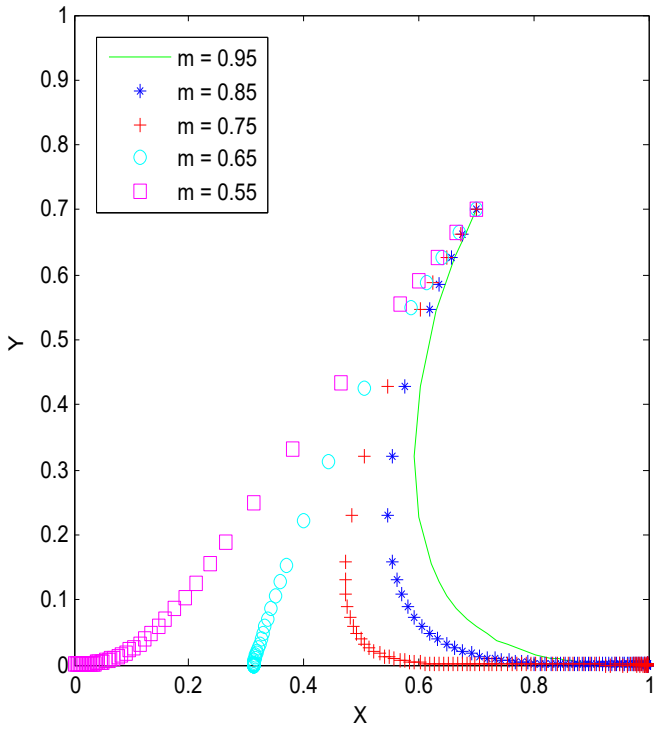

Fig. 7. ESS analysis when m of Model 1 changes.
Note: "m" represents the proportional heterogeneity coefficient.

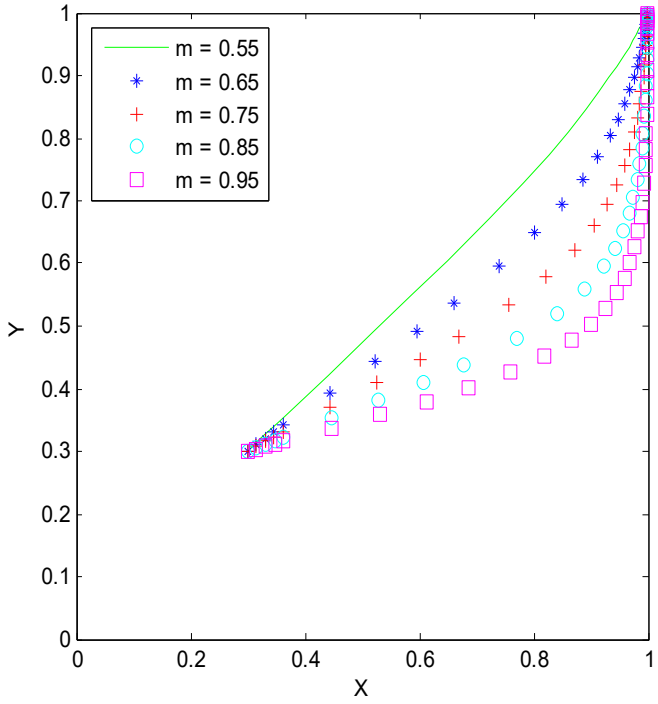

Fig. 8. ESS analysis when m of Model 2 changes.
Note: "m" represents the proportional heterogeneity coefficient.

green innovation strategy. However, in reality, greenwashing is deceptive. Therefore, it cannot be fully discovered and punished by the government. In this model, we assume that enterprises only have two selections, but in reality, enterprises can choose other strategies in specific practice besides the green innovation strategy

or the greenwashing strategy. If the proportional heterogeneity coefficient is 0.5, then the heterogeneity gap between superior and inferior enterprises is smallest, and in this way, their strategic choices and convergence speed would maintain a balanced position. When m is greater than 0.5, the heterogeneity gap is larger than in the previous situation. Above all, with the difference in the convergence speed of the dominant and inferior enterprises increasing, the dominant enterprises can more quickly push the strategic choice to equilibrium.

5.2. The influence of the government punishment amount on the ESS of enterprises

P represents the penalties for companies that implement greenwashing behaviors, and the penalties include fines, the loss of reputation, etc.; in this model, these are converted into fines because the size relationships of fines are easy to compare and understand.

Model 1 The parameters are assumed as follows: $R = 300$, $c = 100$, $C_1 = 90$, $C_2 = 10$, $v = 0.1$, and $m = 0.7$. The dynamic evolutionary process with the increase from 0 to 40 of the parameter "P" is shown in Fig. 9.

Model 2 The parameters are assumed as follows: $R = 300$, $c = 100$, $C_1 = 50$, $C_2 = 10$, $v = 0.1$, and $m = 0.7$. The dynamic evolutionary process with the increase from 30 to 70 of the parameter "P" is shown in Fig. 10.

According to Fig. 9, even if the probability of the enterprises' initial selection rate of green innovation is 0.9, over time, they would eventually select the greenwashing strategy. In this example, the government punishment mechanism has no governance effect on enterprises.

According to Fig. 10, as P increases, the ESS transfers from point A(0,0) to point B(0,1) to point D(1,1). The high penalty has a significant effect on the strategy selection of dominant and inferior enterprises, and dominant enterprises respond to government penalties more rapidly and obviously than inferior enterprises.

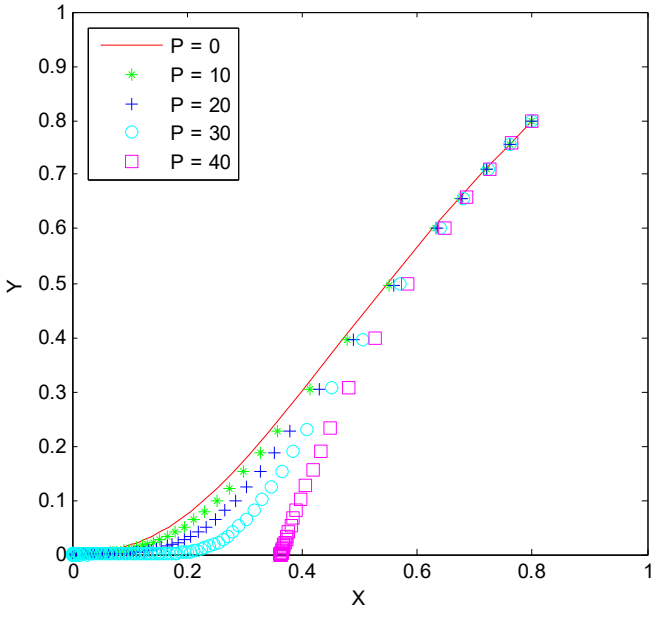

Fig. 9. ESS analysis when P of Model 1 changes.
Note: "P" represents government punishment amount for companies that implement greenwashing behavior.

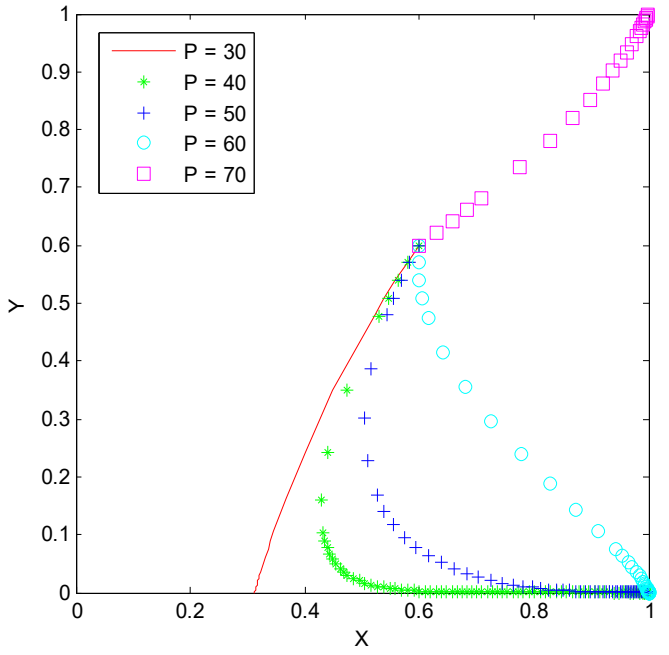

Fig. 10. ESS analysis when P of Model 2 changes.
Note: "P" represents government punishment amount for companies that implement greenwashing behavior.

In this example, the critical values of P are 40 and 70. When P is less than 40 and P is increasing, the convergence speed of the two types of enterprises to the greenwashing strategy slows, which indicates that the punishment amount causes some enterprises to hesitate about the selection of greenwashing. When P is greater than 40 and less than 70 and P is increasing, the dominant enterprises would gradually converge to the green innovation strategy, and the convergence speed accelerates. At this time, dominant enterprises own high market return because of their dominant position, so a low amount of punishment can be an effective warning for them. At the same time, inferior enterprises decelerate to greenwashing. When P is greater than 70 and P is increasing, both types of enterprises would converge to the green innovation strategy at a high speed. Therefore, the government punishment mechanism is significantly effective.

Above all, by observing the preconditions of the model, we can determine whether the government punishment amount plays a major role in the governance of the greenwashing of dominant and inferior enterprises. In this model, the preconditions should ensure that the potential cost of greenwashing, including the psychological loss cost and the government punishment amount, is greater than the sum of innovation costs, including the green innovation and the appropriated gains.

5.3. The influence of the tax subsidy coefficient on the ESS of enterprises

Model 1: The parameters are assumed as follows: $R = 300$, $c = 100$, $C_1 = 80$, $C_2 = 10$, $v = 0.1$, and $m = 0.7$. The dynamic evolutionary process with the increasing from 0.075 to 0.475 of the parameter "b" is shown in Fig. 11.

Model 2: The parameters are assumed as follows: $R = 200$, $c = 100$, $C_1 = 50$, $C_2 = 30$, $v = 0.01$, and $m = 0.7$. The dynamic evolutionary process with the increasing from 0.24 to 0.64 of the parameter "b" is shown in Fig. 12.

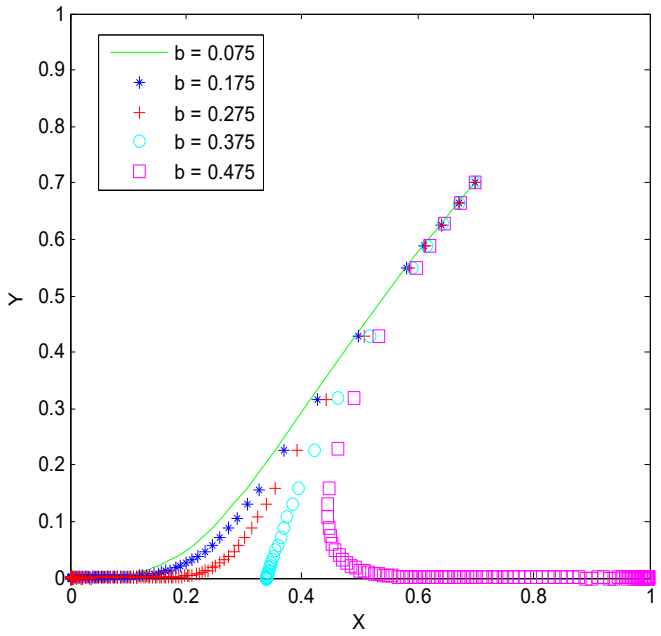

Fig. 11. ESS analysis when b of Model 1 changes.
Note: "b" represents the tax subsidy coefficient.

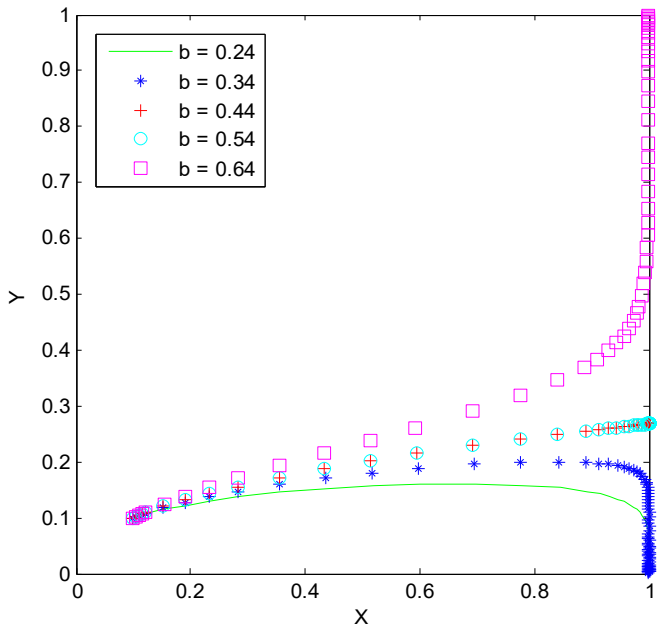

Fig. 12. ESS analysis when b of Model 2 changes.
Note: "b" represents the tax subsidy coefficient.

According to Fig. 11, when b increases, the ESS in this system transfers from point A(0,0) to point B(0,1), which suggests that the tax compensation coefficient has an impact on the strategic selection of dominant enterprises. In this example, 0.375 is the critical value of b. When b is less than 0.375, with the increase of b, both inferior and dominant enterprises still converge to the greenwashing strategy; fortunately, the convergence rate is slowed down. When b is greater than 0.375, with the increase of b, the dominant enterprises change their strategic selection and gradually converge to the green innovation strategy.

From Fig. 12, we can see that as b increases, the ESS in this system transfers from point C(1,0) to point D(1,1). In this example, 0.54 is the critical value of b. When b is less than 0.54 and b is increasing, the inferior enterprises slowly converge to the greenwashing strategy; at the same time, the dominant enterprises converge to the green innovation strategy at a high speed. When b is greater than 0.54, both types of enterprises converge to the green innovation strategy. Additionally, the convergence rate of dominant enterprises remains at a high level, while inferior enterprises' convergence rate clearly changes. The high tax compensation coefficient has a significant impact on the strategic selection of the enterprises. The evolution process of the dominant enterprise's strategy is more affected by the tax compensation coefficient. This result is the same as that in the government penalty mechanism model. However, the preconditions of this example are more difficult to realize in reality.

6. Discussion

The above theoretical model illustrates the equilibrium point and evolution process of the dominant and inferior enterprises influenced by the government punishment mechanism and tax subsidy mechanism in the evolutionary game. At the same time, it analyzes of the impact of the heterogeneity difference ratio coefficient, the penalty amount, and the tax subsidy coefficient on the decision making of both sides of the game. This paper enriches the literature on the prevention of greenwashing, and it supplements the research on the validity of implementing a government regulation for greenwashing, which is a severe problem in practice and is rarely discussed in depth (Duan et al., 2016). This section will provide more information for research through a discussion of real-world issues.

(1) Does the government punishment mechanism prevent greenwashing?

In the three cases of the greenwashing model influenced by the government punishment mechanism, A(0,0), C(1,0), D(1,1) are the possible ESS points. In case 1, A(0,0) is the ESS, which means that Enterprise-A and Enterprise-B both choose the greenwashing strategy. In case 2, C(1,0) is the ESS, which means that Enterprise-A chooses the green innovation strategy and Enterprise-B chooses the greenwashing strategy. In case 3, D(1,1) is the ESS, which means that Enterprise-A and Enterprise-B both choose the green innovation strategy. In case 3, the cost of green innovation is less than the cost of greenwashing. Considering the aim of maximizing benefits, Enterprises-A and Enterprises-B would choose the green innovation strategy. Therefore, the government punishment mechanism effectively prevents greenwashing under certain circumstances and promotes the development of green innovation continuously.

As the government punishment amount increases, the dominant enterprises abandon the greenwashing strategy and choose a green innovation strategy, and then the inferior enterprises change their strategic selection. When the potential cost of a greenwashing strategy is greater than the potential cost of a green innovation strategy, green innovation strategy has become the dominant choice for all enterprises. Therefore, the green innovation strategy has become the only evolutionary stable state of the game. Additionally, the greater the punishment amount, the faster the strategy will evolve into a green innovation strategy. This conclusion supports the conclusion of the researcher to some extent. Wang, H., et al. proved that punishment can help the model achieve a balanced evolution, which could in turn help solve environmental problems (Wang et al., 2011). Therefore, the premise that the government punishment mechanism is an effective mechanism for

greenwashing governance is that the benefits of greenwashing are far less than the benefits of green innovation. However, we still need to consider another problem.

In this paper, it is assumed that the green innovation behaviors and greenwashing behaviors under the constraints of governance mechanisms will be discovered completely and are subject to the corresponding punishment or tax incentives. However, in reality, it is impossible to be comprehensive and thorough by government supervision alone. Therefore, to prevent and control greenwashing, a multiagent supervision system needs to be established. The government needs to encourage the public, industry institutions and third-party supervisors to participate in the supervision of corporate greenwashing behavior (Delmas and Burbano, 2011).

(1) Does the government tax subsidy mechanism prevent greenwashing?

In the three cases of the model influenced by the tax subsidy mechanism, A(0,0), C(1,0), and D(1,1) are the possible ESS points. B(0,1) cannot become the ESS. This shows that Enterprise-B will not choose the green innovation strategy. The ESS result is the same as the government punishment mechanism; however, reaching the precondition of D(1,1) as the ESS is difficult according to the observation and in reality. There are three reasons for this, which are as follows:

Initially, the government gives tax subsidies to innovative green enterprises, and these subsidies will reduce the costs of innovation. However, the problem is that a government financial burden is induced by raising tax subsidies without considering the cost. The high financial burden will decrease the enthusiasm of government officials to manage the greenwashing. Therefore, the high financial burden is not advisable. This is similar to Yang Y.'s view on government regulation in e-waste recycling. Yang Y., et al. believe that if the government subsidies and penalties are large enough, then producer groups will eventually tend to choose the recycling of E wastes; if there are less government subsidies and punishment, then only some manufacturers may choose to recycle E-wastes; and if the government subsidies and penalties are low enough, then the producer groups ultimately choose not to recycle E-wastes (Yang et al., 2016).

In this paper, if the government subsidies are sufficiently large, then enterprises will eventually tend to choose the green innovation strategy; if there are less government subsidies, then only some dominant enterprises may choose the green innovation strategy; if the government subsidies are sufficiently low, then the enterprises ultimately choose the greenwashing strategy. Therefore, to encourage enterprises to be more actively involved in green innovation, the government must rationalize the number of subsidies.

Additionally, consumers do not have the ability to completely identify green products; therefore, greenwashing enterprises may appropriate the market returns belonging to other enterprises.

Therefore, green enterprises need to educate the consumers and help consumers enhance their green identification capabilities. However, in this process, green enterprises should avoid the situation in which corporate environmental communications may backfire if citizens and activists feel a company is engaging in excessive self-promotion (Lyon and Montgomery, 2013).

Finally, the cost of innovation needs to be lower than before; however, in reality, it cannot decrease casually. The only way is to increase the psychological loss cost to reduce the cost difference between greenwashing and green innovation. Over the past two decades, increasing numbers of U.S. firms have voluntarily issued costly standalone Corporate Social Responsibility (CSR) reports (Mahoney et al., 2013). We hope that with the increasing of the spontaneous disclosure behavior of enterprises, the cost of psychological loss for speculative enterprises will increase greatly, and the cost of the greenwashing will increase correspondingly.

Above all, the government tax subsidy mechanism cannot control the greenwashing of enterprises perfectly. Even with the increase of the tax subsidy coefficient, it only reduces the rate of dominant enterprises to some degree. This conclusion verifies Zheng X, Du's conclusion. After the government offers a number of funds, the enterprises will still choose the strategy that is not expected by the government (Zheng and Du, 2017).

(3) What is the difference between the dominant enterprises and the inferior enterprises affected by government regulations?

In the process of biological evolution, different populations compete with the same living resources in the same environment. The result of the competition is that only those that obtain higher fitness (offspring survival rate) survive, while those that obtain lower fitness are eliminated in the competition (that is, the survival of the fittest) (Wei and Yang, 2018).

In repeated games of enterprises, dominant and inferior enterprises with limited information can constantly adjust their strategies to the greenwashing strategy or green innovation strategy to improve their own interests based on their vested interests, and they can constantly replace less satisfactory situations with a more satisfactory strategy, and finally achieve a dynamic equilibrium.

The different strategic preferences of players in the game and the government regulation of greenwashing become the key factors in the stability of the game. Additionally, the heterogeneity of the enterprises causes the power of players to become unbalanced, which further affects the distribution of total market returns. This suggests that the heterogeneity of the enterprises is also a critical factor for determining the ESS of the players (Wu et al., 2017) In the above model, compared with inferior enterprises, dominant enterprises are affected more by government regulations, including the government tax subsidy mechanism and the punishment mechanism, and dominant enterprises respond quickly to these regulations. Therefore, government regulation of greenwashing has better governance effects on dominant enterprises. Specifically, a greater proportional heterogeneity coefficient means greater disparity of strength of the enterprises. Thus, dominant enterprises push quickly to the ESS that is beneficial to themselves.

What is the biggest difference between dominant and inferior enterprises? The biggest difference between the two is the benefits of innovation. Coercive, normative, and mimetic pressures from the institutional environment may motivate companies to commit to policies, but the economic advantage is the most likely motivator for companies to implement specific environmental policies. This coincides with the views in the study by Ramus, C.A. and Montiel, I. If the companies do not have the economic incentive to implement the policy, then external stakeholders should be skeptical of any company committed to the policy (Ramus and Montiel, 2005).

7. Conclusions and recommendations

7.1. Conclusions

In this paper, we use theoretical analysis and simulation to demonstrate whether government regulation for greenwashing is active and under what preconditions it will be useful. The main conclusions of this paper are summarized below.

Without the constraints of government regulation and under the government tax subsidy mechanism, the greenwashing of enterprises cannot be controlled adequately. The government

punishment mechanism can effectively control the greenwashing practices of enterprises and ensure the stable development of green innovation by enterprises. The necessary precondition of the effective mechanism is that the government penalties should be higher than the additional benefits of the greenwashing behaviors. Therefore, the government punishment mechanism is an inevitable choice for the government to reach the desired result.

7.2. Recommendations

Green practice is the most stable way to solve the contradiction between economic growth and environmental sustainability (Tang et al., 2018). Under this situation, reducing the rate of greenwashing behaviors, improving the level of green innovation of enterprises, and stabilizing the development model of green innovation are the aims of the current regulation. From the results and the literature review, the following policy recommendations are proposed:

(1) The government should perfect the punishment mechanism and strengthen the supervision and inspection of local enterprises to discover any greenwashing practices. To improve the transparency of the firm's environmental performance, a multistakeholder supervision system that includes the government, society and the public should be established to monitor greenwashing. The government should immediately implement punishment measures for greenwashing enterprises. To improve the enthusiasm of the local government for controlling greenwashing, it is also necessary to strengthen the assessment ability of government officials on indicators, such as local green development and innovation capabilities.
(2) The government should strengthen corporate social responsibility construction. Stronger corporate social responsibility means a higher cost of psychological loss for greenwashing. Ultimately, this method will reduce the need for government intervention and the cost of government governance.
(3) How to improve the level of green income for enterprises is also a top priority. The government should educate consumers, activate green demand and consolidate the green ideas by modern media so that a consensus on the overall interests of society will be reached. While building a green civilization, it is necessary to incorporate the concept of green development into our daily lives. In this way, consumers will transfer from passive behaviors to active behaviors. At the same time, the government should establish a particular management institution for greenwashing that can shift the corresponding management power. Therefore, it will widen public opinion, and protect the legitimate rights and interests of consumers. Finally, it will avoid the crisis of trust in regard to green products and increase the benefits of green innovation.

The government that is a state administrative organ that plays a complex and vital role in reducing the rate of greenwashing behaviors. Considering the interests and cost of the governance, we should take the government into consideration in the evolutionary game. The government will become involved in the research work, and we will have a more in-depth discussion in the future.

Acknowledgments

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