Evolution of Tripartite Dynamic Game and Simulation Analysis among Regulators, Fund Managers and Investors

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ABSTRACT
In recent years, securities investment fund plays an increasingly important role in China's securities market, which is a collective securities investment mode of interest co-existence and risk-sharing. However, principal-agent problems arise due to information asymmetry and utility imbalance among three parties of securities investment: fund manager, regulator, and investors. This paper analyzes the balanced relationship among fund managers, regulators, and investors from the perspective of the dynamic game. The results show that the additional effects of penalty intensity, credit loss, and supervision greatly affect the specific behaviors of the three parties. In order to make a perfect investment system of China's securities investment fund market, this paper makes some suggestions to fund managers, regulators, and investors on perfecting laws and regulations, increasing punishment, and raising investment awareness.

Keywords: *Securities investment fund, behavior analysis, dynamic game, replication dynamic equation, simulation analysis, penalty intensity, legal supervision, tripartite evolutionary game*

1. INTRODUCTION

Incorporated into an institutional arrangement in China in 1998, securities investment fund is a collective securities investment mode of interest co-existence and risk-sharing. In recent years, securities investment fund has become one of the most important investment institutions with increasing importance in the Chinese securities market. At present, the scale of the fund industry in China shows a steady growth trend, but it still faces many problems, such as insufficient supervision of fund managers by regulators, moral hazard and agency problems of fund managers, information asymmetry between investors and managers, etc. This paper analyzes the tripartite evolutionary game among fund managers, regulators and investors.

The current situation of the fund is as follows: moral hazard in securities investment refers to the phenomenon that by taking the advantage of his own private information, the fund manager damages the economic interests of the investors to maximize his own economic interests without transparent information and public behavior under contract conditions[1]. In addition, some fund managers utilize the information advantages of fund investment companies to conduct insider trading to obtain improper interests and seek high management fees for themselves by insufficient information disclosure.

In August 2021, the Shanghai High Court issued a judgment: Private equity fund managers Ju Zhou Assets blame and contract obligation for violating its private-equity fund managers, disputing with investors Zhou Yaohua , involving fake "equity transfer agreement" and in the underlying asset trading session, not truthfully informing investors corresponding risks, legal risks of equity generation, not making disclosure and verification, not prudent obligation of auditing irregularities, seriously violating regulations and responsibilities of the manager in the stage of fundraising, investment, management, finally sentenced to assume 100% liability for compensation.

This paper starts from the three main bodies of fund regulators, fund managers, and investors, and considers regulatory costs, moral hazard, information asymmetry,

and other factors based on the interests of the three parties. This paper analyzes the game among regulators, fund managers, and fundholders, obtains expectations from it, and verifies the correctness, reliability, and robustness of the three-party game model by using replicative dynamic equation and simulation analysis. The conclusion is drawn that to what extent should the regulator improve the legal mechanism and strengthen supervision, so as to supervise fund managers more effectively and prevent moral hazard. Investors should strengthen awareness of risk prevention. Thus fund investment market and the existing system can be better standardized and improved.

The remaining parts of the paper are as follows: The second part analyzes the violations of administrators and the regulation of supervisors; the third part introduces the hypothesis and construction of the tripartite evolutionary game model adopted by the research and solves the stable state of the tripartite decision by replication dynamic equation. The fourth part shows the simulation analysis of numerical simulation and tripartite stability strategy. The fifth part is the summary of the research results and shortcomings.

2. LITERATURE REVIEW

The market behavior of fund investors will influence fund managers, and the operation of fund managers is also one of the influencing factors of investor preference. Lin et al. studied investor behavior and found that the subscription and redemption behaviors of mutual fund investors in China will have an impact on the non-discretionary trading of fund managers. Under the influence of controlling the subscription and redemption behaviors of fund investors, the discretionary trading of fund managers will have a positive impact on fund performance [2]. Liu studied the influence of fund managers' "running to private" on investor base flow. (1) After fund managers "running to private", fund flow will decline even if fund performance does not change, and fund outflow exceeds 18% of fund assets half a year later; (2) The longer the former fund manager manages a fund, the more the fund flow declines; (3) Individual investors are more sensitive to relationship interruption and withdraw more money [3].

The principal-agent problem is a common problem in fund investment. Xu and Yan analyzed and studied the data of 2,246 global infrastructure funds from 2005 to 2016, and concluded that investors preferred infrastructure funds with high customer loyalty and investment in the international market. At the level of infrastructure fund companies, investors follow the trend of investment, and with the increase of information opacity and income uncertainty. There is a principal-agent problem between investors and fund managers, which is reflected in the conclusion that the fund rate does not match the expected performance [4]. Some scholars in the game theory Angle to analyze the problem of agency, Cui, Zhang and Wang use two complete information static game models, analyzes the game between independent directors and fund management companies, fund trustee and fund manager, pointed out that by changing the payoff matrix can change the position of the Nash equilibrium solution, and put forward practical measures to improve relevant laws and regulations to strengthen the role of independent directors [5]. Richard Fairchild studies the behavioral game between hedge fund managers and regulators. Regulators decide whether to regulate fund strategies, managers decide to choose safe or risky strategies, and how much effort to put into the probability of success. At the same time, the incentive of future capital flows to managers and the policy factors that influence regulators' decisions are considered in the game, and how short-sighted or far-sighted management behaviors can provide information for the regulatory debate of the entire financial market cycle [6].

This paper uses the tripartite evolutionary game model to further study the interesting relationship among fund managers, regulators, and investors. Wang and Li studied the quality safety system through tripartite evolutionary game and simulation analysis, solved the tripartite replication dynamic equation, and found the optimal solution of the tripartite evolutionary game [7]. T. Zhou, S. Zhou, and L. Liu, based on the government, bike-sharing enterprises, and consumers, verified the evolution path of the tripartite dynamic game and the sensitivity change direction and intensity of each influencing factor, then proposed stability strategy suggestions [8].

H. Wang and M. li study the model and draw the following conclusions: For the government, it must strengthen the contact with the consumers, making consumers participate more in regulation so that it can reduce the government cost, increasing the government's regulation punishment of benefits and no regulatory trust loss, improving the efficiency of supervision, prompting pork quality safety traceability system effective operation.

3. BEHAVIOR ANALYSIS OF PARTIAL SUBJECT

3.1 Analysis of irregularities of fund managers

The fund manager relies on its professional investment ability, rich information resources, and other advantages, makes use of the fund assets to invest in securities in accordance with the contract, and charges investors certain fees, such as front-end subscription fee, commission, fund custody fee, and management fee, etc. However, the problems of information asymmetry and utility imbalance between fund managers and clients lead to principal-agent problems, and the widespread moral

hazard is difficult to control and leads to related party transactions, insider trading, market manipulation, rat positions, and other behaviors. The main reasons are as follows:

3.1.1 Separation of ownership and management rights of securities investment funds

The ownership and management of securities investment funds are organized in different forms, with the investors owning the ownership and the fund manager owning the management right. Investors entrust fund managers to invest and manage their own assets, forming a principal-agent relationship, but there is no representative of investors in the fund management company. This contradiction is the root cause of moral hazard. Both fundholders and managers have their own interests maximized, but their expected investment goals and risk proportions are different: Holders hope to get higher investment returns and bear most of the responsibility for losses, while managers tend to get higher management commission fees and only bear limited liability when losses occur, which leads to managers' tendency to choose high-risk investment projects or conduct insider trading.

3.1.2 High supervision cost and insufficient punishment

Development time of securities investment fund in our country is short, development of the existing regulatory system is slow and updating of supervision model is not timely, regulator’s power of control is not strong. These problems cannot perfectly adapt to the rapid development of investment funds, cannot solve the issue of deregulation, and various irregularities process-ing on the market is not timely, all of which lead to a serious moral hazard problem.

3.1.3 Information asymmetry between managers and investors

Fund holders can only get incomplete historical information from public websites, such as the qualifications and past investment performance of fund managers, and cannot know in real-time what current fund management measures are taken by managers. Fund managers, with their specialized knowledge and unpublished information, have an incentive to internalize the benefits to them and externalize the risks to investors.

3.2 Behavior analysis of regulatory agencies

3.2.1 Regulatory Independence

Securities regulatory agencies belong to government regulatory agencies [9], and their government regulatory power comes from the authorization of laws and regulations led by the Securities Law, which is independent to a certain extent and helps to increase regulatory flexibility and improve regulatory efficiency by avoiding unlimited expansion of administrative organization scale.

The authorized model inevitably has some defects, first the misconduct phenomenon of securities regulatory often occurred in the power and responsibility to a wide range, second, there are many new problems needed to be regulated in the stage of the development in China's securities market, but if the laws and regulations did not specifically authorize supervisors, they would have no power to regulate and fail to control the problem.

3.2.2 Protection of the holder by the supervisor

On one hand, China Securities Regulatory Commission set up a securities investor Protection Fund Company. The stock exchange supervises the information disclosure of listed companies, to ensure that important information can be released in time[10]. They also supervise and manage illegal behaviors of managers, and play a role in protecting the safety of fund transactions.

On the other hand, there is still insufficient protection of the holder by the regulator. For insider trading, market manipulation, and other violations in the fund trading link, the CSRC usually penalizes the corresponding institutions but does not make up for the losses of the investors. The administrative factor of the Securities Industry Association blurs the boundary between government supervision and self-regulation. Pan supposes although there are many self-discipline rules, they are weak in operability and difficult to implement [11].

4. RESEARCH METHODS

4.1 Model Assumptions

Before building the dynamic game model, it is necessary to put forward premise assumptions for the behavior decision-making of the participants. Combined with the characteristics of the three participants in this paper, the following hypotheses are proposed. (1)After the above analysis, the operation of China's fund market is mainly macro controlled by regulatory agencies, fund managers carry out specific operations, and investors choose investment objects. Therefore, this paper assumes that the three subjects involved in the behavior are: regulators, fund managers, and investors. (2) In the context of the market environment, the main participants are all in the pursuit of profit maximization, and their behavior choices follow the limited rational economic man hypothesis.

(3) Among the three parties involved in the fund market, if the regulator's strategic choice is "supervision" or "non-supervision", the result of the whole game will be affected. When the regulator chooses "supervision", it will produce supervision costs, and also obtain certain social benefits, such as the promotion of the image of the institution, the increase of public credibility, etc. When regulators choose "no regulation", that is, they do not participate in the supervision and construction of the fund market and leave it to its own devices, then regulators do not need to pay costs, and their image and credibility will decline.

(4) In the fund market, when the fund managers' strategic choice is "violation" or "non-violation", it will directly affect the interests of investors as well as the legal and effective operation of the fund market. When fund managers choose "law-abiding operation", it will produce lower returns, but the regulatory authorities will also reward fund managers, that is, give basic rewards to their contributions in maintaining the legality and order of fund operation. When the fund manager chooses an "illegal operation", the regulator will impose punishment on it, which means that the fund manager has insider trading or market manipulation in the process of equity investment. At the same time, it causes the loss of fund managers' image and investors' trust to a certain extent.

(5) During the operation of the fund market, the effective operation of the fund market will be affected to some extent when investors respond to the fund manager's violations as "aware" or "unaware". When investors are "unaware" of the fund manager's illegal operations, that is, they have confidence in the operation of the fund market, they will not withdraw the trust and continue to hold the fund; On the contrary, investors "are aware of" the fund manager's illegal operations, that is, investors lose confidence in the operation of the fund market, withdraw the trust and receive compensation from the regulatory authorities.

4.2 Model Construction

4.2.1 Participants

As the main participants of fund market operation, regulatory agencies' behavioral strategies can be divided into "supervision" and "non-supervision". If the probability of "supervision" by the regulator is a，$a \in [0,1]$，on the contrary, the probability of "non-supervision" by the regulator is $1-a$. If the regulator chooses "non-supervision", there will be a lot of illegal operations in the fund market, leading to the loss of trust. As an important participant of fund market operation, fund manager's behavior strategy is "law-abiding operation" and "illegal operation". If the probability of "law-abiding operation" of the fund manager is b, and $b \in [0,1]$, the probability of "illegal operation" is $1-b$. Faced with the choice of different behavioral strategies by regulators and fund managers, investors will make different behavioral strategies. If the probability of "awareness" by investors is c，and $c \in [0,1]$，the probability of "unawareness" by investors is $1-c$.

In the process of fund market operation and in the case of information asymmetry, due to the different behavior choices of regulators and fund managers, there will be cost expenditure and credibility changes. This paper analyzes the path of "cost-income" by constructing a three-party game model of "regulator - fund manager - investor". The three-party game strategy combination of "regulators, fund managers, and investors" is shown in Figure 1.

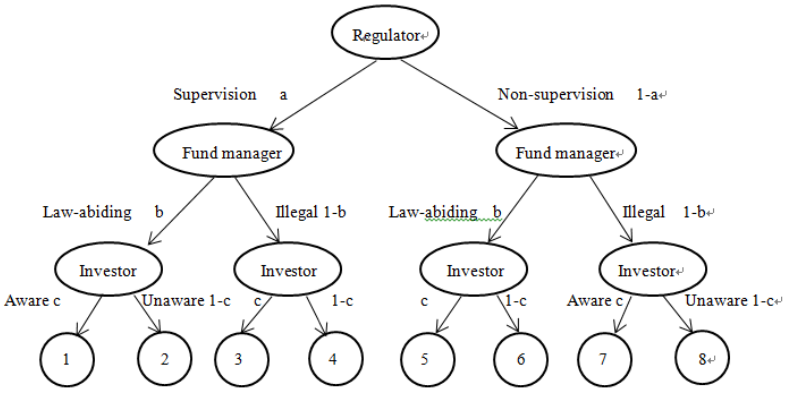

Figure 1 Tripartite Game Relationship Among Regulators, Fund managers, and Investors

4.2.2 Parameter Setting and pay off matrix

As shown in Table 1, the following parameters are set for the cost and benefit of each participant to study the benefit of each participant under a different combination of strategies.

According to the parameter setting in Table 1, the pay off matrix of each subject can be further constructed. There are 8 game combinations among regulators, fund managers and investors. Based on the above parameters, the respective returns of regulators,

fund managers and investors in these 8 strategy combinations can be obtained, as shown in Table 2.

Table 1. Related parameter Settings and interpretation

Related parameter Settings	Interpretation
The cost of regulation by regulators	C1
The extra revenue gained when regulators choose to monitor	R1
The loss when investors find violations but regulators choose not to regulate	T1
The cost of compliance by fund managers	C2
The incentive benefits to fund managers' law-abiding operations by regulators	R2
Regulatory penalties for violations received by fund managers	T2
Additional income obtained by fund managers due to illegal operations	R3
The manager's loss when the investor discover their illegal operation and recover the trust	T3
An investor's safety gain from a manager's compliance with the law	R4
Costs incurred by investors seeking to verify whether managers have violated regulations	L1
The original cost of buying a fund by an investor	C3
The compensation that regulators give to investors when they find irregularities	R5

Table 2. Profit and loss of the tripartite game among regulators, fund managers and investors

Game state	Regulator profit and loss value a	fund manager b	Investor profit and loss value c
1 abc	$R1-C1-R2$	$R2-C2$	$R4-L1$
2 $ab(1-c)$	$R1-C1-R2$	$R2-C2$	$R4$
3 $a(1-b)c$	$R1-C1+T2-R5$	$R3-T2-T3$	$R5-L1$
4 $a(1-b)(1-c)$	$R1-C1+T2$	$R3-T2-T3$	$-C3$
5 $(1-a)bc$	0	$-C2$	$R4-L1$
6 $(1-a)b(1-c)$	0	$-C2$	$R4$
7 $(1-a)(1-b)c$	$-T1-R5$	$R3-T3$	$R5-L1$
8 $(1-a)(1-b)(1-c)$	0	$R3$	$-C3$

4.3 Model Analysis

4.3.1 Expected return function

Based on the tripartite game pay-off matrix shown in Table 2, the expected returns of regulators, fund managers, and investors in the fund market can be obtained. The expected return of "supervision" by the regulator is E_{11}. When the regulator chooses "no regulation" considering the high cost of regulation, the expected revenue of the regulator in the game can be set as E_{12}. Similarly, the average expected revenue of the regulator can be calculated accordingly and is set as $\overline{E_1}$. In the hypothesis of this paper, all the companies that are responsible for the investment operation of fund assets and strive for maximum returns for investors are regarded as fund managers. When the fund manager chooses a "law-abiding operation", then shows its expected return for producers, E_{21}. When choosing "irregularities", so the same calculating the expected revenue, set to E_{22}, the average expected return of fund managers is $\overline{E_2}$; In addition, when investors are "aware" of the manager's illegal operations, the corresponding expected return of investors in the game process can be temporarily set as E_{31}; when investors are "unaware" of the manager's illegal operations, the expected return can still be obtained as E_{32}; similarly, the average expected return of investors is set as $\overline{E_3}$.

Expected return of regulators:

$$E_{11} = bc(R1-C1-R2) + c(1-b)(R1-C1+T2-R5) + b(1-c)(R1-C1-R2) + (1-b)(1-c)(R1-C1+T2)$$

$$= -b(R2+T2) + R1 - C1 + T2 - R5c + bcR5 \quad (1)$$

$$E_{12} = (1-b)c(-T1-R5) \quad (2)$$

Average expected return of regulators:

$$\overline{E_1} = aE_{11} + (1-a)E_{12}$$

$$= -ab(R2 + T2) + a(R1 - C1 + T2 - R5c + bcR5) + (1 - a)(bc - c)(T1 + R5) \quad (3)$$

Expected return of fund managers:

$$E_{21} = ac(R2 - C2) + a(1 - c)(R2 - C2) + (1 - a)c(-C2) + (1 - a)(1 - c)(-C2)$$

$$= aR2 - C2 \quad (4)$$

$$E_{22} = ac(R3 - T2 - T3) + a(1 - c)(R3 - T2 - T3) + (1 - a)c(R3 - T3) + (1 - a)(1 - c)R3$$

$$= a(R3 - T2 - T3) - (1 - a)c(T3) \quad (5)$$

Average expected return of fund managers:

$$\overline{E_2} = bE_{21} + (1 - b)E_{22}$$

$$= b(aR2 - C2) + (1 - b)[a(R3 - T2 - T3) - (1 - a)c(T3)] \quad (6)$$

Expected return of investors:

$$E_{31} = ab(R4 - L1) + a(1 - b)(R5 - L1) + (1 - a)b(R4 - L1) + (1 - a)(1 - b)(R5 - L1)$$

$$= b(R4 - R5) + R5 - L1 \quad (7)$$

$$E_{32} = abR4 + a(1 - b)(-C3) + (1 - a)bR4 + (1 - a)(1 - b)(-C3)$$

$$= bR4 - (1 - b)C3 \quad (8)$$

Average expected return of investors:

$$\overline{E_3} = cE_{31} + (1 - c)E_{32}$$

$$= c[b(R4 - R5) + R5 - L1] + (1 - c)[bR4 - (1 - b)C3] \quad (9)$$

4.3.2 Replication dynamic equation of three-party game model

Replication dynamic equations of regulatory agencies:

$$G(a) = \frac{\partial a}{\partial t} = a(E_{11} - \overline{E_1})$$

$$= a(1 - a)[b(-R2 - T2 + cR5 - cT1 - cR5) + (cT1 + R1 - C1 + T2)] \quad (10)$$

$$\text{When } b = \frac{cT1+R1-C1+T2}{R2+T2+cT1} \quad (11)$$

$$G(a) = \frac{\partial a}{\partial t} \equiv 0 \quad (12)$$

any value of a is stable.

$$\text{When } b \neq \frac{cT1+R1-C1+T2}{R2+T2+cT1} \quad (13)$$

$$\text{, set } G(a) = \frac{\partial a}{\partial t} = 0 \quad (14)$$

there are two stable states: $b = 0$ and $b = 1$.

The derivative of $G(a)$ is obtained:

$$\frac{\partial G(a)}{\partial t} = (1 - 2a)[b(-R2 - T2 + cR5 - cT1 - cR5) + (cT1 + R1 - C1 + T2)] \quad (15)$$

$$\text{When } b > \frac{cT1+R1-C1+T2}{R2+T2+cT1} \quad (16)$$

$$\text{set } \frac{\partial G(a)}{\partial a}|_{a=1} > 0 \quad (17)$$

$$\frac{\partial G(a)}{\partial a}|_{a=0} < 0 \quad (18)$$

when a is at the origin, the regulatory institution keeps stable in the evolution process.

$$\text{When } b < \frac{cT1+R1-C1+T2}{R2+T2+cT1} \quad (19)$$

$$\text{set } \frac{\partial G(a)}{\partial a}|_{a=1} < 0 \quad (20)$$

$$\frac{\partial G(a)}{\partial a}|_{a=0} > 0 \quad (21)$$

when $a = 1$, the regulatory institution keeps stable in the evolution process.

Replication dynamic equations of fund managers:

$$G(b) = \frac{\partial b}{\partial t} = b(E_{21} - \overline{E_2})$$

$$= b(1 - b)[a(R2 - R3 + T2 + T3 - cT3) - C2 + cT3] \quad (22)$$

$$\text{When } a = \frac{C2-cT3}{R2-R3+T2+T3-cT3} \quad (23)$$

$$G(b) = \frac{\partial b}{\partial t} \equiv 0 \quad (24)$$

fund managers are in a stable state no matter how the regulator chooses to change.

$$\text{When } a \neq \frac{C2-cT3}{R2-R3+T2+T3-cT3} \quad (25)$$

$$\text{set } G(b) = \frac{\partial b}{\partial t} = 0 \quad (26)$$

there are two stable states: $b = 0$ and $b = 1$.

The derivative of $G(b)$ is obtained:

$$\frac{\partial G(b)}{\partial t} = (1 - 2b)[a(R2 - R3 + T2 + T3 - cT3) - C2 + cT3] \quad (27)$$

$$\text{When } a > \frac{C2-cT3}{R2-R3+T2+T3-cT3} \quad (28)$$

$$\text{set} \frac{\partial G(b)}{\partial b}|_{b=1} < 0 \quad (29)$$

$$\frac{\partial G(b)}{\partial b}|_{b=0} > 0 \quad (30)$$

when $b = 1$, the fund managers keeps stable in the evolution process.

$$\text{When } a < \frac{C2-cT3}{R2-R3+T2+T3-cT3} \quad (31)$$

$$\text{set} \frac{\partial G(b)}{\partial b}|_{b=1} > 0 \quad (32)$$

$$\frac{\partial G(b)}{\partial b}|_{b=0} < 0 \quad (33)$$

b is at the equilibrium point of the origin, the fund manager's evolutionary stability strategy is to choose illegal operations.

Replication dynamic equations of investors:

$$G(c) = \frac{\partial c}{\partial t} = c(E_{31} - \overline{E_3})$$

$$= c(1-c)[-b(R5+C3) + R5 - L1 + C3] \quad (34)$$

$$\text{When } b = \frac{R5-L1+C3}{R5+C3} \quad (35)$$

$$G(c) = \frac{\partial c}{\partial t} \equiv 0 \quad (36)$$

investors are in a stable state no matter how the fund managers chooses to change.

$$\text{When } b \neq \frac{R5-L1+C3}{R5+C3} \quad (37)$$

$$\text{set } G(c) = \frac{\partial c}{\partial t} = 0 \quad (38)$$

there are two stable states: $c = 0$ and $c = 1$.

The derivative of $G(c)$ is obtained:

$$\frac{\partial G(c)}{\partial t} = (1-2c)[-b(R5+C3) + R5 - L1 + C3] \quad (39)$$

$$\text{When } b > \frac{R5-L1+C3}{R5+C3} \quad (40)$$

$$\text{set } \frac{\partial G(c)}{\partial c}|_{c=1} > 0 \quad (41)$$

$$\frac{\partial G(c)}{\partial c}|_{c=0} < 0 \quad (42)$$

when $c = 0$, the investors keeps stable in the evolution process as unawareness.

$$\text{When } b < \frac{R5-L1+C3}{R5+C3} \quad (43)$$

$$\text{set } \frac{\partial G(c)}{\partial c}|_{c=1} < 0 \quad (44)$$

$$\frac{\partial G(c)}{\partial c}|_{c=0} > 0 \quad (45)$$

when $c = 1$, the investors keeps stable in the evolution process as awareness.

4.4 Results Analysis of the Model

The analysis of the dynamic game evolution trend of the fund market above shows that: in the tripartite dynamic game process of regulators, fund managers and investors, any change in the behavior of one party will affect the behavior of the other two parties. This is mainly because the maximization of the interests pursued by all parties overlap, that is, the three parties have common interests, but also have their own costs and behavioral choices produced different benefits. Specifically, when the fund manager conducts illegal operations, investors will be aware of it. When the investors' rights and interests are damaged, they will complain to the regulatory authorities or use government supervision to curb the manager's behavior, and finally achieve a relatively balanced state. However, it is not always the absolute balance state, but the relative balance state. After the interests of the three parties tilt in the dynamic game, one party restricts the other party, so as to reverse the unbalanced state and achieve the relative balance state. In the process of simulation, we can also see that no matter how the coefficient is set, after a period of time, the game of all parties is at a stable level.

$$\text{When } b > \frac{cT1+R1-C1+T2}{R2+T2+cT1} \quad (46)$$

Regulators' behavior choice is infinitely close to 1, that is, regulators tend to choose "supervision". The probability that regulators will monitor strategies increases as the probability that managers will choose "law-abiding practices" decreases, and they have a negative effect. When the probability of the "law-abiding operation" of the manager is reduced, the effectiveness of the fund market operation is reduced, and the amount of punishment imposed by the regulator on the manager will increase. Moreover, the probability that regulators will choose to regulate will decrease as the probability that investors will detect irregularities increases. Therefore, regulators and investors should strengthen contact and let investors participate more in supervision, so as to reduce the cost of supervision, increase the punishment benefits brought by supervision and the loss of trust without supervision, improve supervision efficiency and promote the effective operation of the fund market.

$$\text{When } a > \frac{C2-cT3}{R2-R3+T2+T3-cT3} \quad (47)$$

The behavior choice of the fund manager is infinitely close to 1, that is, the manager eventually tends to choose a "law-abiding operation". The higher the probability that the regulator will choose the regulatory strategy is, the higher the probability that the manager will choose the law-abiding operation strategy. Managers choose more "law-abiding practices" in their choices, and investors choose less "unaware" strategies. Therefore, increasing the connection among managers, regulators and investors can reduce the costs of managers and increase their benefits. These include rewards from regulators and external spillovers as investor recognition increases. Managers' balance between the benefits of choosing "law-abiding operation" and the losses of choosing "illegal operation" strategy, this kind of trade-off can promote managers' compliance with securities trading.

$$\text{When } b < \frac{R5-L1+C3}{R5+C3} \quad (48)$$

Investors' behavioral choice is infinitely close to 1, that is, investors eventually tend to choose "unawareness". Among them, the higher the probability of investors choosing the imperceptive strategy, the lower the probability of managers choosing the law-

abiding operation strategy. The probability of investors choosing the imperceptive strategy increases as the probability of regulators choosing the regulatory strategy increases. Therefore, reducing the cost of investors' choice of strategies and increasing their returns will encourage investors to strengthen the target supervision.

5. NUMERICAL SIMULATION AND SIMULATION ANALYSIS

Parameters are set as: the cost when the government selects supervision C1 is 1; When the government regulates, the regulatory income R1 is 4; When the government does not regulate, the loss of consumer trust T1 is 6; The cost of fund managers' law-abiding operation C2 is 3; The incentive income of the government for the manager's law-abiding operation R2 is 5; Regulatory penalties for violations received by fund managers is 3; The loss to the manager caused by the withdrawal of entrustment by the investor found illegal operation T3 is 1; The extra income obtained by the manager's illegal operation R3 is 3; The cost of investors seeking to verify whether managers violate rules L1is 2; The following is a specific simulation analysis.

5.1 Simulation Analysis of Regulatory Stability Strategy

The initial strategy of regulatory institutions $a = 0.2, a = 0.4, a = 0.6, a = 0.8$ was analyzed numerically, and four groups of data were randomly generated to analyze the influence of strategy selection probability of managers and investors on the stability strategy of regulatory institutions. Figure 2 shows that when fund managers tend to choose law-abiding operations, regulators are more inclined to "no regulation". When managers are more likely to opt for "non-compliance", regulators tend to opt for "regulation". Therefore, in the process of evolutionary game, if the manager chooses illegal operation, the probability of investors being aware of it will increase, and they will take complaint measures to affect the manager's income. Under such pressure, managers tend to choose the strategy of "law-abiding operation" in order to avoid losses to the greatest extent. In order to maximize social benefits, in this case, the intensity of "supervision" by the regulator is reduced, which will form a more ideal market environment.

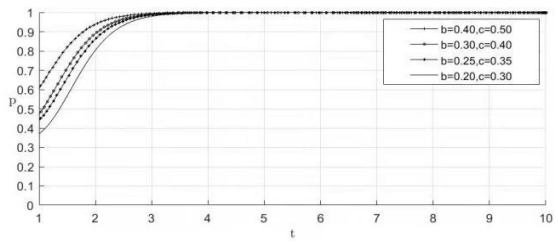

Figure 2 Simulation Analysis of Regulatory Stability Strategy

5.2 Simulation analysis of fund manager stability strategy

The initial strategy of the manager is numerically analyzed. Four groups of data are randomly generated and the influence of the probability of strategic selection of regulators and investors on the stability strategy of the manager is analyzed. As shown in Figure 3, the simulation results are as follows: When the probability of regulators choosing supervision is increasing, managers tend to adopt a stable strategy of law-abiding operation. When the probability of regulatory agency to choose regulation decreases, producers tend to adopt the stable strategy of illegal operation. In order to avoid punishment from regulatory authorities, the manager will choose a stable strategy of law-abiding operation, at which time investors are satisfied with the manager's behavior. In the three-party game, the regulatory agency plays a dominant role and its strategic choice affects the other two. Therefore, strengthening the supervision of regulatory agencies and appropriately rewarding and punishing managers for their strategic choices will reduce their violations.

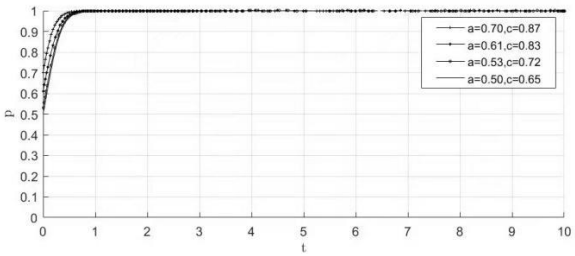

Figure 3 Simulation Analysis of Fund Manager Stability Strategy

5.3 Simulation Analysis of Investor Stability Strategy

The initial strategies of investors are numerically analyzed, and four groups of data are randomly generated to analyze the influence of the probability of strategic selection of regulators and managers on the stability strategies of investors. As shown in Figure 4, the simulation results are as follows: When regulators tend to choose "supervision", investors also tend to adopt the "unawareness" strategy. When the probability of "no supervision" is increased, investors tend to be "aware" of the manager's behavior. In the process of evolution, investors' strategic choices occupy a subordinate position and are influenced by the regulatory agencies' and managers' strategies.

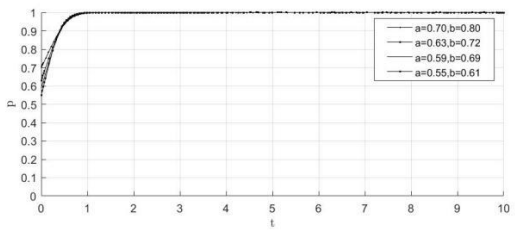

Figure 4 Simulation Analysis of Investors Stability Strategy

6. CONCLUSIONS

In recent years, securities investment fund plays an increasingly important role in China's securities market. However, information asymmetry and utility imbalance cause principal-agent problems. As a result, it reduces the profit of investors and turmoils of market. This paper analyzes the balanced relationship among three parties: fund manager, regulator, and investors by using dynamic game, replication dynamic equation, tripartite evolutionary game, numerical simulation and simulation analysis.

By using average expected return and replication dynamic equation, we get the equilibrium points of three parties and testify the stability using simulation analysis. For the regulators, when fund managers tend to choose law-abiding operations and investors tend to choose unawareness, regulators are more inclined to "no regulation". For the fund managers, when the probabilities of regulators choosing supervision and investors choosing awareness are increasing, managers tend to adopt a stable strategy of law-abiding operation. For the investors, when regulators tend to choose "supervision", investors also tend to adopt the "unawareness" strategy. When the probability of "no supervision" is increased, investors tend to be "aware" of the manager's behavior.

In conclusion, this paper is mainly focus on pure strategy instead of mixed strategy, also there is no stochastic factor of market and empirical study. In the future study we would combine probability event and random distribution of stock market to make the dynamic game model perfect.

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