Research on the Regulation of Futures Market Manipulation Based on the Evolutionary Game Theory

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Abstract: As a main part of the capital market, futures market occupies an important place in the modern financial system. In order to establish a safe, healthy and sustainable market, it has become an urgent issue to be solved about how to effectively prevent joint manipulation, regulate markets’ transactions, ensure the reality and effectiveness of price information and protect the rights and interests of traders. This paper, based on the perspective of the Evolutionary Game Theory, provides an economic analysis about the long-term existence of the joint manipulations in futures market.

Keywords: futures; joint manipulation; Evolutionary Game

1. Introduction

In September, 1990, Zhengzhou Grain Wholesale Market introduced the futures trading mechanism for the first time, which was a curtain-raiser to the development of futures trading market in China. After 20 years of construction and growth, China’s futures market has made great progress and trading behaviors have been more and more regulative. However, irregularities like joint manipulation or vicious market corners occurred many times during the development of futures market, such as 327 National Debt Futures Event, Suzhou Red Bean Futures Event, Shanghai Plywood Event, Guanglian Soybean Meal Event, Hainan Coffee Event and Zhengzhou Strong Gluten Wheat Event, etc. These joint manipulation behaviors seriously caused the distortion of price information in the trade of futures and greatly influenced the hedging function of futures market. In order to make the futures markets develops healthily, to protect the rights of investors, and to deeply study the evolution path of joint manipulation behaviors, it has been an urgent but important task to properly improve the supervisory system.

Scholars at home and abroad have done many profound studies about the joint manipulation behaviors of futures market. Wang (1999) used Bayesian Estimation, under incomplete information, constructed the dynamic model of price manipulation and discussed the necessary condition for the existence of joint manipulation. Gilert (1997) observed the distortion degree of the term structure of futures prices, and based on which tell the futures market manipulation. Pirrong (2004) used a series of econometric approaches like Event-study Analysis, Conditional Heteroscedastic Model and Error Correction Model, to confirm the joint manipulation phenomenon in soybean futures markets. Zhu Guohua (1999) analyzed several classical models of joint manipulations and further put forward some methods to prevent joint manipulations. He also especially mentioned the functions of contract designs in preventing joint manipulation. Shi Xiaobo (2015) especially introduced the forms of joint manipulation behaviors in futures market of China. What’s more, he introuduced some methods to prevent joint manipulations in China’s futures markets. Based on the practice of China’s futures market and the cases of joint manipulation in recent years, Sun QiuPeng (2016) made some comments on the shortcomings of the regulatory authorities and put forward some improvement measures.

In summary, foreign researches mainly focused on quantitative methods to tell whether joint manipulation behaviors exist or not. They seldom touched on the issues about the evolutionary direction of joint manipulation and supervision system arrangements. Domestic studies have explored the supervision system arrangements and prevention methods, but they were limited to experience introduction and cases study. Some conclusions were similar to each other. Because of the above reasons, this paper uses the bounded rationality of Evolutionary Game Theory, analyzes the endogenous evolution mechanism of joint manipulation behaviors and put forwards some improvements to regulation arrangements. There are two main characteristics of this article. On one hand, the hypothesis of bounded rationality is closer to reality. On the other hand, the conclusion based on the game model is of better universality and guiding significance.

2. Materials and methods

2.1 The establishment of the model

According to the features of joint operators’ behaviors in the futures market, this paper divides the joint operator group into two subgroups, i.e. initiator of joint manipulation (marked as Group M) and the facilitator of joint manipulation (marked as Group N). According to the subjective motives of the both parties who carry out joint manipulation, this paper divides individuals’ joint manipulation strategies into two categories, i.e. one of which is a strategy that members of Group M are willing to implement joint manipulation and members of Group N are willing cooperate with Group M to implement joint manipulation (called "collusion" strategy) and the other strategy is that members of Group M are not willing to implement joint manipulation and members of Group N are not willing to cooperate with Group M to implement joint manipulation (called "no-collusion" strategy). Therefore, Group M and N have the same strategy choice zone ("collusion" and "no-collusion")

Regulators successful joint investigation manipulate groups M, N the probability of a member of the implementation of joint manipulation obey distribution

Hypothesis One: The probability of joint manipulation implemented by the members of Group M and N obey the probability distribution of $[0, +\infty)$. The distribution functions are $A_M(w) = \int_0^w a_M(t)dt$ and $A_N(x) = \int_0^x a_N(t)dt$. 0 < w < +∞ and 0 < x < +∞ are respectively the internal information of the members of Group M and N owned by regulatory authority. Here $a_M(t) > 0$ and $a_N(t) > 0$ show that the greater is the information W and x owned by regulatory authority, the higher is the rate $A_M(w)$ and $A_N(x)$ of joint manipulation carried out by members of Group M and N who are successfully investigated by regulatory bodies.

Hypothesis Two: The joint manipulation rate of the conspirators selected form Group M and N also obeys the portability distribution $[0, +\infty)$. The distribution functions are respectively $B_M(y) = \int_0^y b_M(t)dt$ and $B_N(z) = \int_0^z b_N(t)dt$. 0 < y < +∞ and 0 < z < +∞ are respectively the game counterparts’ internal information owned by the members of Group M and N. Here, $b_M(t) > 0$ and $b_N(t) > 0$ show that...
the greater is the amount of information \( y \) and \( z \) owned by members of Group M and N, the higher is the rate \( B_u(y) \) and \( B_e(z) \) that the conspirators will be selected by the members of Group M and B.

Hypothesis Three: When the members of Group M and N take the "no conspiracy" strategy at the same time, members of the group M can get normal earnings because of its normal business. Similarly, members of the Group N can get normal earnings.

Hypothesis Four: When the members of Group M and N take the "conspiracy" strategy at the same time, Group M members achieve their envisioned goal of joint manipulation and obtain the illegal earnings \( R_e \) because the counterpart provides convenience for their joint manipulation behaviors. After finishing the conspiracy, Group N’s members naturally will charge a payment, i.e. the illegal earnings \( R_e \).

Regulatory bodies investigate the distribution of \( B(l, A_s(w)) \) and \( B(l, A_s(w)) \) based on the parameters of \( A_s(w) \) and \( A_s(x) \) and charge Group M’s and N’s members a penalty of \( T_u \) which is several times more than their illegal earnings \( R_e \). \( M \) will obtain the earning of \( R_e \) whenever \( l \) chooses "conspiracy" strategy, and \( N \) will get the earning of \( R_e \) whenever \( l \) chooses "non-conspiracy" strategy. Especially when regulatory bodies know nothing about the members of Group M and N, that is to say, when the internal information \( W \rightarrow \phi \), \( A_s(w) = 0 \), \( A_s(x) = 0 \), even though the members of both groups take “conspiracy” strategy, the rate that they will be investigated by regulatory bodies is 0. They will respectively obtain the profits, \( R_e + R_e \) and \( R_e + R_e \). Obviously, the rational choice must be “conspiracy”. But when the regulatory body knows everything about the members of Group M and N, and when they own the internal information \( W \rightarrow \phi \), \( A_s(w) = 1 \) and \( A_s(x) = 1 \), that is to say, if both groups’ members choose “conspiracy” strategy, the rate that they will be investigated by regulatory bodies will be 1. Both of them cannot obtain any profits and also will suffer great loss \( T_u R_e \) and \( T_u R_e \).

Hypothesis Five: If \( p \), a member from Group M, thinks that \( q \), a member form Group N, may agree to help him to finish joint manipulation, then we can consider that \( p \) implements “conspiracy” strategy. But \( q \) rejects such trading because of some reasons (for example, \( q \) may think that the risk that such behavior will be punished by the regulatory body is great), then we think that \( q \) implements “non-conspiracy” strategy. \( p \) will therefore suffers from some losses. On one hand, initial information searching costs will not be compensated. On the other hand, when \( q \) rejects offer relevant cooperation, the covertness of \( p \)’s action has been destroyed. These losses are monetized and discounted as \( C_q(1 - B_u(y)) \), then the profits that \( p \) obtains will be \( R_e - C_q(1 - B_u(y)) \), and \( p \)’s profit is \( R_e - C_q(1 - B_u(y)) \), while \( q \) still obtains the normal earning \( R_e \). Especially when \( p \) knows nothing about \( q \), when the internal information owned by \( p \) is \( y = 0 \) and \( B_u(y) = 0 \), that is to say, if \( p \) takes “conspiracy” strategy, then he should suffer the greatest conspiracy cost \( C_q \); When \( p \) knows everything about \( q \), his internal information \( y \rightarrow \infty \), \( B_u(y) = 1 \). If \( p \) chooses “conspiracy” strategy, he doesn’t have to bear any cost, \( C_q(1 - B_u(y)) = 0 \).

Hypothesis Six: \( q \), a member from Group N, finds out that \( p \) who is a member from Group M may initiate joint manipulation. In order to obtain higher profits, \( p \) put forward that he can help to start the joint manipulation. Such behavior means that \( N \) chooses “conspiracy” strategy. But if \( p \) does not want to finish the joint manipulation by cooperating with \( q \), or he does not want to take the joint manipulation at all, it means that \( p \) implements the “non-conspiracy” strategy, and \( q \) will suffer the loss. On one hand, \( q \) does not achieve the purpose of earning high returns after spending some searching costs. On the other hand, such trading itself should be covert, but another "outsider" knows \( q \) is a participant of the joint manipulation. Then the rate that \( q \) may be investigated and punished will be higher. These two types of losses can be monetized and discounted as \( C_q(1 - B_u(y)) \), then \( q \)’s profits is \( R_e - C_q(1 - B_u(y)) \), while \( p \) still get the normal earnings \( R_e \). Especially when \( q \) knows nothing about \( p \), and his internal information \( z = 0 \), \( B_e(z) = 0 \), that is to say, when \( q \) chooses “conspiracy” strategy, then \( q \) will bear the greatest cost \( C_q \) because of his choice. When \( q \) knows everything about \( p \), his internal information \( z \rightarrow \infty \), \( B_e(z) = 1 \), that is to say, if \( q \) chooses “conspiracy” strategy, he doesn’t need to bear the cost \( C_q(1 - B_u(y)) = 0 \) caused by the choice.

According to Hypothesis 3-6, the paired games between Group M and N may have four strategy combinations, so we can get that the benefit payments matrix under different strategies taken by Group M and N. Among which, when the two groups’ members take different strategy combinations ("conspiracy", "non-conspiracy"), the two groups’ members take the "non-conspiracy" strategy at the same time ("conspiracy", "conspiracy", "non-conspiracy"), all of the strategy combinations are objectively beneficial to the occurrence of joint manipulation. These three combinations can be seen as a self-limiting process of the model. Only when both the groups choose "conspiracy" strategy ("conspiracy", "conspiracy") can ensure the successful completion of this behavior, which is the focus of regulatory bodies. The benefit payoff matrix is shown as Table 1.
The average earnings of Group M’s members:

\[ E_M = mE_{nc} + (1-m)E_{nc'} = mn(R_{M} + R_{cc})L(A_{M}(w)) - mT_{R}R_{M}A_{M}(w) + m(1-n)[R_{M} - C_{M}(1 - B_{M}(z))] + (1 - m)R_{M} \]  

(3)

According to (1), (2), (3), the replicate dynamic equation of Group M’s choice of the "conspiracy" strategy is:

\[ \frac{dm}{dt} = m(E_{nc} - E_M) \]

\[ = m(1 - n)[n(R_{M} + R_{cc})L(A_{M}(w)) - nT_{R}R_{M}A_{M}(w) - nR_{M} + nC_{M}(1 - B_{M}(z)) - C_{M}(1 - B_{M}(z))] \]  

(4)

Similarly, in Group N, the expected earnings of the individuals who choose "conspiracy" strategy is:

\[ E_{NC} = mR_{N} + (1-m)R_{N} \]  

(6)

The average earnings of Group N’s members:

\[ E_{N} = nE_{nc} + (1-n)E_{nc'} = mn(R_{N} + R_{cc})L(A_{N}(x)) - mnT_{R}R_{N}A_{N}(x) + n(1-m)[R_{N} - C_{N}(1 - B_{N}(z))] + (1 - n)R_{N} \]  

(7)

According to (5), (6), (7), the replicate dynamic equation of Group N’s choice of the "conspiracy" strategy is:

\[ \frac{dn}{dt} = n(E_{nc} - E_N) \]

\[ = n(1 - n)[m(R_{N} + R_{cc})L(A_{N}(x)) - mT_{R}R_{N}A_{N}(x) - mR_{N} + mC_{N}(1 - B_{N}(z)) - C_{N}(1 - B_{N}(z))] \]  

(8)

From (4), we get:

\[ m' = 0, \quad m'' = \frac{C_{M}(1 - B_{M}(y))}{(R_{M} + R_{cc})(1 - A_{M}(w)) - T_{R}R_{M}A_{M}(w) - R_{M} + C_{M}(1 - B_{M}(y))} \]

From (8), we get:

\[ n' = 0, \quad n'' = \frac{C_{N}(z)}{(R_{N} + R_{cc})(1 - A_{N}(x)) - T_{R}R_{N}A_{N}(x) - R_{N} + C_{N}(1 - B_{N}(z))} \]

Mark:

\[ \alpha = C_{M}(1 - B_{M}(y)) \]

\[ \beta = (R_{M} + R_{cc})(1 - A_{M}(w)) - T_{R}R_{M}A_{M}(w) - R_{M} \]

\[ \lambda = C_{N}(1 - B_{N}(z)) \]

\[ \mu = (R_{N} + R_{cc})(1 - A_{N}(x)) - T_{R}R_{N}A_{N}(x) - R_{N} \]

So, the game evolutionary process of Group M and N can be described by the differential equation system constituted by (4), (5), (6), (7), and (8) and we can get 5 balance points \((m',n')\): \((0,0)\), \((1,0)\), \((0,1)\), \((1,1)\) and \((\frac{\lambda}{\mu + \lambda}, \frac{\alpha}{\beta + \alpha})\). The stability of the balance points can be worked out from the partial stability analysis of the corresponding Jacobian matrix. Use (4) and (8) to work out the partial derivatives of \(m\) and \(n\), then we can get the Jacobian matrix:

\[ J = \begin{bmatrix} \frac{dm}{dt} \\ \frac{dn}{dt} \end{bmatrix} = \begin{bmatrix} \frac{\partial m}{\partial m} & \frac{\partial m}{\partial n} \\ \frac{\partial n}{\partial m} & \frac{\partial n}{\partial n} \end{bmatrix} = \begin{bmatrix} 1 - 2m(\alpha + \beta + \lambda) - \alpha \mu & m(m + \beta + \mu) \\ n(1 - 2\mu - \lambda) - \alpha \mu & m(1 - \beta + \mu) \end{bmatrix} \]

Then, judge the local stability of the five equilibrium points according to local stability analysis. The result is shown in Table 2:

<table>
<thead>
<tr>
<th>Equilibrium Point</th>
<th>J determinant and symbols</th>
<th>J traces and symbols</th>
<th>Local stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0,0)</td>
<td>(\alpha \mu, +)</td>
<td>(-\alpha - \beta, -)</td>
<td>ESS</td>
</tr>
<tr>
<td>(1,0)</td>
<td>(\alpha \mu, +)</td>
<td>(\alpha + \mu, +)</td>
<td>Unstable</td>
</tr>
<tr>
<td>(0,1)</td>
<td>(\beta \lambda, +)</td>
<td>(\beta + \lambda, +)</td>
<td>Unstable</td>
</tr>
<tr>
<td>(1,1)</td>
<td>(\beta \lambda, +)</td>
<td>(-\beta - \mu, -)</td>
<td>ESS</td>
</tr>
<tr>
<td>((\frac{\lambda}{\mu + \lambda}, \frac{\alpha}{\beta + \alpha}))</td>
<td>(-\frac{\beta \mu \lambda}{(\beta + \alpha)(\mu + \lambda)}, -)</td>
<td>0</td>
<td>Saddle Point</td>
</tr>
</tbody>
</table>

Table 2 shows that, among the 5 equilibrium points, \((0,0)\) and \((1,1)\) have local stability, which corresponds to the evolutionary stability equilibrium and evolutionary stability strategy (ESS) of the whole group (including Group M and N). (1,1) represents that when the whole group reaches evolutionary stability, individuals of both the two sub-groups use the "conspiracy" strategy, then "conspiracy" is the only evolutionary stable strategy; \((0,0)\) represents that when the whole group reaches evolutionary stability, individuals of both the two
sub-groups use the "non-conspiracy" strategy, then "non-conspiracy" is the only evolutionary stable strategy. \((1,0)\) and \((0,1)\) is the unstable equilibrium point of the evolution system, \(\frac{\lambda}{\mu + \lambda}, \frac{\alpha}{\beta + \alpha}\) is the saddle point. The dynamic evolution process of the individuals’ paired games is shown in Diagram 1.

![Diagram 1 Replication dynamic phase diagram of Groups M and N strategies choice](image)

Diagram 1 shows that the polygonal line (consisting of a saddle point E and two instability points D and E) is a critical line that Group M and N members choose different strategies when the dynamic evolutionary game reaches equilibrium. In Zone BEC and DEC, the system will converge to the \((1,1)\) point, which is a zone that members of both Group M and N choose "conspiracy". In Zone ABE and ADE, the system will converge to the \((0,0)\) point, which is a zone that members of both Group M and N choose "non-conspiracy".

When the group reaches a stable equilibrium, all group members will either select the "conspiracy" (ESS) or "no conspiracy" (ESS). It shows that even though in a single game, Group M’s members may reject Group N’s, or Group N’s members may reject Group M’s, if other conditions remain unchanged, then during the long-term joint manipulation games, the trend may be Group M’s and N’s members will reach a tacit understanding or become estranged.

3. Discussion

Diagram 1 shows that joint manipulation groups’ evolutionary process may be influenced by the position of the saddle point \(\frac{\lambda}{\mu + \lambda}, \frac{\alpha}{\beta + \alpha}\). And the saddle point \(\frac{\lambda}{\mu + \lambda}, \frac{\alpha}{\beta + \alpha}\) has exogenous variable \(\alpha\), \(\beta\), \(\lambda\) and \(\mu\), whose changes will influence the position of the saddle point and influence the whole system’s evolutionarily stable equilibrium path and evolutionary stable strategy from the initial state. \(\alpha = C_1(1 - B_1(\lambda))\) and \(\lambda = C_1(1 - B_1(\lambda))\) respectively represents the losses caused by the two parties’ choice of “non-conspiracy” and “conspiracy”, which is not the variables that can be directly influenced by regulatory bodies. In contrast, \(\beta = (R_1 + R_2(\lambda) - A_2(\lambda)) - T_1(R_1 + R_2(\lambda) - A_2(\lambda)) - T_2(R_2(\lambda) - R_1)\) respectively represents that after the regulatory bodies successfully investigate conspiracy behaviors based on the rates of \(A_2(\lambda)\) and \(A_1(\lambda)\) and punish the illegal institutions with \(T_1\) and \(T_2\) as the punishment forces, the part that joint operators gain exceed the normal earnings is the excessive return. \(T_1, T_2, A_1(\lambda)\) and \(A_2(\lambda)\) are some variables that can be directly controlled by the regulatory bodies. So the following part of the paper will mainly analyze the influence on the model stability caused by the change of \(\beta\) and \(\mu\).

3.1 \(\beta\) and \(\mu\) increase simultaneously

If \(\alpha\) and \(\lambda\) maintain unchanged, when \(\beta\) and \(\mu\) increase simultaneously, the two coordinate values of the saddle point \(\frac{\lambda}{\mu + \lambda}, \frac{\alpha}{\beta + \alpha}\) will both decrease, which is shown as the horizontal and vertical direction get far away from \(C(1,1)\) at a constant speed away and get close to \(A(0,0)\). In this case the “conspiracy” area BEDC becomes bigger, and the “non-conspiracy” area ABED becomes smaller. So, if both \(\beta\) and \(\mu\) become bigger (regardless of how the ratio changes), the possibility of the initial state of the system in the "conspiracy" area will increase and the system may be more possible to reach \(C(1,1)\). The final evolution stability strategy will be the only “conspiracy” strategy. So, as long as the party who are willing to implement the joint manipulation expects that his earnings will increase with the help of the counterparty, the number of individuals who choose “conspiracy” will increase as well. After the n round game, all individuals choose “conspiracy”, the whole system will reach the evolution stability state, and “conspiracy” will become the only evolutionary stable strategy. Both parties of the game have chosen the "conspiracy" strategy, which is the actual occurrence of the joint manipulation. The extreme case is when \(\beta, \mu \to \infty\), the saddle point E will be located on a vertical or horizontal axis. The whole system’s evolutionary zone will become the “conspiracy” zone (BEDC), and then the system will have a 100% chance to evolve towards \(C(1,1)\).
3.2 $\beta$ and $\mu$ decrease simultaneously

If $\alpha$ and $\lambda$ maintain unchanged, when $\beta$ and $\mu$ decrease simultaneously, the two coordinate values of the saddle point $\frac{\lambda}{\mu+\lambda}$ and $\frac{\alpha}{\beta+\alpha}$ will both increase, which is shown as the horizontal and vertical direction get far away from $A(0,0)$ at a constant speed away and get close to $C(1,1)$. In this case the "conspiracy" area BEDC becomes smaller, and the "non-conspiracy" area ABED becomes bigger. So, if both $\beta$ and $\mu$ become smaller (regardless of how the ratio changes), the possibility of the initial state of the system in the "non-conspiracy" area will increase and the system may be more possible to reach $A(0,0)$ . The final evolution stability strategy will be the only "non-conspiracy" strategy. So, as long as the party who are willing to implement the joint manipulation expects that his earnings will decrease because of the counterparty’s cooperation, the number of individuals who choose “non-conspiracy” will increase as well. After the n round games, all individuals choose “non-conspiracy”, the whole system will reach the evolution stability state, and the “non-conspiracy” will become the only evolutionary stable strategy. Both parties of the game have chosen the “non-conspiracy” strategy. Especially when $\beta, \mu \to \infty$, the saddle point E will be located on a vertical or horizontal axis. The whole system’s evolutionary zone will become the “non-conspiracy” zone (ABED), and then the system will have a 100% chance to evolve towards $A(0,0)$.

3.3 $\beta$ increases and $\mu$ decreases

If $\alpha$ and $\lambda$ maintain unchanged, when $\beta$ incases and $\mu$ decreases, the horizontal axis coordinate of the saddle point $\frac{\lambda}{\mu+\lambda}$ will increase and the vertical axis coordinate $\frac{\alpha}{\beta+\alpha}$ will decrease. The horizontal direction will get far away from $A(0,0)$ and get close to $C(1,1)$; the vertical direction get will get far away from $C(1,1)$ and get close to $A(0,0)$. Then the DEC zone in the “conspiracy” zone will be bigger and BES zone will become small; AED zone in “non-conspiracy” zone will become bigger and AEB becomes smaller. So, the change of “conspiracy” Zone BEDC and the “non-conspiracy” Zone ABED depends on the amplitude of the increase of $\beta$ and decrease of $\mu$. When $\frac{d\beta}{d\mu} > 1$, that is to say, the increase magnitude of $\beta$ is greater than the decrease magnitude of $\mu$, “conspiracy” zone BEDC becomes bigger and the “non-conspiracy” zone ABED becomes smaller. The system will be more possible to develop towards “more and more joint manipulation”. When $\frac{d\beta}{d\mu} < 1$, that is to say, the increase magnitude of $\beta$ is smaller than the decrease magnitude of $\mu$, “conspiracy” zone BEDC becomes smaller and the “non-conspiracy” zone ABED becomes bigger. The system will be more possible to develop towards “less and less joint manipulation”. When $\frac{d\beta}{d\mu} = 1$, that is to say, the increase magnitude of $\beta$ is equal to the decrease magnitude of $\mu$, “conspiracy” zone BEDC and the “non-conspiracy” zone ABED remain the same. The system will remain in the primary stable state.

3.4 $\beta$ decreases and $\mu$ increases

Similarly, if $\alpha$ and $\lambda$ maintain unchanged, when $\beta$ decreases and $\mu$ incases, the horizontal axis coordinate of the saddle point $\frac{\lambda}{\mu+\lambda}$ will decrease and the vertical axis coordinate $\frac{\alpha}{\beta+\alpha}$ will increase. The saddle point along the horizontal direction will get far away from $C(1,1)$ and get close to $A(0,0)$; the saddle point along the vertical direction get will get far away from $A(0,0)$ and get close to $C(1,1)$. Then the DEC zone in the “conspiracy” zone will be smaller and BES zone will become bigger; AED zone in “non-conspiracy” zone will become smaller and AEB becomes bigger. So, the change of “conspiracy” zone BEDC and the “non-conspiracy” zone ABED depend on the amplitude of the decrease of $\beta$ and increase of $\mu$. When $\frac{d\beta}{d\mu} > 1$, that is to say, the decrease magnitude of $\beta$ is greater than the increase magnitude of $\mu$, “conspiracy” zone BEDC becomes smaller and the “non-conspiracy” zone ABED becomes bigger. The system will be more possible to develop towards “less and less joint manipulation”. When $\frac{d\beta}{d\mu} < 1$, that is to say, the decrease magnitude of $\beta$ is smaller than the increase magnitude of $\mu$, “conspiracy” zone BEDC becomes bigger and the “non-conspiracy” zone ABED becomes smaller. The system will be more possible to develop towards “more and more joint manipulation”. When $\frac{d\beta}{d\mu} = 1$, that is to say, the decrease magnitude of $\beta$ is equal to the increase magnitude of $\mu$, “conspiracy” zone BEDC and the “non-conspiracy” zone ABED remain the same. The system will remain in the primary stable state.

Based on the above analysis, only when $\beta$ and $\mu$ decrease simultaneously can the evolutionary game’s equilibrium develop towards the “non-conspiracy”. $R_u$, $R_u'$, $R_n$, and $R_n'$ respectively represents the normal earnings and illegal earnings of the joint manipulation initiators and facilitators. They are not controlled by the regulatory bodies. Only $T_u$, $T_n$, $A_u(w)$ and $A_n(s)$ are the parameters that can be influenced by the regulatory bodies and the increase of them is useful for the decrease of $\beta$ and $\mu$.

4. Conclusion
This paper establishes the evolutionary game’s model of the futures joint manipulation and analyzes its dynamic evolutionary process. Here is the conclusion:

First, among the four strategy combinations of the paired evolutionary games, the combination that both the two parties choose different strategy can occur in a single game, but such case cannot extensively exist in the system. The trend of the long-term change must point to two results. The first result is that some people who have such behavior history reach and maintain a certain level of trust and understanding. The other result is that potential perpetrators have a certain degree of fear and such acts cannot be implemented.

Second, the potential joint manipulation group’ evolutionary path and stability strategy towards the steady state is influenced by the position of the saddle point. Exogenous variables $\alpha$, $\beta$, $\lambda$ and $\mu$ will influence the relationship by influencing the position of the saddle point. This can be seen from the game’s replication dynamic diagram. System’s evolution path to equilibrium is generally nonlinear.

References