

Research on the Game Behavior of Environmental Protection Strategies Between Government and Enterprises

Yuxin Liao^{1,a,*}

¹*College of Science, Zhejiang University of Technology, Hangzhou, China*
a. 202105130310@zjut.edu.cn

**corresponding author*

Abstract: In recent years, the global environment has been deteriorating. To achieve win-win environmental protection and economic development, the Chinese government has issued various environmental governance policies. However, as an important part of the economy and society, enterprises often ignore the impact on the environment while realizing economic development. Therefore, how the government and enterprises develop appropriate environmental protection strategies to achieve parallel environmental protection and development has become the main problem faced at present. Based on the method theory and practical application of game theory, experts in related fields have studied this problem deeply. According to the different research subjects, this paper starts from five different research objects, such as the mutual influence between government and enterprises under environmental governance, the regulation between governments at all levels, the evolution game of government-enterprise-media, the evolution game of government-enterprise-public, and the game of government-enterprise-media-public, introduces the analysis of the decisions of government and enterprises based on game theory, put forward advice to consider the influence of other factors and explore the connection between various factors, to provide detailed reference for scientific governance environment and realize economic sustainable development.

Keywords: Enterprise, environmental protection strategy, government regulation, game

1. Introduction

In today's world, a series of environmental pollution problems such as global warming, soil erosion, and vegetation degradation are emerging one after another, causing great harm to human survival and sustainable economic development. Countries around the world have reached a consensus on environmental protection and signed a series of environmental protection conventions, aiming to jointly solve environmental problems. In 2016, China officially signed the Paris Climate Agreement and made a commitment to peak carbon emissions by 2030 and achieve carbon neutrality by 2060. In the latest national EPI released by Yale University, although China has made significant progress compared to 2018, it still ranks lower in the world, and environmental governance issues are urgent.

The path of green development is the only way to achieve the sustainable development of the Chinese nation [1]. The Fifth Plenary Session of the 18th Central Committee of the Communist Party of China put forward the concept of green development, emphasized the importance of adhering to sustainable development, and realizing the concept of green development and taking the path of

sustainable development has become the primary goal of China's current economic development. Since the reform and opening up, with the rapid development of our country, environmental protection issues have become increasingly prominent, in addition to posing a serious threat to human life safety, it also has an impact on the development of the social economy. As the main body of economic activities, pursuing maximum benefits is the essence of enterprises. However, in the process of pursuing economic benefits, the production behavior of enterprises often causes pollution to the environment. To reduce production costs, some companies may choose to ignore environmental issues and directly discharge pollutants into the environment. This behavior not only damages the environment but also threatens human health and survival. The government, as a manager and servant of society, is responsible for maintaining public interests and social order. In terms of environmental protection, the government needs to balance the relationship between economic development and environmental protection. On the one hand, the government needs to regulate the production behavior of enterprises and reduce environmental pollution by formulating environmental protection policies and regulations; On the other hand, the government also needs to consider the needs of economic development and cannot excessively restrict the production activities of enterprises. In this context, how do governments and businesses choose the right environmental strategy has become particularly complex.

Enterprises hope to reduce costs and enhance competitiveness by reducing environmental investment; The government hopes to protect the environment and achieve sustainable development by strengthening environmental supervision. This game not only involves the distribution of economic benefits but also involves considerations of social responsibility and moral ethics. Therefore, the research on the game of environmental strategy choices between enterprises and governments has important practical significance and theoretical value. By conducting in-depth research on this game relationship, people can reveal the conflicts of interest and cooperation mechanisms between enterprises and the government in environmental protection issues, providing theoretical support and practical guidance for the government to formulate more scientific and reasonable environmental policies and regulations. At the same time, it can also promote enterprises to raise environmental awareness, strengthen environmental investment, and achieve coordinated development of the economy, society, and environment. This article will focus on five different subjects: the relationship between government and enterprises in environmental protection behavior, hierarchical regulation between governments, the influence of media factors, the influence of public supervision, and the interaction between multiple influencing factors. It will review relevant literature on the game of ecological protection between government and business. Research has found that :firstly, the supervision of local governments by the central government will have an impact on the selection of environmental protection strategies by local governments; secondly, enterprises will change their environmental protection strategies due to media coverage; thirdly, public scrutiny will affect the selection of environmental protection strategies by governments and enterprises; in addition, there is a mutual influence between media coverage and public reporting. Based on the above findings, relevant policy suggestions will be proposed to provide ideas for implementing more scientific and effective environmental protection strategies.

2. The Game of Environmental Protection Strategy Choices for Local Governments and Enterprises

Since the 19th CPC National Congress, the country's attention to ecological civilization construction has reached an unprecedented political height, and it has issued a series of environmental governance policies, such as the Environmental Protection Tax Law that was implemented in 2018, and all environmental protection taxes will be treated as local government revenue, without being intercepted by the central government; In 2020, the General Office of the

Communist Party of China Central Committee and the General Office of the State Council issued the Guiding Opinions on Building a Modern Environmental Governance System, which stipulated that expect for important environmental governance affairs, local government should mainly bear the responsibility for environmental governance expenditures. The above policies all reflect the leading role of local governments in local ecological management and protection. However, because the governments also undertake important tasks in developing the local economy, and enterprises as the source of economic development and one of the main sources of environmental pollution, the relationship between the two in environmental behavior choices has become a focus of research by experts and scholars in various fields.

Therefore, by constructing a game tree between local governments and enterprises, as shown in Figure 1. Tao Min et al. established a static game model between local governments and enterprises based on China's "government-led" environmental protection model. They plotted the curves of the benefits of government nonregulation and the probability of enterprises not treating pollution, as well as the benefits of enterprises not treating pollution and the probability of government nonregulation. They found a direct connection between whether the government regulates and whether enterprises reduce emissions [2]. Based on Tao Min et al., Wang Xiaohong et al. further analyzed the dynamic game relationship between the government and enterprises, established an incomplete information dynamic game model between the government and enterprises, and more closely studied the environmental protection game relationship between the government and enterprises. Based on the conclusion that government regulation can promote enterprise emission reduction, they proposed suggestions such as increasing government supervision, establishing and improving environmental protection mechanisms, and enhancing enterprise environmental participation awareness [3].

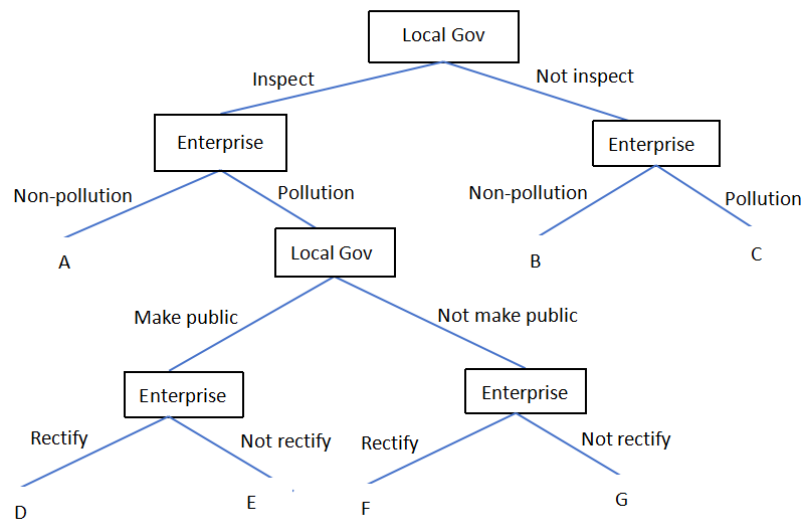


Figure 1: Local government-enterprise sides game tree.

3. Consider the Environmental Protection Game between the Government and Enterprises under the Hierarchical Supervision between Governments

To conduct a more in-depth study of the influencing factors of environmental behavior between local governments and enterprises, and provide more effective suggestions and measures, Fan Ruguo et al. set up an evolutionary game model by introducing regulatory capture, while considering policy inclination of local governments. They comprehensively considered the benefits of local governments implementing strict and relaxed environmental policies and the expected benefits for

enterprises. They found that when environmental pollution control cannot be coordinated with financial construction, local governments often find it difficult to impose severe punishment on enterprises, leading to difficulty in truly solving environmental pollution problems. The supervision of local governments by the central government has become the key to solving the problem [4]. The game strategy tree of the central government, local government, and polluting enterprises is shown in Figure 2.

Given this, Zhang Ming et al. took into account the influence of the central administration, a three party game model of "central government-local government-polluting enterprises" was built. By changing parameter settings of central and local government, and enterprise strategy probabilities, and using system simulation, they obtained the conclusion that the incentive effect of central regulation on enterprises is more obvious than that of local governments. At the same time, high regulatory costs can easily encourage local governments and polluting enterprises to choose environmental strategies that are not regulated but not treated. Based on this, they proposed three suggestions for the central government to implement regulation: reducing inspection costs, implementing multiple rewards and punishments, and policy transparency [5]. Hu Min et al. applied the three-way evolutionary game model of "central local government polluting enterprises" to Hebei Province, referring to relevant values in Hebei Province, set parameters for emission reduction rewards and exceeding emission penalties, and conducted simulation analysis. The results showed that the game of environmental protection strategy selection would reach equilibrium when strengthening supervision by the inspection team and strict supervision by local governments, and increasing emission reduction by polluting enterprises [6].

According to the above research on the impact of central government regulation on the environmental protection strategy choices of local governments and enterprises, it is found that strengthening the supervision of local authorities by the central government and improving rewards and penalties mechanisms can effectively enhance their intensity of local government environmental governance, promote enterprises to reduce emissions, and thus improve the environment.

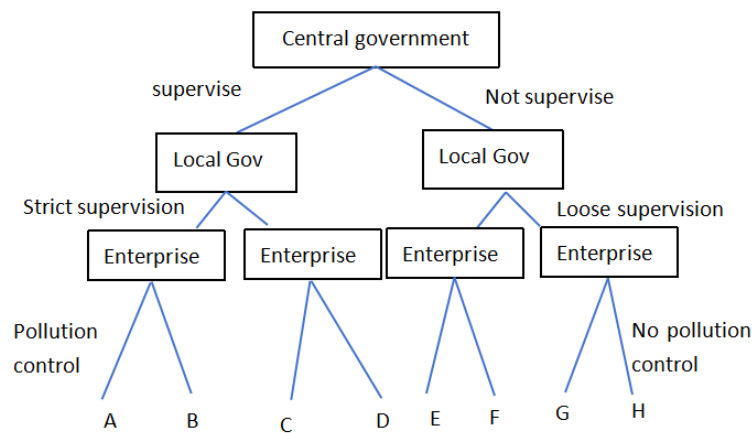


Figure 2: Central government- local government -enterprises tripartite game tree.

4. Environmental Protection Game between Government and Enterprises Considering Public Factors

Environmental issues are the result of complex social conditions and diverse conflicts of interest, and are a complex interaction process among diverse entities such as enterprises, the public, and the

government in the context of social norms [7]. Wang Feng established a tripartite evolution model under two scenarios: government participation in environmental protection and government non-participation in environmental protection, demonstrating that public participation in environmental protection will have a supervisory effect on enterprises, thereby promoting emission reduction. Whether the government participates in environmental protection directly affects public enthusiasm for maintaining the environment, which thereby affects the environmental choices of enterprises [8].

Four scholars, including Chen, established a tripartite evolutionary game model about the government, the public, and enterprises. The strategy combination is shown in Figure 3, and model parameters are set according to relevant requirements to study their interaction mechanism. Empirical analysis was conducted on data from 30 provincial levels in China, and it was found that expanding communication platforms between the government and the public can effectively reduce environmental pollution behavior [9]. Utilizing principle of maximizing profits, Zhong Zhaoqiang et al. constructed a tripartite game model of "government-enterprise-public" when the government carries out environmental protection policy and dose not regulate environment. Using different initial parameters and making use of system dynamics simulation. Through continuous evolution, it was found that enterprise decisions are influenced by government decisions, while public choices almost do not affect government decisions but will have an impact on enterprises [10].

In summary, strengthening government participation in environmental protection and government communication with citizens, improving reward and punishment mechanisms, can motivate the public to participate in supervising the green development of enterprises, thereby achieving the purpose of maintaining ecological security.

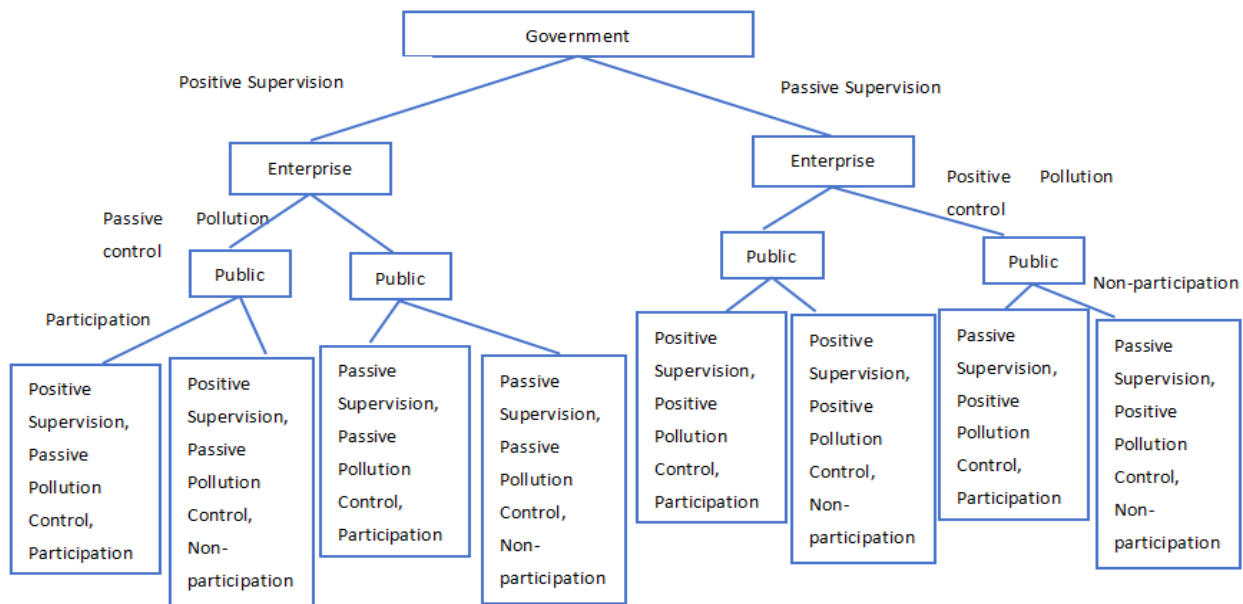


Figure 3: Government-enterprise-public tripartite game tree.

5. The Game about Environmental Protection Measures between Government and Business Considering Media Factors

From the perspective of government functions, governments at all levels are both regulators of market behavior and coordinators of market interests. It is necessary to strengthen government responsibilities and ensure the timely transformation of government functions [11]. As government

regulatory objects and market entities, enterprises are influenced by government actions in their behavior. As an external regulatory force, the media can to some extent expose internal management issues in enterprises, while also attracting government attention and joining the regulatory ranks [12]. Starting from the media attention related to the environment, Fu Yinghe empirically studied multiple samples of listed companies on the Shanghai Stock Exchange in China and found that media coverage has a promoting effect on enterprises implementing environmental protection measures [13]. Xie Zhiming explained and analyzed the impact of government and media regulation on corporate environmental behavior from the perspective of media rent-seeking behavior. After empirical testing, it was also shown that media coverage can significantly promote corporate environmental management behavior [14].

Based on the game strategy tree of government, enterprises, and media shown in Figure 4, Jiang Qunyong et al. established a "government-enterprise-media" evolutionary game model, taking into account the social supervision role of media and the rent-seeking behavior between enterprises and media. Through stability analysis of the model, three evolutionary optimal strategies were obtained. The dynamic analysis method was used to analyze the evolution process of the three evolutionary strategies obtained. It was found that increasing the government's reward and punishment efforts on media and enterprises will achieve a transition to the optimal strategy. Based on this, it was concluded that the government's formulation of a reasonable reward and punishment mechanism can effectively suppress media rent-seeking and promote enterprises to choose environmental protection strategies, providing direction for formulating more scientific and reasonable environmental protection strategies[15].

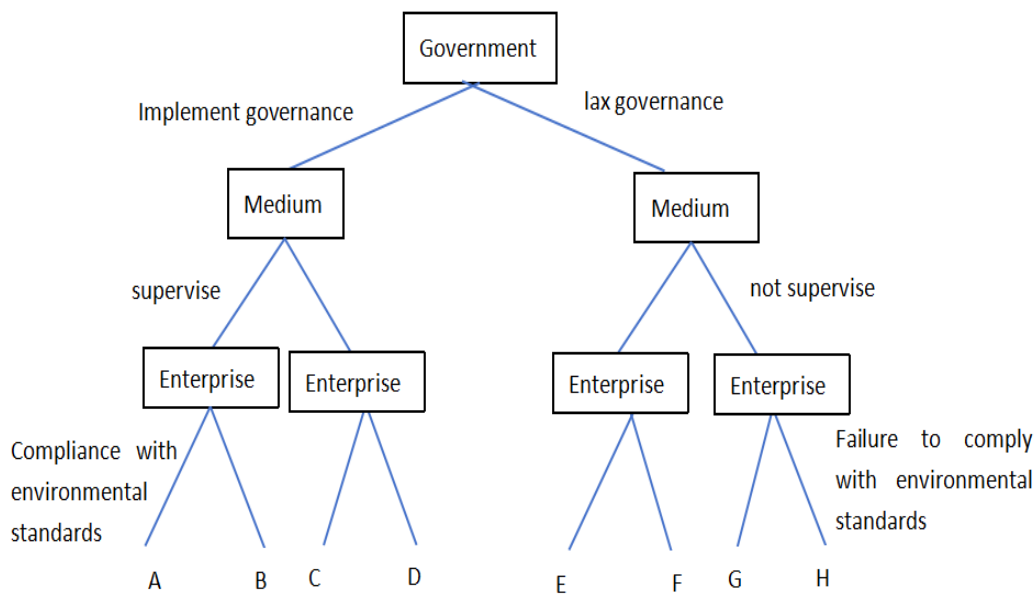


Figure 4: Government-enterprise-media tripartite game tree.

6. A Comprehensive Consideration of the Environmental Protection Game

At present, the exploration of government and corporate environmental protection behavior mostly uses a two party evolutionary game model for simple analysis of the choice between the two, while for more complex behavior studies that consider multiple factors, specific research is mainly conducted by establishing a three party evolutionary game model. However, for complex and diverse environmental problems, research on the two party or three party game model is often not

comprehensive. In recent years, a few scholars have been exploring the use of the four party evolutionary game model to study environmental problems, providing more comprehensive suggestions and new directions for solving environmental problems.

Wu Xiling's research indicates that the media has a certain promoting effect on public environmental awareness [16]. Based on this, scholars led by Pan Feng have innovatively constructed a tetragonal evolutionary game model of "central government-local government-enterprise-public" on the basis of considering the influence of media factors on environmental protection strategy selection in the absence and presence of media factors. The game strategy tree is shown in Figure 5. By adopting the allocation method proposed by predecessors, various parameters in the model were reasonably allocated. Numerical simulations and comparative analysis were conducted on the two models. The results showed that media attention did not affect the selection of central government environmental protection strategies, but promoted the implementation of positive environmental protection strategies by local governments and enterprises, and had a substitution effect on public supervision [17].

Through the review of the above literature, it is found that there is an interaction between the media and the public. Strengthening media supervision will also increase public participation, so as to more effectively promote the government to strictly implement environmental protection policies and enterprises to actively implement emission reduction work.

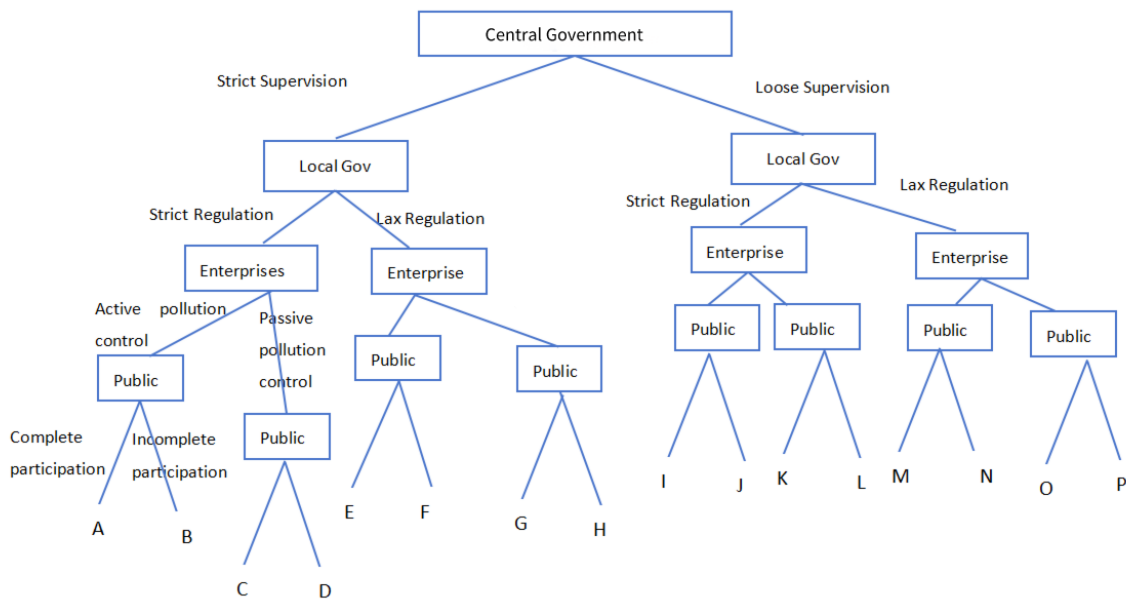


Figure 5: Central government-local government-enterprise-public four-square game tree.

7. Conclusion

Chinese scholars have conducted in-depth research and analysis on the environmental game behavior which is about the government and enterprises, and overall, they have solved the problem of balancing the selection of environmental protection strategies between the government and enterprises. However, they still face many difficulties and challenges due to the social complexity and diverse interests of environmental protection issues.

Scholars have pointed out that there is mutual influence between environmental strategy choices made by local governments and enterprises. The management of local governments by the central government, as well as the disclosure of media and public reports on pollution behavior, can also affect their environmental behavior. Based on the above research, here are some suggestions for the

selection of environmental protection strategies between governments and enterprises offered: In terms of government, the central administration should strengthen inspection of local governments and improve system of rewards and penalties; local governments should strictly govern and increase their supervision of enterprises. In terms of enterprises, environmental awareness should be strengthened and environmental standards should be followed. On the public side, it is necessary for the government to build a communication platform with the public to enhance the public's sense of participation in environmental protection. In terms of media, it is necessary to strengthen attention to government and corporate pollution behavior, expand negative impacts, and promote governments and businesses to choose environmentally friendly policy guidelines.

In last several years, Chinese professors have studied the environmental protection game behavior between the government and enterprises using evolutionary game models. However, in situations where the government and enterprises are well aware of the game rules, using evolutionary game models appears too complex. In this case, it can be considered to change the game rules into dynamic games and directly obtain equilibrium strategies. At present, the existing literature mainly related to research objects such as central government, enterprises, local governments, the public and media, etc. However, in addition, factors such as discount factors and environmental tax collection can also affect the choice of environmental protection plans by the government and enterprises. Therefore, in future research, it is possible to analyze how other different factors affect the selection of environmental protection strategies and consider the internal connections between each factor, providing more scientific and reasonable suggestions for solving the problem of government and enterprise environmental protection strategy selection.

References

- [1] Du, C.J. (2018) *Overview of Xi Jinping's Ecological Civilization Thought*. *Journal of Beijing Jiaotong University (Social Science Edition)*, 17(1), 151-158.
- [2] Tao, M.,Ye, B.Q. (2006) *Game Analysis about Environment Protection Behavior among Local Government and Enterprise*. *Science Technology and Engineering*, (07), 848-850.
- [3] Wang, X.H., Bao, Y.N. (2019) *Government Control, Enterprise Operation and Environmental Protection Supervision Game*. *Economic and Social Development*, 17(04), 48-54.
- [4] Fan.R.G., Wu, T., Fan, W. (2022) *Research on Tripartite Governance Evolutionary Game Model and Environmental Governance Strategy Under Environment Tax and Regulation Capture*. *Soft Science*,36(05), 122-130.
- [5] Zhang, M., Sun, X.R. (2023) *Central Environmental Protection Inspector and Air Pollution Governance: Evolutionar Game Analysis Based on Vertical Governments and Polluting Enterprises*.*Chinese Journal of Management Science*, 31(04): 171-182.
- [6] Hu, M., Wang, Z.H. (2023) *Tripartite Evolutionary Game and Simulation Analysis of Corporate Pollution Regulation under Central Environmental Supervision*.*Modernization of Management*, 43(03), 134-144.
- [7] Cui M. (2021) *Tripartite Evolutionary Game Analysis for Environmental Credit supervision under the background of collaborative governance*.*Systems Engineering—Theory&Practice*, 41(3), 713-726
- [8] Wang, F. (2008) *A Game Analysis on Environmental Behavior of Governments, Enterprises and the Public*. *Economic Issue*, (06), 20-22+129.
- [9] Chen, Y., Zhang, J., Tadikamalla, P.R., Gao, X. (2019) *The Relationship among Government, Enterprise, and Public in Environmental Governance from the Perspective of Multi-Player Evolutionary Game*. *Int J Environ Res Public Health*. 16(18), 3351.
- [10] Zhong, Z., Peng, B. (2023) *Multi-agent behavior strategy game and evolutionary simulation analysis under environmental regulation*. *Energy and Environment*, 34(8), 3365-3390.
- [11] Ren, H. (2020) *On the Government's Responsibility to Optimize the Business Environment: Realistic Value and Operating Path*. *Journal of Beijing University of Technology*. 20(4), 49-57.
- [12] Chen, Z.J., Dong, M.T., Ma, P.C. (2020) *Impacts of Interactions between Media Coverage and Investor Attention on Internal Control: Empirical Investigation on State-owned Listed Firms in China*. *Financial and Trade Research*, 31(9), 110.
- [13] Fu, Y.H. *A Study of Media Coverage on Corporate Environmental Inputs*. Nanjing Agricultural University, 2012.

- [14] Xie, Z.M. (2014) *The Impact of Government and Media Regulation on Enterprise Environmental Management Behavior*. *Search*, (09), 70-74.
- [15] Jiang, Q.Y., Xu, H.P. (2022) *Research on Enterprise Environmental Protection Strategy Supervision based on a Tripartite Game model*. *Environmental Protection Science*, 48 (06), 39-46+69.
- [16] Wu, X.L. (2008) *The Effect Test of Media Influencing Public Environmental Awareness*. *News Enthusiast (Theory Edition)*, (08), 26-27.
- [17] Pan, F., Diao, Z.X., Wang, L. (2023) *The Impact Analysis of Media Attention on Local Environmental Governance based on Four-party Evolutionary Game*. *Ecological Modelling*, 478.