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Evolutionary Game Analysis on Auditing Collusion

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Abstract: Considering that the players of auditing collusion are always bounded rationality, the strategies' choice on the interaction between the manager and auditor is studied by using evolutionary game theory. The results show that when the payoff for manager's finance information manipulation is lower than the cost, the manager reports the true information; when the payoff for auditing collusion is smaller than the cost, the auditor rejects collusion. When the payoff for auditing collusion is large, also the probability of finding auditor collusion is small and the penalty of auditing collusion is light, then the auditor is more likely to taking collusion action. Monitoring the auditing collusion strictly and punishing auditing collusion heavily can proof auditing collusion.

Key words: Auditing collusion, bounded rationality, evolutionary game

INTRODUCTION

Auditing collusion refers to a social-economic phenomenon that auditors and managers conspire to take unfair measures to cheat audit clients and the general public for profit. Auditing collusion makes the accounting information and the market price signal distortion, investors decision fault, even make the entire socio-economic order in chaos. So, analysis on the formation mechanism of auditing collusion and taking measures to prevent auditing collusion are necessary.

In view of the universality and criticality of auditing collusion, scholars have given a great deal of attention to it. Kofman and Lawarree (1993) construct a mathematical model and prove that auditors have high existing value only when they have good message and the manager's responsibility is very high. They also demonstrate that to use the external auditor randomly can prevent auditing collusion than internal auditor. Kofman and Lawarree (1996) propose a prisoner's dilemma model to inhibit auditing collusion. Dittmann (1999) considers a principal-agent model with auditing and collusion, in which the audit costs are a convex function of the audit reliability. He turns out that the optimal audit reliability strongly depends on the given maximum punishment and on whether collusion is possible or not. Kessler (2000) studies a stylized three-layer agency framework in which a principal hires a supervisor to monitor an agent's productive effort. He demonstrates that the possibility of collusion imposes no additional cost on the principal if the supervisor's report is "hard" information.

Khalil and Lawarree (2006) study the optimal auditing contract when collusion between an agent and an auditor is possible. They show that the auditor can be totally useless if the auditor's independence can be compromised with relative ease. Even very stiff sanctions on fraud will be unable to make auditing optimal. Chen and Liu (2007) generalize Khalil (1997) static model to a multi-period one in the tenure-track auditing. Three penalty systems considered are full-transfer-dependent, partial-transfer-dependent and transfer-independent ones. It is found that the equilibrium under the tenure-track auditing is also an equilibrium under the periodic auditing. Kirschenheiter et al. (2011) discuss some special issues on accounting and auditing, especially on audit regulation and auditor reputation. Kuhn and Siciliani (2013) model purchaser-provider contracts when providers can inflate reimbursable activity through manipulation. Providers are audited and fined upon detected fraud. They characterize the optimal price and audit policy both in the presence and absence of commitment to an audit intensity.

We can see from the above researches that their researches based on the premise that the auditing collusive participants are full rational. Different from their research, in this paper, the auditing collusive participants are usually bounded rationality and their stable strategy resulted from the continual imitation and adjustment is focused on. Using evolutionary game approach to analyze the mechanism of auditing collusion and reveal the reasons for the formation of the auditing collusion, which can provide a theoretical basis for the relevant parties taking measures to prevent auditing collusion. The structure of the paper is as follows: the second part is the

analysis on the strategy choice evolutionary stable equilibrium between managers and auditors and the last part is conclusion.

ANALYSIS ON EVOLUTIONARY STABLE EQUILIBRIUM OF STRATEGY SELECTION BETWEEN MANAGERS AND AUDITORS

Model construction: Due to the separation of ownership and management, shareholders hire professional managers to run the business. Usually the manager's remuneration paid by the shareholders is connected with his operation results. Therefore, when the manager discloses the enterprise's performance, he is faced with two strategic options: one is to disclose the company's financial information truthfully and get the remuneration corresponding with his operating results; the other one is to seek personal gains by using asymmetric information and manipulating the corporate accounting information, by fabricating business performance and stating false financial reporting. And corresponding with the manager's strategy, the auditor which supervises the manager may take the strategy: not conspiracy; collusion with the manager and sharing collusive gains.

If the manager discloses financial information truthfully, he can earn performance pay α . The manager manipulates accounting information and colludes the auditor, which can increase revenue v but should pay bribery charges m to the auditor. The probability that the manager manipulate accounting information would be found is p_1 and the punishment cost is F_1 ; if the auditor does not conspire, he can get earnings b (audit fees), the probability that the auditor's collusive action will be found is p_2 and then the punishment is F_2 . Both the manager and the auditor's game payoff matrix are shown in Fig. 1.

It is assumed that the probability of the manager's accounting information manipulation is x and the probability of the auditor's auditing collusion is y . Then the expected earning which the manager manipulates accounting information is:

$$E_x = y(\alpha + v - m - p_1 F_1) + (\alpha - p_1 F_1)(1 - y)$$

to the manager discloses the accounting information truthfully, the expected earning is $E_{1-x} = \alpha y + \alpha(1 - y) = \alpha$. The average expected earning of the manager's mixed strategy (manipulate accounting information and disclose accounting information truthfully) is $\bar{E}_m = xE_x + (1 - x)E_{1-x}$, thus, the duplicate dynamic equation when the manager takes accounting information manipulation strategy is:

		Auditor collusion	Auditor not collusion
Measurement	Manipulate accounting information	$\alpha + v - m - p_1 F_1, b + m - p_2 F_2$	$\alpha - p_1 F_1, b$
	Disclose accounting information	$b, \alpha, b - p_2 F_2, \alpha, b$	

Fig. 1: Payoff matrix of the manager and the auditor

$$\begin{aligned} \frac{dx}{dt} &= x(E_x - \bar{E}_m) = x(1 - x)(E_x - E_{1-x}) \\ &= x(1 - x)(vy - my - p_1 F_1) \end{aligned} \quad (1)$$

The expected earning of the auditor's auditing collusion is $E_y = x(b + m - p_2 F_2) + (1 - x)(b - p_2 F_2)$, if the auditor does not collude with the manager, the expected earning is $E_{1-y} = bx + b(1 - x) = b$, the average expected earning of the auditor's mixed strategy (not collusion and auditor collusion) is $\bar{E}_a = yE_y + (1 - y)E_{1-y}$, thus, the duplicate dynamic equation when the auditor takes the auditing collusion strategy is:

$$\begin{aligned} \frac{dy}{dt} &= y(E_y - \bar{E}_a) = y(1 - y)(E_y - E_{1-y}) \\ &= y(1 - y)(mx - p_2 F_2) \end{aligned}$$

Analysis on evolutionary stable strategy: Differential Eq. 1 and 2 describe the population dynamics of the manager and the auditor's strategy selection evolution system. The system has five equilibrium points. They are $(1, 0), (0, 1), (0, 0), (1, 1)$:

$$\left(\frac{p_2 F_2}{m}, \frac{p_1 F_1}{v - m} \right)$$

and

$$0 < \frac{p_2 F_2}{m} < 1, 0 < \frac{p_1 F_1}{v - m} < 1$$

Since a population dynamics described by a differential equation system, which equilibrium points' stability can get from local stability analysis by using Jacobian matrix, the Jacobian matrix composed of differential Eq. 1 and 2 is as following:

$$J = \begin{bmatrix} (1 - 2x)(vy - my - p_1 F_1) & x(1 - x)(v - m) \\ my(1 - y) & (1 - 2y)(mx - p_2 F_2) \end{bmatrix} \quad (3)$$

The determinant of matrix J can be described as:

$$\begin{aligned} \det J &= (1 - 2x)(vy - my - p_1 F_1)(1 - 2y)(mx - p_2 F_2) \\ &\quad - x(1 - x)(v - m)my(1 - y) \end{aligned}$$

Table 1: Stability analysis results of equilibrium points

Equilibrium points	Condition	Sign of detJ	Sign of trJ	Results
$x = 0, y = 0$		-	+	ESS
$x = 1, y = 1$	$v-m > p_1F_1$ $m > p_2F_2$	+	-	ESS
$x = 1, y = 0$	$v-m > p_1F_1$ $m > p_2F_2$	+	+	Unstable
$x = 0, y = 1$	$v-m > p_1F_1$ $m > p_2F_2$	+	+	Unstable
$x = \frac{p_2F_2}{m}, y = \frac{p_1F_1}{v-m}$	$v-m > p_1F_1$ $m > p_2F_2$	-	0	Saddle point

and the trace of J is:

$$\text{tr}J = (1-2x)(vy-my-p_1F_1) + (1-2y)(mx-p_2F_2)$$

thus the detJ and trJ value at equilibrium point can be calculated, the stability of the system can be judged depended on whether the value is positive or negative. The results of stability analysis are shown in Table 1.

We can see from table1, when $v-m > p_1F_1$, $m > p_2F_2$, it is say that when the increased net revenue of the manager's accounting information manipulation is larger than the punishment cost, the increased net revenue of the auditor's auditing collusion is larger than the penalty cost, the system has two stable equilibrium point O (0, 0), C (1, 1), respectively. They correspond to the manager and auditor's evolutionary stable strategy: truthful disclosure of accounting information, not collusion; manipulation of accounting information, auditing collusion. In addition, there are two unstable equilibrium point A (1, 0), B (0, 1) and a saddle point:

$$D\left(\frac{p_2F_2}{m}, \frac{p_1F_1}{v-m}\right)$$

in this evolutionary system.

Phase trajectory of the system in Fig. 2 describes the dynamic evolution process of the manager and auditor's strategy selection. The bold line consisted of the unstable point A (1, 0), B (0, 1) and the saddle point:

$$D\left(\frac{p_2F_2}{m}, \frac{p_1F_1}{v-m}\right)$$

is the critical line of the system, which converges to the different states. When the initial state is in OADB region, the system will converge to the O (0,0), the bounded rationality manager selects the strategy of disclosing accounting information truthfully, while the bounded rationality auditor chooses not to collude with the manager. When the initial state is in ADBC region, the system converges to C (1, 1), the bounded rationality

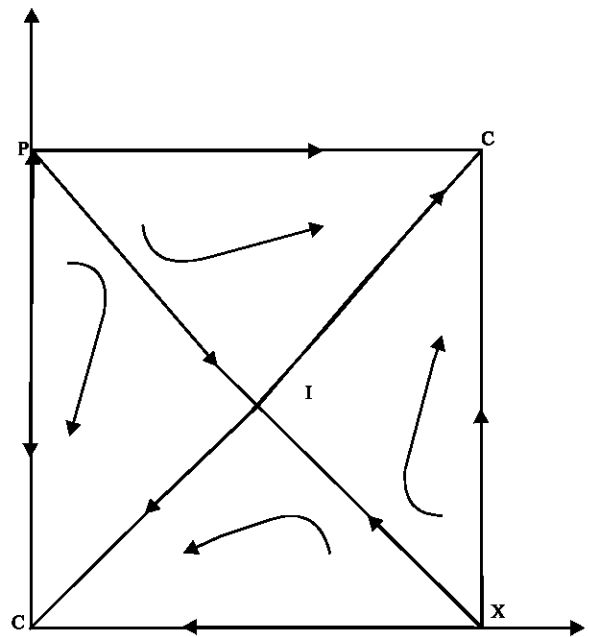


Fig. 2: Dynamic evolution phase diagram of the system

manager chooses to manipulate accounting information, while the bounded rationality auditor chooses to collude with the manager. It is visible that the results of the long-term evolution game strategy selection are different depending on the initial states, the desired evolution stable equilibrium can be achieved by controlling the related variables. The problem that how the parameters change influences the evolution trend of the manager and auditor's strategy selection will be discussed as the follows.

Parametric analysis: From table1, when $v-m < p_1F_1$, $m < p_2F_2$, it means that when the net revenues v increased from manipulating accounting for the manager minus the bribery pay m to the auditor is not enough to offset the punishment and the increased collusive revenues is less than the cost for the auditor, the unique evolutionary stable strategy is that the manager discloses accounting information truthfully and the auditor does not collude with the manager. This situation usually happens when the cost of manager's accounting information manipulation and the auditor's collusion is high. As the cost of the manager's accounting information manipulation and the cost of the auditor's collusion depend on the discovery probability and punishment respectively. Therefore, improving the probability of finding the manager's accounting information manipulation and increasing the punishment both can reduce the probability of the manager's accounting

information manipulation. In addition, to increase monitoring of auditor collusion, once the auditor collusion is found, the heavy penalties are given, which can prevent the auditor from colluding with the manager.

When $v-m > p_1 F_1$, $m > p_2 F_2$, there are two evolutionary stable equilibrium points (0,0) and (1,1). Based on different initial conditions, the strategy selections of the bounded rationality manager and auditor will respectively converge to disclose true accounting information, not collusion and manipulate accounting information, audit collusion. How the parameters in the conditions of $v-m > p_1 F_1$, $m > p_2 F_2$ influence on the evolutionary stable strategy will be analyzed in the following.

v is the increased revenue of the manager's accounting information manipulation, the larger v is, the larger the increased net revenue $v-m$ for the manager by manipulating accounting information is. Point D in Fig. 2 is moved downward, ADBC area increases, the probability of the system converging to point C increases. Thus, the more the increased revenue of the manager's accounting information manipulation is, the greater the probability of manager's accounting information manipulation is.

p_1 is the probability that the manager's accounting information manipulation is found. The greater the p_1 is, point D moves up, the OADB area increases, the greater the probability that the system converges to O point is. Thus, the probability of the manager's accounting information manipulation behavior being found is greater, the manager is more likely to take truthful accounting information disclosure strategy. To improve various control system and monitoring tools and skills, to strengthen the monitoring efforts of manager behavior and improve the probability of finding the manager's accounting information manipulation, can effectively prevent the manager from manipulating accounting information.

F_1 is the punishment given to the manager's accounting information manipulation. The greater the F_1 is, point D moves up, the OADB area increases, the greater the probability that the manager will disclose accounting information truthfully is. Apparently, to increase the punishment given to the manager's accounting information manipulation, the manager tends to disclose accounting information truthfully. Given heavy fines to the manager's accounting information manipulation, a sound manager market, played the reputation mechanism constraints role, all of them can reduce the probability of the manager's accounting information manipulation.

m is an increase of income, which comes from auditors' audit collusion. The greater the m is, point D

moves to the left, ADBC area increases, the probability of system both converging to point C and auditor choosing collusion strategy increase.

p_2 is the probability of finding audit collusion, p_2 is larger, point D moves toward right, OADB area becomes large and the probability that the auditor does not collude with the manager increases. Therefore, to strengthen the monitoring of audit collusion is one of effective measures to prevent audit collusion.

F_2 is the punishment given to audit collusion. F_2 is larger, point D moves toward right, OADB area increases, the auditor tends to choose not to conspire. This shows that the phenomenon of audit collusion appears frequently, one of the main reasons is that the light punishment on audit collusion and the low cost of auditor collusion. To prevent the audit collusion, it is necessary to increase the punishment.

CONCLUSION

Considering that the participants of auditing collusion are always bounded rationality, in this article, the evolutionary game method is used to analyze the audit collusive mechanism. The following main conclusions can be drawn by a balanced analysis of managers and auditors' evolutionary stable strategy choice: when the increased earnings arising from managers' accounting information manipulation are insufficient to pay the cost, then managers will disclose accounting information truthfully; the more the earnings of managers' accounting information manipulation is and the smaller the probability of discovering auditing collusion is and also the lighter the penalty given to the managers for the accounting information manipulation being found is, the greater the probability of managers' accounting information manipulation is. If the auditor finds the income of auditing collusion is less than collusive cost, the auditor will not take collusion strategy instead of collusion. If the larger the audit collusive earning is and the smaller the probability of auditing collusion is and also the lighter the penalty given to auditing collusion is, the more likely the auditors conspire with each other is.

Based on the above analysis, the following measures can be taken to regulate the managers and the auditors' action and to prevent auditing collusion. Firstly, to perfect capital market so as to reducing the income of the manager's accounting information manipulation; Secondly, the regulatory authorities should strengthen supervision and improve the professional skills of the supervising officer, in order to increase the probability of discovering accounting information manipulation; Thirdly, giving heavy penalty to the managers'

accounting information manipulation and using the role of reputation mechanism, all these can be used to bind the manager's accounting information manipulation; Fourthly increasing crackdown on managers' bribe behavior, reducing the auditors' conspiracy earnings and strengthening the supervision of auditing collusion behavior, once the managers' auditing collusion is discovered, the managers will be given heavy penalty.

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