

# Deposit Insurance System, Information Disclosure and Bank Risk-Taking: Empirical Evidence from Chinese Banking Industry

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## Abstract

We incorporate the deposit insurance system into the analysis framework of the impact of bank information disclosure on their risk-taking, and empirically test the impact and synergistic effect of deposit insurance system and bank information disclosure on their risk-taking using the data of 266 Chinese commercial banks from 2007 to 2019. We find that the improvement of bank information disclosure will reduce bank risk taking, and the implementation of deposit insurance system will help reduce bank risk taking. The implementation of deposit insurance system and the improvement of bank information disclosure can not only inhibit the bank's risk taking, but also play a synergistic role in reducing bank's risk taking. Several extensions for future research are also offered.

## Keywords

Deposit Insurance System, Bank Information Disclosure, Bank Risk Taking, Synergy Effect

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## 1. Introduction

The sound operation of the financial system is of great significance to the sustainable development of the economy. However, maintaining the steady operation of the financial system not only depends on the self-regulation of the market, but also needs the timely and effective intervention of the government. Among them, market constraint, as one of the three pillars of Basel II Capital Accord, has received great attention from the policy authorities and academia of

various countries. Information disclosure is an important means of market discipline, in the banking industry, investors and depositors will use bank information disclosure to measure their risks and make investment decisions. For China, the government has rescued many banks that are considered too big to fail, indicating that although China has failed to establish an explicit deposit insurance system for a long time, the implicit deposit insurance system still exists, thus affecting the sensitivity of market players to bank information and weakening the market restraint function of information disclosure. According to the research of some scholars [1] [2] and Fitch support the rating results that China implements an incomplete implicit deposit insurance system, that is, due to the different types and sizes of banks, the probability of obtaining government bailouts is also different. In 2013, the Third Plenary Session of the 18th CPC Central Committee clearly proposed to establish a deposit insurance system, and in 2015, The State Council issued the Regulations on Deposit Insurance to formally implement the deposit insurance system. However, the existing research has paid more attention to bank supervision than market constraints, and there are few theoretical studies, and even fewer literatures discussing the impact of bank information disclosure on the heterogeneity of different banks under the background of deposit insurance system. Therefore, this paper incorporates the deposit insurance system into the analysis framework of the relationship between bank information disclosure and bank risk-taking, studies the relationship between bank information disclosure and bank risk-taking under the deposit insurance system, and uses the data of China's banking industry to conduct an empirical test.

As the Basel Committee proposed the use of external credit rating agencies in bank capital regulation, supplemented by more market constraints and emphasizing the role of information disclosure in market constraints, more and more studies have found that information disclosure is conducive to improving credit market performance, and the more information disclosure, the stronger market discipline. For example, improved information disclosure helps investors to assess bank risks and promote banks to implement risk management [3]; strengthening information disclosure helps to reduce banks' risk-taking and gain more profits [4]; banks with high information disclosure quality will get favorable Moody's financial strength rating, and bank soundness is positively correlated with information disclosure [5]. The higher the degree of information sharing is, the lower the banks' risk-taking is [6]; the improvement of bank information disclosure by regulatory authorities can enhance the robustness of banks [7]. Moreover, some scholars have also discussed the impact of information disclosure on banks' risk-taking under the deposit insurance system. For example, the deposit insurance system will reduce the incentive of market subjects to supervise banks' risk-taking behaviors and weaken the market constraint effect of information disclosure [8]; the function of information disclosure in reducing banks' risk-taking depends on the institutional basis and market environment.

When the information disclosure is sufficient under the implicit deposit insurance system, banks tend to choose prudent risk-taking strategies and weaken the constraint effect of information disclosure on banks' risk-taking [9]. Improving bank information disclosure helps to reduce financing cost and deposit insurance contribution rate, alleviate the moral hazard of deposit insurance system, and has a synergistic effect of reducing banks' risk-taking [10]; increasing information disclosure will reduce the moral hazard of banks and the moral hazard of liability business caused by the deposit insurance system [11].

Information disclosure can affect bank risk-taking through a variety of ways, and the impact on bank risk-taking is heterogeneous in different environments. For example, Bertomeu & Magee [12] explored the impact of financial reporting regulation on macroeconomic cycle, and found that economic downturn would shift political power to interest groups with low financial transparency, and more non-reporting loans would increase risk-taking; Bourgain *et al.* [13] found that depositors can reallocate funds to safer developed economies to curb risk-taking, and a sufficiently high degree of financial openness helps to strengthen the positive impact of financial transparency on financial stability; Based on the spatial model of bank competition, Vauhkonen [7] found that strict information disclosure would improve financial conservatism, and improving the quality of information disclosure would help strengthen the positive effect of capital requirements on bank safety. Wilson *et al.* [14] found that the prudential supervision of New Zealand banks largely relied on risk information disclosure, and the information disclosure system did effectively inhibit banks' excessive risk-taking. Moreover, some scholars have also explored the impact of information disclosure on banks' risk-taking by taking China's banking industry as the research object. For example, Wu & Bowe [15] analyzed the comprehensive sample of China's banking industry and found that joint-venture banks that disclosed more information to the public maintained a higher capital adequacy ratio, while banks that released more transparent financial information tended to hold more capital to reduce risk taking. Wu & Bowe [15] studied the relationship between information disclosure and depositor behavior in Chinese banking industry and found that the deposits of banks with higher information transparency grew faster, and banks with higher information transparency, sufficient capital and adopting international accounting standards were more able to increase deposits by raising interest rates. Huang [16] studied the relationship between the stability of China's banking industry and information disclosure and found that information disclosure would encourage more market investors to implement effective market constraints on banks' risk-taking behaviors, timely adjust the cost of banks' risk positions, reduce banks' moral hazard, and thus improve banks' stability to a certain extent.

From the current academic research on China's deposit insurance system, experts and scholars at home and abroad have discussed the types of deposit insurance system. To sum up, it can be divided into three categories: first, al-

though China has not established an explicit deposit insurance system, many rescues to banks in the past have fully shown that China has implemented an implicit deposit insurance system [17] [18] [19]. Second, China implements a completely implicit deposit insurance system, that is, when the government rescues banks, it will not vary according to the types of banks and deposits [1] [2]. Third, China implements an incomplete implicit deposit insurance system, that is, whether the government rescues the banks actually depends on the status of the banks and the government's concern [20] [21] [22]. In view of this, this paper intends to supplement the existing research from three aspects. Although the existing literature also discusses the impact of deposit insurance system on the effectiveness of market constraints, it is mainly based on the comparative analysis of different types of deposit insurance systems. The second is to explore the internal relationship and mechanism between bank information disclosure and risk-taking. Most of the existing literature focuses on the impact of deposit insurance system or bank information disclosure on bank risk-taking, while this paper incorporates deposit insurance system into the analysis framework of the impact of bank information disclosure on bank risk-taking. The third is to explore the heterogeneous impact of bank information disclosure on different banks under the background of deposit insurance system. Most of the existing literature analyzes the effectiveness of market constraints from the perspective of shareholders, but explores the impact of bank information disclosure on different types and sizes of banks under the background of deposit insurance system. This paper attempts to reveal that deposit insurance system helps investors monitor banks' risk-taking behavior from the perspective of information disclosure, which has important policy implications.

## 2. Theoretical Analysis and Research Hypothesis

### 2.1. The Impact of Bank Information Disclosure on Bank Risk-Taking

Theoretically, information asymmetry will lead to moral hazard and adverse selection in the credit market, which will affect banks' risk-taking. For example, information asymmetry will lead to uneven credit rationing, resulting in conservative borrowers withdrawing from the credit market and capital flowing to risk-oriented investors [23]; Moral hazard and adverse selection will exacerbate the degree of information asymmetry. Information disclosure will improve information asymmetry, strengthen market constraints, increase banks' buffer capital, and reduce banks' risk-taking, and this effect is more obvious for banks that are not protected by the government [22]. With the innovation and development of new financial instruments, financial transactions and investment methods become more diversified, bank risk information is more hidden, and the problem of information asymmetry is prominent. However, some studies have argued that there are constraints on the role of information disclosure in reducing banks' risk-taking. For example, in information disclosure, capital al-

location will be adjusted due to the increase in implementation costs [24]. At present, the protection of commercial banks in China has weakened the restraint effect of information disclosure on banks' risk-taking. If the bank information disclosure is sufficient, the bank risk investment will become open and transparent, and market investors will demand high returns to compensate for the risk exposure, indicating that the more the bank information disclosure is, the stronger the market constraints will be, and the less the risk taking will be. Xu [21] pointed out that only when financial marketization is high and bank information disclosure is fully effective, market constraints from creditors can restrain banks' risk-taking. If market investors can make timely and correct decisions based on bank information disclosure, it will promote banks to improve corporate governance and enhance operational stability through non-systematic fluctuations that affect bank stock price, and play a role in reducing banks' risk-taking. Based on this, this paper puts forward research hypothesis 1:

**Hypothesis 1: Bank information disclosure is negatively correlated with bank risk-taking.**

## **2.2. The Effect of Deposit Insurance System on Bank Risk-Taking**

As an important institutional arrangement to protect the interests of depositors and a basic part of the financial safety net, deposit insurance system is an important defense line to prevent and defuse financial risks. Theoretically, the deposit insurance system can not only provide explicit institutional guarantee for banks, when the insured banks have liquidity crisis due to poor management, it can provide assistance or merger to the insured banks according to the insured amount, so as to avoid the run crisis and maximize the protection of the interests of depositors. It can also supervise and manage the banks and urge the rectification when the risks of the insured banks rise. Reduce bank risk-taking as much as possible to maintain the security and stability of the financial system [25] [26] [27]. According to the Core Principles of an Effective Deposit Insurance System jointly formulated by the Basel Committee on Banking Supervision and the International Association of Deposit Insurers, the deposit insurance system mainly prevents moral hazard by providing limited protection to depositors, adopting the risk differential rate mechanism, and timely and early intervention and disposal of problem banks, so as to reduce the risk-taking of the banking system. The implementation of the deposit insurance system will not only strengthen the market constraint mechanism, the deposit premium rate and rating results as well as the possible early corrective measures will convey the bank operation information to the market, but also improve the bank governance mechanism. Banks with high risks will correspondingly face high premiums and strict supervision, prompting banks to strengthen the supervision measures on loans, thus improving their governance level [21] [28] [29]. From the perspective of the effectiveness of the deposit insurance system, banks' risk-taking is closely related to their franchise value, capital ratio and bank size. As far as China is

concerned, there is no risk of bank bankruptcy under the implicit deposit insurance system. Its effectiveness depends on whether it can weaken the negative relationship among franchise value, capital ratio, bank size and bank risk-taking [16]. Moreover, with the improvement of China's marketization, more and more studies have proposed the transition from implicit deposit insurance system to explicit deposit insurance system. For example, Zhang and Zhao [30] pointed out that when the bank franchise value is low, the credibility of explicit deposit insurance system is high, and the proportion of insured deposits in total liabilities is high, the transformation from implicit deposit insurance to explicit deposit insurance helps to reduce banks' risk-taking. Based on this, this paper puts forward research hypothesis 2:

**Hypothesis 2: Banks tend to take lower risks under the deposit insurance system.**

### **2.3. Synergistic Effect of Deposit Insurance System and Bank Information Disclosure on Bank Risk-Taking**

Theoretically, the deposit insurance system will cause moral hazard, which will not only reduce the motivation of investors to pay attention to bank information disclosure, make banks have a greater tendency to take risks, and weaken the restraint effect of information disclosure on bank risk taking, but also cause stakeholders to lose the incentive to supervise banks and pay more attention to bank earnings rather than its operating stability and performance. In turn, it stimulates excessive investment by banks [8] [31]. Specifically, from the perspective of the deposit insurance system's monitoring of the depositor market, depositors monitor banks through the channels of fund price and fund availability. When they find that the bank's asset quality deteriorates, they will generally demand high interest rate or withdraw money in advance to offset the high risk. From the perspective of the deposit insurance system's monitoring of banks, banks usually need to respond to the monitoring results of the depositor market and take effective countermeasures. Therefore, the improvement of the implementation efficiency of deposit insurance system lies in reducing its risk-taking and giving better play to its financial stability effect. For example: Although the differential deposit insurance payment mechanism aims to adjust insurance underwriting to guide banks to diversify investment and reduce risk taking, the information asymmetry makes the deposit insurance fund management institutions unable to effectively screen the operation and management and risk status of banks, weakening the implementation effect of the risk differential rate. It can facilitate the payment of deposit insurance and reduce banks' risk-taking [19] [21]. Moreover, in the design of China's deposit insurance system, risk differential rate, deposit insurance rating and early corrective measures are all disclosing bank operation and management information to the market and strengthening the market restraint mechanism including information disclosure [11] [16]. Based on this, this paper puts forward research hypothesis 3:

**Hypothesis 3: The deposit insurance system will strengthen the constraint effect of bank information disclosure on bank risk-taking.**

## **2.4. Heterogeneity of the Synergistic Effect of Deposit Insurance System and Bank Information Disclosure on Bank Risk-Taking**

Previous studies have shown that the effectiveness of deposit insurance system is related to factors such as bank franchise value, capital ratio and bank size. Among them, the franchise value is the net present value of excess earnings obtained by the bank in the future continuous operation, that is, the opportunity cost of bank bankruptcy, which will be transferred and negatively correlated with the bank's risk-taking [32]; Capital ratio measures the extent to which banks bear losses with their own capital before depositors and creditors suffer losses. Banks with larger assets have more advantages in absorbing liabilities at low interest rates and have more diversified financing channels, which leads to lower risk taking [33]. Moreover, for China's big banks, there is a widespread understanding that banks are too big to fail or even that banks cannot fail, and senior managers do not have the motivation to take excessive risks, and are subject to stricter supervision and stronger risk management ability [16]. After the implementation of the deposit insurance system, if the banks with low franchise value continue to take excessive risks, they will face the potential cost caused by the increase of insurance premium and the implementation of early corrective measures by the regulatory authorities, which will encourage them to reduce the risk taking and maintain the risk taking at a reasonable level. Depositors and investors can obtain more bank information and demand higher interest rate return for banks with low capital as risk compensation, thus strengthening the market restraint mechanism and promoting banks to adopt low-risk business strategies to reduce the erosion of capital by risks. The market constraint mechanism will be significantly strengthened, prompting banks to choose the appropriate risk level by weighing costs and benefits, and guiding banks, especially large banks, to pay more attention to risk management. Moreover, from the perspective of China's implementation of the Regulations on Deposit Insurance, the deposit insurance system itself is an important measure to promote banks to improve information disclosure, strengthen the market restraint mechanism and improve the financial governance ability. Based on this, this paper puts forward hypothesis 4:

**Hypothesis 4: As the bank's franchise value, capital ratio and asset scale increase, the bank's risk-taking will decrease, and the synergistic constraint effect of deposit insurance system and bank information disclosure on its risk-taking will be weakened.**

## **3. Research Design**

### **3.1. Data**

We select China's micro bank data as the research sample. Information disclo-



sure data, bank financial data and Fitch public support rating data come from BankScope database, and other macro data come from Wind Information. In the sample selection, this paper only retains the samples of more than two consecutive years, and finally obtains the data of 266 Chinese banks from 2007 to 2019 to construct the panel model, including 6 large state-owned banks, 12 joint-stock commercial banks, 97 urban commercial banks, 132 rural commercial banks and 19 foreign banks.

### 3.2. Effects

#### 3.2.1. To Examine the Impact of Bank Information Disclosure and Deposit Insurance System on Bank Risk-Taking

According to the research of Acharya & Yorulmazer [34] and Zhu *et al.* [10], both deposit insurance system and bank information disclosure have an impact on banks' risk-taking. Taking bank information disclosure and deposit insurance system as explanatory variables, and introducing two control variables at the micro banking entity and macroeconomic and financial levels, the deposit insurance system is introduced into the analytical framework of the impact of bank information disclosure on its risk-taking, and the following model is constructed to investigate the impact of bank information disclosure and deposit insurance system on banks' risk-taking:

$$Risk_{it} = \alpha_0 + \alpha_1 Risk_{t-1} + \alpha_2 DIS_{it-1} + \alpha_3 INS_{it-1} + \alpha_4 BCV_{it} + \alpha_5 Cap_{it} + \alpha_6 Size_{it} + w_1 Control + \mu_i + \varepsilon_{it} \quad (1)$$

Where  $i$  represents a bank and  $t$  represents the year;  $Risk$  represents banks' risk-taking, and  $\alpha_1$  is expected to be significantly positive due to the continuity of bank risks.  $DIS$ ,  $INS$  respectively represent bank information disclosure index and deposit insurance system variables. According to hypothesis 1 and hypothesis 2,  $\alpha_2$ ,  $\alpha_3$  are expected to be significantly negative;  $BCV$ ,  $Cap$  and  $Size$  are the three core explanatory variables, respectively representing the bank's franchise value, capital ratio and asset size.  $\alpha_4$ ,  $\alpha_5$ ,  $\alpha_6$  are expected to be significantly negative.  $Control$  represents the other control variables, including bank loan-to-deposit ratio ( $LDR$ ) and deposit to asset ratio ( $DAR$ ) at the micro level and interbank offered rate ( $IIR$ ) and GDP growth rate ( $GDPGR$ ) at the macro level;  $\mu_i$  is the bank fixed effect,  $\varepsilon_{it}$  is the random disturbance term.

#### 3.2.2. Test the Synergistic Effect of Bank Information Disclosure and Deposit Insurance System on Bank Risk-Taking

The introduction of China's Deposit Insurance Regulations in 2015 marked the formal establishment of the explicit deposit insurance system. This paper introduces the cross term of bank information disclosure and deposit insurance system on the basis of Equation (1), establishes the following model to investigate the interaction effect of bank information disclosure and deposit insurance system on bank risk-taking, and explores whether there is a synergistic effect between bank information disclosure and deposit insurance system on bank risk-taking:



$$\begin{aligned}
Risk_{it} = & \alpha_0 + \alpha_1 Risk_{t-1} + \alpha_2 DIS_{it-1} + \alpha_3 INS_{it-1} + \alpha_4 BCV_{it} + \alpha_5 Cap_{it} \\
& + \alpha_6 Size_{it} + \alpha_7 DIS_{it-1} \times INS_{it-1} + w_1 Control + \mu_i + \varepsilon_{it}
\end{aligned} \tag{2}$$

Among them,  $DIS \times INS$  is the cross term of bank information disclosure and deposit insurance system, which describes the synergistic effect of bank information disclosure and deposit insurance system on bank risk-taking. If  $\alpha_7$  is significantly different from 0, it indicates that the relationship between bank information disclosure and risk-taking is affected by the deposit insurance system. Theoretically, the implementation of the deposit insurance system not only contains more disclosure information, but also encourages banks to improve their information disclosure, thus strengthening the market constraint effect of bank information disclosure on their risk-taking (the estimated coefficient of the negative risk indicator is significantly positive).

### 3.2.3. Test the Heterogeneity

According to the research of Osborne & Lee [35], Xiang and Zhang [16] and other scholars, the effectiveness of the deposit insurance system is closely related to factors such as bank franchise value, capital ratio and asset scale, and these factors are naturally important variables to test the heterogeneity of the synergistic effect between bank information disclosure and the deposit insurance system. Therefore, in order to test Hypothesis 4, we introduces the cross term of bank franchise value (capital ratio, asset scale) with bank information disclosure and deposit insurance system on the basis of Equation (2), and establishes the following model to explore whether the synergistic effect of bank information disclosure and deposit insurance system will be heterogeneous due to the impact of bank franchise value (capital ratio, asset scale).

$$\begin{aligned}
Risk_{it} = & \alpha_0 + \alpha_1 Risk_{t-1} + \alpha_2 DIS_{it-1} + \alpha_3 INS_{it-1} + \alpha_4 BCV_{it} + \alpha_5 Cap_{it} \\
& + \alpha_6 Size_{it} + \alpha_7 DIS_{it-1} \times INS_{it-1} + \alpha_8 BCV_{it} \times DIS_{it-1} \times INS_{it-1} \\
& + \alpha_9 CAP_{it} \times DIS_{it-1} \times INS_{it-1} + \alpha_{10} Size_{it} \times DIS_{it-1} \times INS_{it-1} \\
& + w_1 Control + \mu_i + \varepsilon_{it}
\end{aligned} \tag{3}$$

Among them,  $BCV(CAP, Size) \times DIS \times INS$  represents the cross term of bank franchise value (capital ratio, asset scale) and bank information disclosure and deposit insurance system, respectively, and describes the impact of bank franchise value (capital ratio, asset scale) on the synergistic effect of bank information disclosure and deposit insurance system. If  $\alpha_8$  ( $\alpha_9$ ,  $\alpha_{10}$ ) is significantly different from 0, it indicates that the synergistic effect of bank information disclosure and deposit insurance system on bank risk-taking is affected by the bank's franchise value (capital ratio, asset size). Theoretically, banks' risk-taking is negatively correlated with their franchise value (capital ratio, asset size). From the perspective of institutional design, the synergistic effect of bank information disclosure and deposit insurance system on bank risk-taking is positively correlated with bank risk-taking itself. Further, as the bank franchise value (capital ratio, asset scale) gradually increases, the bank's risk-taking will tend to decrease,

and the synergistic effect of bank information disclosure and deposit insurance system on bank's risk-taking will tend to weaken. Therefore, when  $\alpha_7$  is significantly negative as expected above, it is expected that  $\alpha_8$  ( $\alpha_9$ ,  $\alpha_{10}$ ) is significantly positive here (where the estimated coefficient of the cross term of negative risk indicators is significantly negative).

### 3.3. Variable Definition and Description

#### 3.3.1. Bank Risk-Taking (*Risk*)

We adopt the methods of Xu and He [36] and Delis and Kouretas [37] to select three indicators of bank risk-taking: the first is the non-performing loan ratio (*NPL*), that is, the ratio of non-performing loans to total loans, which measures the credit risk of a bank's asset portfolio. Since a certain proportion of non-performing loans will lead to bank losses, an increase in the non-performing loan ratio will increase banks' risk-taking. The second is the loan-to-loan ratio (*LLPR*), that is, the ratio of loan provisions to total loans. The higher the loan-to-loan ratio is, the stronger the bank's ability to resist risks is. The third is Z value ( $\ln Z$ ), which measures the bank bankruptcy risk. It is defined as:  $z_{i,t} = (ra_{i,t} + ek_{i,t}) / \sigma(ra_{i,t})$ . Where  $ra_{i,t}$  is the return on average assets,  $ek_{i,t}$  is the ratio of shareholders' equity to total assets, and  $\sigma(ra_{i,t})$  is the three-year rolling standard deviation of  $ra_{i,t}$  based on periods  $t$ ,  $t-1$ ,  $t-2$ . A higher value of Z means that the bank is further away from the exhaustion of equity capital, the bank stability is also higher, and the bank risk taking is lower. Since the distribution of Z value is biased, this paper refers to the method of Laeven & Levine [38] to take the natural logarithm of Z value, which is expressed as  $\ln Z$ .

#### 3.3.2. Information Disclosure Index (*DIS*)

With reference to the practice of Xu [21] and Wan Ibrahim *et al.* [39], we select 20 project disclosures in BankScope for measurement, including: Balance sheet (non-profitable assets, off-balance sheet items, interbank lending ratio, net loans/savings and borrowings, current assets/savings and short-term funds, equity/net loans, equity/liabilities), income statement (net income, net interest margin, ROA, ROE, cost-to-income ratio), credit risk profile (allowance for loan losses, impairment/non-performing assets, non-performing loan ratio, provision coverage ratio) and capital adequacy (total capital, core capital, capital adequacy ratio, core capital ratio).  $S_i$  represents the score of each information disclosure, which is 1 if it is disclosed, and 0 otherwise. Since the weight determination is subjective to some extent, this paper adopts the simple average method to calculate the information disclosure index, which is defined as  $DIS = \sum_{i=1}^{20} S_i / 20$  and the value is between 0 and 20. Considering that the main financial information of banks is disclosed in the annual report, and the annual report is usually published in the following year, the information disclosure index lagged by one period is used as the explanatory variable to study the impact of bank information disclosure on their risk-taking.

### 3.3.3. Deposit Insurance System (*INS*)

Referring to the practice of scholars such as Barth *et al.* and Le [40] [41], we takes the year of the establishment of the deposit insurance system as the cut-off point of the deposit insurance variable 0 and 1, that is, the deposit insurance system will be implemented after 2015, and the value is 1; otherwise, it is 0.

### 3.3.4. Core Explanatory Variable

The first is the franchise value (*BCV*). We refer to the method of Li Yan [42] to measure the franchise value, which is defined as  $BCV = (ROE' - r_f) / (1 + \delta)$ , where  $ROE'$  is the pre-tax return on capital, namely the ratio of pre-tax profit to total capital;  $r_f$  is the risk-free rate of return and  $\delta$  is the discount rate. We used the weighted average interbank lending rate (7 days) as the risk-free rate and the rate of return on interest-bearing assets as the discount rate. The second is the capital ratio (*Cap*), which is the ratio of equity capital to total assets. Third, the size of banks (*Size*) is the natural logarithm of total bank assets.

### 3.3.5. Other Control Variables

We refer to the practice of scholars such as Le and Wang *et al.* to select control variables to avoid the problem of missing variables [9] [41]. Including: loan-to-deposit ratio (*LDR*); Deposits to assets ratio (*DAR*); Interbank offered rate (*IIR*); GDP growth rate (*GDPR*), in which the national GDP growth rate is used for state-owned commercial banks and joint-stock commercial banks, and the regional GDP growth rate is used for urban commercial banks, rural commercial banks and foreign banks. (See **Table 1**)

## 3.4. Descriptive Statistics of the Variables

**Table 2** presents the descriptive statistics of the variables. In terms of banks' risk-taking, the mean and median of non-performing loan ratio, loan-to-loan ratio and Z-value are basically the same, and all of them are greater than their respective standard deviations, showing relatively stable fluctuations in general. The mean and median of the bank disclosure index are basically equivalent and substantially higher than the standard deviation, indicating that the fluctuation of the information disclosure index within the observation window is highly stable. The median of the deposit insurance system is greater than the mean, and all of them are greater than the standard deviation, indicating that the deposit insurance system variables of most banks are below the median, and the fluctuation is relatively stable. For the core explanatory variables, the mean value of bank franchise value is greater than the median, and the standard deviation is between the mean and the median; The mean and median of bank capital ratios are comparable and substantially higher than the standard deviation; The average value of the bank's asset size is slightly larger than the median, and both of them are significantly larger than the standard deviation. For the control va-

riables, no matter the deposit and loan ratio and deposit to asset ratio at the micro level, or the inter-bank lending ratio and GDP growth rate at the macro level, their mean and median are basically the same, and all are significantly higher than their respective standard deviations, indicating that the fluctuation of these control variables is relatively stable.

**Table 1.** Variable definition and calculation description.

Variable	Proxy variable	Symbol	Calculation method
Bank risk-taking	Non-performing loan ratio	NPL	non-performing loans to total loans ratio (%)
	Loan allocation ratio	LLPR	Ratio of loan provisions to total loans (%)
	Z value	lnZ	$z_{i,t} = (ra_{i,t} + ek_{i,t}) / \sigma(ra_{i,t})$ . $ra_{i,t}$ is the average return on assets, $ek_{i,t}$ is the ratio of shareholders' equity to total assets, and $\sigma(ra_{i,t})$ is the three-year rolling standard deviation of $ra_{i,t}$ based on periods $t$ , $t-1$ and $t-2$ .
Information disclosure	Information disclosure index	DIS	The disclosure situation of 20 items in BankScope is selected for measurement and defined as: $DIS = \sum S_i / 20$ , where $S_i$ represents the score of various information disclosure. If it is disclosed, it is denoted as 1; otherwise, it is denoted as 0.
Deposit insurance system	dummy variable	INS	Implementation of the deposit insurance system after 2015 takes the value of 1 and 0 otherwise.
Core explanatory variable	Value of franchise	BCV	$BCV = (ROE' - r_f) / (1 + \delta)$ , where $ROE'$ is the pre-tax return on capital; $r_f$ is the risk-free rate of return and $\delta$ is the discount rate.
	Capital adequacy ratio	Cap	Equity capital to total assets ratio (%)
	Size of assets	Size	Natural logarithm of the Bank's total assets (RMB100 million)
Variable of control	Loan-to-deposit ratio	LDR	loan-to-deposit ratio (%)
	Deposits to assets ratio	DAR	deposits to assets ratio (%)
	Interbank offered rate	IIR	Weighted average interbank lending rate (7 days) (%)
	GDP growth rate	GDPR	The national GDP growth rate is used for state-owned commercial banks and joint-stock commercial banks, while the regional GDP growth rate (%) is used for urban commercial banks, rural commercial banks and foreign banks.

**Table 2.** Descriptive statistics of the variables.

	mean	median	minimum	standard deviation	number of observations
NPL	1.53	1.45	0.15	0.94	1719
lnZ	1.72	1.98	-1.97	1.60	1719
LLPR	3.34	3.16	0.24	1.37	1719
RADR	0.86	0.74	-0.34	0.57	1719
LPLR	3.35	3.18	0.72	1.37	1719
DIS	15.58	15.00	0.00	2.29	1719
INS	0.56	1.00	0.00	0.50	1719
BCV	7.57	6.26	-4.72	6.81	1719
Cap	0.64	0.67	0.12	0.21	1719
Size	3.13	2.96	1.44	0.76	1719
LDR	0.66	0.67	0.33	0.11	1719
DAR	0.72	0.73	0.21	0.12	1719
IIR	3.21	3.26	1.28	0.64	1719
GDPR	8.41	7.90	3.10	2.38	1719

## 4. Empirical Results and Analysis

### 4.1. The Impact of Deposit Insurance System and Bank Information Disclosure on Bank Risk-Taking

**Table 3** shows the estimated results of the impact of deposit insurance system and bank information disclosure on bank risk-taking. The impact of the lagged term of bank risk-taking is significantly positive within the 99% confidence interval, and the estimated coefficients are all less than 1, indicating that bank risk-taking is continuous and will eventually return to equilibrium with the continuous bank risk. The impact of banks' information disclosure on their non-performing loan ratio and loan-to-loan ratio is significantly negative within the 99% confidence interval, and the impact on their Z-value is significantly positive within the 99% confidence interval, indicating that the improvement of banks' information disclosure will reduce banks' risk-taking. The impact of the deposit insurance system on banks' non-performing loan ratio and loan-to-loan ratio is significantly negative within the 99% confidence interval, and the impact on banks' Z value is positive but not significant, which indicates that the implementation of the deposit insurance system helps to reduce banks' risk-taking. From the perspective of core explanatory variables, the impacts of bank franchise value, capital ratio and asset scale on non-performing loan ratio are signif-

icantly negative at least within 90% confidence interval, significantly negative at least within 95% confidence interval, and significantly positive at least within 99% confidence interval on Z-value. This shows that banks with lower franchise value, lower capital ratio and smaller asset scale take higher risks. In terms of other control variables, loan-deposit ratio, deposit-asset ratio, interbank lending rate and GDP growth rate will also affect banks' risk-taking. Hypotheses 1 and 2 are verified.

**Table 3.** Estimation results of the impact of deposit insurance system and bank information disclosure on bank risk-taking.

	RISK substitute variable: NPL	RISK substitute variable: LLPR	RISK substitute variable: lnZ
RISK(-1)	0.109*** (6.57)	0.136*** (8.48)	0.449*** (28.44)
DIS(-1)	-0.015*** (-4.61)	-0.012*** (-2.62)	0.033*** (6.85)
INS(-1)	-0.512*** (-10.59)	-1.149*** (-17.75)	0.060 (0.918)
BCV	-0.020*** (-7.87)	-0.007** (-2.02)	0.043*** (12.18)
Cap	-0.125* (-1.49)	-0.475*** (-4.29)	0.931*** (7.99)
Size	-0.125*** (-5.20)	-0.296*** (-9.17)	0.587*** (17.64)
LDR	1.427*** (10.14)	1.943*** (10.48)	0.318* (1.63)
DAR	2.041*** (19.59)	3.517*** (25.50)	0.775*** (5.37)
IIR	-0.158*** (-6.75)	0.255*** (8.20)	0.096*** (2.97)
GDPR	0.037*** (4.29)	-0.002 (-0.15)	0.066*** (5.62)
Constant term	-0.256* (-1.60)	-0.987*** (-4.69)	-3.003*** (-13.44)
Durbin-Watson	1.992	2.051	2.133
Adjusted R <sup>2</sup>	0.317	0.559	0.519
Total number of panel observations	3192	3192	3192

Note: t value is in parentheses; \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively.

## 4.2. Synergistic Effect of Deposit Insurance System and Bank Information Disclosure on Bank Risk-Taking

**Table 4** presents the estimated results of the synergy effect of the deposit insurance system and bank information disclosure on bank risk-taking. It can be seen that the above estimated results and significance are robust, and the estimated results of the cross term between deposit insurance system and bank information disclosure are also consistent with theoretical expectations. Among them,

**Table 4.** Estimation results of the synergy effect of deposit insurance system and bank information disclosure on bank risk-taking.

	RISK substitute variable: NPL	RISK substitute variable: LLPR	RISK substitute variable: lnZ
RISK(-1)	0.110*** (6.58)	0.136*** (8.50)	0.431*** (27.49)
DIS(-1)	-0.015*** (-4.59)	-0.012*** (-2.67)	0.042*** (8.55)
INS(-1)	-0.423*** (-2.65)	-1.036*** (-4.91)	1.924*** (8.83)
BCV	-0.020*** (-7.86)	-0.007** (-2.02)	0.044*** (12.52)
Cap	-0.126*** (-1.49)	-0.476*** (-4.30)	0.919*** (8.00)
Size	-0.126*** (-5.22)	-0.296*** (-9.18)	0.582*** (17.72)
DIS(-1)*INS(-1)	-0.009*** (-2.77)	-0.076** (-1.98)	0.141*** (9.54)
LDR	1.430*** (10.15)	1.946*** (10.49)	0.363** (1.88)
DAR	2.043*** (19.59)	3.521*** (25.50)	0.840*** (5.90)
IIR	-0.157*** (-6.706)	0.256*** (8.22)	0.114*** (3.57)
GDPR	0.036*** (4.23)	-0.002 (-0.19)	0.058*** (4.95)
Constant term	-0.250* (-1.56)	-0.980*** (-4.643)	-2.909*** (-12.18)
Durbin-Watson	1.993	2.053	2.148
Adjusted R <sup>2</sup>	0.317	0.559	0.533
Total number of panel observations	3192	3192	3192

Note: t value is in parentheses; \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively.



the respective impacts of deposit insurance system and bank information disclosure on risk indicators are significant within the 99% confidence interval, and the impacts of their cross terms on risk indicators are also significant within the 99% confidence interval, indicating that the implementation of deposit insurance system and the improvement of bank information disclosure can not only inhibit banks' risk-taking alone. Moreover, the implementation of the deposit insurance system includes more information disclosure requirements, which will encourage banks to improve their information disclosure status, thus strengthening the market constraint effect of bank information disclosure and playing a synergistic role in reducing banks' risk-taking. From the perspective of core explanatory variables, the influence of bank's franchise value, capital ratio and asset scale on its non-performing loan ratio is significantly negative within the 99% confidence interval, the influence on its loan-to-loan ratio is significantly negative at least within the 95% confidence interval, and the influence on its Z-value is significantly positive within the 99% confidence interval. It indicates that the lower the bank's franchise value, the lower the capital ratio and the smaller the asset size, the higher the risk it takes. Compared with the above estimation results, the model fitting effect is better after the introduction of the cross term between the deposit insurance system and the bank information disclosure, indicating that the synergy effect between the deposit insurance system and the bank information disclosure is an important factor affecting the bank's risk-taking. Hypothesis 3 is verified.

#### 4.3. Heterogeneity of the Synergistic Effect of Deposit Insurance System and Bank Information Disclosure on Bank Risk-Taking

**Table 5** shows the estimated results of the heterogeneity of the synergistic effect of deposit insurance system and bank information disclosure on bank risk-taking. When the estimated results of other variables are consistent with the theoretical expectations, the estimated results of the synergistic effect between deposit insurance system and bank information disclosure continue to be robust. Further estimation shows that the synergistic effect of deposit insurance system and bank information disclosure on bank risk-taking through bank capital ratio and asset scale is significant for all risk measures, while the synergistic effect of deposit insurance system and bank information disclosure on bank risk-taking through franchise value is only significant for non-performing loan ratio and Z value. The impact of the cross term between deposit insurance system and bank franchise value and information disclosure on non-performing loan ratio is significantly positive within the 99% confidence interval, the impact on loan-to-loan ratio is positive but not significant, and the impact on Z-value is significantly negative within the 99% confidence interval. The impact of the cross term between deposit insurance system and bank capital ratio and information disclosure on non-performing loan ratio and loan-to-loan ratio of banks is significantly positive at least within 90% confidence interval, and the impact on

**Table 5.** Estimation results of the heterogeneity of the synergistic effect of deposit insurance system and bank information disclosure on bank risk-taking.

	RISK substitute variable: NPL	RISK substitute variable: LLPR	RISK substitute variable: lnZ
RISK(-1)	0.108*** (6.52)	0.134*** (8.35)	0.427*** (27.35)
DIS(-1)	-0.017*** (-5.01)	-0.014*** (-3.05)	0.043*** (8.86)
INS(-1)	-0.379*** (-2.38)	-0.968*** (-4.58)	2.003*** (9.23)
BCV	-0.014*** (-4.73)	-0.005* (-1.33)	0.036*** (9.21)
Cap	-0.263*** (-2.41)	-0.631*** (-4.38)	1.518*** (10.20)
Size	-0.083*** (-2.63)	-0.189*** (-4.53)	0.649*** (15.21)
DIS(-1)*INS(-1)	-0.041*** (-2.48)	-0.044** (-2.03)	0.229*** (10.19)
BCV*DIS(-1)*INS(-1)	0.002*** (5.23)	0.001 (0.70)	-0.002*** (-2.82)
CAP*DIS(-1)*INS(-1)	0.022** (1.91)	0.025* (1.63)	-0.098*** (-6.30)
Size*DIS(-1)*INS(-1)	0.011*** (3.17)	0.017*** (3.77)	-0.011*** (-2.42)
LDR	1.382*** (9.82)	1.979*** (10.65)	0.427** (2.23)
DAR	1.946*** (17.93)	3.399*** (23.63)	0.661*** (4.48)
IIR	0.152*** (6.47)	0.260*** (8.32)	0.096*** (3.00)
GDPR	0.036*** (4.21)	0.001 (0.01)	0.667*** (5.72)
Constant term	-0.240 (-1.467)	-1.104*** (-5.10)	-3.260*** (-14.48)
Durbin-Watson	1.989	2.059	2.158
Adjusted R <sup>2</sup>	0.324	0.561	0.540
Total number of panel observations	3192	3192	3192

Note: t value is in parentheses; \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively.

**Table 6.** Estimation results using the system GMM estimation method to deal with the endogeneity problem.

	RISK substitute variable: NPL	RISK substitute variable: LLPR	RISK substitute variable: lnZ
RISK(-1)	0.117*** (4.18)	0.146*** (3.26)	0.087*** (4.43)
DIS(-1)	-0.043*** (-6.64)	-0.025*** (-2.44)	0.016*** (3.08)
INS(-1)	-0.817* (-1.46)	-2.642*** (-5.58)	1.913*** (4.90)
BCV	-0.005* (-0.45)	-0.009* (-1.54)	0.033*** (8.63)
Cap	-0.292** (-1.89)	-0.648*** (-2.91)	1.290*** (7.29)
Size	-0.232*** (-2.94)	-0.140* (-1.51)	0.690*** (12.03)
DIS(-1)*INS(-1)	-0.084*** (-2.65)	-0.050* (-1.62)	0.108*** (4.33)
BCV*DIS(-1)*INS(-1)	0.004*** (5.35)	0.009* (1.21)	-0.002*** (-2.48)
CAP*DIS(-1)*INS(-1)	0.135* (1.32)	0.087*** (5.54)	-0.082*** (-4.96)
Size*DIS(-1)*INS(-1)	0.031*** (4.20)	0.040* (1.28)	-0.010* (-1.88)
LDR	0.615* (1.80)	2.187*** (4.67)	0.479*** (2.59)
DAR	1.947*** (4.37)	2.920*** (7.12)	0.488*** (3.30)
IIR	1.653 (1.09)	2.385 (0.97)	-0.013 (-0.03)
GDPR	0.042* (1.58)	0.097*** (2.91)	0.046*** (3.99)
Sargan statistic (p-value)	0.475	0.802	0.329
AR (1) (P value)	0.000	0.000	0.000
AR (2) (P value)	0.547	0.594	0.997
Total number of panel observations	2660	2660	2660

Note: t value is in parentheses; \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively.

**Table 7.** Estimation results of the risk-taking indicators for changing banks.

	RISK substitute variable: RADR	RISK substitute variable: LLPR
RISK(-1)	0.143*** (5.76)	0.334*** (7.71)
DIS(-1)	-0.026* (-1.50)	-0.231*** (-6.18)
INS(-1)	-1.151* (-1.35)	-2.642*** (5.58)
BCV	-0.006*** (-2.45)	-0.010*** (-2.38)
Cap	-0.166* (-1.62)	-0.686*** (-4.31)
Size	-0.001 (-0.03)	-2.032*** (-2.79)
DIS(-1)*INS(-1)	-0.027* (-1.17)	-0.022* (-0.87)
BCV*DIS(-1)*INS(-1)	0.001* (0.35)	0.012* (1.79)
CAP*DIS(-1)*INS(-1)	0.026*** (3.35)	0.022* (1.30)
Size*DIS(-1)*INS(-1)	0.001* (0.22)	0.002*** (2.61)
LDR	0.513*** (4.56)	1.963*** (8.91)
DAR	0.877*** (7.05)	2.700*** (14.96)
IIR	0.422*** (3.07)	0.001 (0.001)
GDPR	0.060*** (6.57)	0.086*** (5.54)
Sargan statistic (p-value)	0.473	0.877
AR (1) (P value)	0.000	0.000
AR (2) (P value)	0.153	0.495
Total number of panel observations	860	2926

Note: t value is in parentheses; \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively.

Z-value is significantly negative at 99% confidence interval; The impact of the cross term between deposit insurance system and banks' asset size and information disclosure on banks' non-performing loan ratio and loan-to-loan ratio is significantly positive within the 99% confidence interval, and the impact on Z-value is significantly negative within the 99% confidence interval. In summary, the higher the bank's franchise value, the higher the capital ratio, the larger the asset size, the lower the corresponding risk taking, and the weaker the synergy effect of deposit insurance system and bank information disclosure on its risk taking. Hypothesis 4 is verified.

#### 4.4. Robustness Test

We focus on the robustness test from two aspects. First, considering the possible reverse causality between the deposit insurance system and banks' risk-taking, the dynamic panel system generalized method of moments (GMM) is used to solve the OLS estimation errors caused by the endogeneity of the deposit insurance system. System GMM integrates horizontal GMM and difference GMM into the same system, which is helpful to improve the estimation efficiency [43]. However, on the premise that the first-order difference of disturbance terms has first-order autocorrelation but no autocorrelation above second-order. Therefore, with the help of AR (1) and AR (2) statistics, the autocorrelation test of the difference term of the system GMM disturbance term is carried out. The Sargan statistic is used to test the exogeneity of instrumental variables, and the test P values are all greater than 10%, indicating that the test cannot reject the null hypothesis that instrumental variables are in line with exogeneity. Second, considering that both non-performing loan ratio and loan-to-loan ratio indicators are aimed at loans, it may not be scientific to evaluate only from the perspective of loan impairment provisions, and Z value tends to measure the overall risk of banks, which is different from the deposit insurance system and bank credit quality, which mainly measure bank credit risk. Therefore, the weighted risk asset impairment reserve ratio (RADR) and the loan impairment reserve to total loan ratio (LPLR) are used for robustness test. Among them, the weighted risk asset impairment reserve rate is the ratio of asset impairment reserve to weighted risk asset. **Table 6** and **Table 7** successively provide the corresponding robustness test results, which show that the basic conclusions remain robust.

### 5. Conclusions

We incorporate the deposit insurance system into the analysis framework of the impact of bank information disclosure on their risk-taking, and empirically test the impact and synergistic effect of deposit insurance system and bank information disclosure on their risk-taking using the data of 266 Chinese commercial banks from 2007 to 2019. The results show that: first, the improvement of bank information disclosure will reduce bank risk-taking, and the implementation of deposit insurance system will help to reduce bank risk-taking, which further

enriches the research results of bank risk-taking. The existing literature either focuses on the impact of the deposit insurance system on banks' risk-taking, or focuses on the restraint effect of bank information disclosure on their risk-taking. The research conclusions obtained are more systematic and comprehensive. Secondly, the implementation of the deposit insurance system and the improvement of bank information disclosure can not only inhibit banks' risk-taking, but also encourage banks to improve their information disclosure status, which can strengthen the market constraint effect of bank information disclosure and play a synergistic role in reducing banks' risk-taking. Compared with the existing literature, this paper mainly considers the impact of bank's franchise value, capital ratio, asset size and other key variables on bank's risk-taking when constructing the empirical model. Third, the higher the bank's franchise value, the higher the capital ratio, the larger the asset size, the lower the corresponding risk taking, and the weaker the synergy effect of deposit insurance system and bank information disclosure on its risk taking. Although the existing literature discusses the impact of deposit insurance system or bank information disclosure on bank risk-taking, it does not combine the two to analyze their synergistic effect on bank risk-taking. We find that deposit insurance system and bank information disclosure can act synergistically on bank risk-taking, especially for banks with lower franchise value, lower capital ratio and smaller asset size.

The conclusions of this paper have important implications for maintaining the stability of the banking system. First, we will give full play to the financial stability effect of the deposit insurance system. We should not only improve early correction and risk disposal measures, strengthen monitoring and management of the risks of insured banks, dynamically adjust differential rates in light of the risks of insured banks, and appropriately adjust insurance limits in light of the implementation of policies, but also strengthen the construction of the banking regulatory environment system, and introduce targeted comprehensive and strict supervision measures in the access and operation of banks. It is also necessary to strengthen the independence and supervisory functions of deposit insurance institutions, explore co-insurance and bank-funded deposit insurance funds, implement the "constructive ambiguity" rescue policy, maintain some uncertainty about whether, when and how to rescue troubled banks, and build a modern financial safety net to maintain the stability of the banking system.

The second is to maximize the synergistic effect of the deposit insurance system and market constraints. Institutional measures such as reasonable insurance duration and coverage, stratified risk pricing and insurance rate setting, and risk disposal according to rules should be implemented to achieve a desirable balance of interests and responsibilities among regulators, deposit insurance institutions, banks and stakeholders, and improve the transparency of government rescue policies. To achieve the multiple goals of reducing the expectation of banking institutions getting bailouts, improving the flexibility of policy operation and maintaining the credibility of government decision-making, it is also necessary

to improve the public awareness of the deposit insurance system, accurately convey the basic information of the policy objectives, coverage and operation mode of the deposit insurance system, and conduct independent assessment of the public awareness. Realize the integration of deposit insurance system and bank information disclosure. Third, differentiated design considers heterogeneous deposit insurance system measures and bank information disclosure requirements. It is necessary not only to consider the dynamic adjustment of the deposit insurance system and bank information disclosure requirements by financial regulation and bank governance under different economic and policy cycles, but also to track and evaluate the implementation and effect of the deposit insurance system, and implement differentiated supervision according to the characteristics of banks such as franchise value, capital ratio and asset scale. It is also necessary to effectively manage market subjects' expectations about government guarantee and the public, and reduce the adverse impact of the strengthening of government guarantee expectation and the weakening of information disclosure on banks' risk-taking.

### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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