

## The Audit Research of Local Government Debt Replacement

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### Abstract

The successful implementation of local government debt replacement is of great significance and the solution to the problem of local government debt in China. However, local government debt replacement poses characteristics of fiscal risks financially. These risks will not only affect the implementation effect of local debt replacement, but will further influence the security and stability of our financial system. In this paper, based on the risk of local government debt replacement, evolutionary game theory is used as the analysis tool together with an evolutionary game model to build the local government debt management audit. The paper analyzes the evolution stability of the main strategies of both the local government and the commercial banks. Through a "scene-response" concept derived from the computational experiment method, the computational experiment method is used to simulate the initial probability of different strategies as a result of the evolutionary game model. It is found that improving the auditing mechanism and improving the effects of risk management can greatly shorten the time for government departments and commercial banks to change to the positive strategy of debt replacement. Finally, this paper puts forward the audit governance policy combination of debt exchange risk from three aspects: supervision responsibility, evaluation efficiency and information transparency.

**Keywords:** Local government debt; Debt replacement risk; Audit governance; Evolutionary game; Computational experiments

### Introduction

In 2014, the State Council issued the 43rd "Opinions on Strengthening the Management of Local Government Debt", and, in the framework of the new budget law, for the first time put forward the idea of stock debt replacement, providing short-term measures to alleviate the problem of local government debt. In March, June and August, 2015, the Ministry of Finance issued a total of 3.2 trillion yuan of local government stock debt replacement quota in three batches and allocated the quota to provincial local governments. The local governments needed to issue bonds in full in accordance with the replacement quota. This practice proves that debt replacement, as a policy tool to solve the problem of local government debt stock, has a remarkable effect on alleviating the pressure on local government's financial repayment. However, as a kind of contingency measure, local government debt substitution has the characteristics of transforming fiscal risk into financial risk. As debt replacement continues to advance, the proportion of the replacement bonds in the financial system is increasing. How to carry out the debt replacement work scientifically? The prevention of financial risk will become the key factor that influences the effect of debt replacement.

In October 2017, Xi Jinping proposed to reform the audit management system in the report at the 19<sup>th</sup> National Congress of the Communist Party of China. As the State supervision Department, the audit institutions should give full play to the function of the management of local government debt replacement risk. Meanwhile, the Financial Supervision Department should actively cooperate with the local government debt replacement risk audit work, and form the resultant force to prevent and control systemic financial risks, thus achieving the goal of good governance in the country. On the one hand, this paper applies the auditing state governance theory to the study of local government debt replacement risk, expands its application extension theoretically, and enriches the theoretical space of government debt audit research. On the other hand, based on the calculation experiment method, this paper demonstrates the necessity for the government department to implement the Audit governance

strategy in the process of debt replacement, constructs the overall framework of audit governance of debt replacement risk and tries to analyze the problem of local government debt replacement risk from the perspective of audit governance, which has important practical significance for the smooth development of local government debt replacement.

There is scant research on local government debt replacement in the literature, although research on local government debt replacement has been increasing since 2015. Zhan Xiang Yang believed that the replacement of local debt has eased the repayment pressure on local governments, which is helpful to the marketization, standardization and transparency of a local Government's financing mode [1]. However, the substitution of local government debt in China is essentially characterized financially by the fiscal risks, which may cause negative effects on China's commercial banks, bond market and money market [2]. Concerning the impact of debt replacement on commercial banks, Yin Jian Feng posited that the replacement of local government debt is to a large extent the bank's lending to the local financing platform into the bank's local Treasury bonds, so that the bank's asset structure changes, which will increase the risk to banks [3]. Due to the long period and poor liquidity of local replacement debt, the risk of a mismatch of assets and liabilities is aggravated by banks' short loan length. At the same time, the average yield of bonds after replacement is lower than the interest rate of the same term platform before replacement, and debt replacement will reduce the interest income and profits of banks [4]. As the government determines and holds fixed the list of

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replacement loan counterpart enterprises, it is possible to borrow debt replacement to reduce the cost of local quality enterprise financing, which further exacerbates the loss of bank earnings.

Local government debt replacement has a feature of administrative intervention. Commercial banks' willingness to cooperate with the completion of debt replacement and their hope of obtaining the financial deposits and project resources provided by local governments are closely related, and frequently there is an "off-site agreement" with local governments [5,6]. In addition, the replacement of local government debt affects the money supply and market interest rate in the bond issue stage. On the one hand, since the term of the replacement bond is usually 5-10 years, the bond replacement will increase the medium and long term interest rate and the financing cost, thus causing a crowding out effect on private investment [7,8]; On the other hand, in the actual operation of local government debt replacement, there is a significant time difference between bond issuance and stock debt replacement, which leads to a great impact on the bond market caused by local government debt substitution having caused the sharp fluctuation of money market funds interest rate, which requires the central bank's short-term liquidity management to offset related shocks [9].

Foreign scholars mainly study the local government debt audit from the perspective of the local government financial monitoring system and the budget management point of view. Liu and Pradelli proposed the minimum indicators for monitoring fiscal and debt development and considered the need for an appropriate fiscal structure to coordinate and oversee the budget and borrowing policies of local governments at all levels [10]. Mpakaniye studied the influence of internal audit on the budget management of Rwandan local governments by taking the Musanze area as an example [11]. In recent years, domestic scholars have gradually applied the audit to the governance of local government debt risk, and have made some breakthroughs in both theory and practice. In theoretical research on local government debt audit, Liu Luyang concluded that the implementation of local government debt audit is necessary and feasible by analyzing the historical reasons for the formation of local government debt and the negative effects of local government debt risk on the central and local areas [12]. In the local government debt audit, it is necessary to pay attention to the performance appraisal audit of the relevant departments and to supervise the local governments to prevent debt risk [13]. An audit of local government debt should not only pay attention to the size of debt, financing projects, but also pay attention to the adequacy of local government management system of debt [14]. Wang Ying summarizes the three levels that local government debt audit in China should focus on: first, the sound system of local government debt management; second, audit the ability of local government to repay debt and evaluate whether local government has constructed an effective debt repayment mechanism; third, audit whether the use of local government debt funds is compliant and effective [15].

In addition, domestic scholars have also proposed improvement measures from the practical point of view to optimize the local government debt audit work. Li Ling and others believed that the government audit function must be improved by strengthening the systematic supervision of local government debt through the implementation of daily and regular audits [16]. Ding Jiying summarized the insufficiency of our country's local government debt audit, and believed that our country's local government debt audit system must be perfected continuously [17]. When performing local government debt audit, it is necessary to use the combination of up-down audit and cross-audit to smooth the audit channel, unify the

performance audit and economic responsibility audit to improve the scientific nature of the audit; promote fiscal audit and financial audit to guarantee the comprehensiveness of audit results; and, normalize occasional audits and special audits to ensure authentic and reliable auditing [18]. Hu Duanhong and others think that improving the debt audit modality will also require a review of extra budgetary hidden obligations and a track audit of the earnings of major investment projects [19].

The method of computational experiment is a simulation method based on modern computer science and technology, useful for revealing macroeconomic operations under the specific economic and social environment by setting up specific learning mode and behavior mechanism of microscopic subject [20,21]. Pérez and others assessed the probability of default on home mortgage loans, and calculated the credit risk of a bank housing mortgage loan based on the calculation experiment method [22]. In the field of computational experimental research based on the evolutionary game model, Xu Chao and Zhou Zongfang constructed the evolutionary game model from the UNPROFOR loan organization composed of two small and medium-sized enterprises and analyzed the evolution mechanism of the credit behavior of the UNPROFOR loan organization [23]. They also investigated (using the simulation method) the influence of the size of the UNPROFOR organization and the initial credit level of the organization member on the evolution of credit risk. Liu Hua and Chenhan constructed an evolutionary game model for the local government debt cooperative governance audit and used the computational experiment method to simulate the influence of the improvement degree of each subsystem on the evolutionary game results [24].

In summary, our scholars have conducted a thorough analysis of the local government debt substitution and the local government debt risk audit governance question, which has provided valuable experience for research on the local government debt replacement risk audit governance. At present, there is still not much research on local government debt replacement, and it is not enough to apply the audit governance to the local government debt replacement risk supervision. Therefore, based on the audit of national governance theory, this paper studies the audit governance of local government debt replacement risk, which can provide a reference for subsequent local government debt replacement work, and can provide good ideas for audit departments in conducting effective debt replacement risk management.

## Materials and Methods

### The risk analysis of local government debt replacement

The risk of local government debt in China cannot be ignored, and this risk will have a great impact on China's financial security and systemic financial risks. However, in recent years, with the emergence of debt replacement, real debt, drawer agreement, commitment repurchase, Public-Private Partnership and management plan, the hidden debt of local governments has risen rapidly and is much higher than the book debt. The large probability of hidden debt and the great influence of potential risk resulted in new requirements for the existing debt risk supervision system.

As an innovative mode of relieving local debt pressure, local government debt replacement is a way for local governments to pay off their debts by borrowing new debts and delaying the debt under the condition of moderate interest rates. However, the local government debt replacement involves many related subjects, so the risk source is more complicated. On the one hand, most of the replacement bonds

are held by commercial banks. If the principal and interest cannot be repaid on time, it will affect the operating profit of commercial banks. The large inflow of replacement bonds into the bond market will impact the market mechanism of bond market and not benefit the healthy development of China's bond market. Moreover, there may be differences in the amount of funds in place and the expiry time of the stock debt such that the large amount of funds flowing into our country's money market will cause a sharp fluctuation of the capital interest rate.

On the other hand, the exchange bond and the local government general bond are the local government's debt, but they are managed separately. The former cannot be transferred into circulation but only held by the commercial bank, while the latter can be listed in circulation. Under the macro background of the economic downturn, if the local government is under pressure to repay all its debts, the preferential payment of general bonds will inevitably be chosen in order to reduce the social impact. Therefore, the risk of replacement bonds is actually greater than the local government bonds. In addition, since the yield of replacement bonds is lower than the loan, local governments are likely to borrow more money to reduce the financing costs of local quality enterprises and key projects. For banks, this means not only the loss of revenue, but also the loss of quality customers and business opportunities. In recent years, with the prosperity of the capital market, the increase of all kinds of investment products, especially the rise of internet financial management, the tendency of short-term deposit of commercial banks is becoming more and more prominent. Another problem of mismatch of assets and liabilities is aggravated by the characteristics that local replacement bonds cannot circulate and have a long period of longer duration. These put forward new challenges for the management of such debts.

Since 2015, our country has been carrying out local government debt replacement work, and has been carrying it out successfully in many provinces in China. For example, in May 2018, Shandong Province successfully issued a second batch of government bonds of \$30 billion for this year (all of which were 7-year replacement bonds), which provided for the replacement of the approved debt stock of all levels of government prior to the annual borrowing. From this case of debt replacement, it can be seen that its main participants are commercial banks and local governments; commercial banks, as the main debtors of local government debt, constitute an important force in the promotion of the debt replacement of local governments. However, at the same time, commercial banks, as profit-making institutions, have the impulse to refuse debt replacement in order to maximize their benefits, and the negative effect of many risk sources of local government debt replacement is also the main reason for the lack of replacement power of commercial banks. As the direct beneficiary of the substitution policy, local governments need to reduce the risk of debt replacement and effectively promote policy implementation.

Based on the uncertain factors in the process of debt replacement operation, this paper studies the behavioural characteristics of Government Departments (G) and Commercial Banks (B) in standardizing debt substitution, and analyzes the influence of government departments' risk supervision on the debt substitution behavior of commercial banks (to prevent the unreasonable evolution of debt substitution into financial market systemic risk).

### An experimental analysis on the audit governance of government debt replacement risk

Due to the ductility of local government debt and its replacement

risk for the financial market, combined with the audit experience of local government debt, it is known that the construction of an audit governance system will be the best choice for government departments to prevent financial systemic risk in the process of debt replacement. Under the different auditing strategies of government departments, commercial banks will choose different debt substitution strategies according to the risk situation of local debt replacement, and a dynamic game process will be formed by government departments and commercial banks.

**Model assumptions:** On the one hand, local governments are closely related to regional financial institutions, such as commercial banks [25]. A large amount of local government debt comes from commercial bank loans [26]. Although debt replacement is conducive to the elimination of local debt stock risk, it still will bring some negative impacts to commercial banks [27], and has a significant impact on the bank's risk structure and asset return level [28]. Obviously, scholars generally believe that local governments and financial institutions, especially commercial banks, are the most important participants in the replacement of government debt and debt. Therefore, this paper simplifies the complex process of debt replacement and puts forward the following basic hypothesis:

➤ **Hypothesis 1:** In the process of government debt replacement, the risk exists between the two replacement bodies, which are represented as government departments and commercial banks, respectively. Among these, the broad-sense government departments include government audit institutions and financial risk supervision agencies; commercial banks include joint-stock commercial banks and national policy banks.

On the other hand, foreign scholar Inman first introduced game theory analysis into the local debt problem in 2001 and domestic scholar Wang Changjiang constructed the signal game model between government and bank in the process of government financing, and studied the government debt risk of China [29]. Based on the audit report of local government debt from the Audit Office, Wu Kai conducted an analysis from the perspective of game theory and found that the central government acquiesced in the local government's borrowing behavior; when the local government has a debt crisis, the central government's probability of rescue is greater, coupled with a lack of punishment and restraint mechanism, resulting in local government debt emergence and continued expansion [30]. At present, China's local government debt replacement time is relatively short so both sides of the game cannot make a decision in favour of maximizing their own interests. In this context, this paper introduces the evolutionary game theory, studies the process of the government departments and commercial banks in the process of formulating strategies, and puts forward the following basic hypothesis:

➤ **Hypothesis 2:** The level of cognition of each individual in the two groups of government departments and commercial banks is different, and the degree of attention to debt substitution policy is different, which leads to the limited rationality of the choice of strategy. In the face of local government debt replacement risk, government departments can choose to implement "audit governance" or not, while commercial banks can choose "replacement" or "no substitution" for the replacement debt.

**Evolutionary game model and parameter setting:** Under the premise of the model hypothesis, the two game subjects of government departments and commercial banks have four strategy combinations. In order to use the evolutionary game model to depict the behavior of

government departments and commercial banks in the process of debt replacement, the game model parameters are set up, and the benefits of the game on both sides of each strategy combination are shown in Table 1.

In Table 1, the total amount of credit funds for local government in commercial banks is  $I$ , the loan cost is  $C_b$ , the proportion of local government debt in the total amount of local government funds is  $\alpha_1$ , and the proportion of local government debt which does not meet the replacement conditions is  $\alpha_2$ . If a commercial bank replaces a local government debt that meets the replacement conditions, the yield is  $\beta_1$ , otherwise the yield is  $\beta_2$ . Commercial banks have a yield of  $\beta_2$  for non-replacement of local government debt that does not meet the replacement conditions. The social losses caused by the non-participation of commercial banks in local debt replacement are  $\pi_2$ . The expected future benefits to society brought by the audit of government departments during debt replacement process to effectively resolve debt risk are described as  $\Delta\pi_1$ . The long-term value of the audit of the debt replacement process brought by government departments to commercial banks is added to the  $\Delta\pi_3$ . However, when government departments implement audit governance, the losses that commercial banks face when they are not involved in debt replacement are  $L_1$ . In addition, the social benefits of government departments due to the implementation of debt replacement by commercial banks are  $\pi_1$ , and the financial cost of government departments to carry out audit governance is  $C_g$ .

According to the Game Payment Matrix in Table 1, the probability that government departments choose to implement the "Audit governance" strategy is  $p$ , the probability of not implementing "Audit governance" is  $1-p$ ; the probability of the commercial bank choosing debt "Substitution" is  $q$ , and the probability of "not replacing" debt is  $1-q$ . The average utility function of the government department is that the government adopts the "audit governance" and "non-audit governance" strategy respectively and its utility function can be expressed as:

$$U_{g1} = q(-C_g + \Delta\pi_1 + \pi_1) + (1-q)(-C_g - \pi_2) \quad (1)$$

$$U_{g2} = q\pi_1 + (1-q)(-\pi_2) \quad (2)$$

$$\bar{U}_g = pU_{g1} + (1-p)U_{g2} \quad (3)$$

The utility function of commercial banks is that the utility function of the strategy of "replacement debt" and "non-replacement debt" is respectively, and its utility functions are:

$$U_{b1} = p[I(\alpha_1\beta_1 + \alpha_2\beta_2) - C_b + \Delta\pi_3] + (1-p)[I(\alpha_1\beta_1 + \alpha_2\beta_2) - C_b] \quad (4)$$

$$U_{b2} = p[I(\alpha_1\beta_3 + \alpha_2\beta_2) - C_b - L_1] + (1-p)[I(\alpha_1\beta_3 + \alpha_2\beta_2) - C_b] \quad (5)$$

$$\bar{U}_b = qU_{b1} + (1-q)U_{b2} \quad (6)$$

According to the method of maximizing payment income, the only Nash equilibrium solution of government department and Commercial Bank is  $(p^*, q^*)$ , and  $p^* = \frac{I\alpha_1(\beta_3 - \beta_1)}{\Delta\pi_3 + L_1}$ ,  $q^* = \frac{C_g}{\Delta\pi_1}$ ,  $(0 \leq \frac{I\alpha_1(\beta_3 - \beta_1)}{\Delta\pi_3 + L_1} \leq 1, 0 \leq \frac{C_g}{\Delta\pi_1} \leq 1)$ .

## Results

### Equilibrium point analysis of evolutionary game model

While commercial banks may play games with government departments, commercial banks are not independent of each other. The strategic choice of government departments not only considers the strategic choice of government departments, but also influences the choice of other commercial banks' strategies. Similarly, government departments will learn from each other's strategies in order to achieve higher effectiveness, in addition to considering the implementation of the debt replacement of commercial banks. According to the idea of evolutionary replication, the game with lower income strategy will change its strategy and imitate the opponent with higher profit strategy. According to the Malthusian Dynamic equation, the rate of dynamic change in the proportion of government departments implementing the "Audit governance" strategy is  $\frac{dp}{dt}$  while the rate of dynamic change in the proportion of commercial banks choosing "replacement" local government debt strategy is  $\frac{dq}{dt}$ . This can be represented by the following replication dynamic equation:

$$F(p) = \frac{dp}{dt} = p(1-p)(U_{g1} - U_{g2}) \quad (7)$$

$$G(q) = \frac{dq}{dt} = q(1-q)(U_{b1} - U_{b2}) \quad (8)$$

Formulas (7) and (8) reflect the speed and direction of game learning between government departments and commercial banks, respectively. When the replication dynamic equation of government departments and commercial banks equals zero, the game of local government debt substitution will reach a relatively stable equilibrium state, at which time the learning speed of both governmental departments and commercial banks is zero.

In order to obtain the differential between  $P$  and  $Q$  in the replication dynamic equations of government departments and commercial banks, the Jacobian matrix can be obtained:

$$J = \begin{vmatrix} (1-2p)(q\Delta\pi_1 - C_g) & p(1-p)\Delta\pi_1 \\ (1-2q)[p(\Delta\pi_3 + L_1) + I\alpha_1(\beta_1 - \beta_3)] & q(1-q)(\Delta\pi_3 + L_1) \end{vmatrix} \quad (9)$$

According to  $X=[F(p), G(q)]=0$ , combining Jacobian matrix, five answers can be obtained:  $X_1(0,0)$ ;  $X_2(0,1)$ ;  $X_3(1,0)$ ;  $X_4(1,1)$  and  $X_5(p^*, q^*)$ ;

among which  $p^* = \frac{I\alpha_1(\beta_3 - \beta_1)}{\Delta\pi_3 + L_1}$ ,  $q^* = \frac{C_g}{\Delta\pi_1}$ ,  $(0 \leq \frac{I\alpha_1(\beta_3 - \beta_1)}{\Delta\pi_3 + L_1} \leq 1, 0 \leq \frac{C_g}{\Delta\pi_1} \leq 1)$ .

### Stability analysis of evolutionary game model

#### Stability Analysis of government department strategy choice: 1.

When  $q = \frac{C_g}{\Delta\pi_1}$ ,  $f(p) \equiv 0$ , all  $p$  values at this point are the evolutionary stabilization strategies of government departments.

2. When  $q \neq \frac{C_g}{\Delta\pi_1}$ , according to the stability theorem of differential equations and the nature of evolutionary stability strategy, when

| Strategy Choice of Game Subjects |                            | Commercial Banks(B)                                                                    |                                                                  |
|----------------------------------|----------------------------|----------------------------------------------------------------------------------------|------------------------------------------------------------------|
|                                  |                            | Replacement (q)                                                                        | No Replacement (1-q)                                             |
| Governments (G)                  | Audit Governance (p)       | $-C_g + \Delta\pi_1 + \pi_1, I(\alpha_1\beta_1 + \alpha_2\beta_2) - C_b + \Delta\pi_3$ | $-C_g - \pi_2, I(\alpha_1\beta_3 + \alpha_2\beta_2) - C_b - L_1$ |
|                                  | Non-Audit Governance (1-p) | $\pi_1, I(\alpha_1\beta_1 + \alpha_2\beta_2) - C_b$                                    | $-\pi_2, I(\alpha_1\beta_3 + \alpha_2\beta_2) - C_b$             |

Table 1: Payment matrix of government debt replacement game.

$F(p)' < 0$ ,  $p^*$  is the evolutionary stabilization strategy of government departments. Therefore, when  $q > \frac{C_g}{\Delta\pi_1}$ ,  $F(p)'_{p=0} > 0$ ,  $F(p)'_{p=1} < 0$ ,  $P=1$  is an evolutionary stabilization strategy for government departments but when  $q < \frac{C_g}{\Delta\pi_1}$ ,  $F(p)'_{p=0} < 0$ ,  $F(p)'_{p=1} > 0$ ,  $P=0$  is an evolutionary stabilization strategy for government departments.

#### Stability analysis of strategic choice of commercial banks: 1.

When  $p = \frac{I\alpha_1(\beta_3 - \beta_1)}{\Delta\pi_3 + L_1}$ ,  $F(q) \equiv 0$ , all  $Q$  values are the evolutionary stabilization strategies of government departments;

2. When  $p \neq \frac{I\alpha_1(\beta_3 - \beta_1)}{\Delta\pi_3 + L_1}$ , according to the stability theorem of differential equations and the properties of evolutionary stability strategies, When  $F(q^*)' < 0$ ,  $q^*$  is the evolutionary stability strategy for commercial banks. Therefore, when  $p > \frac{I\alpha_1(\beta_3 - \beta_1)}{\Delta\pi_3 + L_1}$ ,  $F(q)'_{q=0} > 0$ ,  $F(q)'_{q=1} < 0$ ,  $q=1$  is the stability strategy of commercial bank evolution, When  $p < \frac{I\alpha_1(\beta_3 - \beta_1)}{\Delta\pi_3 + L_1}$ ,  $F(q)'_{q=0} < 0$ ,  $F(q)'_{q=1} > 0$ ,  $q=0$  is the stability strategy of commercial bank evolution.

**Analysis of the evolution stability of strategic choice of government departments and commercial banks:** Based on the analysis of evolutionary stability strategy of government departments and commercial banks, a dynamic evolutionary phase diagram of the Audit governance game strategy of local government debt replacement risk can be drawn, as shown in Figure 1.

In Figure 1, the coordinates of the midpoint  $F$  are  $[\frac{I\alpha_1(\beta_3 - \beta_1)}{\Delta\pi_3 + L_1}, \frac{C_g}{\Delta\pi_1}]$ .

When the initial state of evolutionary game is in Quadrilateral CDFA, the system converges to the C-point (0,0), that is, the government does not implement the "Audit governance" strategy, and the commercial banks take a "non-replacement" local government debt strategy. When the initial state is in the quadrilateral AFDB, the system converges to the B-spot, that is, the government implements the "Audit governance" strategy, and the commercial bank adopts the "replacement" local government debt strategy. Therefore, the polyline AFC is the system

converging to the C point (0,0) and point B(p) of the adjacent line: when the initial state is under the AFD polyline, the system eventually converge to the C point (0,0) but when the initial state is above the AFD, the system finally converges at point B(P). It can be seen that the initial state determines the evolution direction of the system.

When  $q=1-p$  ( $p$  is the probability that government departments choose "audit governance" and  $q$  is possibility that the commercial banks choose to implement debt "replacement"), the system converges to C (0,0) and B ( $q=1-p$ ) with the same probability; when  $q > 1-p$ , the area of the quadrilateral AFDB is smaller than the area of the quadrilateral CDFA. After repeated trial of errors and learning, the probability of the system converging to C (0,0) is greater than the probability of convergence to B (1,1); When  $q < 1-p$ , the area of quadrilateral CDFA is smaller than that of the quadrilateral AFDB, and the probability of convergence to B (1,1) is greater than that of convergence to C (0,0).

Through further analysis of Figure 1, it can be seen that the initial values of and changes in some parameters of the profit function of

both sides of the game will cause a change of  $\frac{I\alpha_1(\beta_3 - \beta_1)}{\Delta\pi_3 + L_1}$  and  $\frac{C_g}{\Delta\pi_1}$ , thus changing the area of the quadrilateral AFDB and prompting the evolutionary system to converge to both sides of the game adopting the positive strategy. Among them, the area formula of quadrilateral AFDB is:

$$S = 1 - \frac{1}{2} \left[ \frac{I\alpha_1(\beta_3 - \beta_1)}{\Delta\pi_3 + L_1} + \frac{C_g}{\Delta\pi_1} \right] \quad (10)$$

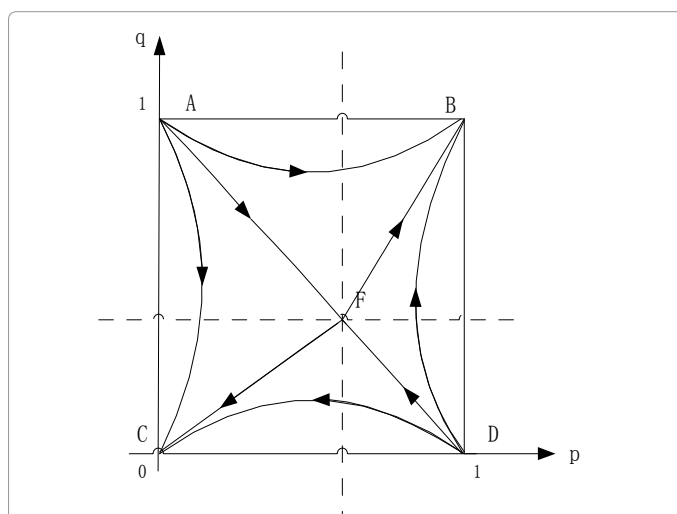
The first derivative of the area formula of quadrilateral AFDB is given in turn, with the following results:

1. In the case of other parameters, the parameters  $C_g$ ,  $I$ ,  $1$  and  $3$  are negatively correlated with the area of the quadrilateral AFDB. If the government's audit governance costs are reduced and the total amount of local government funds in the bank are reduced, the proportion of local government debt that meets the replacement condition in the total amount of local governments' credit funds will be reduced and banks' rate of return on non-replacement of local government debt that meets replacement conditions will become lower, thus point  $F$  will move to the left. As the area of quadrilateral AFDB increases, the probability that the game system eventually evolves to the point (1,1) increases.

2. In the case of other parameters, the parameters  $L_1$ ,  $\beta_1$ ,  $\Delta\pi_3$  and  $\Delta\pi_1$  are positively correlated with the area of the quadrilateral AFDB. When the government adopts the strategy of "audit governance", this results in a higher loss for commercial banks' non-participation in debt replacement, a higher bank's return on the local government debt which accords with the replacement condition, and a higher value for the government department's debt replacement to the commercial bank to carry out the audit to the replacement process. The higher the social benefit of the government department to the debt substitution audit, the more the point  $F$  will move to the left. As the area of the quadrilateral AFDB increases, the probability that the game system evolves to the point (1,1) increases.

## Discussion

In order to explain the strategy evolution process of both sides of the game more clearly, this paper simulates and analyzes the game behavior of government departments and commercial banks in the local debt substitution. First, in March 2018, the Audit Cadre College of the Auditing Commission and the School of Finance of Nanjing Audit University formed a research group and obtained

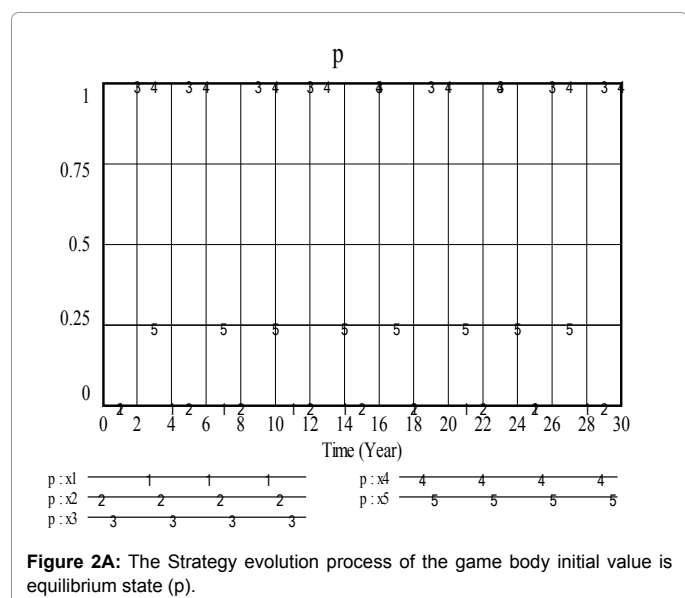


**Figure 1:** The game dynamic Evolution phase diagram of government departments and commercial banks.

the total amount of credit funds of the local government in the debt replacement project of one billion yuan through the field investigation of a commercial bank in Jiangsu Province. The loan cost of commercial banks to local governments is 90 million yuan, and the proportion of local government debt in total local government credit funds that conforms to the replacement condition is 50%. Due to the negative effect of the "Debt Replacement" strategy and the corresponding risk, the profitability of the replacement of local government debt in accordance with the replacement conditions is 6%, and the return rate of non-substitution for local government debt that does not meet the replacement conditions is 8%, and the yield of the local government debt that meets the replacement conditions is 10%. Second, in order to further the simulation of the audit governance of local government debt replacement risk and analyze the evolution trend of the dynamic game-related variables, the corresponding parameters in the model of the initial value are set as follows:  $C_1=1$  billion yuan,  $\pi_1=0.3$  billion yuan,  $\pi_2=0.5$  billion yuan,  $\Delta\pi_1=1.5$  billion yuan,  $\Delta\pi_3=0.5$  billion yuan,  $L_1=0.3$  billion yuan. According to the dynamic characteristics of the evolutionary game system under the initial conditions of different ratios of government departments and commercial banks, the simulation analysis is carried out using the computational experiment platform.

1. According to evolutionary game analysis, when the initial values of government departments and commercial banks are balanced, neither side of the game will actively change its strategy. When  $(p,q)$  is  $X_1(0,0)$ ,  $X_2(0,1)$ ,  $X_3(1,0)$  and  $X_4(X_5)$ , both government departments and commercial banks adopt pure strategies, and the evolution of five pure strategies for government departments and commercial banks is shown in Figures 2A and 2B.

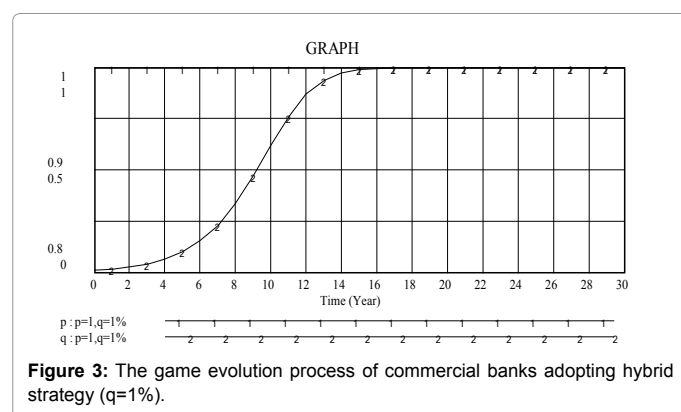
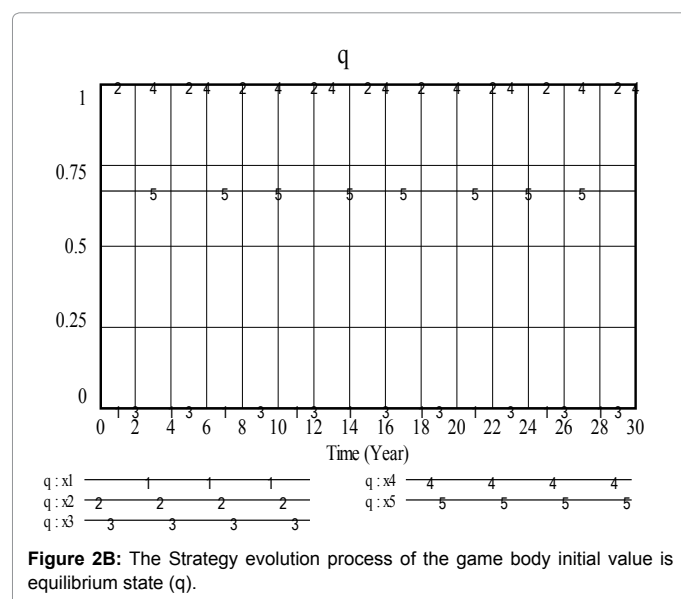
In the case of  $X_1(0,0)$  and  $X_4(1,1)$ , when all government departments do not adopt the "Audit Governance" strategy, the best strategy for commercial banks is "No Replacement". When all government departments adopt the "Audit Governance" strategy, the commercial banks' strategy is to implement the debt "Replacement". In the case of  $X_2(0,1)$  and  $X_3(1,0)$ , in the group where the main body of the game is located, no individual adopts the new strategy, the game individual does not have the space to learn to improve, and once any party of the game subject has a new strategy to obtain higher returns for the individual, the whole game system will quickly stabilize to  $X_1(0,0)$  and



$X_4(1,1)$  state. For example, if all government departments implement the "Audit governance" strategy in the beginning, the probability of local debt replacement of commercial banks is only 1%. However, when commercial banks learn from each other, the dynamic evolution of the choice of commercial bank strategy will eventually stabilize to the  $(1,1)$  state, as shown in Figure 3.

2. The evolutionary game model analysis shows that when commercial banks choose the probability of substitution  $\bar{q} < q < 1$ ,  $p=1$  is the evolutionary stability point of government departments. Therefore, the initial value of  $q$  for 0.7, the initial value of  $p$  is 0.1. Simulate once every time when the initial value of  $p$  has 0.1 change; the simulation results of strategy evolution are shown in Figures 4 and 5.

The simulation results show that with the increase of the initial value of  $p,q$  converges to 0 more and more slowly. When the initial value of  $p$  is 0.3,  $Q$  begins to converge at 1, and as the  $p$  value increases,  $q$  converges to 1 faster. Therefore, when the probability that commercial banks choose to implement debt replacement is greater than  $2/3$ , as long as the government maintains that the probability of implementing audit governance is above 0.25, the group ratio of government departments implementing audit governance will evolve to 1 and promote the development of game results to the direction of audit governance and replacement so as to ensure the orderly implementation of local



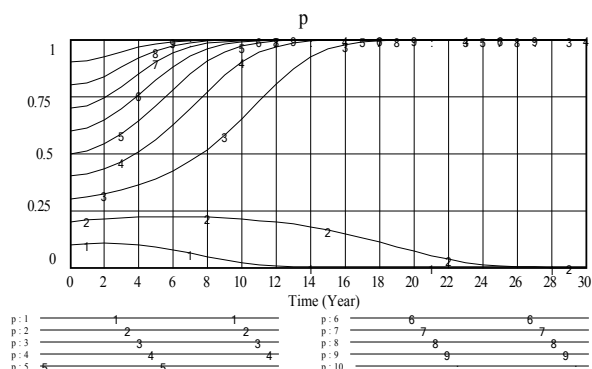


Figure 4: The simulation results of p when the initial value of q is 0.7.

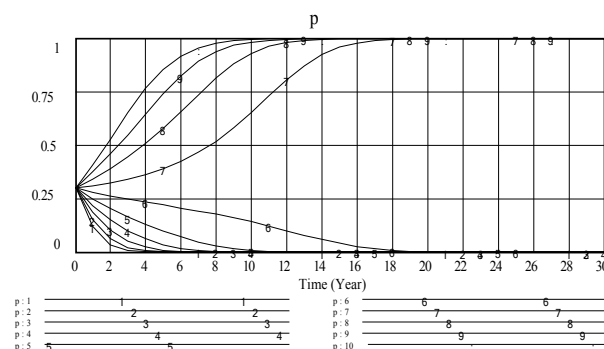


Figure 6: The simulation result of p when p initial value is 0.3.

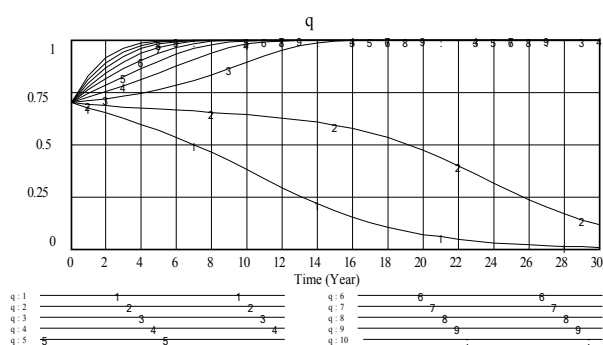


Figure 5: The simulation results of Q when the initial value of q is 0.7.

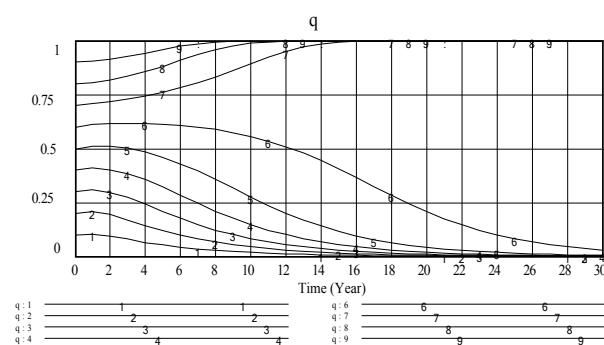


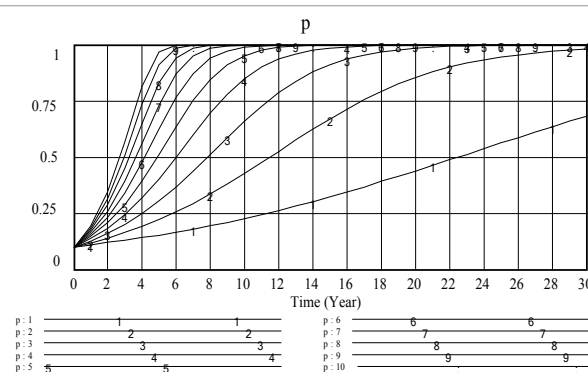
Figure 7: The simulation results of q when the initial value of p is 0.3.

government debt replacement and the effective prevention and control of the risk.

3. According to evolutionary game model analysis, when the probability of government departments choosing to implement "audit governance" local government debt replacement risk satisfies  $0.25 < p < 1$ ,  $q=1$  is the strategic choice of commercial banks' evolutionary stability point. The initial value of p to 0.3, q is 0.1, q for each change of 0.1, and the simulation results of the strategy evolution of Figures 6 and 7 are obtained.

Simulation results show that, with the increase of the initial value of q, p converges to 0 more slowly. When the initial value of q is 0.7, p begins to converge to 1, and as the Q value increases, p converges to 1 faster. When the probability of government departments choosing to implement the "Audit Governance" strategy is greater than 0.25, as long as commercial banks can maintain the ratio of the replacement to more than 0.7, commercial banks' choice to implement the debt "replacement" strategy of the group ratio will evolve to 1, but at the same time will promote game results to the direction of audit governance and replacement. This means that in the end, local government departments will be encouraged to audit the risk of debt replacement.

4. When the probability that the commercial bank chooses to implement the debt "substitution" strategy q is 1, p, the probability government departments choose to implement "Audit governance" is 0.1. If the revenue from the Government's implementation of the "Audit governance" strategy  $\Delta\pi_1$  increases from 100 million yuan to 200 million yuan, simulation results of the strategy evolution of Figure 8 can be obtained with each increase of 10 million yuan simulation.

Figure 8:  $\Delta\pi_1$  Changes, simulation results of p.

From the simulation results, it can be seen that when the commercial banks implement the debt "substitution" strategy, the more effective "audit governance" government departments implement, the faster the P-value converges from 0.1 to 1. Therefore, perfecting the debt audit mechanism can promote the government departments to choose the active strategy in the process of debt replacement, so as to effectively control the risk of debt replacement.

When the probability of government departments choosing to implement "audit governance" is 1 and the probability commercial banks choosing the "Debt Replacement" is 0.1, if the loss of commercial banks from debt replacement is increased from 10 million yuan to 55

million yuan, simulation results of the strategy evolution of Figure 9 can be obtained with each increase of 5 million yuan simulation.

In addition, when the probability that the government department chooses to implement "audit governance" is 1 and the probability of the commercial bank choosing debt "substitution" is 0.1, if the "Audit governance" strategy of government departments on debt replacement risk is implemented and the increase in commercial banks' revenue increases from 35 million yuan to 80 million yuan, simulation results of the strategy evolution of Figure 10 can be obtained with each increase of 5 million yuan simulation.

As can be seen from the simulation results in Figure 9, when the government departments implement the "Audit governance" strategy, the greater the loss of the commercial banks' debt replacement, the faster the  $q$  value converges from 0.1 to 1. From the simulation results shown in Figure 10, it can be seen that when the government departments implement the "Audit governance" strategy, the higher the profit of the commercial banks' debt replacement, the faster the  $q$  value converges from 0.1-1. Therefore, improving the risk management ability of the audit, increasing the loss of the commercial banks without carrying out the debt replacement, and guaranteeing the proper rights and interests of the commercial banks in the debt replacement, will promote the commercial banks to choose active strategies in the debt replacement process, thus effectively reducing the corresponding risk of debt replacement.

Based on the "Situation-Responding" thought of computational experiment, this paper analyzes the dynamic game behavior of government departments and commercial banks in the process of

debt replacement by using an evolutionary game model, and simulates the evolution of the game strategy of government departments and commercial banks. The result shows that once government departments choose to implement the "Audit Governance" strategy, after a period of evolution, commercial banks will eventually choose to "replace" the local government debt strategy; and improving the audit mechanism and the effectiveness of risk management can greatly shorten the time required for government departments and commercial banks to choose the active strategy. Based on the analysis of computational experiments, this paper combines the three functions of audit supervision, evaluation and attestation of "State Governance" in order to realize the government's goal of good governance of debt replacement, and puts forward the audit governance policy as a combination of debt replacement risk from supervision responsibility, evaluation efficiency and information transparency.

First, supervision responsibility should be made clear and the risk disclosure function should be improved. From the risk analysis of local government debt replacement, it can be seen that the audit object coverage of local government debt replacement risk is more extensive, focusing not only on the fiscal audit of the replacement debt, but also on the financial audit and performance audit, which means it is necessary not only to audit the debtors involved in debt replacement, but also to supervise the local commercial banks, bond markets and money markets involved in debt replacement. In addition, according to the dynamic evolution phase diagram of audit governance game Strategy (Figure 1), and based on the evolutionary game strategy of local government debt replacement, the conclusion related to the analysis of simulation (Figures 2A, 2B and 3), it is found that once any party of the game main body has adopted a new strategy to obtain higher returns for the individual, the whole game system will quickly stabilize to the  $X_1(0,0)$  and the  $X_4(1,1)$  state, that is, the two participants in the game process have behavior synergy. Therefore, in the audit governance of debt replacement risk, it is necessary for local audit institutions to take the lead, clarify the supervision responsibility of all parties, establish the audit organization mechanism with audit institutions as the core, and coordinate the internal audit of commercial banks and financial supervision institutions to complement each other at different stages of debt replacement. At the same time, these institutions must give full play to their respective professional advantages in accordance with their respective responsibilities, so that the main body in the audit process produces a benign complementary situation and maximizes the risk of debt replacement audit governance effectiveness.

Second, improve the evaluation mechanism to limit the size of government debt. The duration of the replacement bond is generally 5-10 years, and it can be seen from the simulation of the evolutionary game strategy of the local government debt substitution that both sides of the game cannot make decisions that are beneficial to maximize their own interests at once, and need to change their own decisions over time (for example, Figures 4 and 5). Therefore, the audit governance of debt replacement risk cannot be concluded with the release of the replacement bond, but attention must be paid to the predictability of risk, the follow-up effect of the replacement bond on China's bond market and the income of the investment item. As the local government's economic situation and debt repayment ability will vary with time, the audit institution should revise relevant indexes in time when using the risk warning mechanism, scientifically and reasonably reveal the risk of local government debt replacement, and exert the immune effect of audit on financial system risk in national governance. The essence of local government debt replacement is to postpone the debt. If the local

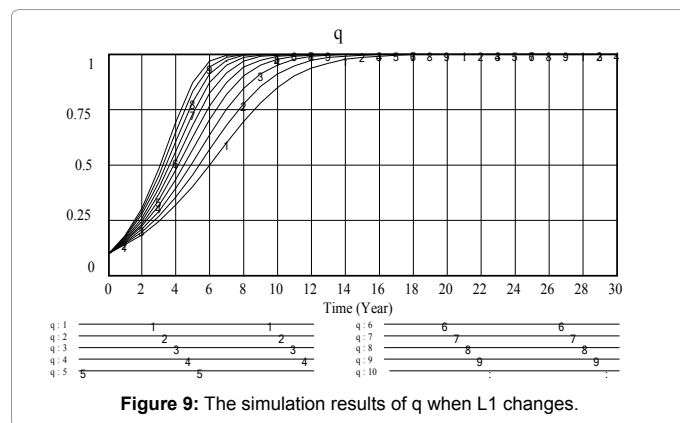


Figure 9: The simulation results of  $q$  when  $L_1$  changes.

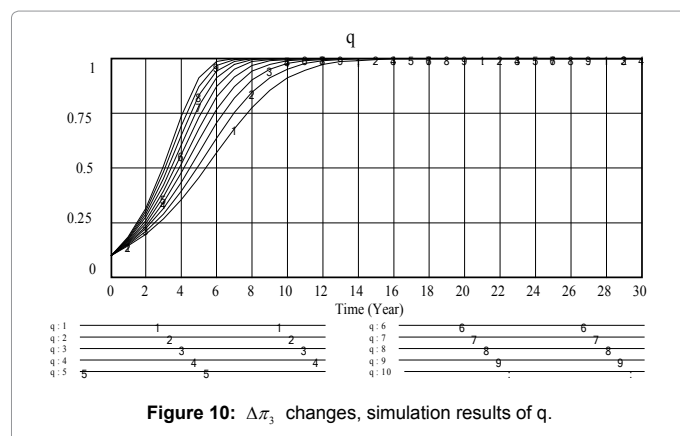


Figure 10:  $\Delta\pi_3$  changes, simulation results of  $q$ .

government still has no repayment ability, the commercial bank will still face credit risk. Therefore, restricting the size of local government's debt can effectively reduce the default risk of local government for the replacement bond.

## Conclusions

Finally, strengthen the transparency of information and improve the level of risk protection. It is the proper intention of a national audit to improve the transparency of audit information and to realize national good governance. In the course of the simulation of the evolutionary game strategy of local government debt replacement, it is concluded that improving the risk management ability of audit, increasing the loss of commercial banks without debt replacement, and ensuring the proper rights and interests of commercial banks in debt replacement will promote commercial banks to choose positive strategies in the process of debt replacement. In turn, the corresponding risk of debt replacement is effectively reduced. Therefore, the State should enact relevant laws and regulations, prompting local governments to set up special bulletin pages to fully disclose the relevant debt information, including debt capital investment projects, the use of debt funds and the post-project income status, so as to help our central government to allocate a reasonable replacement quota. The information disclosure of the detailed local debt should also include the basic information of the replacement bonds, the use of the replacement funds, and the late bond repayment status. In addition, local government debt replacement is intended to convert short-term high-interest loans into long-term low-interest replacement bonds, essentially extending the existing debt of local governments to future repayment. The tenure of local government officials in China is generally shorter than the term of the replacement bond, and in order to relieve the current pressure, incumbent officials have the impulse to defraud the replacement quota and escape the obligation to repay the debt. Therefore, the central government should implement the long-term accountability system of debt replacement, under which the audit work of the incumbent officials of the local governments will be strengthened to reduce the moral hazard in the replacement process to a certain extent and guarantee the quality of the replacement bonds.

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