Evolutionary game analysis of financial fraud governance behavior of listed companies based on Prospect Theory

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Abstract. To solve the problem of financial fraud of listed companies is the fundamental way to maintain the smooth operation of the whole stock market. In order to explore the related problems of the governance of the financial fraud of the listed companies, the prospect theory is introduced in the process of constructing the evolutionary game model between the listed companies and the regulatory departments, and the limited rationality is run through the listed companies. In the whole decision-making process of the supervision department, the strategy selection and evolution path and mechanism of the related game subject are analyzed under the condition of the uncertainty of the risk, and the game model is simulated and analyzed with the Matlab tool. The research shows that only when the difference between the regulatory cost and the actual income is greater than the negative income that the non regulation may bring and the perceived benefit of the listed company's non fraud is greater than the perceived net income that the fraud can bring, the system will eventually evolve to the supervision of the regulatory department and the listed company will not go out of fraud. This stable strategy, at the same time, due to the strong sensitivity of the listed companies to the degree of loss and the corresponding perceived value, should increase the punishment of the fraudulent behavior of the listed companies or the related rewards to the behavior of non fraud. Among the above two measures, the listed companies are more sensitive to the punishment intensity.

Keywords: Listed companies; Financial fraud; Governance behavior; Prospect theory; Evolutionary game

1 Introduction

Since the 21st century, with the rapid development of the world economy, the number of Listed Companies in the capital market has increased day by day. However, the following financial fraud incidents of listed companies have also begun to emerge. Internationally, from the first shocking fraud case of Nanhai company exposed by Britain in 1720, to the Enron incident in the United States in 2001 and the subsequent

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fraud incidents of Xerox and southern health care, The financial fraud of listed companies occurs continuously in the securities market. In China, Xintai electric appliance company (300372), one of the top ten black listed companies on the Internet in 2016, was forced to delist due to fraud, becoming the first GEM listed company to delist. In 2017, companies such as * ST Zhonghe (002070) and Erkang Pharmaceutical (300267) were punished due to false profits and other problems, as well as geeya Technology (300028) and * ST olefin (000511), which were listed on the list for two consecutive years and have increased in ranking, In 2021, LETV's accumulated false income increased by 1.872 billion yuan and its accumulated false profit increased by 1.737 billion yuan in the past ten years. From the above financial fraud methods, most enterprises increased their operating income by various means or recorded less financial expenses, thus increasing their profits and eventually forming financial fraud incidents. With the widespread financial fraud of Listed Companies in the current securities market and the increasingly serious related problems, it is necessary for the relevant regulatory departments to take appropriate regulatory measures and improve the relevant rules and regulations, reduce or eliminate the possibility of fraud of listed companies, and promote their standardized operation, so as to maintain the order of the securities market and maintain the stability of the securities market.

At present, scholars have conducted in-depth research on the financial fraud of listed companies. These studies mainly focus on the causes, identification and governance of financial fraud. In terms of the causes of financial fraud, Libby (1990) and Fairchild (2008) believe that the tenure of auditors and the sympathy that most auditors may have are the main causes of financial fraud [1, 2]. Dunn (2004) believes that the imperfect internal governance structure of listed companies is also the main reason for financial fraud of Listed Companies [3]. Xiong Fangjun (2022) and others took Ruixing coffee as an example, combined with the financial indicators of Ruixing coffee industry and its own financial indicators, and used the fraud triangle model and the gray correlation model to identify the incentive risk and the result risk of Ruixing coffee's financial fraud [4]. Ye Qinhua and Ye Fan (2022) constructed a framework model for financial fraud identification based on accounting information system theory and big data [5].

Xu Xiaoyang(2020)With the gradual development and improvement of prospect theory and evolutionary game theory, scholars also apply prospect theory and evolutionary game theory to various fields [6]. For prospect theory, Diao Shujie(2021) applied prospect theory to the study of whether flexible attitude to risk can be captured [7].

In general, although domestic and foreign scholars have made rich achievements in the research on financial fraud and the application of prospect theory and evolutionary game theory, there are still some shortcomings: most of the research on financial fraud is mainly qualitative, and the research mainly focuses on the causes, identification and governance measures of financial fraud of listed companies; The traditional application research of evolutionary game does not completely run through the assumption of bounded rationality, and the income calculation for the relevant players is still mainly based on the expected utility theory, often ignoring the subjective value perception of the relevant players; The application of prospect theory and evolution-

ary game theory to other fields has been widely studied by relevant scholars, but it is rarely used in the research of fraud prevention and control of listed companies. In view of this, this paper combines prospect theory and evolutionary game theory to build an evolutionary game model between listed companies and regulatory authorities, analyzes the financial fraud prevention and control behavior of listed companies using quantitative methods, and builds a perceived income matrix between relevant game players based on the value function in the previous scenario theory, This is different from the traditional evolutionary game model in which the income function calculates the income of relevant subjects. It runs the limited rationality through the whole decision-making process of listed companies and regulatory departments, and carries out simulation analysis to investigate the sensitivity of relevant subjects to the changes of corresponding variables, and puts forward countermeasures and suggestions to govern the financial fraud of listed companies, so as to reduce or eliminate the possibility of fraud of listed companies, Promote its standardized operation, and provide scientific reference for relevant regulatory authorities to formulate corresponding laws and regulations.

2 Model assumptions

Hypothesis 1: There are two kinds of bounded rational subjects in the whole process, namely, the listed company and the regulatory department. At the same time, these two subjects have two strategic choices. The listed company will choose the two strategies of fraud or non fraud according to its own psychological perception with the goal of maximizing its own interests.With the goal of maximizing social benefits, the regulatory authorities will also choose the two strategies of supervision or non supervision according to their own psychological perception, which is in line with the prospect theory.

Hypothesis 2: The game between the listed company and the regulatory authority is a dynamic repeated game process, and both parties will learn and adjust until they reach the optimal strategy. In addition, due to the limited rationality assumption of the two game players, this paper combines prospect theory and evolutionary game theory to analyze the financial fraud of listed companies. In prospect theory, foreground value of decision is $V(p,x)=\sum_{i=1}^{n}\pi(p_i)v(\Delta\omega_i)$, and among $\pi(p_i)$ is weight function，and $v(\Delta\omega_i)$ is value function.The value function has the following characteristics: value function $v(\Delta\omega_i)$ has different concavo convex properties on $(-\infty,0)$ and $(0,+\infty)$ .It appears as a concave function on $(0,+\infty)$ .It is a convex function on $(-\infty,0)$, and has stronger sensitivity on $(-\infty,0)$ .The weight function $\pi(p_i)$ has the following characteristics: $\pi(0)=0,\pi(1)=1$ .In addition to the minimum probability events, there are $\pi(p)<p$ and $\pi(p)+\pi(1-p)\le 1$ ； $\exists 0<\gamma<1$ ， $\pi(\gamma p)<\gamma\pi(p)$ ； for $0<p_1,p_2,\gamma\le 1$ ， there are $\pi(p_1p_2)/\pi(p_1)<\pi(\gamma p_1p_2)/\pi(\gamma p_1)$

Hypothesis 3: The supervision cost of the supervision department is set as C_2 ， and at the same time, supervision will bring positive benefits, set as V_2 .Non regulation will bring negative benefits, set as V_2' ， Suppose $V_2+V_2'>0$ .The normal income of the

listed company is set as: V_1 .The additional income obtained by fraud is set as: ΔV_1 .The punishment coefficient of the regulatory authority for fraud of listed companies is set as k_1 .Therefore, the punishment for the listed company's fraud is set as: $k_1\Delta V_1$ .The listed company's standardized operation may be rewarded by the relevant departments, and the improvement is set as follows J_1 .

Hypothesis 4 :There is uncertainty about the punishment of the regulatory authorities due to listing.Therefore, there is a psychological perception of the penalty value $k_1\Delta V_1$, Here, set the foreground value of the penalty as $v(k_1\Delta V_1)$ .Similarly, since the listed company also has uncertainty about the rewards it can get from its standardized operation,and it has a psychological perception of the benefits it can bring, and its prospect value is set as $v(J_1)$.

3 Establishment of game model between listed company and regulatory department based on Prospect Theory

According to the above assumptions, the perceived income matrix between listed companies and regulatory authorities is constructed, as shown in the following table 1：

Table 1. Perceived benefit matrix

		Regulatory authority	
		Regulated (y)	Unregulated $(1-y)$
Listed company	No fraud x	$V_1 + v(J_1)$ ；	$V_1 + v(J_1)$ ；
		$V_2 - C_2 + v(-J_1)$	$-V_2' + v(-J_1)$
	Fraud $(1-x)$	$V_1 + \Delta V_1 + v(-k_1\Delta V_1)$ ；	$V_1 + \Delta V_1$ ；
		$V_2 - C_2 + v(k_1\Delta V_1)$	$-V_2'$

It is assumed that the probability of the listed company choosing the no fraud strategy is x , The probability of fraud is $1-x$, Where x is a function of the time variable t ; The probability that the regulatory authority chooses to supervise is y , The probability of non supervision is $1-y$, Where y is also a function of time t 。The basic form of the value function is shown in hypothesis 2, which is introduced into the replication dynamic equation as follows:

The expected income and average income of the listed company when it chooses the fraud strategy and the non fraud strategy are as follows:

$$\begin{cases} U_{C1} = y[V_1 + v(J_1)] + (1-y)[V_1 + v(J_1)] \\ U_{C2} = y[V_1 + \Delta V_1 + v(-k_1\Delta V_1)] + (1-y)(V_1 + \Delta V_1) \\ U_C = xU_{C1} + (1-x)U_{C2} \end{cases} \tag{1}$$

U_{C1} represents the expected return of the listed company when it selects the non-fraud strategy . U_{C2} represents the expected return when selecting the fraud strategy. U_C means average income， $U_C = (1-x)[\Delta V_1 + yv(-k_1\Delta V_1)] + xv(J_1) + V_1$.

The expected return and average return of the regulatory department's selection of regulatory strategy and non regulatory strategy are as follows:

$$\begin{cases} U_{G1} = x\left[V_2 - C_2 + v(-J_1)\right] + (1-x)\left[V_2 - C_2 + v(k_1\Delta V_1)\right] \\ U_{G2} = x\left[-V_2' + v(-J_1)\right] + (1-x)(-V_2') \\ U_G = yU_{G1} + (1-y)U_{G2} \end{cases} \tag{2}$$

U_{G1} represents the expected return when the regulatory department selects the regulatory strategy. U_{G2} represents the expected return when the regulatory department chooses the non regulatory strategy. U_G means average income， Here are: $U_G = y(V_2 - C_2 + V_2') + (1-x)yv(k_1\Delta V_1) + xv(-J_1) - V_2'$

According to the above expected return and average return, the dynamic equation of replication can be obtained as follows:

Replication dynamic equation of listed companies:

$$\begin{cases} \dfrac{dx}{dt} = x(U_{C1} - U_C) = E(x) \\ E(x) = x(1-x)\left[v(J_1) - yv(-k_1\Delta V_1) - \Delta V_1\right] \end{cases} \tag{3}$$

Replication dynamic equation of regulatory authorities:

$$\begin{cases} \dfrac{dy}{dt} = y\left[U_{G1} - U_G\right] = F(y) \\ F(y) = y(1-y)\left[(1-x)v(k_1\Delta V_1) + V_2 - C_2 + V_2'\right] \end{cases} \tag{4}$$

Let $\frac{dx}{dt} = 0$ 、 $\frac{dy}{dt} = 0$ and there are five replication dynamic stable points： $O_1(0,0)$ 、 $O_2(0,1)$ 、 $O_3(1,0)$ 、 $O_4(1,1)$ and $O_5(x^*, y^*)$ ，there are $x^* = \frac{v(k_1\Delta V_1) + V_2 - C_2 + V_2'}{v(k_1\Delta V_1)}$ ， $y^* = \frac{v(J_1) - \Delta V_1}{v(-k_1\Delta V_1)}$ 。According to the calculation method of system evolution stability strategy proposed by Friedman.The Jacobi matrix can be used to calculate the evolution stability strategy (ES). According to the above replication dynamic equation, the Jacobi matrix can be obtained as follows:

$$\begin{bmatrix} (1-2x)\left[v(J_1) - yv(-k_1\Delta V_1) - \Delta V_1\right] & x(1-x)\left[-v(-k_1\Delta V_1)\right] \\ y(1-y)\left[-v(k_1\Delta V_1)\right] & (1\text{-}2y)\left[(1-x)v(k_1\Delta V_1) + V_2 - C_2 + V_2'\right] \end{bmatrix} \tag{5}$$

According to the above prospect theory, the value function $v(\Delta\omega_i)$ in the Jacobi matrix is taken into account:

$$\begin{bmatrix} (1-2x)\left[J_1^{\varepsilon} + \lambda y(k_1\Delta V_1)^{\varepsilon} - \Delta V_1\right] & x(1-x)\left[\lambda(k_1\Delta V_1)^{\varepsilon}\right] \\ y(1-y)\left[-(k_1\Delta V_1)^{\varepsilon}\right] & (1-2y)\left[(1-x)(k_1\Delta V_1)^{\varepsilon} + V_2 - C_2 + V_2'\right] \end{bmatrix} \tag{6}$$

4 Evolutionary game analysis of listed companies and regulators based on Prospect Theory

According to the above Jacobi matrix, the evolutionary stability strategy can be determined by judging its local stability.That is, when there is determinant $DetJ > 0$ and trace $TrJ < 0$ holds, the point is the local stable point，When both are greater than 0, they are unstable points, from which the following inferences can be obtained:

Inference 1: When there is $J_1^{\varepsilon} < \Delta V_1$ and $(k_1 \Delta V_1)^{\varepsilon} + V_2 - C_2 < -V_2'$ holds，and $O_1(0,0)$ is the stable point of the system. The listed company will choose the fraud strategy, and the regulatory authority will choose the non regulatory strategy. In this case, the fraud of listed companies will cause greater harm to society, and the negative inaction of regulatory authorities will also contribute to the persistence of fraud of listed companies.

Under these circumstances，Because the additional perceived income J_1^{ε} that the listed company may bring by choosing the non fraud strategy is less than the additional income ΔV_1 that the fraud may bring,and the listed company will choose the fraud strategy to safeguard its own interests for the sake of maximizing its own interests.When the sum of the positive benefits of supervision and the negative benefits of non supervision by the regulatory authority is not enough to offset the costs of supervision, and the regulatory authority will choose the non supervision strategy, and eventually the stabilization strategy will evolve to $O_1(0,0)$ 。

In addition, under the above conditions，if $J_1^{\varepsilon} < \Delta V_1 - \lambda (k_1 \Delta V_1)^{\varepsilon}$ holds，and at this time，$O_4(1,1)$ is the unstable point of the system，and minor changes will lead to changes in the final strategy choice.That is, at this time, the regulatory authorities finally choose the regulatory strategy to maximize the social benefits. The listed companies are deterred by the regulation or do not cheat out of social morality. However, because the listed companies aim to maximize their own interests, they will ultimately choose the fraud strategy to obtain greater economic benefits driven by economic interests. At this time, the regulatory authorities will finally abandon the regulatory strategy because of regulatory failure. At the same time, according to the above analysis, we can get the evolution path diagram, as shown in Figure 1 left side:

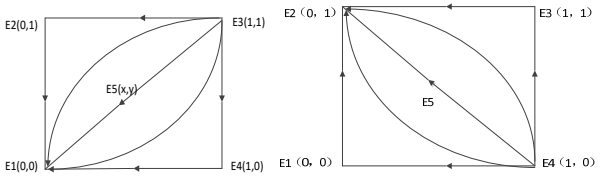

Fig. 1. System Evolution Diagram

Inference 2:When $J_1^{\varepsilon} < \Delta V_1 - \lambda (k_1 \Delta V_1)^{\varepsilon}$ and $(k_1 \Delta V_1)^{\varepsilon} + V_2 - C_2 > -V_2'$ hold，and at this time, $O_2(0,1)$ is the stable point of the system，and listed companies will choose fraud strategies, and regulatory authorities will choose regulatory strategies. This situation is the

worst of the four states, because listed companies still choose fraud strategies when regulatory authorities adopt regulatory strategies. At this time, regulatory authorities' supervision is ineffective and listed companies are in a passive resistance state.

Under these circumstances，the perceived additional income J_1^{ε} of listed companies without fraud is less than the additional net income $\Delta V_1 - \lambda(k_1 \Delta V_1)^{\varepsilon}$ of fraud strategies，and listed companies will choose fraud strategies to maximize benefits. At this time, the supervision of the regulatory authorities is invalid for listed companies. Even though the punishment of the regulatory authorities may be greater, listed companies are reluctant to choose fraud free strategies. For regulators，as the regulated net income $(k_1 \Delta V_1)^{\varepsilon} + V_2 - C_2$ is greater than the unregulated income $-V_2'$，and at this time, the regulatory authorities will choose to supervise whether from the perspective of social benefits or their own benefits. If the above conditions are met，$V_2 - C_2 > -V_2'$，at this time, $O_3(1,0)$ is the unstable point of the system，minor changes may lead to system imbalance.In this case, there will be a temporary equilibrium situation in which the regulatory authority does not supervise and the listed company will not cheat, but this situation is not stable, and the system will eventually evolve to listing fraud and the regulatory authority will choose the regulatory strategy. According to the above analysis, the evolution path is shown in Figure 1 right side:

Inference 3:When $J_1^{\varepsilon} > \Delta V_1$ and $V_2 - C_2 < -V_2'$ hold，and at this time, $O_3(1,0)$ is the stable point of the system，listed companies will choose no fraud strategy, and regulators do not need to supervise. This is the most ideal stable state. However, because listed companies are driven by interests, and regulators will not choose no supervision for social responsibility and interests, this situation is difficult to achieve in practice.

Under these circumstances，because the perceived additional income J_1^{ε} of listed companies when they choose non regulatory strategies is greater than the additional income that fraud can bring，In order to maximize the interests, listed companies will not cheat.At the same time, for the regulatory authorities, the sum of the regulatory revenue V_2 and the regulatory cost C_2 is less than the unregulated revenue，and the supervision department will choose the non supervision strategy。If the above conditions and $(k_1 \Delta V_1)^{\varepsilon} + V_2 - C_2 < -V_2'$ are met.At this time, $O_2(0,1)$ is the unstable point of the system，and minor changes will change the balance of the system.Driven by the maximization of interests, this short-term equilibrium will eventually be broken, and listed companies will eventually choose a fraud free strategy. According to the above analysis, the evolution path is shown in Figure 2 left side:

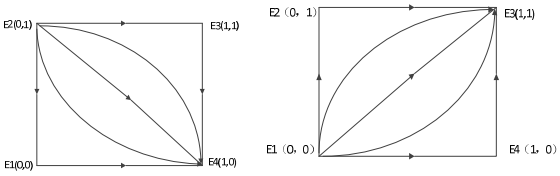

Fig. 2. System Evolution Diagram

Inference 4 :When $J_1^{\varepsilon} > \Delta V_1 - \lambda(k_1\Delta V_1)^{\varepsilon}$ and $V_2 - C_2 > -V_2'$ hold， and at this time, $O_4(1,1)$ is the stable point of the system.This situation is most in line with the actual situation of the entire securities market in China, and is a relatively ideal state that is easy to achieve in the short term. This state is of great significance for the stable and orderly development of the securities market. Under the above circumstances， as the perceived income J_1^{ε} of listed companies due to fraud is greater than the perceived income $\Delta V_1 - \lambda(k_1\Delta V_1)^{\varepsilon}$ of fraud.For the sake of maximizing the interests, listed companies will not choose to cheat in the end， and at the same time, for the regulatory authorities. The perceived income $V_2 - C_2$ brought by the choice of supervision is greater than the income $-V_2'$ when the supervision is not carried out. Therefore, the supervision department will ultimately choose the supervision strategy to maintain the stability of the entire securities market, regardless of whether it is for the benefit maximization or social responsibility. According to the above analysis, the system evolution path is shown in Figure 2 right side:

Inference 5:The stability analysis of point $O_5(\frac{(k_1\Delta V_1)^{\varepsilon} + V_2 - C_2 + V_2'}{(k_1\Delta V_1)^{\varepsilon}}, \frac{J_1^{\varepsilon} - \Delta V_1}{-\lambda(k_1\Delta V_1)^{\varepsilon}})$ is not applicable to Jacobi analysis method, and differential method is required for stability analysis. Therefore, differential method is applied to the relevant replicated dynamic equation to obtain:

$$\begin{aligned} \frac{dE}{dy} &= x(1-x)\cdot\lambda(k_1\Delta V_1)^{\varepsilon} \\ \frac{dF}{dx} &= y(1-y)\cdot\left[-(k_1\Delta V_1)^{\varepsilon}\right] \end{aligned} \tag{7}$$

Substitute O_5 into the above differential equation to obtain:

$$\frac{dE}{dy}(O_5) = \frac{1}{\lambda}\cdot\frac{(C_2 - V_2 - V_2')\left[(k_1\Delta V_1)^{\varepsilon} + (V_2 - c_2 + V_2')\right]}{(k_1\Delta V_1)^{\varepsilon}} \tag{8}$$

$$\frac{dF}{dx}(O_5) = \frac{1}{\lambda}\cdot\frac{(J_1^{\varepsilon} - \Delta V_1)\left[(k_1\Delta V_1)^{\varepsilon} + (J_1^{\varepsilon} - \Delta V_1)\right]}{(k_1\Delta V_1)^{\varepsilon}} \tag{9}$$

It can be seen from the foregoing that there is $x, y \in [0,1]$， So we can conclude that $0 \le \frac{(k_1\Delta V_1)^{\varepsilon} + V_2 - C_2 + V_2'}{(k_1\Delta V_1)^{\varepsilon}} \le 1$； $0 \le \frac{J_1^{\varepsilon} - \Delta V_1}{-\lambda(k_1\Delta V_1)^{\varepsilon}} \le 1$ are true，According to the condition that the system converges to $O_2(0,1)$ and $O_3(1,0)$, there are $\frac{dE}{dy}(O_5) > 0$ and $\frac{dF}{dx}(O_5) > 0$ .Thus, O_5 is the unstable point.

5 Conclusions

In order to better apply the bounded rationality hypothesis to the whole decision-making process of relevant game players, this paper combines the prospect theory and evolutionary game theory to analyze the financial fraud governance behavior of listed companies, uses the value function in the prospect theory to replace the income function in the traditional evolutionary game model to calculate the value income of rele-

vant players, and thus constructs the perceived income matrix, By solving and analyzing the expected return function and the replication dynamic equation, the stability conditions of the relevant stability points are obtained, and using Matlab tools to conduct numerical simulation analysis, to investigate the sensitivity of the relevant players' strategy choices to parameter changes, and to reveal the evolution path and evolution mechanism of the relevant game players' strategy choices, the following conclusions are obtained:

(1) Only when the perceived income from fraud free listed companies is greater than the perceived net income from fraud ($J_1^{\varepsilon} > \Delta V_1$), will the listed companies take the initiative to choose not to engage in fraud free compliance operations, and the regulatory authorities do not need to supervise at this time, because listed companies will voluntarily engage in compliance operations, and there is no fraud in the securities market at this time, but this "ideal state" is difficult to achieve in the actual situation, Therefore, the regulatory authorities need to implement incentive or punishment measures to encourage or deter listed companies from committing fraud. At this time, only when the difference between the perceived income of a listed company from fraud and the perceived income of fraud is greater than 0, that is, $J_1^{\varepsilon} - \left[\Delta V_1 - \lambda(k_1 \Delta V_1)^{\varepsilon}\right] > 0$, and when the difference between the perceived income of the regulatory authorities and the perceived income of non regulatory authorities is greater than 0, that is, $V_2 - C_2 - (-V_2') > 0$, At this time, under the supervision of the regulatory authority, all listed companies will eventually choose to operate in compliance without fraud, and the evolution system will eventually tend to stabilize at $O_4(1,1)$ point.

(2) Listed companies and regulatory authorities are highly sensitive to changes in loss avoidance m and marginal sensitivity n of perceived value. At this time, the regulatory authorities should pay attention to properly controlling the loss avoidance (m) of listed companies and the corresponding marginal sensitivity (n) of perceived value in the whole regulatory process, so they should appropriately increase the punishment for fraud, In order to gradually increase the value of the listed company's degree of loss avoidance, at this time, the listed company will consider that fraud may bring greater losses when making strategic choices, and will ultimately choose compliant operation rather than fraud for loss avoidance. At the same time, a certain amount of material and spiritual rewards should be given to companies that are not fraudulent. Appropriate rewards are given to increase the perceived value of listed companies for fraud. Because they perceive that fraud may bring greater benefits, listed companies will ultimately choose not to cheat when making strategic choices, and ultimately all listed companies will not choose fraud as a stable strategy under the supervision of the regulatory authorities, However, in the whole process, it should also be noted that this kind of reward or punishment should not be overemphasized, just control the value of loss avoidance (m) and the value of perceived value marginal sensitivity (n) within 2.25 and 0.88 respectively.

(3) The additional perceived earnings V_3 of listed companies and the corresponding penalty coefficient y of regulators will have a certain impact on the final evolution trend of the whole system, but the impact of these two variables on the whole system is not the same. Under the condition that $J_1^{\varepsilon} > \Delta V_1 - \lambda(k_1 \Delta V_1)^{\varepsilon}$ and $V_2 - C_2 > -V_2'$, enterprises

are relatively sensitive to increasing the penalty coefficient k_1, and less sensitive to additional perceived earnings V_3, At the same time, it can be seen from the prospect theory that the sensitivity of listed companies to losses is stronger than to earnings. At this time, the regulatory authorities should comprehensively consider the adjustment of relevant variables. Adjusting the penalty coefficient k_1 may make it easier to meet the above conditions to prevent the occurrence of financial fraud of listed companies.

Therefore, relevant departments should adjust measures to increase punishment, such as changing the fixed amount of punishment to an unlimited amount of punishment, setting the additional income that can be obtained from fraud as the punishment base, and setting a coefficient range, which determines its size according to the severity of fraud. In addition to the amount of punishment, all its illegal income should be confiscated and published on relevant websites. In case of serious fraud, it should stop listing, Once such fraud is found, not only can we not get additional benefits, but also our own original interests will be lost, at the same time, the social reputation will be damaged. The triple loss will naturally inhibit the desire of listed companies to commit fraud, and thus choose to operate according to rules. At the same time, it is also possible to set up special complaint websites or enrich complaint channels in the form of WeChat official accounts, so that more people can participate in the supervision process of fraud, which is not only conducive to improving the overall efficiency of the regulatory department, but also can reduce the cost of human resources, complainers' complaint costs, etc., which is of great significance to the governance of fraud of listed companies.

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