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Computer simulation evaluation model of basketball match based on fuzzy neural network

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ABSTRACT

On the basis of fuzzy number theory, this research combines RBF neural network model and data envelopment analysis method with fuzzy comprehensive evaluation model, enhancing the reliability and scientificalness of this evaluation model. Starting from computer simulation, it conducts data mining using mass of data in basketball game. The results show that the model can simulate the process of the game, predict the results of the game, and finally get a scientific and reasonable result.

KEYWORDS

Fuzzy neural network;
Basketball game;
Data mining.

INTRODUCTION

With the advent of computers and rapid development of technology, computer provides a more powerful platform for basketball game research. By collecting data of basketball game, it analyzes the factors that affect the game using computer, simulates the process of basketball game and so on. Currently, computer technology is used fully in the basketball game.

In basketball competitions, numerous rules, refinement of criterion, intense competition and difference of referee' ability, et al, all affect basketball athletes' athletic level and completion result. Therefore, it is particularly important to design a set of a set of fair and impartial, scientific and rational evaluation system. All these factors have certain degree of fuzziness, such as the penalty scale is usually subjectively determined by the referee, and artificially subjective effects are also reflected in the formulation of evaluation standard.

This article builds a fuzzy comprehensive evaluation model on the basis of fuzzy number theory. Due to the high subjectivity of this model, this research combines RBF neural network model and data envelopment analysis method with fuzzy comprehensive evaluation model, enhancing the reliability and scientificalness of this evaluation model. Meanwhile starting from computer simulation, it conducts data mining using mass of data in basketball game.

EVALUATION MODEL OF FUZZY NEURAL NETWORK

RBF neural network is able to simulate the partial adjustment of the human brain and receiver domain of mutual coverage. There is no local minimum problem and it is easy and fast to learn with a high fitting precision. It can change the weight value of indexes in fuzzy comprehensive evaluation model, making it more in line with the practical situation. The determination of the index weight value is particularly important in fuzzy comprehensive evaluation model.

Introduction of RBF neural network

Radial Basis Function (RBF) neural network is a kind of neural network put forward by J. Moody and C. Darken in the late 1980's, and a special three-layer feed-forward network with a single hidden layer. As it simulates the neural network structure of the partial adjustment and receiver domain of mutual coverage in human brain, RBF is considered to a local approximation network, as shown in Figure 1.

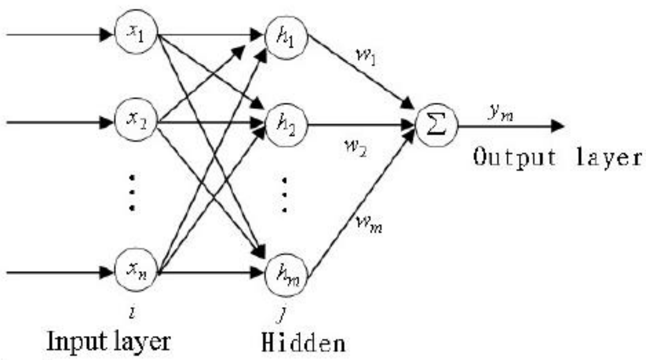

Figure 1 : Structure chart

RBF neural network is able to approximate any continuous function with arbitrary precision and especially fit for the classification problem. The approximation chart is shown in Figure 2.

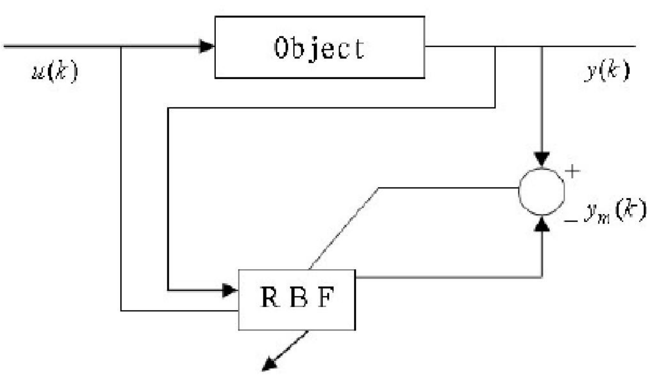

Figure 2 : Approximation chart

Suppose that $X=(x_1,x_2,\cdots,x_n)^T$ is the network's input and $H=(h_1,h_2,\cdots,h_m)^T$ is the base vector in radial direction, in which h_j means the center vector of Gaussian function $h_j=e^{-\frac{\|X-C_j\|^2}{2b_j^2}}\ (j=1,2,\cdots,m)$ and the number j node in network $C_j=(c_{1j},c_{2j},\cdots,c_{nj})^T$. Base width vector is $B=(b_1,b_2,\cdots,b_m)^T$, and b_j is the base width parameter of the node point. Weight vector is $W=(w_1,w_2,\cdots,w_m)$, and the output of the network in time k:

$$y_m(k)=wh=w_1h_1+w_2h_2+\cdots+w_mh_m$$

To reach an ideal output $y(k)$, this article gets a performance index function as:

$$E(k)=\frac{1}{2}(y(k)-y_m(k))^2$$

Modeling

Supposing that $X=(x_1,x_2,\cdots,x_m)$ is the network input, then the number of input is m and the number of output and evaluation grade is n. The connection weight between the second layer and the third layer in the network w_i is the weight value of the index in fuzzy comprehensive evaluation model.

The first layer: the input layer

As can be seen from Figure 1, the total number of neuron in the input layer is m, so the input and output are accordingly:

$$I_i^1=x_i,\ O_{ij}^1=x_i\ \ddot{y}\ i=1,2,\cdots,m\ \ddot{y}\ j=1,2,\cdots,n$$

The second layer: the hidden layer

The evaluation grade of RBF neural network is. Judging from Figure 1, the hidden layer contains neuron. In this paper, the evaluation grade is divided into four levels: = {excellent, good, qualified, unqualified}, i.e. . Therefore, four parameters are needed for the four fuzzy subsets. Membership function is presented in the form of trigonometric function, shown in Figure 3.

When the input is asÿÿ, the hidden layer outputs the membership value of each level as follows:

The third level: the output level

The output layer mainly conducts a comprehensive evaluation of the input indexes. The obtained evaluation grade and vector are:

Input: $I_{ij}^3=O_{ij}^2$

Output: $O_i^3=\sum_{j=1}^{m}w_jI_{ij}^3$

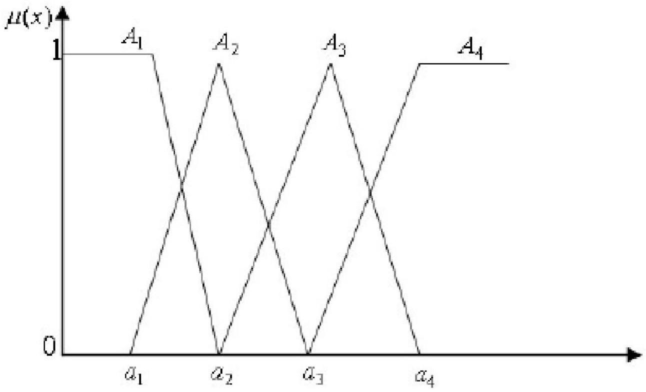

Figure 3 : Membership function

In which $i = 1,2,\cdots,m$, $j = 1,2,\cdots,n$.

Yet RBF neural network has several shortcomings, such as slow convergence rate and local minimum of energy. This article adopts a modified network and improves the connection weight of the network, making the weight value of the indexes in fuzzy neural network evaluation model more suitable for practical situation.

This paper calculates the output value by the reverse of the network and gets the error between the output value and the actual value. Then correct the network's connection weight by the value obtained from the forward of the network, which reduces the network error.

Supposing the output error is, the error function can be expressed as. In this article, gradient descent method in RBF neural network learning algorithm is introduced to amend the weight vector, aiming at reducingand increasing the computational accuracy. The gradient descent method is shown in the following text: if $w_j(k) = w_j(k-1) + \eta h_j(y(k) - y_m(k)) + \alpha(w_j(k-1) - w_j(k-2))$

and $\Delta b_j = (y(k) - y_m(k)) \times$, $w_j h_j \dfrac{\|X - C_j\|^2}{b_j^3}$,

$b_j(k) = b_j(k-1) + \eta\Delta b_j + \alpha(b_j(k-1) - b_j(k-2))$

$\Delta c_{ij} = (y(k) - y_m(k)) \times \quad w_j \dfrac{x_j - c_{ij}}{b_j^2}$ then

$c_{ij}(k) = c_{ij}(k-1) + \eta\Delta c_{ij} + \alpha(c_{ij}(k-1) - c_{ij}(k-2))$, in η whichmeans the learning speed and means momentum factor. Based on Jacobean array, a final result can be achieved: $\dfrac{\partial y(k)}{\partial u(k)} \approx \dfrac{\partial y_m(k)}{\partial u(k)} = \sum_{j=1}^{m} w_j h_j \dfrac{c_{1j} - x_1}{b_j^2}$

Supposing that ΔW is the adjusted value of W , the iterative algorithm formula of ΔW based on gradient descent method is: $\Delta W^{(n)} = -\eta \dfrac{\partial e_p}{\partial W} + \alpha \Delta W^{(n-1)}$

Conduct iteration utilizing the formula of ΔW and end the network training until the error meet the requirements.

Model application

Assume that the number of evaluation indexes is m, and they are A_1 ÿ $A_2, \cdots, A_m$. These indexes cover all the competition requirements for basketball athletes in routine competition, such as strength, rhythm, style, and coordination, content and structure, etc. Suppose that the number of basketball athletes taking part in the competition is n and they are expressed as B_1 ÿ $B_2, \cdots, B_n$. If $A = \{A_1, A_2, \cdots, A_m\}$ and $B = \{B_1, B_2, \cdots, B_n\}$, there reaches the following matrix:

$$\begin{array}{ccccc} & B_1 & B_2 & \cdots\cdots & B_n \\ A_1 & X_{11} & X_{12} & \cdots\cdots & X_{1n} \\ A_2 & X_{21} & X_{22} & \cdots\cdots & X_{2n} \\ \vdots\ \vdots & \vdots\ \vdots & \vdots\ \vdots & \vdots\ \vdots & \vdots\ \vdots \\ A_m & X_{m1} & X_{m2} & \cdots\cdots & X_{mn} \end{array}$$

In which X_{ij} is the membership of the basketball athlete under index A_j and $0 < X_{ij} < 1$. Therefore it can be concluded that when the value of X_{ij} is smaller, the athlete's level and ability under this index is low comparably; and vice verse.

In this research, the obtained membership under each index is given a weight. Then calculate the average of the weights. The average value is considered to be the final result of the basketball athlete, that is $Q_j = \sum_{i=1}^{m} \dfrac{W_i X_{ij}}{m}$.

Suppose that there are t referees and evaluation grade is m, $C_1, C_2, \cdots, C_m$. Provide that the evaluation grade decrease with the increase of index C_i , i.e. decreasing function. Referees would give an evaluation result to each basketball athlete in such way as the following:

$$\begin{array}{cccccc} & C_1 & C_2 & \cdots\cdots & C_m \\ A_1 & Q_{11} & Q_{12} & \cdots\cdots & Q_{1m} \\ A_2 & Q_{21} & Q_{22} & \cdots\cdots & Q_{2m} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ A_m & Q_{m1} & Q_{m2} & \cdots\cdots & Q_{mm} \end{array}$$

According to national regulation, the evaluation indexes are classified into 8 groups in this paper as $A_1, A_2, \cdots, A_8$ and evaluation grade is divided into 5 groups, $C_1, C_2, \cdots, C_5$ as excellent, good, qualified, unqualified and poor. Taking a basketball Championships in certain year as an example, this article reaches to the weight value of the eight evaluation indexes $A_1, A_2, \cdots, A_8$ respectively 0.17, 0.18, 0.13, 0.14, 0.12, 0.15, 0.08, and 0.09. Select 6 basketball athletes randomly and get the evaluation results from the referees. The processed result is shown in TABLE 1.

TABLE 1: Evaluation result

	C_1	C_2	C_3	C_4	C_5
A_1	0.3	0.5	0.01	0	0
A_2	0.1	0.4	0.5	0.1	0
A_3	0.4	0.2	0.3	0	0.2
A_4	0	0.09	0.3	0	0.6
A_5	0.4	0	0	0	0.6
A_6	0.2	0.4	0	0	0.4
A_7	0	0.2	0.6	0.2	0
A_8	0.2	0	0	0	0.8

The evaluation matrix of the evaluation indexes is:

$$R = \begin{pmatrix} 0.3 & 0.5 & 0.01 & 0 & 0 \\ 0.1 & 0.4 & 0.5 & 0.1 & 0 \\ 0.4 & 0.2 & 0.3 & 0 & 0.2 \\ 0 & 0.09 & 0.3 & 0 & 0.6 \\ 0.4 & 0 & 0 & 0 & 0.6 \\ 0.2 & 0.4 & 0 & 0 & 0.4 \\ 0 & 0.2 & 0.6 & 0.2 & 0 \\ 0.2 & 0 & 0 & 0 & 0.8 \end{pmatrix}$$

According to the calculation formula of fuzzy comprehensive evaluation, the final evaluation result is:

$$Q = A \times R = (0.17\ \ 0.18\ \ 0.35\ \ 0.29\ \ 0.01)$$

And $A = (0.17\ 0.18\ 0.13\ 0.14\ 0.12\ 0.15\ 0.08\ 0.09)$. As can be seen from the above final evaluation result, 17% of the referees consider the athlete's ability in this competition to be excellent; 18% of the referees consider the athlete's ability in this competition to be good; 35% of the referees consider the athlete's ability in this competition to be qualified; 29% of the referees consider the athlete's ability in this competition to be unqualified; 1% of the referees consider the athlete's ability in this competition to be poor. Then the final result of this athlete can be determined, combining the corresponding grade of the five evaluation grade.

$$Q = \frac{0.17^2 \times 3 + 0.18^2 \times 2.5 + 0.35^2 \times 2 + 0.29^2 \times 1.5 + 0.01^2 \times 1}{0.17^2 + 0.18^2 + 0.35^2 + 0.29^2 + 0.01^2} = 2.01$$

Similarly, the other five athletes' final results are 2.16, 2.10, 2.13, 2.25, and 2.32.

DATA MINING

Basketball as a team sport, every team player also affects the final result. Meanwhile, a certain influential factor may affect on one player, but it may not affect another player. Each player has his own difference. In this way, we cannot use one model to predict the result. According to the different circumstances of the game, everyone's play is also different. Finally, we get a lot of factors that affect the results of the competition, and their relationship is very complex. So the data we get is vague and subjective.

Since the data of every game is a large number and contain timeliness, earlier data may not be used. So when building predictive models, this paper uses the main factors.

$$v = b_1 v_1 + b_2 v_2,\ b_1 + b_2 = 1$$

Wherein the mathematical expectation of the team I is $v_1 = E(I)$, the predictable result is v_2. And make adjustments of b_1 and b_2 based on the predicted results, as follows:

Order V is the results of the prediction, and the actual result of the team I is T. When $|V - T| > \sigma$, re-evaluate b_1 and b_2 according to equations $\begin{cases} b_1 + b_2 = 1 \\ b_1 v_1 + b_2 v_2 = T \end{cases}$. The use of the rank of the augmented matrix, $\begin{pmatrix} \mathbf{1} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{v_1 - v_2} & \mathbf{T - v_1} \end{pmatrix}$, When $\mathbf{v_1 - v_2 \neq 0}$, solve the equations and obtain $\mathbf{b_1}$ and $\mathbf{b_2}$; When $\mathbf{v_1 - v_2 = 0}$ and $\mathbf{T - v_1 = 0}$ the equation has infinitely many solutions, $\mathbf{b_1}$ and $\mathbf{b_2}$ don not need adjustment; when $\mathbf{v_1 - v_2 = 0}$ and $\mathbf{T - v_1 \neq 0}$ the equation has no solution. At this time, set $\varepsilon = \frac{2}{5}(\mathbf{T - v_1})$. This paper uses neural network model to process the data. When L is in the middle level, $\mathbf{v_2 > T}$ this stated that v_2 can be used, and the error of v_1 is relatively large. At this time increase b_1, decrease b_2, use $\mathbf{v_1{}' = T + \varepsilon L}$ **instead of, to obtain equations, solve and obtain and.**

When is in the low level, , this stated that can be used, and the error of is relatively large. At this time increase, decrease, use instead of, to obtain equations, solve and obtain and.

If one value of and remains at a low level, indicating that the predicted results are not accurate. Parameter can explain whether the recent state of shuttlecock players is in peak or trough.

To sum up this article, the prediction results of a team's next game have little difference between their recent achievements, which shows is stable. So in this paper it is more scientific to take as a result of the forecast.

CONCLUSIONS

This paper first analyzes the status of a basketball team using data mining technology and predicts the team's development trends. It simulates the process of the game, predicts the results of the game, and gets a scientific and reasonable result. Due to the high fuzziness of this model, this research combines RBF neural network model and data envelopment analysis method with fuzzy comprehensive evaluation model, and builds two kinds of evaluation model as fuzzy data envelopment analysis and fuzzy neural network, and finally reaches a satisfactory result.

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Research on the influence of deposit insurance system to the moral hazard of banking

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ABSTRACT

This article establishes a panel model with Difference-in-differences Estimation and a data set of macro economy and financial data of 524 banks in China and Indonesia from 1999 to 2011. With the help of one-sample test and Hausman test, the optimal model is chosen to represent the reality. The method could effectively identify cause and effect by deposit insurance system so as to provide the basis for developing more targeted strategies for risk control policies in China. Empirical research has showed that the subordinated debt ratio, bank's franchise value, GDP Per Capita, country's monetary policy intermediary goals and ultimate goal could have a significant impact on banks' moral hazard in deposit and loan business under deposit insurance system, since deposit insurance system on the whole reduce banks' moral hazard in deposit and loan business. Size of bank has uncertain Influence of deposit insurance system on banks' moral hazard in deposit and loan business.

KEYWORDS

Deposit insurance system;
Moral hazard;
Difference-in-differences estimation;
Basic economic variables.

INTRODUCTION

With the accelerated pace of marketization of China's interest rate, the establishment of deposit insurance system to protect the interests of depositors with a market-oriented financial security system is becoming the focus of the industry.[1] However, to some extent, the deposit insurance system blurs the public identification on the risks of financial institutions, lowers the level of supervision of financial institutions, and relaxes the inhibition of the financial risk from bank risk management behavior. Therefore, banks increase high-risk investment to pass on the cost of insurance in order to obtain high profits. At the same time, banks take deposits to replace their own capital to reduce the equity capital ratio, posing an adverse impact on financial stability[1] thought that deposit insurance system would inevitably induce bank managers to conduct excessive risk investment which gave rise to moral hazard[2] analyzed the problem through arrangement and operation mechanisms of bank and deposit insurance[3] used option pricing model to study the deposit insurance system. Both Park and Merton had reached a similar point of view[4] used the deposit protection scheme in Kansas as an empirical object to prove that there was also moral hazard defect in the United States' early state deposit protection scheme. In addition, more scholars, such as[5-7], argued that the moral hazard caused by financial deregulation and deposit insurance system was the important reason of the increase of bank failures since the 1980s.

About bank moral hazard[8], used stock market crash probability to measure bank moral hazard. Miller[9], described the process of stock price movement with periodic dramatic reversal movement, and then measured the size of moral hazard[10] argued that if the ratio of total debt to GDP deviated from the trend, then the real credit growth would be a better indicator to measure bank moral hazard. WEI[11] validated that the governors of the bank have the obvious disguise and postpone behaviors on credit risk and confirmed the existence of bank moral hazard through the data of commercial loan quality migration and changes of the bank governors.

In summary, there are some limitations in the existing research literature: First of all, most of the literature was mainly qualitative research, lacking in quantitative analysis, especially empirical test. Secondly, in the existing quantitative research, because of lack of data availability, there was no comparison of moral hazard change before and after the establishment of bank deposit insurance system. Thirdly, the samples of classic econometric model were mostly from developed countries. Therefore the comparability was limited so that it had a direct impact on the low relevance and effectiveness of the strategy formulation of risk control.

MODEL AND VARIABLES

Research Method: This paper divided the samples of banks into two groups: one group is the treatment group with the impact of the deposit insurance system, and the other group is the control group without the impact. The econometric model is as follows:

$$Y_{i,t}=\beta_0+\beta_1 T_t+\beta_2 G_i+\beta_3 T_t G_i+\varepsilon_{i,t} \quad (1)$$

G_i is the treatment dummy variable; when the object belongs to the treatment group, G_i is equal to 1; and when the object belongs to the control group, G_i is equal to 0. T_t is the time dummy variable, before the implementation of the deposit insurance system, T_t is equal to 0; after its implementation, T_t is equal to 1. $T_t G_i$ is the interaction term of time dummy variable and treatment dummy variable. Y_i is the outcome variable of the implementation results of the system. ε is the error term, representing the factor which can not be observed or controlled but have influence on dependent variable.

Furthermore, when other variables which can affect outcome variable Y_i are controlled, difference-in-differences regression equation can be transformed into the following form:

$$Y_{i,t}=\beta_0+\beta_1 T_t+\beta_2 G_i+\beta_3 T_t G_i+\beta_4 X_{i,t}+\varepsilon_{i,t} \quad (2)$$

$X_{i,t}$ is the other variables which can affect outcome variable Y_i.

For the control group, before and after the implementation of the system, the average change in the dependent variable is:

$$dif_1=(\beta_0+\beta_1)-\beta_0=\beta_1 \quad (3)$$

For the treatment group, before and after the implementation of the system, the average change in the dependent variable is:

$$dif_2=(\beta_0+\beta_1+\beta_2+\beta_3)-(\beta_0+\beta_2)=\beta_1+\beta_3 \quad (4)$$

By introducing other independent variables which could affect dependent variable and eliminating systematic differences between the control and treatment groups, the net impact of the deposit insurance system on the dependent variable is:

$$dif=dif_2-dif_1=(\beta_1+\beta_3)-\beta_1=\beta_3 \quad (5)$$

So, the parameter β_3 of $T_t G_i$ in equation (1) represents the net impact of the implementation of the system on the dependent variable, which is used as a measure of the effect of implementation of the system.

The Description of Model and Variables

Model and explanation of variables

Bank moral hazard is mainly reflected on asset management and liability management. The bank's main assets business is loan business so we use the Non-performing Loans Ratio (NPL) to represent the moral hazard in asset management. While moral hazard of liability management is primarily embodied in the behavior of replacing banks' own capital for deposits, so we use self-owned capital ratio to measure.

First, for moral hazard led by the deposit insurance system in bank asset management, we built panel difference-in-differences model as follows:

$$Y_{1i,t}=\beta_0+\beta_1 T_t+\beta_2 DI_i+\beta_3 T_t DI_i+\alpha_j X_{ji,t}+\delta_k Z_{ki,t}+\varepsilon_{i,t} \quad (6)$$

T_t is time dummy variable. Since Indonesia established deposit insurance system in 2005, when t is less than 2005, T_t is equal to 0; when t is greater than or equal to 2005, T_t is equal to 1. DI_i is the dummy variable to measure whether banks are constrained by the deposit insurance system. For banks in Indonesia in the treatment group, DI_i is equal to 1; for banks in China in the control group, DI_i is equal to 0. T_tDI_i is the interaction terms of time dummy variable and the dummy variable of the deposit insurance system, and its coefficient β_3 can measure the impact of the implementation of the deposit insurance system on the dependent variable, Non-performing Loans Ratio.

Y_1 is the banks' Non-performing Loans Ratio. X_j (j = 1, 2, 3) is characteristic variables on behalf of the bank i : X_1 is the share of bank assets of the total assets in the banking system, so it represents the scale of bank assets; X_2 is subordinated debt ratio; X_3 is bank's franchise value. In this paper, the unit capital franchise value (UBFV) is used to measure bank's franchise value, $X_3 = UBFV = (ROE - r_c) / (1+r)$. ROE means the return on equity, reflecting the return level of equity; r_c is the cost of capital, approximately equals to the risk-free rate of return of the capital in the long term, which can be replaced by market interest rates; r is the annual rate of return, we can use the average one-year lending rate to measure bank's annual revenue rate.

For the differences between the two countries, the model also introduces the basic economic variable Z_k (k =1, 2, 3) to achieve the purpose of controlling the impact of macroeconomic factors on bank moral hazard. Z_1 is the per capita gross domestic product; Z_2 is inflation rate; Z_3 is the growth rate of the money supply (M_2). Central banks' monetary estimate calibers are not completely consistent across the world, but the fundamental basis of division is consistent.

Similarly, for moral hazard in bank liability management led by the deposit insurance system, the panel difference-in-differences model is as follows (j = 1, 2, 3; k = 1, 2, 3; l = 4, 5, 6; m = 4, 5, 6):

$$Y_{2i,t}=\beta_4+\beta_5T_t+\beta_6DI_i+\beta_7T_tDI_i+\alpha_lX_{ji,t}+\delta_mZ_{ki,t}+\varepsilon_{i,t} \quad (7)$$

Y_2 is the bank's self-owned capital ratio.

Sample selection and data description

Since Indonesia founded the deposit insurance system in 2005, we treat 2005 as a time dummy variable node. The treatment group includes 65 banks in Indonesia, the control group includes 50 banks, and the time interval ranges from 1999 to 2011. We removed the sample with missing data and built unbalanced panel data; there are 348 samples in the treatment group, and the control group is consisted of 176 samples.

The descriptive statistics of related variables are shown in TABLE 1. The comparison of descriptive statistics from the control group and the treatment group in TABLE 2 shows that there are no signifi-

TABLE 1 : The descriptive statistics of related variables

Variables	Sample size	Average value	Standard deviation	Minimum	Maximum
X_1	524	0.0191	0.0336	3.8E-05	0.1805
X_2	524	0.0146	0.0275	0	0.3005
X_3	524	0.0503	0.6086	-4.9341	7.3908
Z_1	524	3985	1801	2295	8600
Z_2	524	0.0713	0.0501	-0.0073	0.2037
Z_3	524	0.1504	0.0531	0.0472	0.2842

TABLE 2 : The comparison of descriptive statistics from the control group and the treatment group

Variables	Control group(China's banks)			Treatment group(Indonesia' bank)		
	Sample size	Average value	Standard deviation	Sample size	Average value	Standard deviation
X_1	176	0.0269	0.0409	348	0.0152	0.0285
X_2	176	0.0076	0.0057	348	0.0182	0.0329
X_3	176	0.1123	0.1797	348	0.0189	0.7342
Z_1	176	6022	1600	348	2954	654
Z_2	176	0.0278	0.0220	348	0.0933	0.0457
Z_3	176	0.1977	0.0422	348	0.1265	0.0405

cant differences in all major respects in the sample banks from the treatment group and the control group.

EMPIRICAL TEST AND RESULTS ANALYSIS

Univariate Test: The univariate test results of the bank's non-performing loan ratio, self-owned capital ratio before and after the establishment of deposit insurance system in the control and treatment groups are shown in TABLE 3. After the establishment of the deposit insurance system, the non-performing loans ratio and self-owned capital ratio of the treatment group are both less than the control group, and the result is significant at the 1% level of confidence. It means deposit insurance system may reduce moral hazard in bank asset management (declined non-performing loan ratio), at the same time, may increase the risk of moral hazard in the bank liability management (declined self-owned capital ratio). The non-performing loan ratio in the treatment group is significantly greater than the ratio before the establishment in the 1% confidence level. The self-owned capital ratio is significantly less than the ratio before the establishment in the 5% confidence level. It shows that deposit insurance system dramatically increased moral hazard, which is embodied in the rise of non-performing loans ratio and the decline of self-owned capital ratio.

Model Estimation and the Hausman Test:

Moral hazard in bank asset management

$$Y_{1i,t}=\beta_0+\beta_1T_t+\beta_2DI_i+\beta_3T_tDI_i+\alpha_jX_{ji,t}+\delta_kZ_{ki,t}+\varepsilon_{i,t} \qquad (6)$$

The regression results are shown in TABLE 4.

We estimated fixed and random effects of panel data model and determined results by the Hausman test. Due to limited space, we take Model 3 for example. Hausman test results shows that the null hypothesis that there are no significant differences between the estimated value of the random effects and fixed effects estimates is rejected, therefore, we should use fixed-effects model. Compared with Model 1and Model 2, F_1 value in the Model 3 suggests that the overall regression equation is significantly showed, which means that the impact of the explanatory variables as a whole to the variable Y_1 is very significant; F_2 value represents the test results of whether there is individual effect in the model, helping us to make a choice among the mixed OLS model, fixed-effects model and random-effects model. The test results confirm the presence of fixed effects, consistent with the results of the Hausman test. Also, Model 3 has better coefficient of determination, higher goodness of fit than Model 1 and Model 2, and more comprehensive variables, including the impact of deposit insurance system, bank individual characteristics and basic economic factors on moral hazard in bank asset management, so Model 3 is selected finally. In order to eliminate the impact of multicollinearity, DI variable is removed during regression in STATA.

Moral hazard in bank liability management

$$Y_{2i,t}=\beta_4+\beta_5T_t+\beta_6DI_i+\beta_7T_tDI_i+\alpha_lX_{ji,t}+\delta_mZ_{ki,t}+\varepsilon_{i,t} \qquad (7)$$

The regression results are shown in TABLE 5.

As the method described before, in Model 7, for example, Hausman test results show that the null hy-

TABLE 3 : The results of univariate test

Variables	Sample size	Average value(A)	Sample size	Average value(B)	Mean Difference (A－B)	T -test
The comparison of moral hazard in the control and treatment groups(1999-2011)						
	Control group(China)		Treatment group(Indonesia)			
Y_1	176	0.0313	348	0.1029	significantly＞0	(-5.1912)***
Y_2	176	0.0595	348	0.1134	significantly＞0	(-7.7141)***
The comparison of moral hazard before and after establishment in the treatment group						
	1999-2004		2005-2011			
Y_1	206	0.1466	142	0.0393	significantly＜0	(8.7590)***
Y_2	206	0.1053	142	0.1252	significantly＜0	(-2.1076)***

Note: The figures in brackets are the T values; *, **, * represent the results are significant at the 10%, 5%, 1% level of confidence respectively.**

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TABLE 4 : Panel difference-in-differences regression analysis(dependent variable Y_1:non-performing loan ratio)

Variable	Model1		Model2		Model3	
	Coefficient	Z value	Coefficient	T value	Coefficient	T value
DI	0.0823	(2.97)***	—	—	—	—
T	-0.0684	(-3.14)***	-0.0689	(-3.06)***	-0.0612	(-2.38)**
*DI*T*	-0.0519	(-2.10)**	-0.0376	(-1.47)	-0.0762	(-3.06)***
X_1	—	—	-0.7116	(-1.32)	-0.0707	(-0.15)
X_2	—	—	-1.4363	(-4.85)***	-1.1312	(-4.26)***
X_3	—	—	0.0163	(1.87)*	0.0167	(2.14)**
Z_1	—	—	—	—	-1.42E-05	(-2.35)**
Z_2	—	—	—	—	1.0085	(9.27)***
Z_3	—	—	—	—	0.7732	(6.47)***
Constant term	0.1310	(15.49)***	0.1611	(11.79)***	0.0189	(0.63)
R^2	0.1411		0.2507		0.4092	
F_1 value	—		27.03		34.72	
Prob.	—		0.0000		0.0000	
F_2 value	—		3.79		3.88	
Prob.	—		0.0000		0.0000	
N	524		524		524	
Wald chi-square test	138.34		—		—	
Prob.	0.0000		—		—	
Hausman test Prob.	0.6904		0.0000		0.0147	
Panel model type	Random-effect model		Fixed-effect model		Fixed-effect model	

Note: The figures in brackets are the T values; *, **, * represent the results are significant at the10%, 5%, 1% level of confidence separately.**

pothesis, that there are no significant differences between the estimated value of the random effects and fixed effects estimates, can not be rejected. Therefore, we should use random-effects model. Compared with Model 4, Model 5 and Model 6, Model 7 has better coefficient of determination, higher goodness of fit, and more comprehensive variables, including the impact of deposit insurance system, bank individual characteristics and basic economic factors on moral hazard in bank liability management. So Model 7 was selected finally.

The Analysis of Estimated Results of Each Variable Coefficient

With the regression results of the Model 3 and the Model 7, the influence of each variable on the dependent variable is shown in TABLE 6.

First, the impact of deposit insurance system on bank moral hazard is negative. With others being held constant, the deposit insurance system generally reduced bank moral hazard.

Second, the impact of size of the bank is uncertain. The results show that the coefficient of bank size is not significant. What impact that the size of the bank will have on bank moral hazard requires further study.

Third, the overall impact of subordinated debt ratio on moral hazard is negative. With others being held constant, the higher the ratio of bank subordinated debt is, the lower the risk of moral hazard is.

Fourth, the overall impact of franchise value on moral hazard is positive. With others being held constant, the higher the bank franchise value is, the higher the risk of moral hazard is.

Fifth, the overall impact of per capita GDP on moral hazard is negative. With others being held constant, the higher the per capita gross domestic product (GDP) is, the bank lower the risk of moral hazard is.

Sixth, the overall impact of inflation rate on moral hazard is positive. With others being held constant, the higher the inflation rate is, the higher the risk of moral hazard is.

Seventh, the overall impact of the growth rate of M_2 bank on moral hazard is positive. With others being

TABLE 5 : Panel difference-in-differences regression analysis (dependent variable Y_2:self-owned capital ratio)

Variable	Model 4		Model 5		Model 6		Model 7	
	Co-efficient	T value	Co-efficient	T value	Co-efficient	T value	Co-efficient	Z value
DI	—	—	—	—	—	—	0.0352	(1.55)
T	0.0099	(0.53)	—	—	0.0122	(0.66)	-0.0051	(-0.23)
*DI*T*	0.0211	(1.00)	—	—	0.0154	(0.73)	0.0464	(2.16)**
X_1	—	—	0.9406	(2.12)**	0.8605	(1.94)*	-0.1918	(-1.03)
X_2	—	—	0.5572	(2.31)**	0.4347	(1.79)*	0.3452	(2.07)**
X_3	—	—	-0.0180	(-2.49)**	-0.0193	(-2.68)***	-0.0151	(-2.40)**
Z_1	—	—	—	—	—	—	1.68E-06	(0.33)
Z_2	—	—	—	—	—	—	-0.4052	(-4.32)***
Z_3	—	—	—	—	—	—	-0.3181	(-3.03)***
Constant term	0.0841	(12.30)***	0.0841	(7.37)***	0.0625	(5.56)***	0.1366	(4.13)***
R^2	0.0127		0.0001		0.0000		0.1235	
F_1 value	4.94		5.50		4.93		—	
Prob.	0.0076		0.0010		0.0002		—	
F_2 value	3.45		3.67		3.42		—	
Prob.	0.0000		0.0000		0.0000		—	
Wald chi-square test	—		—		—		57.58	
Prob.	—		—		—		0.0000	
N	524		524		524		524	
Hausman test Prob.	0.0004		0.0196		0.0001		0.1392	
Panel model type	Fixed-effect model		Fixed-effect model		Fixed-effect model		Random-effect model	

Note: The figures in brackets are the T values; *, **, * represent the results are significant at the10%, 5%, 1% level of confidence respectively.**

TABLE 6 : The influence of each variable on the dependent variable

	Deposit insurance system	The sizeof banks	Subordinateddebt ratio	Bank's franchisevalue	GDPper capita	Inflation rate	The growth rate of money supply (M_2)
	*DI*T*	X_1	X_2	X_3	Z_1	Z_2	Z_3
The impact on the non-performing loan rate	-	- (indistinctively)	-	+	-	+	+
The impact on self-ownedcapital ratio	+	- (indistinctively)	+	-	+(indistinctively)	-	-
The total impact on moral hazard	-	uncertain	-	+	-	+	+

held constant, the higher the growth rate of the money supply (M_2) is, the higher the risk of moral hazard is.

CONCLUSION

The empirical results show that the deposit insurance system can generally lower bank moral hazard. What's more, subordinated debt ratio, the bank's franchise value, the per capita gross domestic product (GDP), the intermediate targets of a country's monetary policy (such as the growth rate of the money supply (M_2)), and the ultimate goal (such as the inflation rate) impact the bank moral hazard in the deposit insurance system significantly. But the regression results show that the bank scale coefficient is not significant, so the overall impact of the size of the bank on the moral hazard in the deposit insurance system is uncertain.

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