Research on the Strategic Choice of Reducing Nitrogen Emissions from the Perspective of Evolutionary Game Theory

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Abstract

This paper puts forward an anti-counterfeiting printing method based on paper medium, and takes the prevention of pirated books for example. To verify and design the authentication code of books through hash algorithm, combined with the computer and network communication technology, the method conducts local and remote interrelated verification to achieve the purpose of making the pirates unable to produce pirated books in batches, so as to curb the economic benefits brought by piracy and crack down on piracy fundamentally.

Keywords

Government supervision, Nitrogen reduction behavior, Evolutionary game, The intensity of reward and punishment.

1. Introduction

It is well-known that Carbon emission of greenhouse gas is the main reason for global warming, but in fact global emission of nitrogen and nitrogen pollution are becoming a more serious problem than Carbon emission which is a long-neglected risk. Emission can cause a variety of environmental impacts, mainly including five aspects: pollution, ozone pollution, acid deposition, particulate pollution, eutrophication. If we continue to ignore the nitrogen emission and pollution, its consequences will not only be global warming, but also have serious long-term impact on human health, biodiversity, global climate and ozone levels [1-3]. With the continuous increase of China's economy and population, if we don't take measures to control the nitrogen oxide emission, nitrogen oxide pollution in the future will show a growing trend. Even around 2020, nitrogen oxide emissions will reach 2363-2914 tons, thus our country will replace the United States with the world's largest emitter of NO_x [4]. This will not only cause serious environmental pollution to our country, but also affect the air quality of our neighbors and increase international pressure on control of nitrogen oxide emissions.

Now for nitrogen pollution problems, more attention is paid to their control and management technology [5-7], the accounting of total emissions amount [8], influence factors [9], and satellite remote sensing to monitor some estimated emission concentration [10-11] at home and abroad. But most of the domestic research don't systematically sort out the macro-control measures and are lack in theory with practice. Therefore, this article combining with evolutionary game theory offers practical suggestions on nitrogen emissions reduction from the perspective of the government's macroeconomic control.

In order to reduce nitrogen pollution, the main control measures should be source control. From the point of emission sources, it turns out that 90% of the nitrogen oxide emissions come from industry based on the first national pollution census data [3]. For industrial enterprises, reducing nitrogen emissions needs to invest greater cost, but the ability to increase direct business operating income are not fully sure. It is closely related to government regulators whether industrial enterprises can respond to national call to reduce nitrogen emissions in accordance with relevant regulations. Therefore, government regulators form a game relationship with industrial enterprises. Ideally, the government play the game with industrial enterprises which seek to maximize their own interests in a completely rational condition. But in fact the game of both is bounded rationality. Bounded rationality means that the game between regulators and enterprises is a process that both imitate and learn from each other, and finally find a better dynamic replication strategy through trial and error process. Therefore, this paper uses evolutionary game theory to establish evolutionary game model of government regulators and industry groups in the process of nitrogen reduction, and analyses steady state. Finally, according to ESS analysis results this paper provides advice for government, so that the strategy of China's nitrogen emission reduction can be effectively implemented.

2. Establishment and assumptions of the model

2.1 The Game of Enterprise's Nitrogen Emission and Government Supervision Mechanism

2.1.1 The Assumptions of Parameter and Modeling

Relations between industrial enterprises and government regulators are as follows:

1) If the industrial enterprises release nitrogen in accordance with the emission standards, then there is no doubt that they need to invest more corresponding reduction technology, equipment, personnel and other capital costs in a nitrogen discharge process, which are referred to as $C_1(a_1,a_2)$, wherein a_1 represents enterprise's nitrogen emissions per unit of output, a_2 represents operating scale of enterprises. If industrial enterprises excessively exhaust emissions, we will not need additional reduction costs.

2) Assuming that in the process of nitrogen emissions monitoring, government regulators have two kinds of behaviors for different industrial enterprises: reward $G_1(a_1,a_2)$ and punishment $G_2(a_1,a_2)$.

3) Assuming that the benefits of industrial enterprises before reducing nitrogen emissions are $\pi(a_1,a_2)$.

4) Assuming that when government regulators monitor nitrogen emissions, the costs needed are E;if government regulators don't monitor nitrogen emissions, the loss of risk of public opinion that government need to bear is B.

5)When industrial enterprises complete nitrogen emissions targets, the spillover effects on the environment are S; In the case of official supervision, when nitrogen emissions from industrial enterprises is excessive, real-time control costs of government regulators are M; in the case of no official supervision, excessive nitrogen emissions will bring negative social environment utility of D, obviously $M < D$. R is the sum of the positive benefits as enterprises complete nitrogen emissions, including: energy cost savings that nitrogen reduction technology brings, positive social acceptance that environmentally friendly production brings.

We can get the payoff matrix shown in Table 1.

Table 1. Payoff Matrix of Dynamic Game Model

Government / Enterprise	Supervision y	No supervision (1-y)
Reduction x	$\pi(a_1,a_2)-C(a_1,a_2)+G_1(a_1,a_2)+R$; $S-E$	$\pi(a_1,a_2)-C(a_1,a_2)+R$; $S-B$
No reduction (1-x)	$\pi(a_1,a_2)-G_2(a_1,a_2)$; $-E-M$	$\pi(a_1,a_2)$; $-D-B$

2.2 Analysis of Evolutionary Game Model

2.2.1 Equilibrium Point of The Evolutionary Game Model

Assuming that in groups of industrial enterprises, enterprises' proportion which choose reduction is $x(x\in[0,1])$, enterprises' proportion of no reduction or excessive emission is 1-x; probability of regulators supervision is $y(y\in[0,1])$, the probability of no supervision is 1-y.

As shown in payoff matrix of table 1, the expected utility of enterprises choosing "reduction" strategy is u_{11} and the expected utility of "no reduction" strategy is u_{12}, group's average utility is $\overline{u_1}$, then we can get:

$$u_{11} = y(\pi(a_1,a_2) - C(a_1,a_2) + G_1(a_1,a_2) + R) + (1-y)(\pi(a_1,a_2) - C(a_1,a_2) + R) \quad (1)$$

$$u_{12} = y(\pi(a_1,a_2) - G_2(a_1,a_2)) + (1-y)\pi(a_1,a_2) \quad (2)$$

$$\overline{u_1} = xu_{11} + (1-x)u_{12} \quad (3)$$

Similarly, the expected utility of regulators selecting "supervision" is u_{21} and the expected utility of "no supervision" is u_{22}, and the average utility is $\overline{u_2}$, we get:

$$u_{21} = x(S-E) + (1-x)(-E-M) \quad (4)$$

$$u_{22} = x(S-B) - (1-x)(D+B) \quad (5)$$

$$\overline{u_2} = yu_{21} + (1-y)u_{22} \quad (6)$$

Based on evolutionary game theory, we can obtain the replicated dynamic equation of industrial enterprises:

$\frac{dx}{dt} = x(u_{11} - \overline{u_1}) = x[(G_1(a_1,a_2) + G_2(a_1,a_2))y + R - C(a_1,a_2)](1-x)$ Similarly the replicated dynamic equation of regulators is:

$\frac{dy}{dt} = y(u_{21} - \overline{u_2}) = y[(M-D)x + D - E + B - M](1-y)$

Consisting of the formula(7)and (8),the replicator dynamics equation of two-dimensional dynamic game system is:

$$\begin{cases} \frac{dx}{dt} = x(u_{11} - \overline{u_1}) = x[(G_1(a_1,a_2) + G_2(a_1,a_2))y + R - C(a_1,a_2)](1-x) \\ \frac{dy}{dt} = y(u_{21} - \overline{u_2}) = y[(M-D)x + D - E + B - M](1-y) \end{cases}$$

Order $\frac{dx}{dt} = 0, \frac{dy}{dt} = 0$, we can obtain equilibrium points of dynamic system (0,0), (0,1), (1,0), (1,1), if $0 < R < C(a_1,a_2) < G_1(a_1,a_2) + G_2(a_1,a_2) + R$, $0 < E - B < D - M$, then $0 < x^* = 1 + \frac{E-B}{M-D} < 1, 0 < y^* = \frac{C(a_1,a_2) - R}{G_1(a_1,a_2) + G_2(a_1,a_2)} < 1$, $\frac{dx}{dt} = 0 \,\&\, \frac{dy}{dt} = 0$,so point (x^*, y^*) is also the equilibrium point.

2.2.2 Stability Analysis of Equilibrium Point

Evolutionary stable strategy point (ESS) is a asymptotically stable fixed point that is stable to small perturbations in the dynamic evolutionary process. Therefore, the equilibrium point obtained from replicator dynamics equation is not necessarily the ESS, we need to analyze local stability of Jacobian matrix through the replicator dynamics equation and then we can determine the stability of the equilibrium point. The Jacobian matrix obtained is:

$J = \begin{bmatrix} (1-2x)[(G_1(a_1,a_2)+G_2(a_1,a_2))y + R - C(a_1,a_2)] & (x-x^2)[G_1(a_1,a_2)+G_2(a_1,a_2)] \\ (y-y^2)(M-D) & [(M-D)x + D - E + B - M](1-2y) \end{bmatrix}$ We can determine the local stability of the *Jacobian* matrix through the sign of the matrix J, that is, if $\det(J) > 0 \,\&\, tr(J) < 0$, then the corresponding equilibrium point is ESS; if $\det(J) > 0 \,\&\, tr(J) > 0$, then the corresponding point is an unstable equilibrium point; if $\det(J) < 0$,then the corresponding equilibrium point is a saddle point. Determinant and trace of each equilibrium point is shown in Table 2.

Table 2. Determinant and Trace of Equilibrium Point

equilibrium point	$\det(J)$	$tr(J)$
$(0,0)$	$(D-E+B-M)[R-C(a_1,a_2)]$;	$D-E+B-M+R-C(a_1,a_2)$;

(0,1)	$[(G_1(a_1,a_2)+G_2(a_1,a_2)+R)-C(a_1,a_2)](E+M-D-B)$;	$E+M-B-D+G_1(a_1,a_2)+G_2(a_1,a_2)+R-C(a_1,a_2)$;
(1,0)	$(C(a_1,a_2)-R)(B-E)$;	$C(a_1,a_2)-R+B-E$;
(1,1)	$[C(a_1,a_2)-(G_1(a_1,a_2)+G_2(a_1,a_2)+R)](E-B)$;	$C(a_1,a_2)-(G_1(a_1,a_2)+G_2(a_1,a_2)+R)+E-B$;
(x^*,y^*)	$(E-B)(1+\frac{E-B}{M-D})(1-\frac{C(a_1,a_2)-R)}{G_1(a_1,a_2)+G_2(a_1,a_2)})[C(a_1,a_2)-R)]$;	0

According to the results in Table 2 and the method of determining the local stability of *Jacobian* matrix, different cases are discussed about the stability of equilibrium:

1) If $0<C(a_1,a_2)<R, B<E, B+D<E+M$, then the dynamic replication system has four equilibrium points, therein point (1,0) is the stable node, point(0,1) is the unstable node, points (0,0), (1,1) are the saddle points;

2) If $0<C(a_1,a_2)<R, B<E, B+D>E+M$ then the dynamic replication system has four equilibrium points, therein (1,0) is stable node, point (0,1) is an unstable node, points (0,0),(1,1)are a saddle point;

3) If $0<C(a_1,a_2)<R, B>E, B+D<E+M$, then the dynamic equilibrium replication system has four equilibrium points, therein the point (1,1) is a stable node, point (0,1) is an unstable node, points (0,0),(1,0) are a saddle point;

4) If $0<C(a_1,a_2)<R, B>E, B+D>E+M$, then the dynamic replication system has four equilibrium points, therein point (1,1) is stable node, point (1,1) is a stable node, point (0,0) is an unstable node, points (0,1),(1,0) are saddle points;

5) If $0<R<C(a_1,a_2)<G_1(a_1,a_2)+G_2(a_1,a_2)+R, B<E, B+D<E+M$, then the dynamic replication system has four equilibrium points, therein point (0,0) is a stable node (ESS), point (0,1) is an unstable node, point (1,1), (1,0) are saddle points;

6) If $0<R<C(a_1,a_2)<G_1(a_1,a_2)+G_2(a_1,a_2)+R, B<E, B+D>E+M$,then the dynamic replication system has five equilibrium points, therein(1,0),(0,0),(0,1),(1,1)are all saddle points, point (x^*,y^*) is a partially unstable point;

7) If $0<R<C(a_1,a_2)<G_1(a_1,a_2)+G_2(a_1,a_2)+R, B>E, B+D<E+M$, then the dynamic replication system has four equilibrium points, therein points (0,0),(1,1) and are stable nodes, points (0,1), (1,0) are unstable nodes;

8) If $0<R<C(a_1,a_2)<G_1(a_1,a_2)+G_2(a_1,a_2)+R, B>E, B+D>E+M$, then the dynamic replication system has five equilibrium points, therein point (1,1) is a stable node , point (1,0) is an unstable node, points (0,0),(0,1) , (x^*,y^*) are saddle points;

9) If $C(a_1,a_2)>G_1(a_1,a_2)+G_2(a_1,a_2)+R, B<E, B+D<E+M$, then the dynamic replication system has four equilibrium points, therein point (0,0) is a stable node ,point (1,1) is an unstable node ,points (1,0), (0,1) are saddle points;

10) If $C(a_1,a_2)>G_1(a_1,a_2)+G_2(a_1,a_2)+R, B<E, B+D>E+M$, then the dynamic replication system has four equilibrium points, therein point (0,1) is a stable node, point (1,1) is an unstable node, points (1,0) and (0,0) are saddle points;

11) If $C(a_1,a_2)>G_1(a_1,a_2)+G_2(a_1,a_2)+R, B>E, B+D<E+M$,

then the dynamic replication system has four equilibrium points, therein point (0,0) is a stable node, point (1,0) is an unstable node, points (0,1) ,(1,1) are saddle points;

12) If $C(a_1,a_2)>G_1(a_1,a_2)+G_2(a_1,a_2)+R, B>E, B+D>E+M$,

then the dynamic replication system has four equilibrium points, therein point (0,1) is a stable node, point (1,0) is an unstable node, points (0,0),(1,1) are saddle points;

2.2.3 Analysis of evolutionary Results

1. Analysis of cases 1) -4): if the cost of nitrogen emissions reduction is low to be less than the sum of positive benefits of emissions reduction, apparently the enterprise will consciously choose to reduce nitrogen emissions. The choice of government depends on the monitoring costs, real-time management expenses, risk of public opinion and side effect of excessive emissions of enterprises. When masses' are less concerned about nitrogen pollution, the pressure of public opinion risk is low, and the costs of monitoring and real-time control are high, the government tends to choose no supervision, so point(1,0) is the evolutionary stable point; If the negative effects of nitrogen emission and the degree of social concern increasingly grow, and the risk of public opinion greatly increases the cost of government supervision, the government will be under social and environmental pressure to monitor enterprises. At this moment point(1,1) is an evolutionary stable point. Evolutionary system's phase diagram of situation 1) is shown in Figure 1-1. Evolutionary system's phase diagram of situation 1)is shown in Figure 1-2.

2. Analysis of cases 5) -8): the costs of emission reduction are higher than the positive benefits of corporate emission reduction, but less than the sum of positive benefits of emission reduction and government incentives. And the costs of the government's supervision and real-time management costs are higher and masses' are less concerned that causes small public opinion. And the negative impacts of excessive nitrogen emission are small. Under the above circumstances, the government will tend to choose no supervision and enterprises will not tend to reduce emission. Thus point (0,0) is an evolutionary stable point. Reversely, the negative effects of excessive nitrogen emissions increases and people are more concerned about environmental protection. Also the risk of public opinion increases and the cost of enterprises increase. At this moment, the system don't have evolutionary equilibrium points. When the risk of public opinion exceed the monitoring cost of the government, but the negative effects of excessive nitrogen emissions are less than the cost of real-time control of the government, the final result of the game depends on the initial condition of the system. If the government does not monitor emissions, the enterprises will not reduce emissions; if the government chooses to monitor emissions, then enterprises will reduce emissions. In this case the evolutionary stable strategies are (no reduction, no supervision) and (reduction, supervision). When the risk of public opinion exceeds the monitoring cost of government and the negative effects of excessive nitrogen emission also exceed the cost of real-time control, the government will tend to supervise enterprises. And enterprises will invest more cost into reduction in the government's incentive system, so at this moment the evolutionary stable point is point(1,1).The phase diagram of evolution system of case 5) is shown in Figure 1-3. The phase diagram of case 7) is shown in Figure 1-4.

3. Analysis of cases 9) - 10): when the cost of nitrogen emissions reduction continue to increase until it is greater than the sum of the positive benefits of emission reduction and government rewards, at this time because of the bigger cost, the enterprises will always tend to choose not to reduce nitrogen emissions. Similarly, the choice of the government at this time will change as monitoring costs and the risk of public opinion change, and therefore there will be two evolutionary stable points (0,0) ,(0,1). The phase diagram of case 10) is shown in Figure 1-5.

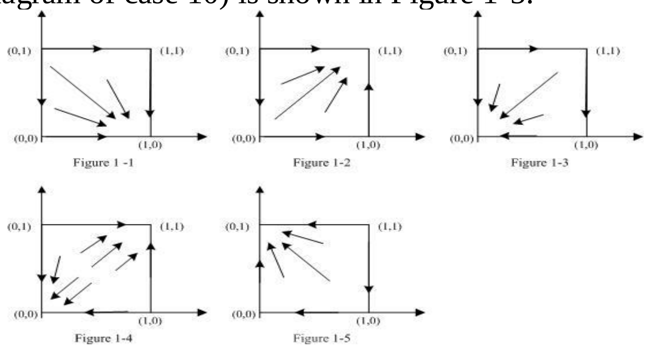

Fig.1 Phase diagram

3. The effect of enterprise's cost of nitrogen emission reduction and the government rewards & punishment system on the evolutionary result

3.1 The Assumptions of Function $G_1(a_1,a_2)$、$G_2(a_1,a_2)$ &$C(a_1,a_2)$

Let the official emission standard per unit of output for enterprises is p; A (A>0) is a constant related to the level of nitrogen reduction technology of the enterprises. The higher the level of corporate nitrogen emission reduction technology is, the smaller A is; enterprises operating scale is reflected by company's products, that is a_2 represents output of enterprises; δ_1, δ_2 represent respectively the reward coefficient and punishment coefficient.

3.1.1 The Analysis of Cost Function $C(a_1,a_2)$ of Enterprise's Nitrogen Emission Reduction

Ideally, assuming that enterprises' nitrogen emissions are excessive, reduction cost is zero; that is if $a_1 > P$, then $C(a_1,a_2)=0$.When an enterprise reduces nitrogen emissions ($a_1 \le P$), reduction cost of enterprises declines with the enhancement of emission reduction technologies, and increases with an increase in degree of reduction. The larger the size of the enterprise is, the higher corporate reduction costs are. The company's cost function is set to:

$$C(a_1,a_2)=\begin{cases} A(P-a_1)a_2^{\,2}+\varepsilon, a_1 \le P \\ 0, a_1 > P \end{cases} \tag{7}$$

Wherein ε is a constant. As shown in Figure 2.

$Fig.2-1: P=5; A=5; \varepsilon=1 \quad Fig.2-2: P=5; A=1; \varepsilon=1 \quad Fig.2-3: P=10; A=5; \varepsilon=1$

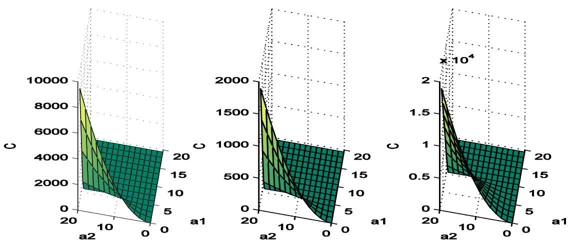

Fig.2 Diagram of enterprises cost of reducing nitrogen emission

As shown in Figure 2-1,when the smaller nitrogen emission per unit of output is, the greater magnitude of the enterprise reduction costs increase; when emissions of enterprises are excessive, enterprises do not need to pay cost. Because of interest-oriented mechanism, if the government does not take any measures, businesses will tend to release pollutants excessively. Figure 2-2 reduces the value of A on the basis of Figure 2-1. That is the reduction cost of enterprises will decrease greatly with enhancement of technology of nitrogen emission reduction. On the basis of the Figure 2-1, we raise the value p of official emission standard of the enterprise per unit of output in Figure 2-3.In contrast, we can see a bit of a lift in value P will cause the cost of nitrogen emissions to increase significantly. So the government should choose the appropriate value p of per unit of output for enterprises.

3.1.2 The Analysis of Government Award and Punishment Function $G_1(a_1,a_2)$、$G_2(a_1,a_2)$

Through stability analysis of the equilibrium point, we find that the government's reward and punishment system plays an important role in the choice of enterprises choosing to reduce nitrogen emissions. When enterprises reduce nitrogen emissions, the government rewards them; when enterprises have excessive emissions, the government fines them. Bonuses will increase with the increase of reduction, and fines will increase with the increase of superscale. Given:

$$G_1(a_1,a_2)=\delta_1(P-a_1)^2 a_2 \quad a_1 \le P$$

$$G_2(a_1,a_2)=\delta_2(a_1\text{-}P)^2 a_2 \quad a_1 > P$$

As shown in Figure 3:

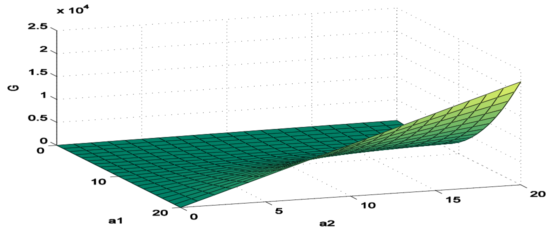

Fig.3 Diagram of government award & punishment function

Increasing the incentive coefficient δ_1 and punishment coefficient δ_2, a contrast figure is gained as follows:

$Fig.4-1: P=5; \delta_1=1; \delta_2=5$ $Fig.4-2: P=5; \delta_1=20; \delta_2=5$ $Fig.4-3: P=5; \delta_1=1; \delta_2=10$

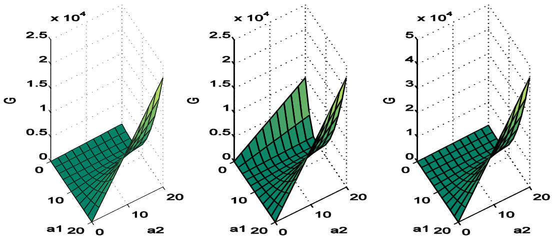

Fig.4 Function comparison chart of award & punishment

When P = 5, as shown in Figure 4, Figure 4-2 is obtained from increasing reward coefficient δ_1 by 20 times on the basis of Figure 4-1.At this time the government's award amount is equal to corporate reduction costs under the same standard; but in Figure 4-3 as long as the punishment coefficient δ_2 increases a little, there will be a sharp rise in the amount of fines. Therefore, the official standard P value can't be set too low, and government can't t constantly pursue the environment condition while ignores the enterprise's economic growth. Otherwise it will cause a substantial increase in the cost of corporate emissions. The degree of government incentives and the amount of fines will increase greatly. All of these will hinder the progress and development of enterprises; while the government should increase the reward of corporate emissions reduction to compensate the higher cost of corporate emissions reduction, so as to promote enterprises to reduce nitrogen emissions. Furthermore the fines also effectively control the tendency of enterprises to release emissions excessively.

3.2 The Comprehensive Analysis of Enterprise's Reduction Cost Function $C(a_1,a_2)$ and Government Reward & Punishment Function $G_1(a_1,a_2)$、$G_2(a_1,a_2)$

According to the above analysis of the stability of the equilibrium point, we can see it has a great influence on results of system evolution that changes in the size of corporate reduction costs $C(a_1,a_2)$, government incentives $G_1(a_1,a_2)$,and punishment $G_2(a_1,a_2)$.Figure 5 is a contrast chart of corporate cost function and government award & fines function.

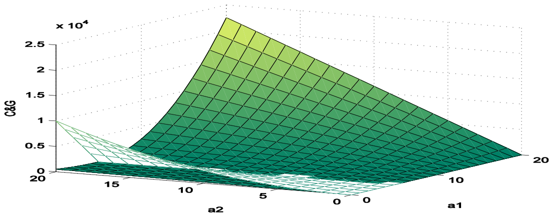

Fig.5 The comparison chart of Enterprise reduction cost function and government award & fines function

As shown in figure 5, with the degree of nitrogen reduction of enterprises increases, nitrogen reduction costs of enterprises will increase rapidly even greatly surpass the sum of government incentives and positive benefits of reduction. A this time, whether the government supervises emission or not, enterprises will gradually tend to release emissions beyond the standard. When nitrogen reduction costs of enterprises decrease, the government should strive to reduce the supervision costs and real-time control costs, so stable strategy of this game have tendency for (reduction, no supervision).When enterprises further have excessive emissions, at this time there are no costs and interest-driven mechanism is relatively obvious. But because of the government fines, the more excessive emissions of enterprises are, the sooner fines rises, which will effectively prevent enterprises releasing emissions excessively. In summary, the government's reward & punishment has a significant impact on enterprises' nitrogen emissions. Government award can compensate enterprises' reduction costs and encourage enterprises to reduce nitrogen emissions, and fines effectively prevent enterprises releasing emissions excessively, which also can be the compensation for government monitoring costs and decrease the cost of government supervision. It will motivate the government to have supervision and promote enterprises to cut emissions voluntarily.

Conclusions and recommendations

This paper uses methods of evolutionary game theory to analyze the behaviors of nitrogen emissions of enterprises and the government supervision, and studies the strategy choice of government and enterprises in nitrogen emission. Analysis shows that the costs of reducing nitrogen emissions are the key of enterprises' strategy choice of nitrogen emission behaviors. When the enterprise's costs are small and the benefits of reducing nitrogen emissions are large, there will be an evolutionary stable equilibrium of (emissions reduction, supervision), (emissions reduction, no supervision);When enterprises' reduction costs are large, whether the government supervise emissions or not, enterprises will not tend to reduce nitrogen emissions. In the evolutionary game of the whole system, several key variables, such as government supervision and reward & punishment system, government monitoring costs, real-time cost of governance and the risk of public opinion, have a great influence on encouraging enterprises to reduce nitrogen emission. Government can use these effects to adjust the behaviors of enterprise's reduction of nitrogen emissions, and promote enterprises to reduce nitrogen emission voluntarily.

Firstly, the government should establish a comprehensive regulatory system for enterprises to reduce nitrogen emissions, and to develop an appropriate reward and punishment system. Bonuses can compensate the cost of reducing nitrogen emissions of enterprises and encourage enterprises to reduce nitrogen emissions. Fines increases enterprises' costs for excessive emissions and reduce the excess return, and effectively prevent enterprises blindly releasing excessive emissions to maximize benefits. Secondly, according to the analysis, the value p of enterprise's emission standard per unit of output is critical for the size of enterprises' costs. When the government establishes a system of rewards and penalties, it should set up an appropriate standard value p based on local specific development and corporate nitrogen emissions. Value p can't be set too high and also can't be set too low. Both can't promote enterprises to reduce nitrogen emissions. It must be practical to select an appropriate intermediate value. Then for enterprises, in order to reduce nitrogen reduction costs, they should greatly improve their equipment and technology. While the government should support enterprises strongly in improving equipment and technology of nitrogen reduction, and set up a platform for enterprises to contacts foreign advanced technology and reduce the cost of the introduction taxation of enterprises. It should encourage and support enterprises to introduce foreign advanced technology of nitrogen emissions and enhance the company's facilities and equipment, which will decrease reduction cost of enterprises. Finally, the public opinion is often ignored by us, but through the analysis on the stability of the equilibrium point, we find that risk of public opinion has a key role in the stability of the equilibrium point. So the government should publicize the seriousness of nitrogen pollution to arouse the masses' environmental awareness. Thus the risk of public opinion will be amplified, which increases the supervision probability of local governments to reduce nitrogen emissions around the nation.

References

[1] T. V. Johnson, "Review of diesel emissions and control," International Journal of Engine Research, vol. 10, no. 5, pp. 275-285, 2009.

[2] X. W. Li, "The global nitrogen emissions and nitrogen pollution," Recent Developments in Science & Technology Abroad, vol. 3, pp. 33-38, 2006.
[3] X. Du, L.C. Zhu, "The foreign experience and domestic measures to control the pollution of Nitrogen Oxides," Environmental Protection and Circular Economy, vol.4, pp. 6-10,2011.
[4] J. Lei, "The study on NOx emission in Process fire coal in China" , Nanchang: Nanchang University, 2010.
[5] Y. L. Sun, J. Zhang, B. Jiang, "NOx control technologies for coal-fired power plants flue gas," Environmental Science & Technology, vol. s1, pp. 174-179,2011.
[6] S. M. Li, "Analysis and management technologies of nitrogen oxides pollutant in the air," Journal of Henan Science and Technology, vol. 24, no. 06, pp. 95-96,2010.
[7] J. Q. Zhao, B. K. Jing, "Engineering examples of treating nitrogen oxides emission," Environmental Engineering, vol. 28, no. 3, pp. 88-90, 2010.
[8] J. T. Lin, M. B. Mcelroy, K. F. Boersma, "Constraint of anthropogenic NOx emissions in China from different sectors: a new methodology using multiple satellite retrievals," Atmospheric Chemistry & Physics Discussions, vol. 9, no. 5, pp. 63-78, 2009.
[9] Y. L. Shi, S. H. Cui, S. Xu, et al. "Factor decomposition of nitrogen oxide emission of china industrial energy consumption," Environmental Science & Technology, vol. s1, pp. 355-362, 2014.
[10] Q. Zhang, G. N. Geng, "Satellite remote sensing of changes in NOx emissions over China during 1996-2010," Chinese Science Bulletin, vol. 57, no. 22, pp. 2857-2864, 2012.
[11] J. Lin, B. Cao, S. Cui, et al. "Evaluating the effectiveness of urban energy conservation and GHG mitigation measures: The case of Xiamen city, China," Energy Policy, vol. 38, no. 9, pp. 5123-5132, 2010.
[12] Q. W. Sun, L. Lu, G. L. Yan, "Asymptotic Stability of Evolutionary Equilibrium under Imperfect Knowledge," Systems Engineering-theory & Practice, vol. 7, pp. 11-16, 2003.
[13] L. Tan, Q. Yu, Z. M. Li, "Research on the Strategic Choice for Government in Supervising of Supplier of Outsourcing in Financial Services—From Evolutionary Game Theory Perspective," Soft Science, vol. 28, no. 6, pp.29-34,2014.
[14] S. Y. Xie, "Economic game theory (third edition)," [M].Shanghai：Fudan University Press, 2007.